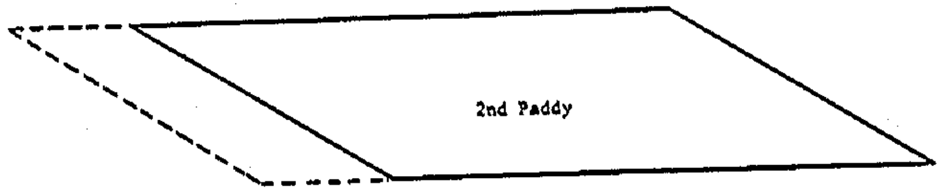
Table 4.1.20 (9) Calculation Sheet of Water Requirement for Paddy

	1978 Nov. 1st	Nov. 2nd	Nov. 3rd	Dec. 1st	Dec. 2nd	Dec. 3rd	1979 Jan. 1st	Jan. 2nd	Jan. 3rd	Feb. 1st	Feb. 2nd	Feb. 3rd	Mar. 1st	Mar. 2nd	Mar. 3rd

Cropping Pattern



Calculation

	Nov. 1st	Nov. 2nd	Nov. 3rd	Dec. 1st	Dec. 2nd	Dec. 3rd	Jan. 1st	Jan. 2nd	Jan. 3rd	Feb. 1st	Feb. 2nd	Feb. 3rd	Mar. 1st	Mar. 2nd	Mar. 3rd
A. Cropping intensity (Ic)															
Early cropping			$\frac{1}{8}$	$\frac{23}{72}$	$\frac{1}{3}$	$\frac{1}{3}$	$\frac{1}{3}$	$\frac{1}{3}$	$\frac{1}{3}$	$\frac{1}{3}$	$\frac{29}{96}$	$\frac{25}{288}$			
Middle "				$\frac{1}{18}$	$\frac{5}{18}$	$\frac{1}{3}$	$\frac{1}{3}$	$\frac{1}{3}$	$\frac{1}{3}$	$\frac{1}{3}$	$\frac{1}{3}$	$\frac{95}{288}$	$\frac{1}{6}$	$\frac{1}{288}$	
Late "					$\frac{1}{72}$	$\frac{5}{24}$	$\frac{1}{3}$	$\frac{1}{3}$	$\frac{1}{3}$	$\frac{1}{3}$	$\frac{1}{3}$	$\frac{1}{3}$	$\frac{1}{3}$	$\frac{71}{288}$	$\frac{1}{32}$
Total			$\frac{1}{8}$	$\frac{3}{8}$	$\frac{5}{8}$	$\frac{7}{8}$	1	1	1	1	$\frac{31}{32}$	$\frac{3}{4}$	$\frac{1}{2}$	$\frac{1}{4}$	$\frac{1}{32}$
B. Crop coefficient (Kc)															
Early cropping			0.80	0.84	0.98	1.14	1.28	1.36	1.32	1.16	0.95	0.70			
Middle "				0.80	0.83	0.94	1.09	1.23	1.34	1.33	1.23	1.08	0.70	0.70	
Late "					0.80	0.82	0.88	1.04	1.20	1.32	1.35	1.26	1.18	0.84	0.70
• Weighting average			0.80	0.83	0.91	0.99	1.08	1.21	1.29	1.27	1.18	1.12	1.02	0.84	0.70
C. Potential evapotranspiration (ETo)			43	43	41	41	45	39	39	43	39	39	31	39	39
D. Consumptive use of water (Cu)			34	36	37	40	49	47	50	55	46	44	32	33	27
E. Percolation loss (Pc)			20	20	20	20	22	20	20	22	20	20	16	20	20
F. Effective rainfall (Re)			42	61	27	38	91	31	27	3	22	51	29	32	25
G. Water req. for paddy field (Wp)			2	0	19	20	0	36	43	74	43	9	9	5	1
H. Water req. for nursery (Wn)	0	3	3	2	3	0									
I. Water req. for puddling (Wd)			20	15	23	21									
J. Farm water req. (Fw) (mm/N days)	0	3	25	17	45	41	0	36	43	74	43	9	9	5	1
K. Diversion water req. (Dw) (mm/N days)	0	5	39	27	70	64		57	67	115	67	15	15	8	1
L. Unit diversion req. (Qd) (l/s/ha)	0	0.054	0.452	0.307	0.814	0.736	0	0.654	0.781	1.210	0.774	0.170	0.210	0.094	0.013

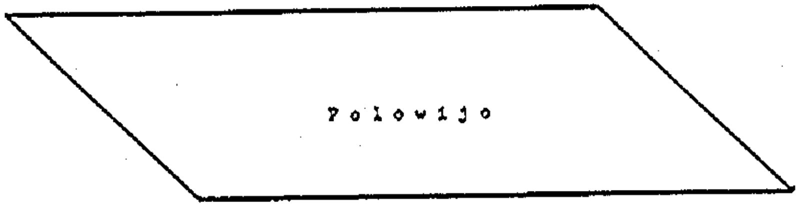
Table 4.1.21 (1) Calculation Sheet of Water Requirement for Polowijo

	1975														
	Jul.			Aug.			Sep.			Oct.			Nov.		
	1st	2nd	3rd	1st	2nd	3rd	1st	2nd	3rd	1st	2nd	3rd	1st	2nd	3rd
Cropping Pattern															

Calculation	Jul. 1st	Jul. 2nd	Jul. 3rd	Aug. 1st	Aug. 2nd	Aug. 3rd	Sep. 1st	Sep. 2nd	Sep. 3rd	Oct. 1st	Oct. 2nd	Oct. 3rd	Nov. 1st	Nov. 2nd	Nov. 3rd
A. Cropping intensity (Ic)															
Early cropping		1/6	1/3	1/3	1/3	1/3	1/3	1/3	1/3	1/3	1/6				
Middle "			1/6	1/3	1/3	1/3	1/3	1/3	1/3	1/3	1/3	1/6			
Late "				1/6	1/3	1/3	1/3	1/3	1/3	1/3	1/3	1/3	1/6		
Total		1/6	1/2	5/6	1	1	1	1	1	1	5/6	1/2	1/6		
B. Crop coefficient (Kc)															
Early cropping		0.31	0.41	0.54	0.67	0.75	0.76	0.72	0.65	0.55	0.40				
Middle "			0.31	0.41	0.54	0.67	0.75	0.76	0.72	0.65	0.55	0.40			
Late "				0.31	0.41	0.54	0.67	0.75	0.76	0.72	0.65	0.55	0.40		
Weighting average		0.31	0.38	0.44	0.54	0.65	0.73	0.74	0.71	0.64	0.56	0.50	0.40		
C. Potential evapotranspiration (ETo)		37	41	44	44	48	46	46	46	50	50	55	43		
D. Consumptive use of water (Cu)		11	15	19	24	31	33	34	33	32	28	28	17		
E. Effective rainfall (Re)		9	15	9	19	21	33	24	21	20	24	23	17		
F. Farm water req. (Fw) (mm/N days)		0.33	0	8	5	10	0	10	12	12	3	3	0		
G. Diversion water req. (Dw) (mm/N days)		0.55	0	13	8	17	0	17	20	20	5	5	0		
H. Unit diversion req. (Qe) (l/s/ha)		0.006	0	0.154	0.096	0.175	0	0.192	0.231	0.231	0.058	0.053	0		

Table 4.1.21 (2) Calculation Sheet of Water Requirement for Polowijo

	Jul. 1st	Jul. 2nd	Jul. 3rd	Aug. 1st	Aug. 2nd	Aug. 3rd	Sep. 1st	Sep. 2nd	Sep. 3rd	Oct. 1st	Oct. 2nd	Oct. 3rd	Nov. 1st	Nov. 2nd	Nov. 3rd
	1 9 7 6														
Cropping Pattern															



	Jul. 1st	Jul. 2nd	Jul. 3rd	Aug. 1st	Aug. 2nd	Aug. 3rd	Sep. 1st	Sep. 2nd	Sep. 3rd	Oct. 1st	Oct. 2nd	Oct. 3rd	Nov. 1st	Nov. 2nd	Nov. 3rd
Calculation															
A. Cropping intensity (Ic)															
Early cropping		1/6	1/3	1/3	1/3	1/3	1/3	1/3	1/3	1/3	1/6				
Middle "			1/6	1/3	1/3	1/3	1/3	1/3	1/3	1/3	1/3	1/6			
Late "				1/6	1/3	1/3	1/3	1/3	1/3	1/3	1/3	1/3	1/6		
Total		1/6	1/2	5/6	1	1	1	1	1	1	5/6	1/2	1/6		
B. Crop coefficient (Kc)															
Early cropping		0.31	0.41	0.54	0.67	0.75	0.76	0.72	0.65	0.55	0.40				
Middle "			0.31	0.41	0.54	0.67	0.75	0.76	0.72	0.65	0.55	0.40			
Late "				0.31	0.41	0.54	0.67	0.75	0.76	0.72	0.65	0.55	0.40		
Weighting average		0.31	0.38	0.44	0.54	0.65	0.73	0.74	0.71	0.64	0.56	0.50	0.40		
C. Potential evapotranspiration (ETo)		37	41	44	44	48	46	46	46	50	50	55	43		
D. Consumptive use of water (Cu)		11	15	19	24	31	33	34	33	32	28	28	17		
E. Effective rainfall (Re)		11	3	9	-	-	-	-	-	5	6	28	6		
F. Farm water req. (Fw) (mm/N days)		0	6	8	24	31	33	34	33	27	22	0	2		
G. Diversion water req. (Dw) (mm/N days)		0	10	14	40	52	55	57	55	45	18	0	3		
H. Unit diversion req. (Qe) (l/s/ha)		0	0.105	0.161	0.463	0.544	0.636	0.656	0.636	0.521	0.212	0	0.035		

Table 4.1.21 (3) Calculation Sheet of Water Requirement for Polowijo

	Jul. 1st	Jul. 2nd	Jul. 3rd	Aug. 1st	Aug. 2nd	Aug. 3rd	Sep. 1st	Sep. 2nd	Sep. 3rd	Oct. 1st	Oct. 2nd	Oct. 3rd	Nov. 1st	Nov. 2nd	Nov. 3rd
	1977														

Cropping Pattern

Calculation

	Jul. 1st	Jul. 2nd	Jul. 3rd	Aug. 1st	Aug. 2nd	Aug. 3rd	Sep. 1st	Sep. 2nd	Sep. 3rd	Oct. 1st	Oct. 2nd	Oct. 3rd	Nov. 1st	Nov. 2nd	Nov. 3rd
A. Cropping intensity (Ic)															
Early cropping		1/6	1/3	1/3	1/3	1/3	1/3	1/3	1/3	1/3	1/6				
Middle "			1/6	1/3	1/3	1/3	1/3	1/3	1/3	1/3	1/3	1/6			
Late "				1/6	1/3	1/3	1/3	1/3	1/3	1/3	1/3	1/3	1/6		
Total		1/6	1/2	5/6	1	1	1	1	1	1	5/6	1/2	1/6		
B. Crop coefficient (Kc)															
Early cropping		0.31	0.41	0.54	0.67	0.75	0.76	0.72	0.65	0.55	0.40				
Middle "			0.31	0.41	0.54	0.67	0.75	0.76	0.72	0.65	0.55	0.40			
Late "				0.31	0.41	0.54	0.67	0.75	0.76	0.72	0.65	0.55	0.40		
Weighting average		0.31	0.38	0.44	0.54	0.65	0.73	0.74	0.71	0.64	0.56	0.50	0.40		
C. Potential evapotranspiration (ETo)		37	41	44	44	48	46	46	46	50	50	55	43		
D. Consumptive use of water (Cu)		11	15	19	24	31	33	34	33	32	28	28	17		
E. Effective rainfall (Re)		-	8	6	-	4	2	-	-	-	-	-	-		
F. Farm water req. (Fw) (mm/N days)		2	4	11	24	27	31	34	33	32	23	14	3		
G. Diversion water req. (Dw) (mm/N days)		3	6	18	40	45	52	57	55	53	39	23	5		
H. Unit diversion req. (Qe) (l/s/ha)		0.035	0.061	0.209	0.463	0.473	0.598	0.656	0.636	0.617	0.450	0.246	0.055		

Table 4.1.21 (4) Calculation Sheet of Water Requirement for Polowijo

	Jul. 1st	Jul. 2nd	Jul. 3rd	Aug. 1st	Aug. 2nd	Aug. 3rd	Sep. 1st	Sep. 2nd	Sep. 3rd	Oct. 1st	Oct. 2nd	Oct. 3rd	Nov. 1st	Nov. 2nd	Nov. 3rd
	1 9 7 8														

Cropping Pattern

Calculation

	Jul. 1st	Jul. 2nd	Jul. 3rd	Aug. 1st	Aug. 2nd	Aug. 3rd	Sep. 1st	Sep. 2nd	Sep. 3rd	Oct. 1st	Oct. 2nd	Oct. 3rd	Nov. 1st	Nov. 2nd	Nov. 3rd
A. Cropping intensity (Ic)															
Early cropping		$\frac{1}{6}$	$\frac{1}{3}$	$\frac{1}{3}$	$\frac{1}{3}$	$\frac{1}{3}$	$\frac{1}{3}$	$\frac{1}{3}$	$\frac{1}{3}$	$\frac{1}{3}$	$\frac{1}{6}$				
Middle "			$\frac{1}{6}$	$\frac{1}{3}$	$\frac{1}{3}$	$\frac{1}{3}$	$\frac{1}{3}$	$\frac{1}{3}$	$\frac{1}{3}$	$\frac{1}{3}$	$\frac{1}{3}$	$\frac{1}{6}$			
Late "				$\frac{1}{6}$	$\frac{1}{3}$	$\frac{1}{3}$	$\frac{1}{3}$	$\frac{1}{3}$	$\frac{1}{3}$	$\frac{1}{3}$	$\frac{1}{3}$	$\frac{1}{3}$	$\frac{1}{6}$		
Total		$\frac{1}{6}$	$\frac{1}{2}$	$\frac{5}{6}$	1	1	1	1	1	1	$\frac{5}{6}$	$\frac{1}{2}$	$\frac{1}{6}$		
B. Crop coefficient (Kc)															
Early cropping		0.31	0.41	0.54	0.67	0.75	0.76	0.72	0.65	0.55	0.40				
Middle "			0.31	0.41	0.54	0.67	0.75	0.76	0.72	0.65	0.55	0.40			
Late "				0.31	0.41	0.54	0.67	0.75	0.76	0.72	0.65	0.55	0.40		
Weighting average		0.31	0.38	0.44	0.54	0.65	0.73	0.74	0.71	0.64	0.56	0.50	0.40		
C. Potential evapotranspiration (ETo)		37	41	44	44	46	46	46	46	50	50	55	43		
D. Consumptive use of water (Cu)		11	15	19	24	31	33	34	33	32	28	28	17		
E. Effective rainfall (Re)		11	15	14	24	3	16	34	25	21	20	23	16		
F. Farm water req. (Fw) (mm/N days)		0	0	4	0	28	17	0	8	11	7	3	0		
G. Diversion water req. (Dw) (mm/N days)		0	0	7	0	47	28	0	13	18	11	4	0		
H. Unit diversion req. (Qe) (l/s/ha)		0	0	0.080	0	0.491	0.328	0	0.154	0.212	0.129	0.044	0		

Table 4.1.21 (5) Calculation Sheet of Water Requirement for Polowijo

	1979 Jul. 1st	Jul. 2nd	Jul. 3rd	Aug. 1st	Aug. 2nd	Aug. 3rd	Sep. 1st	Sep. 2nd	Sep. 3rd	Oct. 1st	Oct. 2nd	Oct. 3rd	Nov. 1st	Nov. 2nd	Nov. 3rd

Cropping Pattern

Calculation

	Jul. 1st	Jul. 2nd	Jul. 3rd	Aug. 1st	Aug. 2nd	Aug. 3rd	Sep. 1st	Sep. 2nd	Sep. 3rd	Oct. 1st	Oct. 2nd	Oct. 3rd	Nov. 1st	Nov. 2nd	Nov. 3rd
A. Cropping intensity (Ic)															
Early cropping		1/6	1/3	1/3	1/3	1/3	1/3	1/3	1/3	1/3	1/6				
Middle "			1/6	1/3	1/3	1/3	1/3	1/3	1/3	1/3	1/3	1/6			
Late "				1/6	1/3	1/3	1/3	1/3	1/3	1/3	1/3	1/3	1/6		
Total		1/6	1/2	5/6	1	1	1	1	1	1	5/6	1/2	1/6		
B. Crop coefficient (Kc)															
Early cropping		0.31	0.41	0.54	0.67	0.75	0.76	0.72	0.65	0.55	0.40				
Middle "			0.31	0.41	0.54	0.67	0.75	0.76	0.72	0.65	0.55	0.40			
Late "				0.31	0.41	0.54	0.67	0.75	0.76	0.72	0.65	0.55	0.40		
Weighting average		0.31	0.38	0.44	0.54	0.65	0.73	0.74	0.71	0.64	0.56	0.50	0.40		
C. Potential evapotranspiration (ETo)		37	41	44	44	48	46	46	46	50	50	55	43		
D. Consumptive use of water (Cu)		11	15	19	24	31	33	34	33	32	28	28	17		
E. Effective rainfall (Re)		6	7	-	-	-	29	-	20	2	-	2	-		
F. Farm water req. (Fw) (mm/N days)		1	4	16	24	31	4	34	13	30	23	13	3		
G. Diversion water req. (Dw) (mm/N days)		2	7	26	40	52	7	57	22	50	39	22	5		
H. Unit diversion req. (Qe) (l/s/ha)		0.019	0.077	0.305	0.463	0.544	0.077	0.656	0.251	0.579	0.450	0.228	0.055		

Table 4.1.22 (1) Unit Diversion Requirement for the Project

Year : 1975

Description	Jan. 1st	Jan. 2nd	Jan. 3rd	Feb. 1st	Feb. 2nd	Feb. 3rd	Mar. 1st	Mar. 2nd	Mar. 3rd	Apr. 1st	Apr. 2nd	Apr. 3rd	May 1st	May 2nd	May 3rd	Jun. 1st	Jun. 2nd	Jun. 3rd
1. Cropping Pattern														1975 1st Paddy				
2. Unit Diversion Requirement (l/s/ha)																		
1975 1st Paddy								0	0.049	0.326	0.312	0.759	0.163	0	0.280	0	0.204	1.042
Total								0	0.049	0.326	0.312	0.759	0.163	0	0.280	0	0.204	1.042

Description	Jul. 1st	Jul. 2nd	Jul. 3rd	Aug. 1st	Aug. 2nd	Aug. 3rd	Sep. 1st	Sep. 2nd	Sep. 3rd	Oct. 1st	Oct. 2nd	Oct. 3rd	Nov. 1st	Nov. 2nd	Nov. 3rd	Dec. 1st	Dec. 2nd	Dec. 3rd
1. Cropping Pattern					1975 Polowijo												1975 2nd Paddy	
2. Unit Diversion Requirement (l/s/ha)																		
1975 1st Paddy	0.262	0.174	0															
1975 Polowijo		0.006	0	0.154	0.096	0.175	0	0.192	0.231	0.231	0.058	0.053	0					
1975 2nd Paddy												0.016	0.018	0.706	0.764	1.192	0.235	0.818
Total	0.262	0.180	0	0.154	0.096	0.175	0	0.192	0.231	0.231	0.058	0.069	0.018	0.706	0.764	1.192	0.235	0.818

Table 4.1.22 (2) Unit Diversion Requirement for the Project

Year : 1976

Description	Jan. 1st	Jan. 2nd	Jan. 3rd	Feb. 1st	Feb. 2nd	Feb. 3rd	Mar. 1st	Mar. 2nd	Mar. 3rd	Apr. 1st	Apr. 2nd	Apr. 3rd	May 1st	May 2nd	May 3rd	Jun. 1st	Jun. 2nd	Jun. 3rd
1. Cropping Pattern		1975 2nd Paddy												1976 1st Paddy				
2. Unit Diversion Requirement (l/s/ha)																		
1975 2nd Paddy	1.215	0.654	1.029	0.651	0.862	0.499	0.170	0										
1976 1st Paddy								0	0.052	0.324	0.347	0.938	0.018	0.691	0.970	0	0.186	0.210
Total	1.215	0.654	1.029	0.651	0.862	0.499	0.170	0	0.052	0.324	0.347	0.938	0.018	0.691	0.970	0	0.186	0.210

Description	Jul. 1st	Jul. 2nd	Jul. 3rd	Aug. 1st	Aug. 2nd	Aug. 3rd	Sep. 1st	Sep. 2nd	Sep. 3rd	Oct. 1st	Oct. 2nd	Oct. 3rd	Nov. 1st	Nov. 2nd	Nov. 3rd	Dec. 1st	Dec. 2nd	Dec. 3rd
1. Cropping Pattern						1976 Polowijo											1976 2nd Paddy	
2. Unit Diversion Requirement (l/s/ha)																		
1976 1st Paddy	0	0.283	0.109															
1976 Polowijo		0	0.105	0.161	0.463	0.544	0.636	0.656	0.636	0.512	0.212	0	0.035					
1976 2nd Paddy												0	0.069	0.139	0.556	0.937	0.613	0.588
Total	0	0.283	0.214	0.161	0.463	0.544	0.636	0.656	0.636	0.521	0.212	0	0.104	0.139	0.556	0.937	0.613	0.558

Table 4.1.22 (3) Unit Diversion Requirement for the Project

Year : 1977

Description	Jan. 1st	Jan. 2nd	Jan. 3rd	Feb. 1st	Feb. 2nd	Feb. 3rd	Mar. 1st	Mar. 2nd	Mar. 3rd	Apr. 1st	Apr. 2nd	Apr. 3rd	May 1st	May 2nd	May 3rd	Jun. 1st	Jun. 2nd	Jun. 3rd
1. Cropping Pattern		1976 2nd Paddy													1977 1st Paddy			
2. Unit Diversion Requirement (l/s/ha)																		
1976 2nd Paddy	0	0.166	0	0.704	0.102	0.380	0.112	0										
1977 1st Paddy								0	0.052	0.347	0.741	0.706	0.869	0.528	0.395	0.222	0	1.042
Total	0	0.166	0	0.704	0.102	0.380	0.112	0	0.052	0.347	0.741	0.706	0.869	0.528	0.395	0.222	0	1.042

Description	Jul. 1st	Jul. 2nd	Jul. 3rd	Aug. 1st	Aug. 2nd	Aug. 3rd	Sep. 1st	Sep. 2nd	Sep. 3rd	Oct. 1st	Oct. 2nd	Oct. 3rd	Nov. 1st	Nov. 2nd	Nov. 3rd	Dec. 1st	Dec. 2nd	Dec. 3rd
1. Cropping Pattern							1977 Polowijo										1977 2nd Paddy	
2. Unit Diversion Requirement (l/s/ha)																		
1977 1st Paddy	0.201	0.500	0.109															
1977 Polowijo		0.035	0.061	0.209	0.463	0.473	0.598	0.656	0.636	0.617	0.450	0.246	0.055					
1977 2nd Paddy												0.018	0.072	0.669	0.253	0.072	0.940	0.555
Total	0.201	0.535	0.170	0.209	0.463	0.473	0.598	0.656	0.636	0.617	0.450	0.264	0.127	0.669	0.253	0.072	0.940	0.555

Table 4.1.22 (4) Unit Diversion Requirement for the Project

Year : 1978

Description	Jan.			Feb.			Mar.			Apr.			May			Jun.		
	1st	2nd	3rd	1st	2nd	3rd	1st	2nd	3rd	1st	2nd	3rd	1st	2nd	3rd	1st	2nd	3rd
1. Cropping Pattern	1977 2nd Paddy												1978 1st Paddy					
2. Unit Diversion Requirement (l/s/ha)																		
1977 2nd Paddy	0.401	0.763	1.26	0.774	0.685	0.504	0											
1978 1st Paddy								0	0.016	0.486	0.602	0.428	0.852	0.510	0.543	0.675	0.458	0.771
Total	0.401	0.763	1.26	0.774	0.685	0.504	0	0	0.016	0.486	0.602	0.428	0.852	0.510	0.543	0.675	0.458	0.771

Description	Jul.			Aug.			Sep.			Oct.			Nov.			Dec.		
	1st	2nd	3rd	1st	2nd	3rd	1st	2nd	3rd	1st	2nd	3rd	1st	2nd	3rd	1st	2nd	3rd
1. Cropping Pattern							1978 Polowijo									1978 2nd Paddy		
2. Unit Diversion Requirement (l/s/ha)																		
1978 1st Paddy	0.352	0	0.207															
1978 Polowijo			0	0.080	0	0.491	0.328	0	0.154	0.212	0.129	0.044						
1978 2nd Paddy												0	0.054	0.452	0.307	0.814	0.736	0
Total	0.352	0	0.207	0.080	0	0.491	0.328	0	0.154	0.212	0.129	0.044	0.054	0.452	0.307	0.814	0.736	0

Table 4.1.22 (5) Unit Diversion Requirement for the Project

Year : 1979

Description	Jan. 1st	Jan. 2nd	Jan. 3rd	Feb. 1st	Feb. 2nd	Feb. 3rd	Mar. 1st	Mar. 2nd	Mar. 3rd	Apr. 1st	Apr. 2nd	Apr. 3rd	May 1st	May 2nd	May 3rd	Jun. 1st	Jun. 2nd	Jun. 3rd
1. Cropping Pattern	1978 2nd Paddy												1979 1st Paddy					
2. Unit Diversion Requirement (l/s/ha)																		
1978 2nd Paddy	0.654	0.781	1.210	0.774	0.170	0.210	0.094	0.013										
1979 1st Paddy								0	0.016	0.312	1.088	0.307	0.109	0.745	0	0.024	0	0.572
Total	0.654	0.781	1.210	0.774	0.170	0.210	0.094	0.013	0.016	0.312	1.088	0.307	0.109	0.745	0	0.024	0	0.572

Description	Jul. 1st	Jul. 2nd	Jul. 3rd	Aug. 1st	Aug. 2nd	Aug. 3rd	Sep. 1st	Sep. 2nd	Sep. 3rd	Oct. 1st	Oct. 2nd	Oct. 3rd	Nov. 1st	Nov. 2nd	Nov. 3rd	Dec. 1st	Dec. 2nd	Dec. 3rd
1. Cropping Pattern					1979 Polowijo													
2. Unit Diversion Requirement (l/s/ha)																		
1979 1st Paddy	0.744	0.382	0.114															
1979 Polowijo		0.019	0.077	0.305	0.463	0.544	0.077	0.656	0.251	0.579	0.450	0.228	0.055					
Total	0.744	0.401	0.191	0.305	0.463	0.544	0.077	0.656	0.251	0.579	0.450	0.228	0.055					

Table 4.1.23 (1) Balance Calculation between Diversion Requirement and Dependable Flow

Work Division I

Year : 1975

Item	Time	Jan. 1st	Jan. 2nd	Jan. 3rd	Feb. 1st	Feb. 2nd	Feb. 3rd	Mar. 1st	Mar. 2nd	Mar. 3rd	Apr. 1st	Apr. 2nd	Apr. 3rd	May 1st	May 2nd	May 3rd	Jun. 1st	Jun. 2nd	Jun. 3rd
Diversion Requirement	(ℓ/s)								0	160	1,080	1,030	2,520	540	0	930	0	680	3,450
Dependable Flow in Tributaries	(ℓ/s)								2,700	2,650	3,130	3,500	3,260	3,090	3,090	3,090	3,370	3,370	900
Deficit	(ℓ/s)																		2,550

Item	Time	Jul. 1st	Jul. 2nd	Jul. 3rd	Aug. 1st	Aug. 2nd	Aug. 3rd	Sep. 1st	Sep. 2nd	Sep. 3rd	Oct. 1st	Oct. 2nd	Oct. 3rd	Nov. 1st	Nov. 2nd	Nov. 3rd	Dec. 1st	Dec. 2nd	Dec. 3rd
Diversion Requirement	(ℓ/s)	870	580	0									50	60	2,340	2,530	3,950	780	2,710
Dependable Flow in Tributaries	(ℓ/s)	970	930	3,180	1,100	3,450	1,140	540	470	450	500	380	410	1,120	1,200	1,070	3,430	7,460	1,500
Deficit	(ℓ/s)														1,140	1,460	520		1,210

Year : 1976

Item	Time	Jan. 1st	Jan. 2nd	Jan. 3rd	Feb. 1st	Feb. 2nd	Feb. 3rd	Mar. 1st	Mar. 2nd	Mar. 3rd	Apr. 1st	Apr. 2nd	Apr. 3rd	May 1st	May 2nd	May 3rd	Jun. 1st	Jun. 2nd	Jun. 3rd
Diversion Requirement	(ℓ/s)	4,030	2,170	3,410	2,160	2,860	1,650	560	0	172	1,070	1,150	3,100	60	2,290	3,210	0	620	700
Dependable Flow in Tributaries	(ℓ/s)	1,180	10,760	980	1,690	920	1,340	900	1,600	1,860	2,010	1,970	1,000	3,160	940	1,000	2,300	2,040	1,800
Deficit	(ℓ/s)	2,850		2,430	450	1,940	310						2,100		1,350	2,210			

Item	Time	Jul. 1st	Jul. 2nd	Jul. 3rd	Aug. 1st	Aug. 2nd	Aug. 3rd	Sep. 1st	Sep. 2nd	Sep. 3rd	Oct. 1st	Oct. 2nd	Oct. 3rd	Nov. 1st	Nov. 2nd	Nov. 3rd	Dec. 1st	Dec. 2nd	Dec. 3rd
Diversion Requirement	(ℓ/s)	0	940	360									0	330	440	1,750	2,950	1,930	1,850
Dependable Flow in Tributaries	(ℓ/s)	4,070	2,040	1,290	1,110	1,450	1,160	300	300	410	740	800	590	1,140	2,070	1,360	3,530	4,850	1,800
Deficit	(ℓ/s)															390			50

1. Area : 2,900 ha
2. Cropping Pattern : Double Cropping of Paddy
3. Intake Efficiency : 80%
4. Irrigation Efficiency : 56%

Table 4.1.23 (2) Balance Calculation between Diversion Requirement and Dependable Flow

Work Division I

Year : 1977

Item	Time	Jan. 1st	Jan. 2nd	Jan. 3rd	Feb. 1st	Feb. 2nd	Feb. 3rd	Mar. 1st	Mar. 2nd	Mar. 3rd	Apr. 1st	Apr. 2nd	Apr. 3rd	May 1st	May 2nd	May 3rd	Jun. 1st	Jun. 2nd	Jun. 3rd
Diversion Requirement	(ℓ/s)	0	550	0	2,330	340	1,260	370	0	170	1,150	2,460	2,340	2,880	1,750	1,310	740	0	3,450
Dependable Flow in Tributaries	(ℓ/s)	10,210	7,860	16,060	3,910	21,860	14,500	7,660	3,860	5,340	8,150	7,620	2,620	2,130	5,660	3,720	3,160	11,160	2,140
Deficit	(ℓ/s)													750					1,310

Item	Time	Jul. 1st	Jul. 2nd	Jul. 3rd	Aug. 1st	Aug. 2nd	Aug. 3rd	Sep. 1st	Sep. 2nd	Sep. 3rd	Oct. 1st	Oct. 2nd	Oct. 3rd	Nov. 1st	Nov. 2nd	Nov. 3rd	Dec. 1st	Dec. 2nd	Dec. 3rd
Diversion Requirement	(ℓ/s)	670	1,660	360									60	240	2,210	840	240	3,120	1,840
Dependable Flow in Tributaries	(ℓ/s)	4,350	2,700	1,610	1,680	1,870	1,280	430	380	560	870	500	430	1,040	1,100	1,840	2,470	5,360	5,100
Deficit	(ℓ/s)														1,110				

Year : 1978

Item	Time	Jan. 1st	Jan. 2nd	Jan. 3rd	Feb. 1st	Feb. 2nd	Feb. 3rd	Mar. 1st	Mar. 2nd	Mar. 3rd	Apr. 1st	Apr. 2nd	Apr. 3rd	May 1st	May 2nd	May 3rd	Jun. 1st	Jun. 2nd	Jun. 3rd
Diversion Requirement	(ℓ/s)	1,330	2,530	4,180	2,570	2,270	1,670	0	0	380	1,610	2,000	1,420	2,820	1,690	1,800	2,240	1,520	2,560
Dependable Flow in Tributaries	(ℓ/s)	2,590	3,730	4,570	1,690	3,340	2,760	3,060	3,620	3,570	2,920	1,960	2,160	3,340	4,520	2,410	3,190	2,790	2,540
Deficit	(ℓ/s)				880							40							20

Item	Time	Jul. 1st	Jul. 2nd	Jul. 3rd	Aug. 1st	Aug. 2nd	Aug. 3rd	Sep. 1st	Sep. 2nd	Sep. 3rd	Oct. 1st	Oct. 2nd	Oct. 3rd	Nov. 1st	Nov. 2nd	Nov. 3rd	Dec. 1st	Dec. 2nd	Dec. 3rd
Diversion Requirement	(ℓ/s)	1,170	0										0	180	1,500	1,020	2,700	2,440	0
Dependable Flow in Tributaries	(ℓ/s)	3,570	3,150	2,510	1,990	1,320	1,430	1,170	530	1,100	1,690	730	630	2,190	3,570	5,920	4,990	5,480	7,750
Deficit	(ℓ/s)																		

1. Area : 2,900 ha
2. Cropping Pattern : Double Cropping of Paddy
3. Intake Efficiency : 80%
4. Irrigation Efficiency : 56%

Table 4.1.23 (3) Balance Calculation between Diversion Requirement and Dependable Flow

Work Division I

Year : 1979 Item	Time	Jan. 1st	Jan. 2nd	Jan. 3rd	Feb. 1st	Feb. 2nd	Feb. 3rd	Mar. 1st	Mar. 2nd	Mar. 3rd	Apr. 1st	Apr. 2nd	Apr. 3rd	May 1st	May 2nd	May 3rd	Jun. 1st	Jun. 2nd	Jun. 3rd
Diversion Requirement	(ℓ/s)	2,170	2,590	4,010	2,570	560	700	310	40	50	1,030	3,610	1,020	360	2,470	0	80	0	1,900
Dependable Flow in Tributaries	(ℓ/s)	10,990	8,920	3,300	1,880	2,560	7,300	5,500	1,930	2,990	4,010	2,140	2,490	6,240	1,800	2,030	3,770	5,100	2,880
Deficit	(ℓ/s)			710	690							1,470			670				

Item	Time	Jul. 1st	Jul. 2nd	Jul. 3rd	Aug. 1st	Aug. 2nd	Aug. 3rd	Sep. 1st	Sep. 2nd	Sep. 3rd	Oct. 1st	Oct. 2nd	Oct. 3rd	Nov. 1st	Nov. 2nd	Nov. 3rd	Dec. 1st	Dec. 2nd	Dec. 3rd
Diversion Requirement	(ℓ/s)	2,470	1,270																
Dependable Flow in Tributaries	(ℓ/s)	1,950	2,220	1,560	1,670	1,170	1,050	390	390	650	740	360	380	1,100					
Deficit	(ℓ/s)	520																	

1. Area : 2,900 ha
2. Cropping Pattern : Double Cropping of Paddy
3. Intake Efficiency : 80%
4. Irrigation Efficiency : 56%

Table 4.1.23 (4) Balance Calculation between Diversion Requirement and Dependable Flow

Work Division II

Year : 1975

Item	Time	Jan. 1st	Jan. 2nd	Jan. 3rd	Feb. 1st	Feb. 2nd	Feb. 3rd	Mar. 1st	Mar. 2nd	Mar. 3rd	Apr. 1st	Apr. 2nd	Apr. 3rd	May 1st	May 2nd	May 3rd	Jun. 1st	Jun. 2nd	Jun. 3rd
Division Requirement	(ℓ/s)								0	220	1,470	1,400	3,410	730	0	1,260	0	920	4,690
Dependable Flow in Tributaries	(ℓ/s)								2,700	2,650	3,130	3,500	3,260	3,090	3,090	3,090	3,370	3,370	900
Deficit	(ℓ/s)												150						3,790
Water Supply from Langkemme River	(ℓ/s)												3,130						860
Deficit	(ℓ/s)																		2,930

Item	Time	Jul. 1st	Jul. 2nd	Jul. 3rd	Aug. 1st	Aug. 2nd	Aug. 3rd	Sep. 1st	Sep. 2nd	Sep. 3rd	Oct. 1st	Oct. 2nd	Oct. 3rd	Nov. 1st	Nov. 2nd	Nov. 3rd	Dec. 1st	Dec. 2nd	Dec. 3rd
Division Requirement	(ℓ/s)	1,180	810	0	690	430	790	0	860	1,040	1,040	260	310	80	3,180	3,440	5,360	1,060	3,680
Dependable Flow in Tributaries	(ℓ/s)	970	930	3,180	1,100	3,450	1,140	540	470	450	500	380	410	1,120	1,200	1,070	3,430	7,460	1,500
Deficit	(ℓ/s)	210							390	590	540				1,380	2,370	1,930		2,180
Water Supply from Langkemme River	(ℓ/s)	930							1,230	1,170	1,180				1,150	1,030	3,290		1,440
Deficit	(ℓ/s)														230	1,340			740

1. Area : 4,500 ha
2. Cropping Pattern : Proposed
3. Intake Efficiency : 80%
4. Irrigation Efficiency : 64%

Table 4.1.23 (5) Balance Calculation between Diversion Requirement and Dependable Flow

Work Division II

Year : 1976

Item	Time	Jan. 1st	Jan. 2nd	Jan. 3rd	Feb. 1st	Feb. 2nd	Feb. 3rd	Mar. 1st	Mar. 2nd	Mar. 3rd	Apr. 1st	Apr. 2nd	Apr. 3rd	May 1st	May 2nd	May 3rd	Jun. 1st	Jun. 2nd	Jun. 3rd
Diversion Requirement	(ℓ/s)	5,470	2,940	4,630	2,930	3,880	2,250	770	0	230	1,460	1,560	4,220	80	3,110	4,370	0	840	950
Dependable Flow in Tributaries	(ℓ/s)	1,180	10,760	980	1,690	920	1,340	900	1,600	1,860	2,010	1,970	1,000	3,160	940	1,000	2,300	2,040	1,800
Deficit	(ℓ/s)	4,290		3,650	1,240	2,960	910						3,220		2,170	3,370			
Water Supply from Langkemme River	(ℓ/s)	1,140		940	1,620	880	1,290						960		900	960			
Deficit	(ℓ/s)	3,150		2,710		2,080							2,260		1,270	2,410			

Item	Time	Jul. 1st	Jul. 2nd	Jul. 3rd	Aug. 1st	Aug. 2nd	Aug. 3rd	Sep. 1st	Sep. 2nd	Sep. 3rd	Oct. 1st	Oct. 2nd	Oct. 3rd	Nov. 1st	Nov. 2nd	Nov. 3rd	Dec. 1st	Dec. 2nd	Dec. 3rd
Diversion Requirement	(ℓ/s)	0	1,270	960	720	2,080	2,450	2,860	2,950	2,860	2,340	950	0	470	630	2,500	4,220	2,760	2,650
Dependable Flow in Tributaries	(ℓ/s)	4,070	2,040	1,290	1,110	1,450	1,160	300	300	410	740	800	590	1,140	2,070	1,360	3,530	4,850	1,800
Deficit	(ℓ/s)					630	1,290	2,560	2,650	2,450	1,600	150				1,140	690		850
Water Supply from Langkemme River	(ℓ/s)					1,390	1,110	780	770	1,060	1,740	1,900				1,300	3,380		1,730
Deficit	(ℓ/s)						180	1,780	1,880	1,390									

1. Area : 4,500 ha
2. Cropping Pattern : Proposed
3. Intake Efficiency : 80%
4. Irrigation Efficiency : 64%

Table 4.1.23 (6) Balance Calculation between Diversion Requirement and Dependable Flow

Work Division II

Year : 1977

Item	Time	Jan.			Feb.			Mar.			Apr.			May			Jun.		
		1st	2nd	3rd	1st	2nd	3rd	1st	2nd	3rd	1st	2nd	3rd	1st	2nd	3rd	1st	2nd	3rd
Division Requirement	(ℓ/s)	0	750	0	3,170	460	1,710	500	0	230	1,560	3,330	3,180	3,910	2,380	1,780	1,000	0	4,690
Dependable Flow in Tributaries	(ℓ/s)	10,210	7,860	16,060	3,910	21,860	14,500	7,660	3,860	5,340	8,150	7,620	2,620	2,130	5,660	3,720	3,160	11,160	2,140
Deficit	(ℓ/s)												560	1,780					2,550
Water Supply from Langkemme River	(ℓ/s)												510	2,040					2,060
Deficit	(ℓ/s)												50						490

Item	Time	Jul.			Aug.			Sep.			Oct.			Nov.			Dec.		
		1st	2nd	3rd	1st	2nd	3rd	1st	2nd	3rd	1st	2nd	3rd	1st	2nd	3rd	1st	2nd	3rd
Diversion Requirement	(ℓ/s)	900	2,410	770	940	1,080	2,130	2,690	2,950	2,860	2,780	2,030	1,190	570	3,010	1,140	320	4,230	2,500
Dependable Flow in Tributaries	(ℓ/s)	4,350	2,700	1,610	1,680	1,870	1,280	430	380	560	870	500	430	1,040	1,100	1,840	2,470	5,360	5,100
Deficit	(ℓ/s)					210	850	2,260	2,570	2,300	1,910	1,530	760		1,910				
Water Supply from Langkemme River	(ℓ/s)					1,790	1,220	1,110	980	1,460	2,060	1,190	1,030		1,050				
Deficit	(ℓ/s)							1,150	1,590	840		340			860				

1. Area : 4,500 ha
2. Cropping Pattern : Proposed
3. Intake Efficiency : 80%
4. Irrigation Efficiency : 64%

Table 4.1.23 (7) Balance Calculation between Diversion Requirement and Dependable Flow

Work Division II

Year : 1978

Item	Time	Jan.			Feb.			Mar.			Apr.			May			Jun.		
		1st	2nd	3rd	1st	2nd	3rd	1st	2nd	3rd	1st	2nd	3rd	1st	2nd	3rd	1st	2nd	3rd
Diversion Requirement	(ℓ/s)	1,800	3,430	5,670	3,480	3,080	2,270	0	0	70	2,190	2,710	1,930	3,830	2,300	2,440	3,040	2,060	3,470
Dependable Flow in Tributaries	(ℓ/s)	2,590	3,730	4,570	1,690	3,340	2,760	3,060	3,620	3,570	2,920	1,960	2,160	3,340	4,520	2,410	3,190	2,790	2,540
Deficit	(ℓ/s)			1,100	1,790							750		490		30			930
Water Supply from Langkemme River	(ℓ/s)			4,330	1,620							1,880		3,210		2,310			2,430
Deficit	(ℓ/s)				170														

Item	Time	Jul.			Aug.			Sep.			Oct.			Nov.			Dec.		
		1st	2nd	3rd	1st	2nd	3rd	1st	2nd	3rd	1st	2nd	3rd	1st	2nd	3rd	1st	2nd	3rd
Diversion Requirement	(ℓ/s)	1,580	0	120	360	0	2,210	1,480	0	690	950	580	200	240	2,030	1,380	3,660	3,310	0
Dependable Flow in Tributaries	(ℓ/s)	3,570	3,150	2,510	1,990	1,320	1,430	1,170	530	1,100	1,690	730	630	2,190	3,570	5,920	4,990	5,480	7,750
Deficit	(ℓ/s)						780	310											
Water Supply from Langkemme River	(ℓ/s)						1,380	3,020											
Deficit																			

1. Area : 4,500 ha
2. Cropping Pattern : Proposed
3. Intake Efficiency : 80%
4. Irrigation Efficiency : 64%

Table 4.1.23 (8) Balance Calculation between Diversion Requirement and Dependable Flow

Work Division II

Year : 1979

Item	Time	Jan. 1st	Jan. 2nd	Jan. 3rd	Feb. 1st	Feb. 2nd	Feb. 3rd	Mar. 1st	Mar. 2nd	Mar. 3rd	Apr. 1st	Apr. 2nd	Apr. 3rd	May 1st	May 2nd	May 3rd	Jun. 1st	Jun. 2nd	Jun. 3rd
Diversion Requirement	(ℓ/s)	2,940	3,510	5,450	3,480	765	950	420	60	70	1,400	4,900	1,380	490	3,350	0	110	0	2,570
Dependable Flow in Tributaries	(ℓ/s)	10,990	8,920	3,300	1,880	2,560	7,300	5,500	1,930	2,990	4,010	2,140	2,490	6,240	1,800	2,030	3,770	5,100	2,880
Deficit	(ℓ/s)			2,150	1,600							2,760			1,550				
Water Supply from Langkemme River	(ℓ/s)			3,170	1,800							2,060			1,730				
Deficit	(ℓ/s)											700							

Item	Time	Jul. 1st	Jul. 2nd	Jul. 3rd	Aug. 1st	Aug. 2nd	Aug. 3rd	Sep. 1st	Sep. 2nd	Sep. 3rd	Oct. 1st	Oct. 2nd	Oct. 3rd	Nov. 1st	Nov. 2nd	Nov. 3rd	Dec. 1st	Dec. 2nd	Dec. 3rd
Deversion Requirement	(ℓ/s)	3,350	1,800	860	1,370	2,080	2,450	350	2,950	1,130	2,610	2,030	1,030	250					
Dependable Flow in Tributaties	(ℓ/s)	1,950	2,220	1,560	1,670	1,170	1,050	390	390	650	740	360	380	1,100					
Deficit	(ℓ/s)	1,400				910	1,400		2,560	480	1,870	1,670	650						
Water Supply from Langkemma River	(ℓ/s)	1,870				1,120	1,010		1,020	1,670	1,760	860	910						
Deficit	(ℓ/s)						390		1,540		110	810							

1. Area : 4,500 ha
2. Cropping Pattern : Proposed
3. Intake Efficiency : 80%
4. Irrigation Efficiency : 64%

Table 4.1.23 (9) Balance Calculation between Diversion Requirement and Dependable Flow

Work Division III

Year : 1975

Item	Time	Jan. 1st	Jan. 2nd	Jan. 3rd	Feb. 1st	Feb. 2nd	Feb. 3rd	Mar. 1st	Mar. 2nd	Mar. 3rd	Apr. 1st	Apr. 2nd	Apr. 3rd	May 1st	May 2nd	May 3rd	Jun. 1st	Jun. 2nd	Jun. 3rd
Diversion Requirement	(ℓ/s)									310	1,910	1,910	4,720	1,640	-	1,790	-	1,310	6,670
Dependable Flow in Tributaries	(ℓ/s)									2,650	3,130	3,500	3,260	3,090	3,090	3,090	3,370	3,370	900
Deficit	(ℓ/s)									-	-	-	1,460	-	-	-	-	-	5,770
Water Supply from Langkemme River	(ℓ/s)									-	-	-	1,460	-	-	-	-	-	860
Deficit	(ℓ/s)									-	-	-	-	-	-	-	-	-	4,910
Water Supply from Sero River	(ℓ/s)									-	-	-	-	-	-	-	-	-	850
Deficit	(ℓ/s)									-	-	-	-	-	-	-	-	-	4,060
Deficit Req. Ratio	(%)																		61

Item	Time	Jul. 1st	Jul. 2nd	Jul. 3rd	Aug. 1st	Aug. 2nd	Aug. 3rd	Sep. 1st	Sep. 2nd	Sep. 3rd	Oct. 1st	Oct. 2nd	Oct. 3rd	Nov. 1st	Nov. 2nd	Nov. 3rd	Dec. 1st	Dec. 2nd	Dec. 3rd
Diversion Requirement	(ℓ/s)	1,680	1,110	-	1,080	-	1,270	-	1,130	1,320	-	-	100	120	4,520	4,600	7,440	1,500	5,240
Dependable Flow in Tributaries	(ℓ/s)	970	930	3,180	1,100	3,450	1,140	540	470	450	500	380	410	1,120	1,200	1,070	3,430	7,460	1,500
Deficit	(ℓ/s)	710	180	-	-	-	130	-	660	870	-	-	-	-	3,320	3,530	4,010	-	3,740
Water Supply from Langkemme River	(ℓ/s)	710	180	-	-	-	130	-	660	870	-	-	-	-	1,450	1,030	3,290	-	1,440
Deficit	(ℓ/s)	-	-	-	-	-	-	-	-	-	-	-	-	-	2,470	2,500	1,510	-	2,300
Water Supply from Sero River	(ℓ/s)	-	-	-	-	-	-	-	-	-	-	-	-	-	2,770	2,500	1,510	-	2,300
Deficit	(ℓ/s)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Deficit Req. Ratio	(%)																		

1. Area : 6,400 ha
2. Cropping Pattern : Proposed
3. Intake Efficiency : 80%
4. Irrigation Efficiency : 64%

Table 4.1.23 (10) Balance Calculation between Diversion Requirement and Dependable Flow

Work Division III

Year : 1976

Item	Time	Jan. 1st	Jan. 2nd	Jan. 3rd	Feb. 1st	Feb. 2nd	Feb. 3rd	Mar. 1st	Mar. 2nd	Mar. 3rd	Apr. 1st	Apr. 2nd	Apr. 3rd	May 1st	May 2nd	May 3rd	Jun. 1st	Jun. 2nd	Jun. 3rd
Diversion Requirement	(ℓ/s)	7,780	4,190	6,590	4,170	5,520	3,190	1,090	-	330	1,910	2,090	5,760	120	4,460	6,210	-	1,190	1,340
Dependable Flow in Tributaries	(ℓ/s)	1,180	10,760	980	1,690	920	1,340	900	1,600	1,860	2,010	1,970	1,000	3,160	940	1,000	2,300	2,040	1,800
Deficit	(ℓ/s)	6,600	-	5,610	2,480	4,600	1,850	190	-	-	-	120	4,760	-	3,520	5,210	-	-	-
Water Supply from Langkemme River	(ℓ/s)	1,140	-	940	1,620	880	1,290	190	-	-	-	120	960	-	900	960	-	-	-
Deficit	(ℓ/s)	5,460	-	4,670	860	3,720	560	-	-	-	-	-	-	-	2,620	4,250	-	-	-
Water Supply from Sero River	(ℓ/s)	9,960	-	9,290	860	2,500	560	-	-	-	-	-	-	-	3,400	1,430	-	-	-
Deficit	(ℓ/s)	2,960	-	2,170	-	1,220	-	-	-	-	-	-	-	-	120	2,820	-	-	-
Deficit Req. Ratio	(%)	38		33		22										45			

Item	Time	Jul. 1st	Jul. 2nd	Jul. 3rd	Aug. 1st	Aug. 2nd	Aug. 3rd	Sep. 1st	Sep. 2nd	Sep. 3rd	Oct. 1st	Oct. 2nd	Oct. 3rd	Nov. 1st	Nov. 2nd	Nov. 3rd	Dec. 1st	Dec. 2nd	Dec. 3rd
Diversion Requirement	(ℓ/s)	-	1,810	700	1,380	2,930	3,520	4,130	4,220	4,030	2,840	2,160	-	670	810	3,440	5,890	3,870	3,760
Dependable Flow in Tributaries	(ℓ/s)	4,070	2,040	1,290	1,110	1,450	1,160	300	300	410	740	800	590	1,140	2,070	1,360	3,530	4,850	1,800
Deficit	(ℓ/s)	-	-	-	270	1,480	2,360	3,830	3,920	3,620	2,100	1,360	-	-	-	2,080	2,360	-	1,960
Water Supply from Langkemme River	(ℓ/s)	-	-	-	270	1,390	1,110	780	770	1,060	1,740	1,360	-	-	-	1,300	2,360	-	1,730
Deficit	(ℓ/s)	-	-	-	-	90	1,250	3,050	3,150	2,560	360	-	-	-	-	780	-	-	230
Water Supply from Sero River	(ℓ/s)	-	-	-	-	90	1,070	1,050	660	660	360	-	-	-	-	780	-	-	230
Deficit	(ℓ/s)	-	-	-	-	-	180	2,000	2,490	1,900	-	-	-	-	-	-	-	-	-
Deficit Req. Ratio	(%)						5	48	59	47									

1. Area : 6,400 ha
2. Cropping Pattern : Proposed
3. Intake Efficiency : 80%
4. Irrigation Efficiency : 64%

Table 4.1.23 (11) Balance Calculation between Diversion Requirement and Dependable Flow

Work Division III

Year : 1977

Item	Time	Jan. 1st	Jan. 2nd	Jan. 3rd	Feb. 1st	Feb. 2nd	Feb. 3rd	Mar. 1st	Mar. 2nd	Mar. 3rd	Apr. 1st	Apr. 2nd	Apr. 3rd	May 1st	May 2nd	May 3rd	Jun. 1st	Jun. 2nd	Jun. 3rd
Diversion Requirement	(ℓ/s)	-	1,060	-	4,510	650	2,430	720	-	330	2,050	4,500	4,370	5,560	3,380	2,530	1,420	-	6,670
Dependable Flow in Tributaries	(ℓ/s)	10,210	7,860	16,060	3,910	21,860	14,500	7,660	3,860	5,340	8,150	7,620	2,620	2,130	5,660	3,720	3,160	11,160	2,140
Deficit	(ℓ/s)	-	-	-	600	-	-	-	-	-	-	-	1,750	3,430	-	-	-	-	4,530
Water Supply from Langkemme River	(ℓ/s)	-	-	-	600	-	-	-	-	-	-	-	1,750	2,040	-	-	-	-	2,060
Deficit	(ℓ/s)	-	-	-	-	-	-	-	-	-	-	-	-	1,390	-	-	-	-	2,470
Water Supply from Sero River	(ℓ/s)	-	-	-	-	-	-	-	-	-	-	-	-	1,390	-	-	-	-	1,470
Deficit	(ℓ/s)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Deficit Req. Ratio	(%)																		

Item	Time	Jul. 1st	Jul. 2nd	Jul. 3rd	Aug. 1st	Aug. 2nd	Aug. 3rd	Sep. 1st	Sep. 2nd	Sep. 3rd	Oct. 1st	Oct. 2nd	Oct. 3rd	Nov. 1st	Nov. 2nd	Nov. 3rd	Dec. 1st	Dec. 2nd	Dec. 3rd
Diversion Requirement	(ℓ/s)	1,290	3,420	1,090	1,340	2,960	3,030	3,830	4,200	4,070	3,950	2,890	1,690	810	4,280	1,620	460	5,950	3,550
Dependable Flow in Tributaries	(ℓ/s)	4,350	2,700	1,610	1,680	1,870	1,280	430	380	560	870	500	430	1,040	1,100	1,840	2,470	5,360	5,100
Deficit	(ℓ/s)	-	720	-	-	1,090	1,750	3,400	3,820	3,510	3,080	2,390	1,260	-	3,180	-	-	590	-
Water Supply from Langkemme River	(ℓ/s)	-	720	-	-	940	1,220	1,110	980	1,460	2,060	1,190	1,030	-	1,050	-	-	590	-
Deficit	(ℓ/s)	-	-	-	-	250	530	2,290	2,840	2,050	1,020	1,200	230	-	2,760	-	-	-	-
Water Supply from Sero River	(ℓ/s)	-	-	-	-	250	530	500	460	420	420	420	230	-	420	-	-	-	-
Deficit	(ℓ/s)	-	-	-	-	-	-	1,790	2,380	1,630	600	780	-	-	2,340	-	-	-	-
Deficit Req. Ratio	(%)							47	37	40	15	27			55				

1. Area : 6,400 ha
2. Cropping Pattern : Proposed
3. Intake Efficiency : 80%
4. Irrigation Efficiency : 64%

Table 4.1.23 (12) Balance Calculation between Diversion Requirement and Dependable Flow

Work Division III

Year : 1978

Item	Time	Jan. 1st	Jan. 2nd	Jan. 3rd	Feb. 1st	Feb. 2nd	Feb. 3rd	Mar. 1st	Mar. 2nd	Mar. 3rd	Apr. 1st	Apr. 2nd	Apr. 3rd	May 1st	May 2nd	May 3rd	Jun. 1st	Jun. 2nd	Jun. 3rd
Diversion Requirement	(ℓ/s)	2,570	4,880	8,060	4,950	4,380	3,230	-	-	100	2,900	3,610	2,420	3,450	3,260	3,480	4,320	2,930	4,930
Dependable Flow in Tributaries	(ℓ/s)	2,590	3,730	4,570	1,690	3,340	2,760	3,060	3,620	3,570	2,920	1,960	2,160	3,340	4,520	2,410	3,190	2,790	2,540
Deficit	(ℓ/s)	-	1,150	3,550	3,260	1,040	470	-	-	-	-	1,850	260	2,110	-	1,070	1,130	140	3,390
Water Supply from Langkemme River	(ℓ/s)	-	1,150	4,330	1,620	1,040	470	-	-	-	-	1,850	260	2,110	-	1,070	1,130	140	2,430
Deficit	(ℓ/s)	-	-	1,050	1,640	-	-	-	-	-	-	-	-	-	-	-	-	-	960
Water Supply from Sero River	(ℓ/s)	-	-	1,050	1,640	-	-	-	-	-	-	-	-	-	-	-	-	-	960
Deficit Req. ratio	(%)																		

Item	Time	Jul. 1st	Jul. 2nd	Jul. 3rd	Aug. 1st	Aug. 2nd	Aug. 3rd	Sep. 1st	Sep. 2nd	Sep. 3rd	Oct. 1st	Oct. 2nd	Oct. 3rd	Nov. 1st	Nov. 2nd	Nov. 3rd	Dec. 1st	Dec. 2nd	Dec. 3rd
Diversion Requirement	(ℓ/s)	2,250	-	170	460	-	3,070	2,150	-	820	740	410	-	230	2,730	1,850	4,970	4,710	-
Dependable Flow in Tributaries	(ℓ/s)	3,570	3,150	2,510	1,990	1,320	1,430	1,170	530	1,100	1,690	730	630	2,190	3,570	5,920	4,990	5,480	7,750
Deficit	(ℓ/s)	-	-	-	-	-	1,640	980	-	-	-	-	-	-	-	240	-	-	-
Water Supply from Langkemme River	(ℓ/s)	-	-	-	-	-	1,380	980	-	-	-	-	-	-	-	240	-	-	-
Deficit	(ℓ/s)	-	-	-	-	-	260	-	-	-	-	-	-	-	-	-	-	-	-
Water Supply from Sero River	(ℓ/s)	-	-	-	-	-	260	-	-	-	-	-	-	-	-	-	-	-	-
Deficit Ref. Ratio	(%)																		

1. Area : 6,400 ha
2. Cropping Pattern : Proposed
3. Intake Efficiency : 80%
4. Irrigation Efficiency : 64%

Table 4.1.23 (13) Balance Calculasion between Diversion Requirement and Dependable Flow

Work Division III

Year : 1979

Item	Time	Jan. 1st	Jan. 2nd	Jan. 3rd	Feb. 1st	Feb. 2nd	Feb. 3rd	Mar. 1st	Mar. 2nd	Mar. 3rd	Apr. 1st	Apr. 2nd	Apr. 3rd	May 1st	May 2nd	May 3rd	Jun. 1st	Jun. 2nd	Jun. 3rd
Diversion Requirement	(ℓ/s)	4,190	4,990	7,740	4,950	1,090	1,340	600	80	100	1,780	6,690	1,960	700	4,770	-	150	-	3,660
Dependable Flow in Tributaries	(ℓ/s)	10,990	8,920	3,300	1,880	2,560	7,300	5,500	1,930	2,990	4,010	2,140	2,490	6,240	1,800	2,030	3,770	5,100	2,880
Deficit	(ℓ/s)	-	-	4,440	3,070	-	-	-	-	-	-	4,550	-	-	1,970	-	-	-	780
Water Supply from Langkemme River	(ℓ/s)	-	-	3,170	1,800	-	-	-	-	-	-	2,060	-	-	1,730	-	-	-	780
Deficit	(ℓ/s)	-	-	1,940	1,270	-	-	-	-	-	-	2,490	-	-	1,240	-	-	-	-
Water Supply from Sero River	(ℓ/s)	-	-	1,940	1,270	-	-	-	-	-	-	2,490	-	-	1,240	-	-	-	-
Deficit	(ℓ/s)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Deficit Req. Ratio	(%)																		

Item	Time	Jul. 1st	Jul. 2nd	Jul. 3rd	Aug. 1st	Aug. 2nd	Aug. 3rd	Sep. 1st	Sep. 2nd	Sep. 3rd	Oct. 1st	Oct. 2nd	Oct. 3rd	Nov. 1st	Nov. 2nd	Nov. 3rd	Dec. 1st	Dec. 2nd	Dec. 3rd
Diversion Requirement	(ℓ/s)	4,760	2,440	730	2,000	2,930	3,520	540	4,220	1,690	3,950	2,880	1,540	-	1,960	5,260	2,940	7,630	6,496
Dependable Flow in Tributaries	(ℓ/s)	1,950	2,220	1,560	1,670	1,117	1,050	390	390	650	740	360	380	1,100	1,060	2,290	1,260	7,170	6,980
Deficit	(ℓ/s)	2,810	220	-	330	1,760	2,470	150	3,830	1,040	3,210	2,520	1,160	-	900	2,970	1,680	460	-
Water Supply from Langkemme River	(ℓ/s)	1,870	220	-	330	1,120	1,010	150	1,020	1,040	1,760	860	910	-	900	2,190	1,220	460	-
Deficit	(ℓ/s)	940	-	-	-	640	1,460	-	2,810	-	1,450	1,660	250	-	-	780	460	-	-
Water Supply from Sero River	(ℓ/s)	940	-	-	-	640	1,320	-	1,500	-	1,450	860	250	-	-	780	460	-	-
Deficit	(ℓ/s)	-	-	-	-	-	140	-	1,310	-	-	800	-	-	-	-	-	-	-
Deficit Req. Ratio	(%)								31			28							

1. Area : 6,400 ha
2. Cropping Pattern : Proposed
3. Intake Efficiency : 80%
4. Irrigation Efficiency : 64%

Table 4.1.24 Operation Frequency of Sero Intake (for 5 years)

Conveyed Discharge (m3/s)	Frequency Time	Frequency %	Cumulative Frequency. Time	Cumulative Frequency. %
0 - 0.5	14	29	14	29
0.5 - 1.0	12	25	26	54
1.0 - 1.5	11	23	37	77
1.5 - 2.0	3	6	40	83
2.0 - 2.5	4	9	44	92
2.5 - 3.0	1	2	45	94
3.0 - 3.5	0	0	45	94
3.5 - 4.0	1	2	46	96
4.0 - 4.5	0	0	46	96
4.5 - 5.0	1	2	47	98
5.0 - 5.5	1	2	48	100

Table 4.1.25 Operation Frequency of Langkemme Intake (for 5 years)

Conveyed Discharge	Frequency		Cumulative Frequency	
	Time	%	Time	%
(m^3/s)				
0 - 0.5	13	16	13	16
0.5 - 1.0	21	26	34	42
1.0 - 1.5	27	33	61	75
1.5 - 2.0	10	12	71	87
2.0 - 2.5	8	10	79	97
2.5 - 3.0	0	0	79	97
3.0 - 3.5	2	2	81	99
3.5 - 4.0	1	1	82	100

Table 4.2.1 Breakdown of Construction Cost in Each Alternative

(Intake Site Study)

Working Items	Unit	Alternative - 1 Quantity	Alternative - 1 Amount (US$)	Alternative - 2 Quantity	Alternative - 2 Amount (US$)	Alternative - 3 Quantity	Alternative - 3 Amount (US$)
I. Earth Work							
1. Excavation (Common)	m^3	160.550	240,825	519,030	778,545	576,100	864,150
2. Excavation (Rock)	m^3	160,550	963,300	12,500	75,000	-	-
3. Embankment	m^3	108.450	488,025	83,200	374,400	69,200	311,400
Sub-total			1,692,150 (1,693,000)		1,227,945 (1,228,000)		1,175,550 (1,176,000
II. Structure Work							
1. Syphone	Nos.	3	204.000	2	136,000	1	68,000
2. Culvert	Nos.	15	225,000	18	270,000	18	270,000
3. Bridge	Nos.	5	60,000	6	72,000	7	84,000
4. Related structure	-	-	430,500	-	535,500	-	511,000
Sub-total			919,500 (920,000)		1,013,500 (1,014,000)		933,000
III. Intake Structure							
1. Diversion Works	-	-	170,000	-	170,000	-	170,000
2. Earth Works	-	-	90,000	-	120,000	-	95,000
3. Concrete Work	-	-	450,000	-	610,000	-	465,000
4. Metal Work	-	-	150,000	-	150,000	-	150,000
5. Head Reach	-	-	340,000	-	340,000	-	340,000
6. Others	-	-	40,000	-	40,000	-	40,000
Sub-total			1,240,000		1,430,000		1,260,000
IV. Construction Road			73,000		-		-
Total			3,926,000		3,672,000		3,369,000

Table 4.2.2 Center of Gravity of the Weir

(Langkemme Intake Weir)

Own Weight (ton)		Arm length (m)		Moment (t.m)	
		Xo	Yo	Mx	My
C 1 = 1.8 x 1.0 x 2.0	= 3.60	1.00	3.80	3.60	13.68
C 2 = 1/2 x 1.8 x 1.4 x 1.4	= 1.76	2.47	3.57	4.35	6.28
C 3 = 1.8 x 0.6 x 2.2	= 2.38	0.30	1.70	0.71	4.05
C 4 = 1.8 x 0.4 x 2.8	= 2.02	1.40	0.70	2.83	1.41
C 5 = 1.8 x 0.5 x 1.0	= 0.90	0.50	0.25	0.45	0.23
C 6 = 1.8 x 1.8 x 0.6	= 1.94	3.10	2.10	6.01	4.07
C 7 = 1/2 x 1.8 x 1.8 x 1.8	= 2.92	4.00	1.90	11.68	5.55
C 8 = 1.8 x 0.8 x 8.2	= 11.81	6.90	0.90	81.49	10.63
C 9 = 1/2 x 1.8 x 1.6 x 1.6	= 2.30	9.47	1.83	21.78	4.21
C10 = 1.8 x 1.6 x 1.0	= 2.88	10.50	2.10	30.24	6.05
C11 = 1.8 x 0.5 x 1.0	= 0.90	10.50	0.25	9.45	0.23
C12 = 2.4 ($2.2^2 - 0.8^2 \pi$)	= 6.79	1.70	2.00	11.54	13.58
S = 1.8 x 0.5 x 9.0	= 8.10	5.50	0.25	44.55	2.03
Total	V = 48.3			228.68	72.00

$$Xo = \frac{\Sigma Mx}{V} = 4.73 \qquad Yo = \frac{\Sigma My}{V} = 1.49$$

Table 4.2.3 Stability Analysis of the Weir
(Langkemme Intake Weir, Case I)

	Force (t)	Arm length (m)	Moment (t.m)
1. Own Weight (V)	48.30	4.73	228.68
2. Seismic force (S)	7.25	1.49	10.80
3. Water Pressure			
$P_1 = 1/2 \times 4.5^2$	10.13	1.50	15.19
$P_2 = 1/2 \times 2.9^2$	-4.21	0.97	-4.08
4. Earth Pressure			
$Pe = 1/2(1.8-1) \times 0.5 \times 4.5^2$	4.05	1.50	6.08
5. Uplift Pressure			
$U_1 = 1/2 \times 4.5 \times 11.0$	-24.75	3.67	-90.83
$U_2 = 1/2 \times 2.9 \times 11.0$	-15.95	7.33	-116.91

$\Sigma V = V + U_1 + U_2 = 7.60$ $\Sigma M = 48.93$

$\Sigma H = S + P_1 + P_2 + Pe = 17.22$

$$e = \frac{\Sigma M}{\Sigma V} - \frac{B}{2} = 6.44 - 5.5 = 0.94 < \frac{B}{6} = 1.83$$

$$n = \frac{f.\Sigma V + C.B}{\Sigma H} = \frac{0.6 \times 7.60 + 25 \times 11.0}{17.22} = 16.23 > 4.4$$

Where, B : Width of the bottom (m)
f : Friction coefficient between the bottom and foundation (0.60)
C : Cohension between the bottom and foundation ($25\ t/m^2$)
e : Eccentricity of resultant force on the bottom
n : Safety factor of horizontal shearing and friction

Table 4.2.4 Stability Analysis of the Weir

(Langkemme Intake Weir, Case II)

	Force (t)	Arm length (m)	Moment (t.m)
1. Own Weight (V)	48.30	4.73	228.68
2. Dead Weight			
$W_1 = 2 \times 4.8$	9.60	1.00	9.60
$W_2 = 1/2 \times 2.7^2$	3.65	2.90	10.59
$W_3 = 2.1 \times 3.2$	6.72	3.60	24.19
$W_4 = 1/2 \times 3.2^2$	5.12	4.13	21.15
$W_5 = 5.3 \times 3.2$	16.96	6.80	115.33
$W_6 = 3.7 \times 1.6$	5.92	9.20	54.46
$W_7 = 1/2 \times 1.6^2$	1.28	8.93	11.43
$W_8 = 3.7 \times 1.0$	3.70	10.50	38.85
$W_9 = 0.8^2 \times 3.14$	2.01	1.70	3.42
3. Water Pressure			
$P_1 = 1/2 \times 4.5^2$	10.13	1.50	15.19
$P_2 = 4.8 \times 4.5$	21.60	2.25	48.60
$P_3 = 2.9 \times 3.7$	-10.73	1.45	-15.56
$P_4 = 1/2 \times 2.9^2$	-4.21	0.97	-4.08
4. Earth Pressure			
$Pe = 1/2(1.8-1) \times 0.5 \times 4.5^2$	4.05	1.50	6.08
5. Uplift Pressure			
$U_1 = 1/2 \times 9.3 \times 11.0$	-51.15	3.67	-187.72
$U_2 = 1/2 \times 6.6 \times 11.0$	-36.30	7.33	-266.08

$$\Sigma V = V + \sum_{i=1}^{9} Wi + U_1 + U_2 = 15.81$$

$$\Sigma M = 114.12$$

$$\Sigma H = \sum_{i=1}^{4} Pi + Pe = 20.34$$

$$e = \frac{\Sigma M}{\Sigma V} - \frac{B}{2} = \frac{114.13}{15.81} - \frac{11}{2} = 1.72 < \frac{B}{6} = 1.83$$

$$n = \frac{f\Sigma V + CB}{\Sigma H} = \frac{0.6 \times 15.81 + 25 \times 11.0}{20.34} = 13.99 > 4.0$$

Table 4.2.5 Center of Gravity of the Weir

(Jupang Intake Weir)

Own Weight	(ton)	Arm length (m)		Moment (t.m)	
		Xo	Yo	Mx	My
C 1 = 1.8 x 2.9 x 2.0	= 10.44	1.00	4.45	10.44	46.46
C 2 = 1.8 x 3.0 x 1/0	= 5.40	0.50	1.50	2.70	8.10
C 3 = 1.8 x 1.0 x 7.7	= 13.86	4.85	1.00	67.22	13.86
C 4 = 1.8 x 2.9 x 0.5	= 2.61	2.25	4.30	5.87	11.22
C 5 = 1.8 x 0.5 x 1.15	= 1.04	3.08	2.95	3.20	3.07
C 6 = 1/2 x 1.8 x 2.1 x 3.25	= 6.14	5.28	3.75	32.43	23.03
C 7 = 1/2 x 1.8 x 1.2 x 2.5	= 2.70	4.17	2.30	11.26	6.21
C 8 = 1.8 x 1.2 x 1.9	= 4.10	5.95	2.10	24.42	8.62
C 9 = 1/2 x 1.8 x 1.2 x 1.8	= 1.94	7.50	2.10	14.55	4.07
C10 = 1/2 x 1.8 x 1.0 x 1.5	= 1.35	9.20	0.83	12.42	1.12
C11 = 1.8 x 0.5 x 2.0	= 1.80	9.20	0.25	16.56	0.45
C12 = 2.4 x 2.1 x 0.2	= 1.01	2.60	4.45	2.62	4.49
C13 = 2.4 x 1.5 x 0.2	= 0.72	3.55	4.15	2.56	2.99
C14 = 2.4 x 0.2 x 1.15	= 0.55	3.08	3.30	1.70	1.82
C15 = 2.0 x 1.5 x 1.0	= 3.00	1.50	2.25	4.50	6.75
C16 = 1/2 x 2.0 x 1.5 x 3.0	= 4.50	3.00	2.00	13.50	9.00
S = 1.8 x 0.5 x 7.2	= 6.48	4.60	0.25	29.81	1.62
	V = 67.64			255.76	152.88

$Xo = \frac{\Sigma Mx}{V} = 3.78$ $\qquad$ $Yo = \frac{\Sigma My}{V} = 2.26$

Table 4.2.6 Stability Analysis of the Weir
(Jupang Intake Weir, Case I)

	Force (t)	Arm Length (m)	Moment (t.m)
1. Own Weight (V)	67.64	3.78	255.76
2. Seismic force (S)	10.15	2.26	22.94
3. Water pressure			
$P_1 = 1/2 \times 5.9^2$	17.41	1.97	19.38
$P_2 = -1/2 \times 2.7^2$	-3.65	-0.90	-3.32
4. Earth pressure			
$Pe = 1/2 \times 0.5 \times 5.9^2(1.8-1)$	6.96	1.97	13.71
5. Uplift pressure			
$U_1 = -1/2 \times 5.9 \times 10.2$	-30.09	3.4	-102.31
$U_2 = -1/2 \times 2.7 \times 10.2$	-13.77	6.8	-93.64

$\Sigma V = V + U_1 + U_2 = 23.78$ $\Sigma 112.44$

$\Sigma H = S + P_1 + P_2 + Pe = 30.87$

$$e = \left| \frac{\Sigma M}{V} - \frac{B}{2} \right| = \left| \frac{112.44}{23.78} - \frac{10.2}{2} \right| = 0.37 < \frac{B}{6} = 1.7$$

$$n = \frac{f\Sigma V + CB}{\Sigma H} = \frac{0.6 \times 23.78 + 25 \times 10.2}{30.87} = 8.72 > 4.0$$

Table 4.2.7 Stability Analysis of the Weir
(Jupang Intake Weir, Case II)

	Force (t)	Arm Length (m)	Moment (t.m)
1. Own Weight (V)	67.64	3.78	255.76
2. Dead Water			
$W_1 = 6.5 \times 20$	13.00	1.00	13.00
$W_2 = 1/2 \times 4.2 \times 4.8$	10.08	3.60	36.29
$W_3 = 2.3 \times 8.2$	18.86	6.10	115.05
$W_4 = 1/2 \times 5.4 \times 8.2$	22.14	7.47	165.39
$W_5 = 0.75 \times 1.78$	1.34	2.97	3.48
3. Water Pressure			
$P_1 = 1/2 \times 5.9^2$	17.41	1.97	34.30
$P_2 = 5.9 \times 6.5$	38.35	2.95	113.13
$P_3 = -2.3 \times 5.9$	-13.57	2.95	-40.03
$P_4 = -1/2 \times 5.9^2$	-17.41	1.97	13.71
4. Earth Pressure			
$Pe = 1/2 \times 0.5 \times 5.9^2(1.8-1)$	6.96	1.97	13.71
5. Uplift Pressure			
$U_1 = -1/2 \times 12.4 \times 10.2$	-63.24	3.4	-215.02
$U_2 = -1/2 \times 8.2 \times 10.2$	-41.82	6.8	-284.38

$$\Sigma V = V + \sum_{i=1}^{4} Wi + U_1 + U_2 = 28.00 \qquad \Sigma\, 176.88$$

$$\Sigma H = \sum_{i=1}^{4} Pi + Pe = 31.74$$

$$e = \frac{\Sigma M}{\Sigma V} - \frac{B}{2} = \frac{176.88}{28.00} - \frac{10.2}{2} = 1.22 < \frac{B}{6} = 1.7$$

$$n = \frac{f\Sigma V + CB}{\Sigma H} = \frac{0.6 \times 28.00 + 25 \times 10.2}{31.74} = 8.56 > 4.0$$

Table 4.2.8 Work Quantities and Construction Cost of Each Alternative

(Study for Main Canal Route)

Work Item	Unit Cost (Rp)	Alternative I		Alternative II	
		Quantity	Amount (10^3 Rp)	Quantity	Amount (10^3 Rp)
1. Earth Work					
- Excavation Common	1,200/m^3	26,000 m^3	31,200	127,000 m^3	152,400
- Excavation Rock	6,200/m^3	17,000 m^3	105,400	130,000 m^3	806,000
- Embankment	1,100/m^3	700 m^3	770	19,000 m^3	20,900
2. Structures					
- Cross Drain	3,000,000	-	-	5 Nos.	15,000
- Culvert	3,500,000	-	-	1 No.	3,500
- Junction	1,000,000	1 No.	1,000	1 No.	1,000
3. Tunnel	820,000/m	720 m	590,400	-	-
Total			728,770		998,800

Table 4.2.9 Equivalent Length of Link Canal to an Intake Weir

(Alternative 3 of Link Canal System)

Link Canal			Equivalent Length		
Canal Type	Design Discharge (m^3/sec.)	Construction Cost (10^3Rp/Km)	Weir Type I/1 (Km)	Weir Type II/2 (Km)	Weir Type III/3 (Km)
1	0.6	28,500	0.3	0.4	1.2
2	0.4	21,200	0.4	0.5	1.6
3	0.1	12,500	0.6	0.8	2.8

/1 : Tirol type weir of 30 m width, construction cost ; 7,220 x 10^3 Rp.

/2 : Tirol type weir of 50 m width, construction cost ; 10,100 x 10^3 Rp.

/3 : Ordinary type with scouring sluice, construction cost ; 34,740 x 10^3 Rp.

Table 4.2.10 Main Features & Direct Construction Cost

(Link Canal System)

(Construction Cost : 10^3Rp)

Item	Alternative-1		Alternative-2		Alternative-3	
	Quantity	Construction Cost	Quantity	Construction Cost	Quantity	Construction Cost
1. Link Canal (Km)	3.5	59,325	79.1	1,340,745	39.5	669,525
2. Intake Weir (Nos.)						
- Type I (tirol type 30 m)	6	43,320	-	-	6	43,320
- Type II (tirol type 50 m)	27	272,700	8	80,800	13	131,300
- Type III (ordinary type)	3	104,220	-	-	3	104,220
Sub-total	36	420,565	8	80,800	22	278,840
3. Related Structures						
- Spillway or Release	8	12,000	13	19,500	16	24,000
- Turnout	-	-	2	2,400	-	-
- Aqueduct	-	-	1	10,600	1	10,600
- Culvert	-	-	26	33,800	5	6,500
Sub-total	-	12,000	-	66,300	-	41,100
Total		491,565		1,487,845		989,465

Table 4.2.11 Hydraulic Features of Canals

Type I. Mountainous Area 1 (Hard Rock, n = 0.035, m = 0.3)

Q	B	I	h	V	B/h	Vls
4.5 - 5.0	3.0	1/2,000	2.11	0.65	1.42	0.70
4.0 - 4.5	3.0	1/2,000	1.97	0.64	1.52	0.65
3.5 - 4.0	3.0	1/2,000	1.83	0.61	1.64	0.65
3.0 - 3.5	2.5	1/2,000	1.91	0.60	1.32	0.65
2.5 - 3.0	2.5	1/2,000	1.73	0.58	1.45	0.60
2.0 - 2.5	2.5	1/2,000	1.54	0.55	1.63	0.60
1.5 - 2.0	2.0	1/1,800	1.51	0.54	1.32	0.60
1.0 - 1.5	2.0	1/1,800	1.25	0.50	1.59	0.50

Where,
Q : Design Discharge (m^3/s)
I ; Hydraulic Gradient
V ; Velocity (m/s)
n : Manning's Coefficient of Roughness
B ; Base Width (m)
h : Water Depth (m)
Vls ; Velocity on the Indonesian Standard (m/s)
m ; Side Slope of Canal Section

Table 4.2.12 <u>Hydraulic Features of Canals</u>

Type II. Mountainous Area 2 (Weathered Rock, n=0.035, m=0.5)

Q	B	I	h	V	B/h	VIs
4.5 - 5.0	3.0	1/2,000	1.92	0.66	1.56	0.70
4.0 - 4.5	3.0	1/2,000	1.80	0.64	1.66	0.65
3.5 - 4.0	2.5	1/2,000	1.87	0.62	1.34	0.65
3.0 - 3.5	2.5	1/2,000	1.73	0.60	1.45	0.65
2.5 - 3.0	2.5	1/2,000	1.58	0.58	1.59	0.60
2.0 - 2.5	2.5	1/2,000	1.41	0.55	1.77	0.60
1.5 - 2.0	2.0	1/1,800	1.37	0.54	1.46	0.60
1.0 - 1.5	2.0	1/1,800	1.15	0.50	1.74	0.50

Table 4.2.13 <u>Hydraulic Features of Canals</u>

Type III Flat Area (Earth, n=0.025)

Q	m	B	I	h	V	B/h	Vls
4.5 - 5.0	1.5	4.5	1/5,000	1.38	0.55	3.26	0.70
4.0 - 4.5	1.5	4.2	1/5,000	1.35	0.54	3.12	0.65
3.5 - 4.0	1.5	4.0	1/5,000	1.29	0.52	3.10	0.65 /1
	1.5	3.5	1/3,000	1.19	0.63	2.94	0.65 /2
3.0 - 3.5	1.5	3.5	1/3,000	1.11	0.61	3.20	0.65
2.5 - 3.0	1.0	3.5	1/3,000	1.08	0.61	3.24	0.60
2.0 - 2.5	1.0	2.8	1/3,000	1.09	0.59	2.52	0.60 /3
	1.0	3.0	1/5,000	1.22	0.49	2.50	0.60 /4
1.5 - 2.0	1.0	2.8	1/3,000	0.96	0.55	2.91	0.60
1.0 - 1.5	1.0	2.8	1/3,000	0.82	0.51	3.43	0.50

/1 : for the canal aligned in the upstream of Hydropower station
/2 : for the canal aligned in the downstream of Hydropower station
/3 : for the Langkemme Main canal
/4 : for the Sero Diversion canal

Table 4.2.14 Hydraulic Features of Canals

Type IV. Flat Area (Earth, n=0.028, m=1.0)

Q	B	I	h	V	B/h	Vls
0.75 - 1.00	1.8	1/3,000	0.86	0.43	2.08	0.50
0.50 - 0.75	1.6	1/3,000	0.78	0.40	2.05	0.45
0.25 - 0.50	1.2	1/3,000	0.71	0.37	1.69	0.40
- 0.25	0.7	1/3,000	0.61	0.31	1.14	0.30

Table 4.2.15 Dimension of Canal Section

Discharge	Freeboard	Width of Berm
(m^3/s)	(m)	(m)
4.5 - 5.0	0.6	2.0
4.0 - 4.5	0.6	1.5
3.5 - 4.0	0.6	1.5
3.0 - 3.5	0.6	1.5
2.5 - 3.0	0.6	1.5
2.0 - 2.5	0.6	1.5
1.5 - 2.0	0.6	1.5
1.0 - 1.5	0.5	1.5
0.75 - 1.0	0.5	1.5
0.50 - 0.75	0.5	1.5
0.25 - 0.50	0.4	1.0
- 0.25	0.3	0.5

Table 4.2.16 Required Numbers of Canal Related Structure

Structures	Nos. of Related Structures		
	Work Division II	Work Division III	Total
Turnout	15	5	20
Release	6	0	6
Check Structure	16	0	16
Culvert	11	2	13
Tunnel	1 (720 m)	0	1
Syphon	6	0	6
Acqueduct	1	3	4
Cross Drain	18	13	41
Spillway	6	0	34
Drop and Chute	35 (chute;1)	0	35 (chute;1)
Junction	14	0	14

Table 4.3.1 Financial Cost of the Project

(US$)

Work Item	Local Currency	Foreign Currency	Total
I. Construction Cost			
(Work Division I)			
Preparation	260,000	-	260,000
Weir in Tributeries	417,000	100,000	517,000
Link Canal in NT Area	1,266,000	240,000	1,506,000
Tertiary Development	412,000	-	412,000
Land Aquisition	163,000	-	163,000
Sub-total	2,518,000	340,000	2,858,000
(Work Division II)			
Preparation	803,000	-	803,000
Langkemme Intake Weir	195,000	99,000	294,000
Langkemme Canal	1,875,000	3,631,000	5,506,000
Link Canal in ST Area	85,000	23,000	108,000
Tertiary Development	1,702,000	-	1,702,000
Land Aquisition	415,000	-	415,000
Sub-total	5,075,000	3,753,000	8,828,000
(Work Division III)			
Preparation	440,000	-	440,000
Sero Intake Weirs	108,000	26,000	134,000
Sero Diversion Canal	1,062,000	2,014,000	3,076,000
Link Canal in DPU Area	126,000	27,000	153,000
Tertiary Development	889,000	-	889,000
Land Aquisition	149,000	-	149,000
Sub-total	2,774,000	2,067,000	4,841,000
Total	10,367,000	6,160,000	16,527,000
II. Engineering Service	464,000	3,238,000	3,702,000
III. Administration Cost	384,000	-	384,000
IV. Physical Contingency (15%)	1,682,000	1,410,000	3,092,000
V. Price Contingency (L-10%, F-7%)	7,162,000	3,708,000	10,870,000
Grand Total	20,059,000	14,516,000	34,575,000

Table 4.3.2 Breakdown of Construction Cost

(Unit : Rp.)

Working Item	Quantity	Unit	Unit Price		Cost Amount		Remarks
			Local	Foreign	Local	Foreign	
(WORK DIVISION I)							
1. Preparation	-	-	-	-	-	-	10% of Direct Cost
2. Weir in Tributaries					260,562,000	62,738,000	
Intake Type I	13	Nos.	7,596,000	1,424,000	98,748,000	18,512,000	
Intake Type II	6	Nos.	10,219,000	2,409,000	61,314,000	14,454,000	
Intake Type III	3	Nos.	33,500,000	9,924,000	100,500,000	29,772,000	
A. Intake Type I	1	No.	-	-	7,596,000	1,424,000	
(1) Excavation							
- Soil	117	m^3	550	-	64,350	-	
- Rock (Pick)	191	m^3	830	3,370	158,530	643,670	
(2) Gabion	86	m^3	15,800	-	1,358,800	-	
(3) Stone Masonry							
- Type A	136	m^3	18,200	-	2,475,200	-	
- Type B	40	m^3	11,000	-	440,000	-	
(4) Filling	74	m^3	190	-	14,060	-	
(5) Concrete	1.1	m^3	21,400	-	23,540	-	
(6) Reinforced Bar	0.055	t	11,760	444,240	647	24,433	
(7) Wooden form	10	m^2	1,770	-	17,700	-	

(to be cont'd)

(Unit : Rp.)

Working Item	Quantity	Unit	Unit Price		Cost Amount		Remarks
			Local	Foreign	Local	Foreign	
(8) Wooden Gate	0.3	t	50,000	100,000	15,000	30,000	
(9) Metal works	0.03	t	255,000	425,000	7,650	12,750	
(10) Screen	0.39	t	255,000	425,000	99,450	165,750	
Sub-total					(4,674,927)	(876,603)	
(11) Others	10	%			467,493	87,660	
(12) Temporary Works	20	%			934,985	175,321	
Sub-total					(6,077,405)	(1,139,584)	
(13) Over head	25	%			1,519,351	284,896	
Total					(7,596,756) (7,596,000)	(1,424,480) (1,424,000)	
B. Intake Type II	1	No.	-	-	10,219,000	2,409,000	
(1) Excavation							
- Soil	203	m^3	550	-	111,650	-	
- Rock (Pick)	321	m^3	830	3,370	266,430	1,081,770	
(2) Gabion	85	m^3	15,800	-	1,343,000	-	
(3) Stone Masonry							
- Type A	214	m^3	18,200	-	3,894,800	-	
- Type B	27	m^3	11,000	-	297,000	-	
(4) Filling	227	m^3	190	-	43,130	-	

(to be cont'd)

(Unit : Rp.)

Working Item	Quantity	Unit	Unit Price		Cost Amount		Remarks
			Local	Foreign	Local	Foreign	
(5) Concrete	4.1	m^3	21,400	-	87,740	-	
(6) Reinforcement Bar	0.205	t	11,760	444,240	2,411	91,069	
(7) Wooden form	35	m^2	1,770	-	61,950	-	
(8) Wooden Gate	0.5	m^2	50,000	100,000	25,000	50,000	
(9) Metal works	0.06	t	255,000	425,000	15,300	25,500	
(10) Screen	0.551	t	255,000	425,000	140,505	234,175	
Sub-total					(6,288,916)	(1,482,514)	
(11) Others	10	%			628,892	148,251	
(12) Temporary Works	20	%			1,257,783	296,503	
Sub-total					(8,175,591)	(1,927,268)	
(13) Over head	25	%			2,043,897	481,817	
Total					(10,219,488) (10,219,000)	(2,409,085) (2,409,000)	
C. Intake Type III	1	No.	-	-	33,500,000	9,924,000	
(1) Excavation							
- Soil	413	m^3	550	-	227,150	-	
- Rock (Pick)	650	m^3	830	3,370	539,500	2,190,500	
(2) Gabion	202	m^3	15,800	-	3,191,600	-	

(to be cont'd)

(Unit : Rp.)

Working Item	Quantity	Unit	Unit Price		Cost Amount		Remarks
			Local	Foreign	Local	Foreign	
(3) Stone Masonry							
- Type A	743	m^3	18,200	-	13,522,600	-	
- Type B	87	m^3	11,000	-	957,000	-	
(4) Filling	450	m^3	190	-	85,500	-	
(5) Concrete	4.1	m^3	21,400	-	87,740	-	
(6) Reinforcement Bar	0.205	t	11,760	444,240	2,411	91,069	
(7) Wooden form	12	m^2	1,770	-	21,240		
(8) Wooden Gate	0.3	m^2	50,000	100,000	15,000	30,000	
(9) Metal works	0.52	t	255,000	425,000	132,600	221,000	
(10) Screen	1	t	255,000	425,000	255,000	425,000	
(11) Steel Gate	10.5	m^3	150,000	300,000	1,575,000	3,150,000	
(12) Cobble	4.1	m^3	810	-	3,321	-	
Sub-total					(20,615,662)	(6,107,569)	
(13) Others	10	%			2,061,566	610,757	
(14) Temporary Works	20	%			4,123,132	1,221,514	
Sub-total					(26,800,360)	(7,939,840)	
(15) Over head	25	%			6,700,090	1,984,960	
Total					(33,500,450) (33,500,000)	(9,924,800) (9,924,000)	

(to be cont'd)

(Unit : Rp.)

Working Item	Quantity	Unit	Unit Price		Cost Amount		Remarks
			Local	Foreign	Local	Foreign	
3. <u>Link Canal in NT Area</u>			-	-	<u>791,530,000</u>	<u>149,812,000</u>	33.9 km
(1) Excavation (BHS)	36,960	m^3	40	490	1,478,400	18,110,400	
(2) Assistance by Man power	7,392	m^3	550	-	4,065,600	-	
(3) Transport from bellow pit							
- Exca (BHS)	18,979	m^3	40	490	759,160	9,299,710	
- Trans (D.T)	18,979	m^3	160	1,540	3,036,640	29,227,660	1 = 5,000
(4) Embankment							
- Spread (Bull)	55,940	m^3	20	310	1,118,800	17,341,400	
- Compaction	55,940	m^3	190	-	10,628,600	-	
(5) Face Smoothing	339,000	m^3	170	-	57,630,000	-	
(6) Stone Masonry	20,420	m^3	18,200	-	371,644,000	-	
(7) Concrete	14	m^3	21,400	-	299,600	-	
(8) Concrete form	28	m^2	1,770	-	49,560	-	
(9) Cobble	100	m^3	810	-	81,000	-	
(10) Reinforced Bar	0.4	t	11,760	444,240	4,704	177,696	
(11) Mortal	14	m^3	20,200	-	282,800	-	
(12) Wooden Plate	6	m^3	130,000	-	780,000	-	
(13) Metal Work	34	t	255,000	425,000	8,670,000	14,450,000	

(to be cont'd)

(Unit : Rp.)

Working Item	Quantity	Unit	Unit Price		Cost Amount		Remarks
			Local	Foreign	Local	Foreign	
(14) Gate	21.9	m^2	50,000	100,000	1,095,000	2,190,000	0.9x0.9x27
(15) Turfing	48,900	m^2	370	-	18,093,000		
Sub-total					(479,716,860)	(90,796,866)	
(16) Others	10	%			47,971,000	9,079,000	
(17) Temporary Works	20	%			105,537,000	19,975,000	
(18) Over head	25	%			158,306,000	29,962,000	
Total					791,530,860 (791,530,000)	149,812,866 (149,812,000)	
4. Tertiary Development					257,141,000		
D - 1	370	ha	88,670	-	32,807,000	-	
D - 2	1,270	ha	88,670	-	112,610,000	-	
D - 3	1,260	ha	88,670	-	111,724,000	-	
(Estimate for 100 ha)							
(1) Diversion Box							
- Tertiary	0.4	Nos.	62,500	-	25,000	-	
- Quarternary	3.4	Nos.	30,200	-	102,680	-	
(2) Outlet	430	Nos.	16,200	-	6,966,000	-	
Sub-total					(7,093,680)		Unit 100 ha

(to be cont'd)

(Unit : Rp.)

Working Item	Quantity	Unit	Unit Price		Cost Amount		Remarks
			Local	Foreign	Local	Foreign	
(3) Over head	25	%			1,773,420		
Total					8,867,100 (8,867,000)		Unit 100 ha 88,670/ha
5. Land Aquisition							
(1) Link Canal	339,000	m^2	300		101,700,000		
(WORK DIVISION II)							
1. Preparation	-	-	-	-	-	-	10% of Direct Cost
2. Langkemme Intake Weir					121,826,000	62,162,000	
(1) Excavation							
- Soil (BHS)	5,730	m^3	40	490	229,200	2,807,700	
- Rock (Pick)	1,236		830	3,370	1,025,880	4,165,320	
- Rock (Blasting)	4,944		2,590	1,660	12,804,960	8,207,040	
(2) Assistance by Man Power							
- Soil	1,146		550	-	630,300	-	5,730x20%
- Rock (Pick)	988		830	3,370	820,040	3,329,560	4,944x20%

(to be cont'd)

(Unit : Rp.)

Working Item	Quantity	Unit	Unit Price		Cost Amount		Remarks
			Local	Foreign	Local	Foreign	
(3) Loading (BHS)							
- Rock	6,180		50	550	309,000	3,399,000	
(4) Transplanting by Dump-Truck							1 = 1,000 m
- Soil	2,480		70	680	173,600	1,686,400	
- Rock	6,180		100	1,040	618,000	6,427,200	
(5) Filling							
- Trans by Man Power	2,340		110	-	257,400	-	
- Compaction	2,340		190	-	444,600	-	
(6) Stone Masonry							
- Type A	2,620	m^3	18,200	-	47,684,000	-	
- Type B	390	m^3	11,000	-	4,290,000	-	
(7) Concrete Works							
- Concrete	130	m^3	19,590	310	2,546,700	40,300	
- Reinforced Bar	6.5	t	11,760	444,240	76,440	2,887,560	
- Wooden form	650	m^2	1,770	-	1,150,500	-	
- Cobble	9	m^3	810	-	7,290	-	
(8) Gabion	180	m^3	15,800	-	2,844,000	-	
(9) Screen & Gate							
- Screen	3.6	t	255,000	425,000	918,000	1,530,000	

(to be cont'd)

(Unit : Rp.)

Working Item	Quantity	Unit	Unit Price		Cost Amount		Remarks
			Local	Foreign	Local	Foreign	
- Mortal	7	m^3	20,200	-	141,400	-	
- Wooden Plate	7	m^3	70,000	-	490,000	-	Nos.
- Gate	6	m^2	150,000	300,000	900,000	1,800,000	2.0x1.5x2
- -do-	8	m^2	150,000	300,000	1,200,000	2,400,000	2.0x2.0x2 "
- Metal works	6.5	t	255,000	425,000	1,657,500	2,762,500	
Sub-total					(81,218,810)	(41,442,580)	122,654,100
(10) Temporary works	20	%			16,243,000	8,288,000	
(11) Over head	25	%			24,365,000	12,432,000	
Total					(121,826,810) (121,826,000)	(62,162,580) (62,162,000)	
3. Langkemme Canal							
(L - 1)	-	-	-	-	517,397,000	1,320,895,000	
Canal	-	-	-	-	234,115,000	861,842,000	
Tunnel	-	-	-	-	136,800,000	370,800,000	
Rerated Structure	-	-	-	-	146,482,000	88,253,000	
A. Canal							L = 7.57 km
(1) Excavation							
- Soil (Bull)	58,800	m^3	30	550	1,764,000	32,340,000	

(to be cont'd)

(Unit : Rp.)

Working Item	Quantity	Unit	Unit Price		Cost Amount		Remarks
			Local	Foreign	Local	Foreign	
- Soil (BHS)	88,200	m^3	40	490	3,528,000	43,218,000	
- R-U (BHS)	10,000	m^3	50	550	500,000	5,500,000	
- R-L (Pick)	40,000	m^3	830	3,370	33,200,000	134,800,000	
- H-R (Blasting)	4,000	m^3	2,590	1,660	10,360,000	6,640,000	
(2) Assist by Man Power							
- Exca. of Soil	29,400	m^3	550	-	16,170,000	-	x 20%
- Pick. of R-U	5,000	m^3	830	3,370	4,150,000	16,850,000	x 50%
- Pick. of H-R	800	m^3	830	3,370	664,000	2,696,000	x 20%
(3) Transport to Deposit Area							
(a) Handling							
Bull only	58,800	m^3	60	1,010	3,528,000	59,388,000	
BHS (R-L)	40,000	m^3	50	550	2,000,000	22,000,000	
BHS (H-R)	4,000	m^3	50	550	200,000	2,200,000	
(b) Transporting							1 = 5,000 m
D.T (Soil)	30,900	m^3	160	1,540	4,944,000	47,586,000	
D.T (R-U)	10,000	m^3	230	2,370	2,300,000	23,700,000	
D.T (R-L)	40,000	m^3	230	2,370	9,200,000	94,800,000	
D.T (H-R)	4,000	m^3	230	2,370	920,000	9,480,000	

(to be cont'd)

(Unit : Rp.)

Working Item	Quantity	Unit	Unit Price		Cost Amount		Remarks
			Local	Foreign	Local	Foreign	
(4) Trans. to Filling point	57,300	m^3	60	570	3,438,000	32,661,000	1 = 1,000 m
(5) Filling							
- Spreading	46,400	m^3	20	310	928,000	14,384,000	
- Compaction	46,400	m^3	190	-	8,816,000	-	
(6) Spreading at Deposit Area	84,900	m^3	20	310	1,698,000	26,319,000	
(7) Face Smoothing	151,400	m^2	170	-	25,738,000	-	20m x 7,570
(8) Turfing	1,500	m^2	370	-	555,000		
(9) Lining	1,180	m^3	18,200	-	21,476,000		
Sub-total					(156,077,000)	(574,562,000)	
(10) Temporary Works	20	%			31,215,400	114,912,000	
Sub-total					(187,292,400)	(689,474,000)	
(11) Overhead	25	%			46,823,000	172,368,000	
Total					234,115,400 (234,115,000)	861,842,000	
B. Tunnel					136,800,000	370,800,000	
Tunnel Construction	720	m	152,000	412,000	109,440,000	296,640,000	See Data Book

(to be cont'd)

(Unit : Rp.)

Working Item	Quantity	Unit	Unit Price Local	Unit Price Foreign	Cost Amount Local	Cost Amount Foreign	Remarks
Overhead	25	%			27,360,000	74,160,000	
Total					(136,800,000)	(370,800,000)	
C. <u>Related Structures</u>					<u>146,482,000</u>	<u>88,253,000</u>	
(1) Cross Drain (I-I)	2	Nos.	6,730,000	1,080,000	13,460,000	2,160,000	@ 5.0
(2) " (II-I)	8	Nos.	2,670,000	930,000	21,360,000	7,440,000	@ 5.0
(3) Turn Out	1	complete			5,630,000	1,620,000	3 Nos.
(4) Junction (Type-II)	1	No.	1,070,000	5,000	1,070,000	5,000	
(5) Check Gate Structure	1	complete			7,870,000	4,390,000	2 Nos.
(6) Spill Way (Type S)	1	No.	5,230,000	0	5,230,000		
(7) Spill Way Special	1	No.	33,845,000	-	33,845,000	-	
(8) Culvert (Type I)	2	Nos.	3,890,000	540,000	7,780,000	1,080,000	
(9) " (Type II)	1	No.	3,220,000	390,000	3,220,000	390,000	
(10) " (Type III)	1	No.	2,670,000	540,000	2,670,000	540,000	
(11) " (Type IV)	1	No.	6,110,000	1,080,000	6,110,000	1,080,000	
(12) Waste Way	1	No.	8,941,000	51,897,000	8,941,000	51,898,000	
Sub-total					(117,186,000)	(70,603,000)	
(13) Overhead	25	%			29,296,000	17,650,000	
Total					(146,482,000)	(88,253,000)	

(to be cont'd)

(Unit : Rp.)

Working Item	Quantity	Unit	Unit Price		Cost Amount		Remarks
			Local	Foreign	Local	Foreign	
(L - 2)					268,378,000	758,618,000	
Canal	-	-	-	-	171,452,000	713,786,000	
Related Structures	-	-	-	-	96,926,000	44,832,000	
A. Canal					171,452,000	713,786,000	∠ = 9.38 km
(1) Excavation							
- Soil (Bull)	49,200		30	550	1,476,000	27,060,000	
- Soil (BHS)	73,800		40	490	2,952,000	36,162,000	
- R-U (BHS)	8,800		50	550	440,000	4,840,000	
- R-L (Pick)	35,200		830	3,370	29,216,000	118,624,000	
- H-R (Blasting)	-		2,590	1,660	-	-	
(2) Assistance by Man Power							
- Exca. of Soil	24,600		550	-	13,530,000	-	x 20%
- Pick of R-U	4,400		830	3,370	3,652,000	14,828,000	x 50%
- Pick of H-R	-		830	3,370	-	-	x 20%
(3) Transport to Deposit Area							
(a) Handling							
- Bull only	49,200		60	1,010	2,952,000	49,692,000	
- BHS (R-L)	35,200		50	550	1,760,000	19,360,000	

(to be cont'd)

(Unit : Rp.)

Working Item	Quantity	Unit	Unit Price		Cost Amount		Remarks
			Local	Foreign	Local	Foreign	
- BHS (H-R)	-		50	550	-	-	
(b) Transporting							1 = 5,000 m
- D.T (Soil)	6,400		160	1,540	1,024,000	9,856,000	
- D.T (R-U)	8,800		230	2,370	2,024,000	20,856,000	
- D.T (R-L)	35,200		230	2,370	8,096,000	83,424,000	
- D.T (H-R)	-		230	2,370	-	-	
(4) Transport to Stock-pile	38,900		90	1,340	3,501,000	52,126,000	
(5) Trans. to Filling point	28,500		60	570	1,710,000	16,245,000	
(6) Filling							
- Spreading	23,100		20	310	462,000	7,161,000	
- Compaction	23,100		190	-	4,389,000	-	
(7) Spreading at Deposit Area	50,400		20	310	1,008,000	15,624,000	
(8) Face Smoothing	187,600		170	-	31,892,000	-	20m x 9380m
(9) Turfing	11,400		370	-	4,218,000	-	
Sub-total					(114,302,000)	(475,858,000)	
(10) Temporary Works	20	%			22,860,000	95,171,000	
Sub-total					(137,162,000)	(571,029,000)	

(to be cont'd)

(Unit : Rp.)

Working Item	Quantity	Unit	Unit Price		Cost Amount		Remarks
			Local	Foreign	Local	Foreign	
(11) Overhead	25	%			34,290,000	142,757,000	
Total					(171,452,000)	(713,786,000)	
B. Related Structures					96,926,000	44,832,000	
(1) Aqueduct (Maddenra)	1	No.	10,400,000	5,190,000	10,400,000	2,890,000	
(2) Syphon (H.P.S.)	1	No.	4,450,000	2,890,000	4,450,000	2,890,000	
(3) " (Baruttungnge)	1	No.	4,360,000	3,300,000	4,360,000	3,300,000	
(4) Syphon (Labempba)	1	No.	4,970,000	4,020,000	4,970,000	4,020,000	
(5) Cross Drain (II-II)	5	Nos.	2,160,000	690,000	10,800,000	3,450,000	@ 3.0
(6) Turn Out	1	complete			6,770,000	1,820,000	4 Nos.
(7) Junction (Type I)	1	No.	960,000	5,000	960,000	5,000	
(8) " (Type II)	2	Nos.	1,070,000	5,000	2,140,000	10,000	
(9) " (Type III)	1	No.	1,110,000	5,000	1,110,000	5,000	
(10) Drop (Type-I)	1	No.	4,900,000	0	4,900,000	0	
(11) " (Type-III)	1	No.	3,420,000	0	3,420,000	0	
(12) Check Gate Structure	1	complete			9,590,000	7,080,000	4 Nos.
(13) Spill Way (Type-B)	1	No.	500,000	0	500,000	0	
(14) " (Type-A1)	1	No.	350,000	0	350,000	0	

(to be cont'd)

(Unit : Rp.)

Working Item	Quantity	Unit	Unit Price		Cost Amount		Remarks
			Local	Foreign	Local	Foreign	
(15) Culvert (Type V)	1	No.	5,630,000	1,030,000	5,630,000	1,030,000	
(16) " (Type VI)	1	No.	2,370,000	3,400,000	2,370,000	3,400,000	
(17) Wasteway	240	m			4,821,000	3,666,000	
Sub-total					(77,541,000)	(35,866,000)	
(18) Overhead	25	%			19,385,000	8,966,000	
Total					(96,926,000)	(44,832,000)	
(L - 3)					386,295,000	189,789,000	
Canal	-	-	-	-	143,193,000	153,607,000	
Related Structures	-	-	-	-	243,102,000	36,182,000	
A. Canal					143,193,000	153,607,000	L = 11.75km
(1) Excavation							
- Soil (Bull)			30	550	-	-	
- Soil (BHS)	54,000		40	490	2,160,000	26,460,000	
- R-U (BHS)	200		50	550	10,000	110,000	
- R-L (Pick)	800		830	3,370	664,000	2,696,000	
- H-R (Blasting)	-		2,590	1,660	-	-	

(to be cont'd)

(Unit : Rp.)

Working Item	Quantity	Unit	Unit Price		Cost Amount		Remarks
			Local	Foreign	Local	Foreign	
(2) Assistance by Man Power							
- Exca. of Soil	10,800		550	-	5,940,000	-	x 20%
- Pick of R-U	100		830	3.370	83,000	337,000	x 50%
- Pick of H-R	-		830	3,370	-	-	x 20%
(3) Transport to Deposit Area							
(a) Handling							
- Bull only	-		60	1.010	-	-	
- BHS (R-L)	800		50	550	40,000	440,000	
- BHS (H-R)			50	550	-	-	l = 5,000 m
(b) Transporting							
- D.T (Soil)	16,200		160	1,540	2,592.000	24,948,000	
- D.T (R-U)	200		230	2,370	46,000	474,000	
- D.T (R-L)	800		230	2,370	184,000	1.896.000	
- D.T (H-R)	-		230	2,370	-	-	
(4) Transport to Stock-pile	-		90	1,340	-	-	l = 5,000 m
(5) Transport to Filling point	37.800		60	570	2.268,000	21,546,000	

(to be cont'd)

(Unit : Rp.)

Working Item	Quantity	Unit	Unit Price		Cost Amount		Remarks
			Local	Foreign	Local	Foreign	
(6) Filling							
- Spreading	58,600		20	310	1,172,000	18,166,000	
- Compaction	58,600		190	-	11,134,000	-	
(7) Spreading at Deposit Area	17,200		20	310	344,000	5,332,000	
(8) Face Smoothing	235,000		170	-	39,950,000	-	20m x 11750m
(9) Turfing	31,800		370	-	11,766,000		
(10) Lining	940	m^3	18,200		17,110,000		
Sub-total					(95,463,000)	(102,405,000)	
(11) Temporary Works	20	%			19,092,600	20,481,000	
Sub-total					(114,555,600)	(122,886,000)	
(12) Overhead	25	%			28,638,000	30,721,000	
Total					(143,193,600) (143,193,000)	(153,607,000)	
B. Related Structures					243,102,000	36,182,000	
(1) Syphon (Cong Kai)	1	No.	5,560,000	5,410,000	5,560,000	5,410,000	
(2) " (Panincong)	1	No.	3,480,000	2,850,000	3,480,000	2,850,000	
(3) " (Macope)	1	No.	3,690,000	3,300,000	3,690,000	3,300,000	
(4) Cross Drain (I-II)	1	No.	5,210,000	780,000	5,210,000	780,000	Q = 2.5

(to be cont'd)

(Unit : Rp.)

Working Item	Quantity	Unit	Unit Price		Cost Amount		Remarks
			Local	Foreign	Local	Foreign	
(5) Cross Drain (I-III)	1	No.	5,060,000	730,000	5,060,000	730,000	Q = 2.0
(6) " (II-IV)	1	No.	2,090,000	640,000	2,090,000	640,000	Q = 2.0
(7) Turn Out	1	complete			13,560,000	1,530,000	10 Nos.
(8) Junction (Type I)	3	Nos.	960,000	5,000	2,880,000	15,000	
(9) " (Type II)	3	Nos.	1,070,000	5,000	3,210,000	15,000	
(10) " (Type III)	3	Nos.	1,110,000	5,000	3,330,000	15,000	
(11) Drop (Type I)	4	Nos.	4,900,000	0	19,600,000	0	
(12) " (Type II)	9	Nos.	3,910,000	0	35,190,000	0	
(13) " (Type III)	3	Nos.	3,420,000	0	10,260,000	0	
(14) " (Type IV)	4	Nos.	4,140,000	0	16,560,000	0	
(15) " (Type V)	1	No.	3,640,000	0	3,640,000	0	
(16) " (Type VI)	8	Nos.	3,220,000	0	25,760,000	0	
(17) " (Type VII)	2	Nos.	2,940,000	0	5,880,000	0	
(18) Check Gate Structure	1	complete			17,350,000	10,230,000	10 Nos.
(19) Spill Way (Type-A2)	3	Nos.	330,000	0	990,000	0	
(20) Culvert (Type VII)	1	No.	1,440,000	290,000	1,440,000	290,000	
(21) " (Type VIII)	1	No.	1,700,000	290,000	1,700,000	290,000	
(22) " (Type IX)	1	No.	2,260,000	490,000	2,260,000	490,000	
(23) " (Type X)	1	No.	1,840,000	290,000	1,840,000	290,000	

(to be cont'd)

(Unit : Rp.)

Working Item	Quantity	Unit	Unit Price		Cost Amount		Remarks
			Local	Foreign	Local	Foreign	
(24) Junction of Outlet	1	No.	1,070,000	5,000	1,070,000	5,000	
(25) Wasteway	118	m			2,872,000	2,066,000	
Sub-total					(194,482,000)	(28,946,000)	
(26) Overhead	25	%			48,620,000	7,236,000	
Total					(243,102,000)	(36,182,000)	
4. Link Canal in ST Area					53,333,000	14,078,000	
(1) Excavation	2,300	m^3	40	490	22,000	1,127,000	
(2) Assistance by Man Power	460	m^3	550	-	253,000	-	
(3) Transport from bellow pit							
- Exca. (BHS)	1,983	m^3	40	490	79,320	971,670	
- Trans. (DT)	1,983	m^3	160	1,540	317,280	3,053,820	
(4) Embankment							
- Spread (Bull)	1,350	m^2	20	310	27,000	418,500	
- Compaction	1,350	m^3	190	-	256,500	-	
(5) Face Smoothing	21,000	m^2	170	-	3,570,000	-	10m x 2,100
(6) Stone Masonry	1,350	m^3	18,200	-	24,570,000	-	

(to be cont'd)

(Unit : Rp.)

Working Item	Quantity	Unit	Unit Price		Cost Amount		Remarks
			Local	Foreign	Local	Foreign	
(7) Concrete	2	m^3	21,400	-	42,800	-	
- Concrete form	4	m^2	1,770	-	7,080	-	
- Cobble	6	m^3	810	-	4,860	-	
- Reinforced Bar	0.2	t	11,760	444,240	2,352	88,848	
(8) Mortal	2	m^3	20,200		40,400	-	
(9) Wooden Plate	2	m^3	130,000		260,000		
(10) Metal works	6	t	255,000	425,000	1,530,000	2,550,000	
(11) Gate	3.24	m^2	50,000	100,000	162,000	324,000	0.9x0.9x4
(12) Turfing	3,000	m^2	370		1,110,000		
Sub-total					(32,324,592)	(8,533,838)	
(13) Others	10	%			3,232,000	853,000	
Sub-total					(35,556,592)	(9,386,838)	
(14) Temporary Works	20	%			7,111,000	1,877,000	
Sub-total					(42,667,592)	(11,263,838)	
(15) Overhead & Others	25	%			10,666,000	2,815,000	
Total					(53,333,592) (53,333,000)	(14,078,838) (14,078,000)	

(to be cont'd)

(Unit : Rp.)

Working Item	Quantity	Unit	Unit Price		Cost Amount		Remarks
			Local	Foreign	Local	Foreign	
5. Tertiary Development	4,500	ha	236,380	-	1,063,710,000	-	
(Estimate for 100 ha)							
(1) Canal Construction							
- Tertiary	800	m	2,230	-	1,784,000	-	
- Quarternary	3,200	m	1,170	-	3,744,000	-	
(2) Canal Rehabili.	100	ha	14,670	-	1,467,000	-	
(3) Structures							
(a) Division Box							
- Tertiary	0.56	Nos.	62,500	-	35,000	-	
- Quarternary	5.1	Nos.	30,200	-	154,020	-	
(b) Outlet	723	Nos.	16,200	-	11,712,600	-	
(c) Weir							
- Tertiary	0.18	Nos.	36,000	-	6,480	-	
- Quarternary	0.71	Nos.	11,900	-	8,449	-	
Sub-total					(18,911,549)	(-)	
(4) Overhead	25	%			4,727,000	-	
Total					(23,638,549) (23,638,000)	(-)	Unit 100 ha 236,380/ha

(to be cont'd)

(Unit : Rp.)

Working Item	Quantity	Unit	Unit Price		Cost Amount		Remarks
			Local	Foreign	Local	Foreign	
6. Land Aquisition					259,410,000	-	
Tertiary Develop.	475,200	m^2	300	-	142,560,000	-	
Link Canal	21,000	m^2	300		6,300,000	-	
Langkemme C.	205,500	m^2	100		20,550,000	-	
- do -	300,000	m^2	300		90,000,000	-	
(WORK DIVISION III)							
1. Preparation	-	-	-	-	-	-	10% of Direct Cost
2. Jupang Intake Weir	-	-	-	-	40,175,000	7,587,000	
(1) Excavation							
- Soil (BHS)	1,790	m^3	40	490	71,600	877,100	
- Rock (Pick)	38		830	3,370	31,540	128,060	
- Rock (Blasting)	152		2,590	1,660	393,680	252,320	
(2) Assistance by Man Power							
- Soil	358		550	-	196,900	-	1,790 x 20%
- Rock (Pick)	30		830	3,370	24,900	101,100	152 x 20%

(to be cont'd)

(Unit : Rp.)

Working Item	Quantity	Unit	Unit Price		Cost Amount		Remarks
			Local	Foreign	Local	Foreign	
(3) Loading (BHS)							
Rock	190		50	550	9,500	104,500	
(4) Transporting							
- By Dump. T.							
- Soil	1,290		70	680	90,300	877,200	
- Rock	190		100	1,040	19,000	197,600	
(5) Filling							
- Transport by Man Power	360		110	-	39,600	-	
- Compaction	360		190	-	68,400	-	
(6) Stone Masonry							
- Type A	1,000	m^3	18,200	-	18,200,000	-	
- Type B	190	m^3	11,000	-	2,090,000	-	
(7) Concrete Works							
- Concrete	22	m^3	19,590	310	430,980	6,820	
- Reinforced Bar	-						
- Wooden form	110	m^2	1,770	-	194,700	-	$22m^3 x 5m^2/m^3$
- Cobble	5	m^3	810	-	4,050	-	
(8) Gabion	200	m^3	15,800	-	3,160,000	-	

(to be cont'd)

(Unit : Rp.)

Working Item	Quantity	Unit	Unit Price		Cost Amount		Remarks
			Local	Foreign	Local	Foreign	
(9) Metal works	3.8	t	255,000	425,000	969,000	1,615,000	
(10) Gate	3.0	m^2	150,000	300,000	450,000	900,000	1.5x1.0x2Nos.
(11) Other Materials							
- Mortal	2	m^3	20,200	-	40,400	-	
- Wooden Bar	5	m^3	60,000	-	300,000	-	
Sub-total					(26,784,550)	(5,059,700)	
(12) Temporary Works	20	%			5,356,000	1,011,000	
Sub-total					(32,140,550)	(6,070,700)	
(13) Overhead	25	%			8,035,000	1,517,000	
Total					(40,175,550) (40,175,000)	(7,587,700) (7,587,000)	
3. Unyi Intake Weir					12,767,000	4,150,000	
(1) Excavation							
- Soil	160	m^3	550	-	88,000	-	
- Soil	160	m^3	830	3,370	132,800	539,200	
- Rock (Pick)	210	m^3	830	3,370	174,300	707,700	
(2) Back Filling	120	m^3	190	-	22,800	-	

(to be cont'd)

(Unit : Rp.)

Working Item	Quantity	Unit	Unit Price		Cost Amount		Remarks
			Local	Foreign	Local	Foreign	
(3) Stone Masonry							
- Type A	150	m^3	18,200	-	2,730,000	-	
- Type B	10	m^3	11,000	-	110,000	-	
(4) Gabion	230	m^3	15,800	-	3,634,000	-	
(5) Cobble	30	m^3	810	-	24,300	-	
(6) Metal works	2.8	t	255,000	425,000	714,000	1,190,000	
(7) Mortal	1.0	m^3	20,200	-	20,200	-	
(8) Wooden Bar	0.4	m^3	120,000	-	48,000	-	
(9) Gate	0.8	m^2	50,000	100,000	40,000	80,000	0.8x0.5x2
Sub-total					(7,738,000)	(2,516,900)	
(10) Others	10	%	-	-	773,800	251,000	
Sub-total					(8,512,200)	(2,767,900)	
(11) Temporary Works	20	%	-	-	1,702,440	555,000	
Sub-total					(10,214,640)	(3,320,900)	
(12) Overhead	25	%			2,553,000	830,000	
Total					(12,767,000)	(4,150,000)	

(to be cont'd)

(Unit : Rp.)

Working Item	Quantity	Unit	Unit Price		Cost Amount		Remarks
			Local	Foreign	Local	Foreign	
4. Pising Intake Weir					15,275,000	4,527,000	
(1) Excavation							
- Soil	175	m3	550	-	96,250	-	
- Soil	175	m^3	830	3,370	145,250	589,750	
- Rock (Pick)	250	m^3	830	3,370	207,500	842,500	
(2) Back Filling	90	m^3	190	-	17,100	-	
(3) Stone Masonry							
- Type A	180	m^3	18,200	-	3,276,000	-	
- Type B	20	m^3	11,000	-	220,000	-	
(4) Gabion	280	m^3	15,800	-	4,424,000	-	
(5) Cobble	30	m^3	810	-	24,300	-	
(6) Metal works	2.9	t	255,000	425,000	739,500	1,232,500	
(7) Mortal	1.0	m^3	20,200	-	20,200	-	
(8) Wooden Bar	0.4	m^3	120,000	-	48,000	-	
(9) Gate	0.8	m^2	50,000	100,000	40,000	80,000	0.8x0.5x2
Sub-total					(9,258,100)	(2,744,750)	
(10) Others	10	%			925,800	274,000	
Sub-total					10,183,900	3,018,750	
(11) Temporary Works	20	%			2,036,780	603,750	
Sub-total					(12,220,680)	(3,622,500)	

(to be cont'd)

(Unit : Rp.)

Working Item	Quantity	Unit	Unit Price Local	Unit Price Foreign	Cost Amount Local	Cost Amount Foreign	Remarks
(12) Overhead	25	%			3,055,000	905,000	
Total					(15,275,680) (15,275,000)	(4,527,500) (4,527,000)	
5. Sero Diversion Canal							
(S - 1)					190,277,000	385,217,000	
Canal					145,090,000	372,511,000	
Related Structures					45,187,000	12,706,000	
A. Canal					145,090,000	372,511,000	$\bar{L}$ = 5.83km
(1) Excavation							
- Soil (Bull)	41,600		30	550	1,248,000	22,880,000	
- Soil (BHS)	62,400		40	490	2,496,000	30,576,000	
- R-U (BHS)	1,000		50	550	50,000	550,000	20%
- R-L (Pick)	4,000		830	3,370	3,320,000	13,480,000	80%
- H-R (Blasting)	7,000		2,590	1,660	18,130,000	11,620,000	
(2) Assistance by Man Power							
- Exca. of Soil	20,800		550	-	11,440,000	-	104,000x20%
- Pick of R-U	500		830	3,370	415,000	1,685,000	x 50%

(to be cont'd)

(Unit : Rp.)

Working Item	Quantity	Unit	Unit Price		Cost Amount		Remarks
			Local	Foreign	Local	Foreign	
- Pick of H-R	1,400		830	3,370	1,162,000	4,718,000	x 20%
(3) Transport to Deposit Area							
(a) Handling							40%
- Bull only	41,600		60	1,010	2,496,000	42,016,000	
- BHS (R-L)	4,000		50	550	200,000	2,200,000	
- BHS (H-R)	7,000		50	550	350,000	3,850,000	
(b) Transporting							1 = 5,000m
- D.T (Soil)	30,500		160	1,540	4,880,000	46,970,000	
- D.T (R-U)	1,000		230	2,370	230,000	2,370,000	
- D.T (R-L)	4,000		230	2,370	920,000	9,480,000	
- D.T (H-R)	7,000		230	2,370	1,610,000	16,590,000	
(4) Transport to Filling Point	31,900	m^3	60	570	1,914,000	18,183,000	1 = 1,000m
(5) Filling							
- Spreading	25,800	m^3	20	310	516,000	7,998,000	
- Compaction	25,800	m^3	190	-	4,902,000	-	
(6) Spreading at Deposit Area	42,500	m^3	20	310	850,000	13,175,000	
(7) Face Smoothing	116,600	m^2	170	-	19,822,000	-	20mx5,830m
(8) Turfing	1,800	m^2	370		666,000		

(to be cont'd)

(Unit : Rp.)

Working Item	Quantity	Unit	Unit Price		Cost Amount		Remarks
			Local	Foreign	Local	Foreign	
(9) Lining	1,050	m^3	18,200	-	19,110,000		
Sub-total					(96,727,000)	(248,341,000)	
(10) Temporary Works	20	%			19,345,400	49,668,000	
Sub-total					(116,072,400)	(298,009,000)	
(11) Overhead	25	%			29,018,000	74,502,000	
Total					(145,090,400) (145,090,000)	(372,511,000)	
B. Related Structures							
(1) Aquiduct (Unyi)	1	No.	13,460,000	6,530,000	13,460,000	6,530,000	
(2) Cross Drain (I-II)	3	Nos.	5,210,000	780,000	15,630,000	2,340,000	Q 2.5
(3) " (II-III)	2	Nos.	2,090,000	640,000	4,180,000	1,280,000	Q 2.5
(4) Small turnout	3	Nos.	960,000	5,000	2,880,000	15,000	Q 0.1
Sub-total					(36,150,000)	(10,165,000)	
(5) Overhead	25	%			9,037,000	2,541,000	
Total					(45,187,000)	(12,706,000)	
(S - 2)					473,866,000	873,547,000	
Canal					399,266,000	852,960,000	
Related Structures					74,600,000	20,587,000	

(to be cont'd)

(Unit : Rp.)

Working Item	Quantity	Unit	Unit Price		Cost Amount		Remarks
			Local	Foreign	Local	Foreign	
A. Canal					399,266,000	852,960,000	
(1) Excavation							
- Soil (Bull)	53,600		30	550	1,608,000	29,480,000	
- Soil (BHS)	80,400		40	490	3,216,000	39,396,000	
- R-U (BHS)	6,800		50	550	340,000	3,740,000	
- R-L (Pick)	27,200		830	3,370	22,576,000	91,664,000	
- H-R (Blasting)	25,000		2,590	1,660	64,750,000	41,500,000	
(2) Assistance by Man Power							
- Exca. of Soil	26,800		550	-	14,740,000	-	x 20%
- Pick of R-U	3,400		830	3,370	2,822,000	11,458,000	x 50%
- Pick of H-R	5,000		830	3,370	4,150,000	16,850,000	x 20%
(3) Transport to Deposit Area							
(a) Handling							
- Bull only	53,600		60	1,010	3,216,000	54,136,000	
- BHS (R-L)	27,200		50	550	1,360,000	14,960,000	
- BHS (H-R)	25,000		50	550	1,250,000	13,750,000	
(b) Transporting							1 = 5,000m
- D.T (Soil)	26,800		160	1,540	4,288,000	41,272,000	

(to be cont'd)

(Unit : Rp.)

Working Item	Quantity	Unit	Unit Price Local	Unit Price Foreign	Cost Amount Local	Cost Amount Foreign	Remarks
- D.T (R-U)	6,800		230	2,370	1,564,000	16,116,000	
- D.T (R-L)	27,200		230	2,370	6,256,000	64,464,000	
- D.T (H-R)	25,000		230	2,370	5,750,000	59,250,000	
(4) Transport to Filling Point	53,600		60	570	3,216,000	30,552,000	
(5) Filling							
- Spreading	43,400		20	310	868,000	13,454,000	
- Compaction	43,400		190	-	8,246,000	-	
(6) Spreading at Deposit Area	85,800		20	310	1,716,000	26,598,000	
(7) Face Smoothing	182,800	m^2	170	-	31,076,000	-	20mx9,140m
(8) Turfing	5,400	m^2	370	-	1,998,000		
(9) Lining	4,460	m^3	18,200		81,172,000		
Sub-total					(266,178,000)	(568,640,000)	
(10) Temporary Works	20	%			53,235,600	113,728,000	
Sub-total					319,413,600	682,368,000	
(11) Overhead	25	%			79,853,000	170,592,000	
Total					(399,266,600) (399,266,000)	(852,960,000)	

(to be cont'd)

(Unit : Rp.)

Working Item	Quantity	Unit	Unit Price		Cost Amount		Remarks
			Local	Foreign	Local	Foreign	
B. Related Structures					74,600,000	20,587,000	
(1) Aquiduct (Pising)	1	No.	13,490,000	6,760,000	13,490,000	6,760,000	
(2) " (Limpo.)	1	No.	7,270,000	3,330,000	7,270,000	3,330,000	
(3) Cross Drain (I-II)	5	Nos.	5,210,000	780,000	26,050,000	3,900,000	Q 2.5
(4) " (II-III)	3	Nos.	2,090,000	640,000	6,270,000	1,920,000	Q 2.5
(5) Culvert (Type XI)	1	No.	1,670,000	340,000	1,670,000	340,000	
(6) " (Type XII)	1	No.	1,090,000	200,000	1,090,000	200,000	
(7) Small turnout	4	Nos.	960,000	5,000	3,840,000	20,000	
Sub-total					(59,680,000)	(16,470,000)	
(8) Overhead	25	%			14,920,000	4,117,000	
Total					(74,600,000)	(20,587,000)	
6. Link Canal in D.P.U.							
(1) Excavation (BHS)	3,829	m^3	40	490	152,800	1,871,800	
(2) Assistance by Man Power	764	m^3	550	-	420,200	-	
(3) Transport from bellow pit							
- Exca. (BHS)	3,315	m^3	40	490	132,600	1,624,350	
- Trans. (D.T)	3,315	m^3	160	1,540	530,400	5,105,100	

(to be cont'd)

(Unit : Rp.)

Working Item	Quantity	Unit	Unit Price		Cost Amount		Remarks
			Local	Foreign	Local	Foreign	
(4) Embankment							
- Spread (Bull)	5,780	m^3	20	310	115,600	1,791,800	
- Compaction	5,780	m^3	190	-	1,098,200	-	
(5) Face Smoothing	35,000	m^2	170	-	5,950,000	-	10mx3,500
(6) Turfing	5,000	m	370	-	1,850,000		
(7) Stone Masonry	2,050	m^3	18,200	-	37,310,000	-	
(8) Cobble	10	m^3	810	-	8,100	-	
Sub-total					(47,567,900)	(10,393,050)	
(9) Others	10	%			4,756,000	1,039,000	
Sub-total					(52,323,900)	(11,432,050)	
(10) Temporary Works	20	%			10,464,000	2,286,000	
Sub-total					(62,787,900)	(13,718,050)	
(11) Overhead	25	%			15,696,000	3,429,000	
Total					(78,483,900) (78,483,000)	(17,147,050) (17,147,000)	
7. Tertiary Development (Estimate for 100 ha)	1,900	ha	292,480	-	555,712,000	-	

(to be cont'd)

(Unit : Rp.)

Working Item	Quantity	Unit	Unit Price		Cost Amount		Remarks
			Local	Foreign	Local	Foreign	
(1) Canal Construction							
Tertiary	800	m	2,230	0	1,784,000	-	
Quarternary	3,200	m	1,170	0	3,744,000	-	
(2) Canal Rehabilitation	100	ha	14,670	0	1,467,000	-	
(3) Structures							
(a) Division Box							
- Quarternary	4	Nos.	30,200	0	120,800	-	
(b) Outlet	1,000	Nos.	16,200	0	16,200,000	-	
(c) Weir							
- Tertiary	1	No.	36,000	0	36,000	-	
- Quarternary	4	Nos.	11,900	0	47,600	-	
Sub-total					(23,399,400)	(-)	
(4) Overhead	25	%			5,849,000	-	
Total					(29,248,400) (29,248,000)	(-)	Unit 100 ha 292,480/ha
8. Land Aquisiton					93,147,000	-	
Tertiary Develop.	200,640	m^2	300	-	60,192,000	-	

(to be cont'd)

(Unit : Rp.)

Working Item	Quantity	Unit	Unit Price		Cost Amount		Remarks
			Local	Foreign	Local	Foreign	
Link Canal	35,000	m^2	300		10,500,000	-	
Sero Diversion C.	224,550	m^2	100		22,455,000	-	
Total					(93,147,000)	(-)	

Table 4.3.3 Operation and Maintenance Cost

			$(10^3$ US\$)
I.	Personnel Cost		170
II.	Depreciation Cost of O/M equipment		120
	1. Vehicle	27.1	
	2. O/M equipment	93.2	
	Sub-total	120.3 (120)	
III.	Maintenance Cost for facilities	20.2 (20)	20
IV.	Office & General Expense		100
	1. Gasoline 0.1	58.3	
	2. Office	13.0	
	3. General Expense	29.0	
	Sub-total	100.3 (100)	
V.	Micro Power Station		35
	Sub-total		445
VI.	Physical Contingency (15%)		66.8 (67)
	Total		512

Table 4.3.4 Replacement Cost

	Item	L/C	F/C	Total	Durable Period
		$(10^3$US\$)	$(10^3$US\$)	$(10^3$US\$)	(Year)
I.	Gate	35	70	105	25
II.	Wooden bar	6	-	6	10
III.	Gabion	83	-	83	10
IV.	Screen & Metal Works	18	31	49	10

Table 4.3.5 Annual Disbursement Schedule of Financial Project Cost

(Unit : 10^3 US$)

	1982			1983			1984			1985			1986			1987		
	L	F	T	L	F	T	L	F	T	L	F	T	L	F	T	L	F	T
Construction Cost																		
Work Division I				844.3	68.0	912.3	937.4	146.4	1,083.8	736.3	125.6	861.9						
Work Division II				1,190.8	789.6	1,980.4	1,463.4	1,584.8	3,048.2	738.5	831.3	1,569.8	1,682.3	547.3	2,229.6			
Work Division III							642.1	97.9	740.0	639.7	1,089.5	1,729.2	1,370.4	876.4	2,246.8	121.8	3.2	125.0
Sub Total				2,035.1	857.6	2,892.7	3,042.9	1,829.1	4,872.0	2,114.5	2,046.4	4,160.9	3,052.7	1,423.7	4,476.4	121.8	3.2	125.0
Engineering Services	52.2	734.9	787.1	129.2	1,020.5	1,149.7	91.7	590.8	682.5	86.8	478.8	565.6	99.4	369.0	468.4	4.3	44.0	48.3
Administration	119.4	-	119.4	150.3	-	150.3	34.4	-	34.4	31.9	-	31.9	29.4	-	29.4	18.1	-	18.1
Sub Total	171.6	734.9	906.5	2,314.6	1,878.1	4,192.7	3,169.0	2,419.9	5,588.9	2,233.2	2,525.2	4,758.4	3,181.5	1,792.7	4,974.2	144.2	47.2	191.4
Physical Contingency (15%)	25.7	110.2	135.9	347.2	281.7	628.9	475.4	363.0	838.4	335.0	378.8	713.8	477.2	268.9	746.1	21.6	7.1	28.7
Sub Total	197.3	845.1	1,042.4	2,661.8	2,159.8	4,821.6	3,644.4	2,782.9	6,427.3	2,568.2	2,904.0	5,472.2	3,658.7	2,061.6	5,720.3	165.8	54.3	220.1
Price Contingency																		
Local (10%)	41.4	-	41.4	881.1	-	881.1	1,691.4	-	1,691.4	1,567.9	-	1,567.9	2,823.1	-	2,823.1	157.3	-	157.3
Foreign (7%)	-	122.5	122.5 (163.9)	-	486.0	486.0 (1,367.1)	-	864.9	864.9 (2,556.3)	-	1,169.2	1,169.2 (2,737.1)	-	1,032.2	1,032.2 (3,855.3)	-	32.9	32.9 (190.2)
Total	238.7	967.6	1,206.3	3,542.9	2,645.8	6,188.7	5,335.8	3,647.8	8,983.6	4,136.1	4,073.2	8,209.3	6,481.8	3,093.8	9,575.6	323.1	87.2	410.3
																		(34,573.8)

Note: L : Local portion
F : Forein portion
T : Total cost

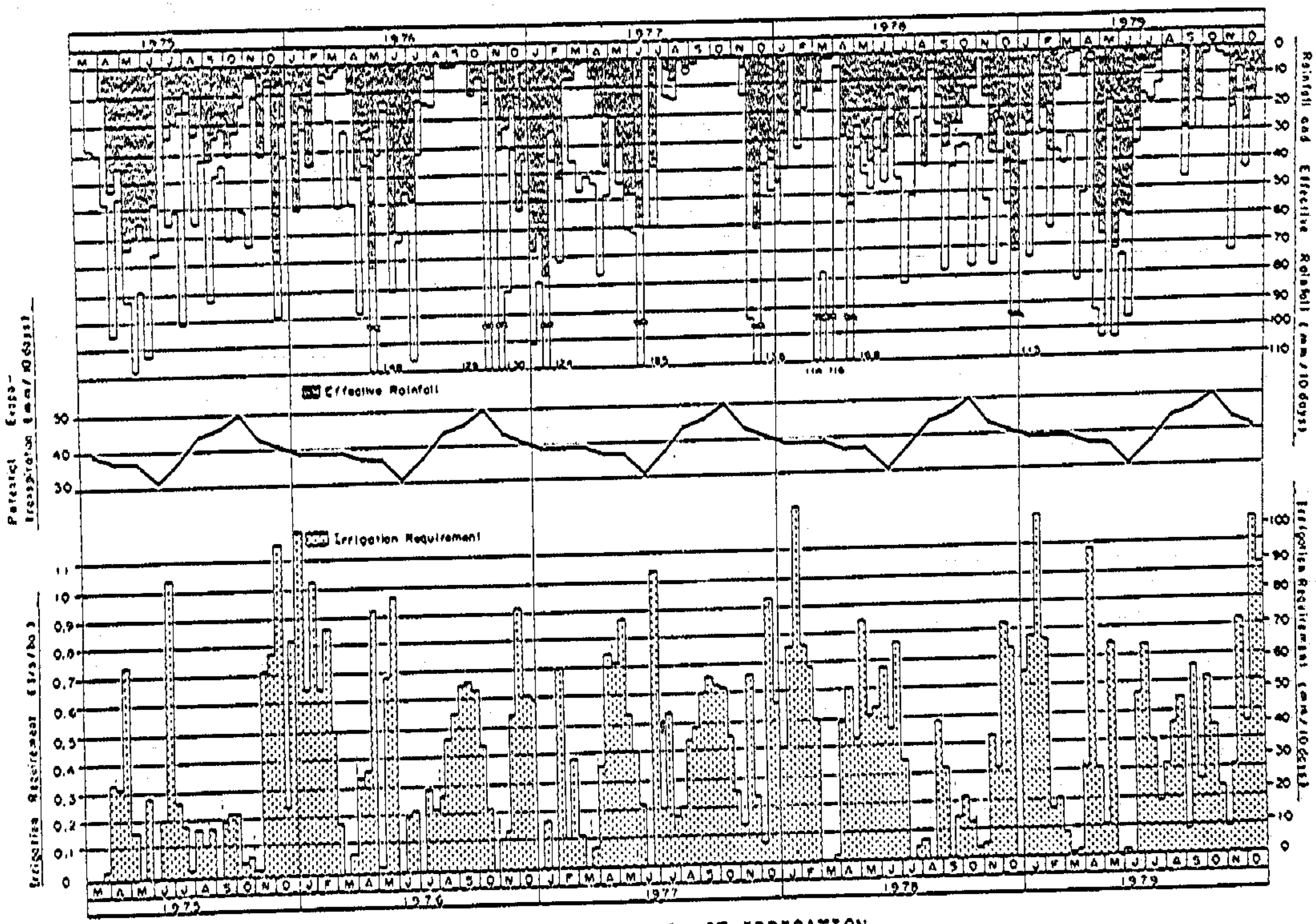


Fig. 4.7.1 SEASONAL FLUCTUATION OF IRRIGATION REQUIREMENT

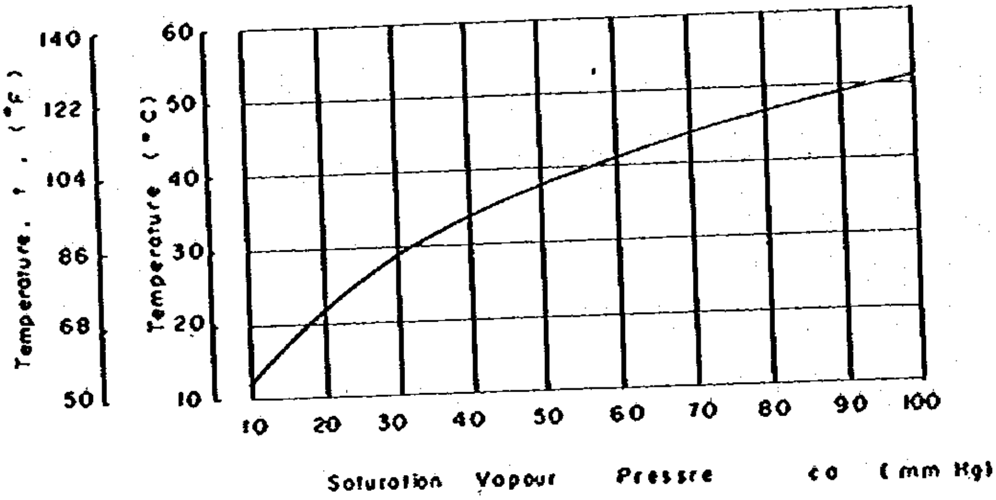


Fig. 4.1.2 SATURATION VAPOUR PRESSURE CURVE

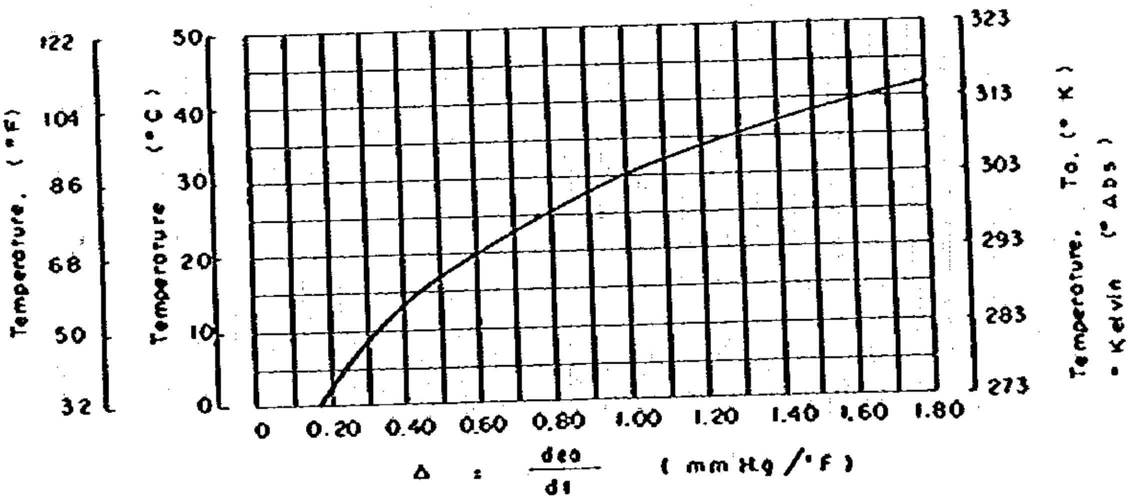


Fig. 4.1.3 SLOPE OF SATURATION VAPOUR PRESSURE CURVE

LEGEND

ETo : Potential evapotranspiration (mm/day)

Hm : Relative humidity (%)

U_2daytime : Daytime wind velocity at zm above

W : Weighting factor for effect of radiation

Rs : Solar radiation (mm H_2O/day)

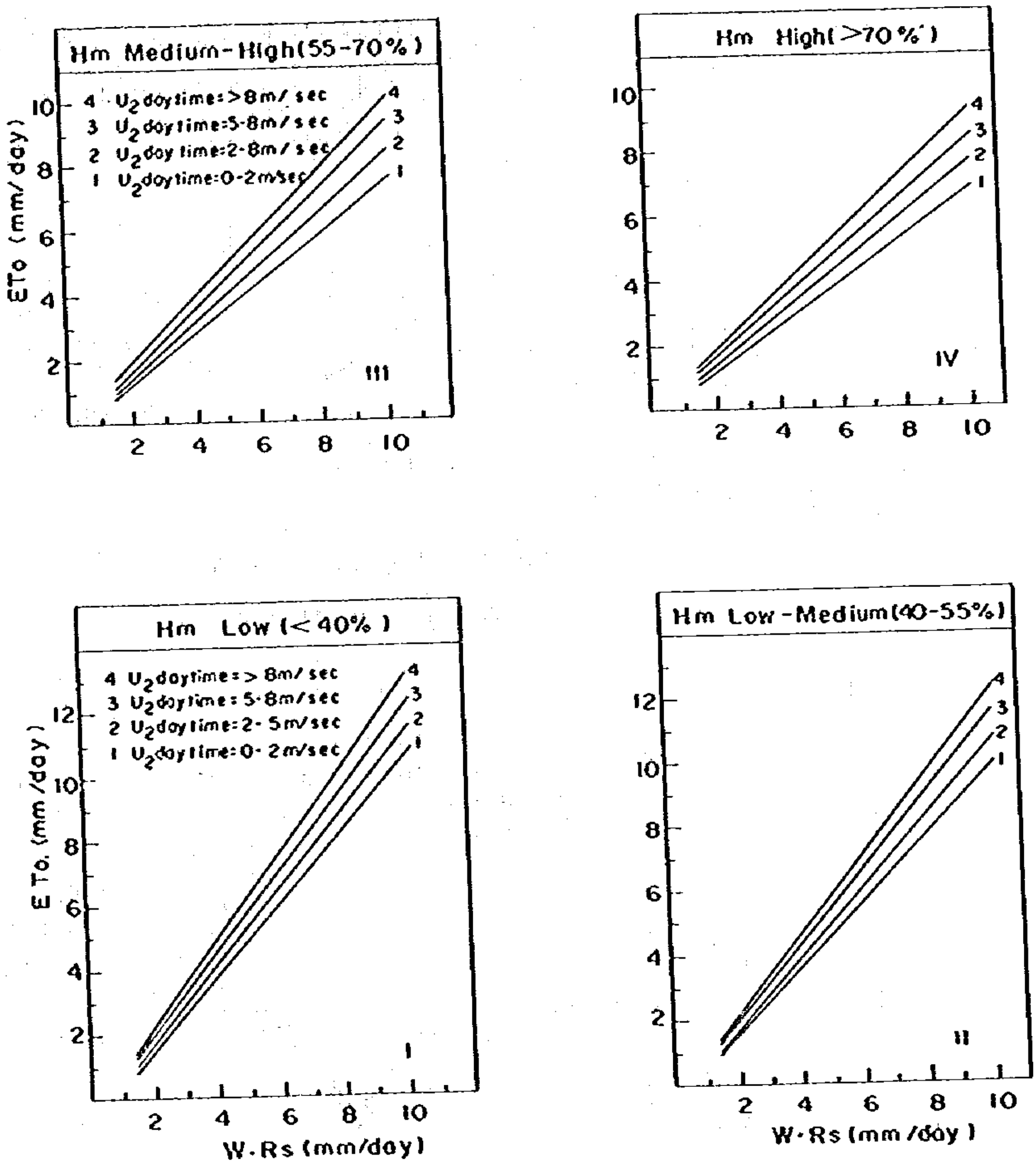


Fig. 4.1.4 PREDICTION OF ETO FROM W.RS FOR EACH HM AND U_2DAYTIME

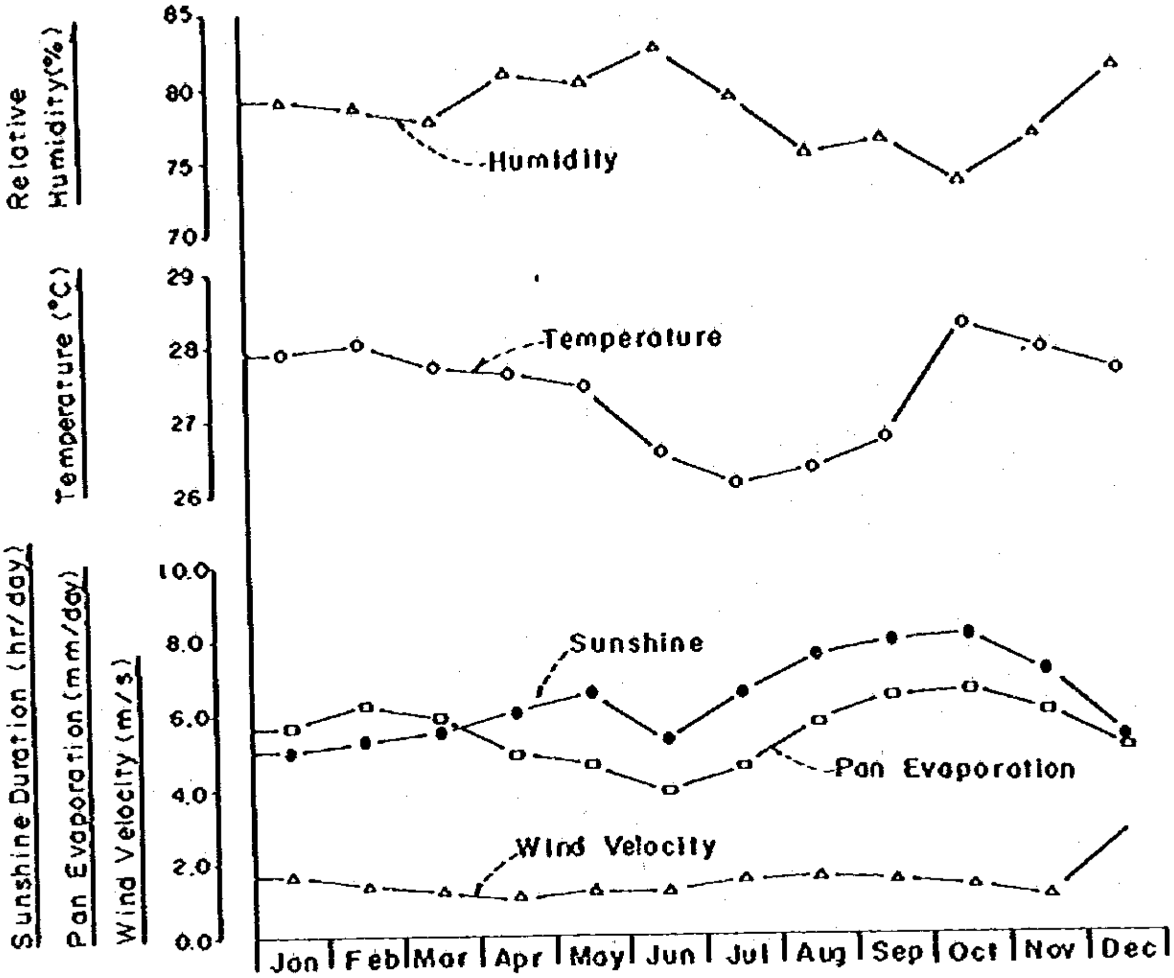


Fig. 4.1.5 METEOROLOGICAL DATA

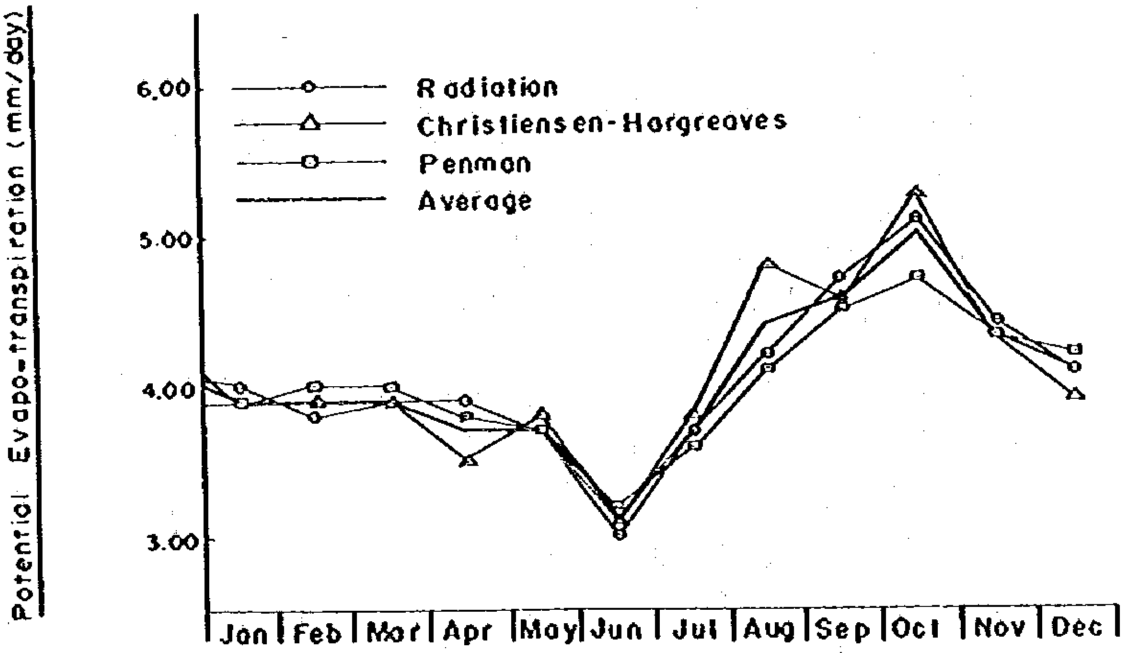


Fig. 4.1.6 POTENTIAL EVAPOTRANSPIRATION

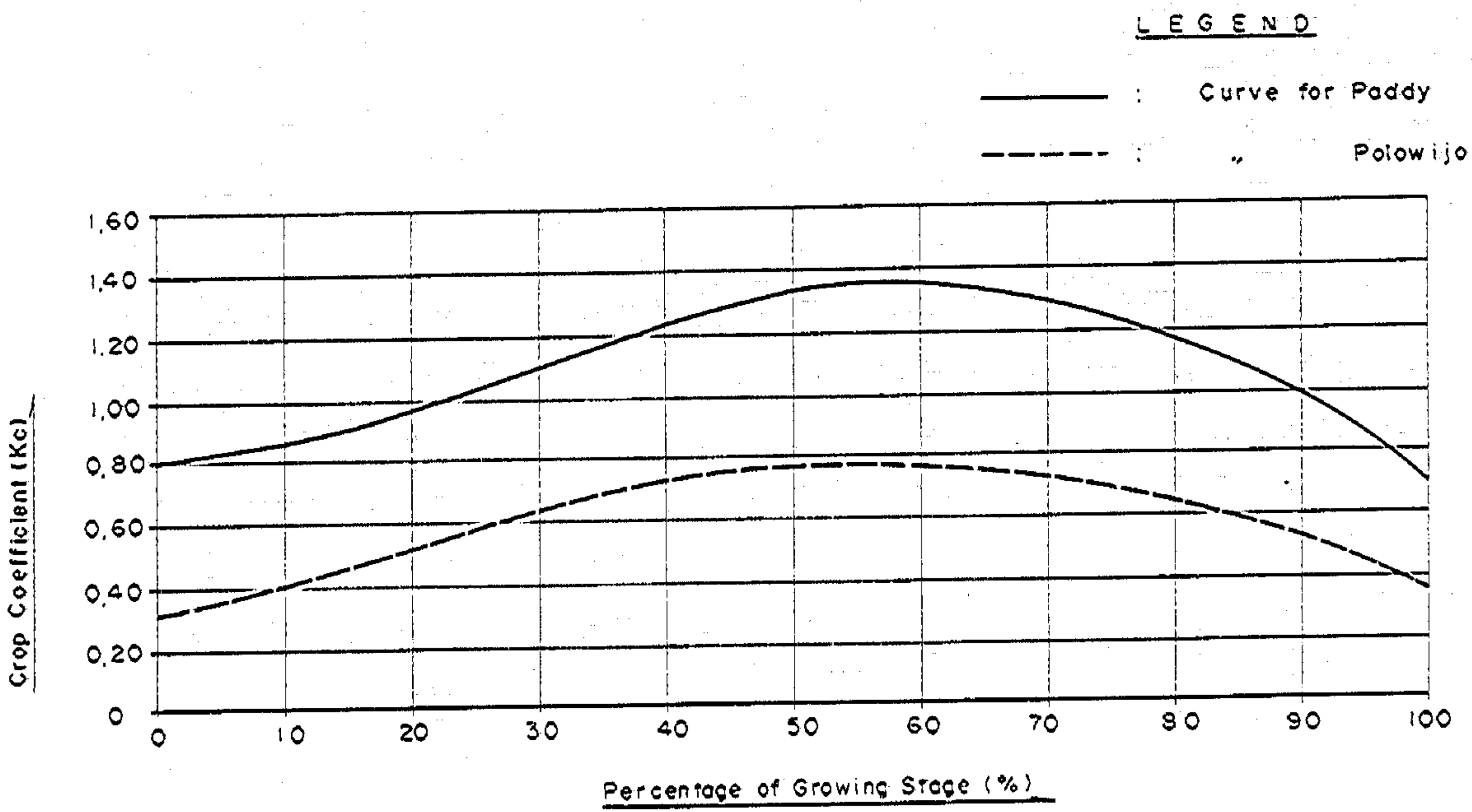


Fig. 4.1.7 CROP COEFFICIENT CURVES OF PADDY AND POLOWIJO

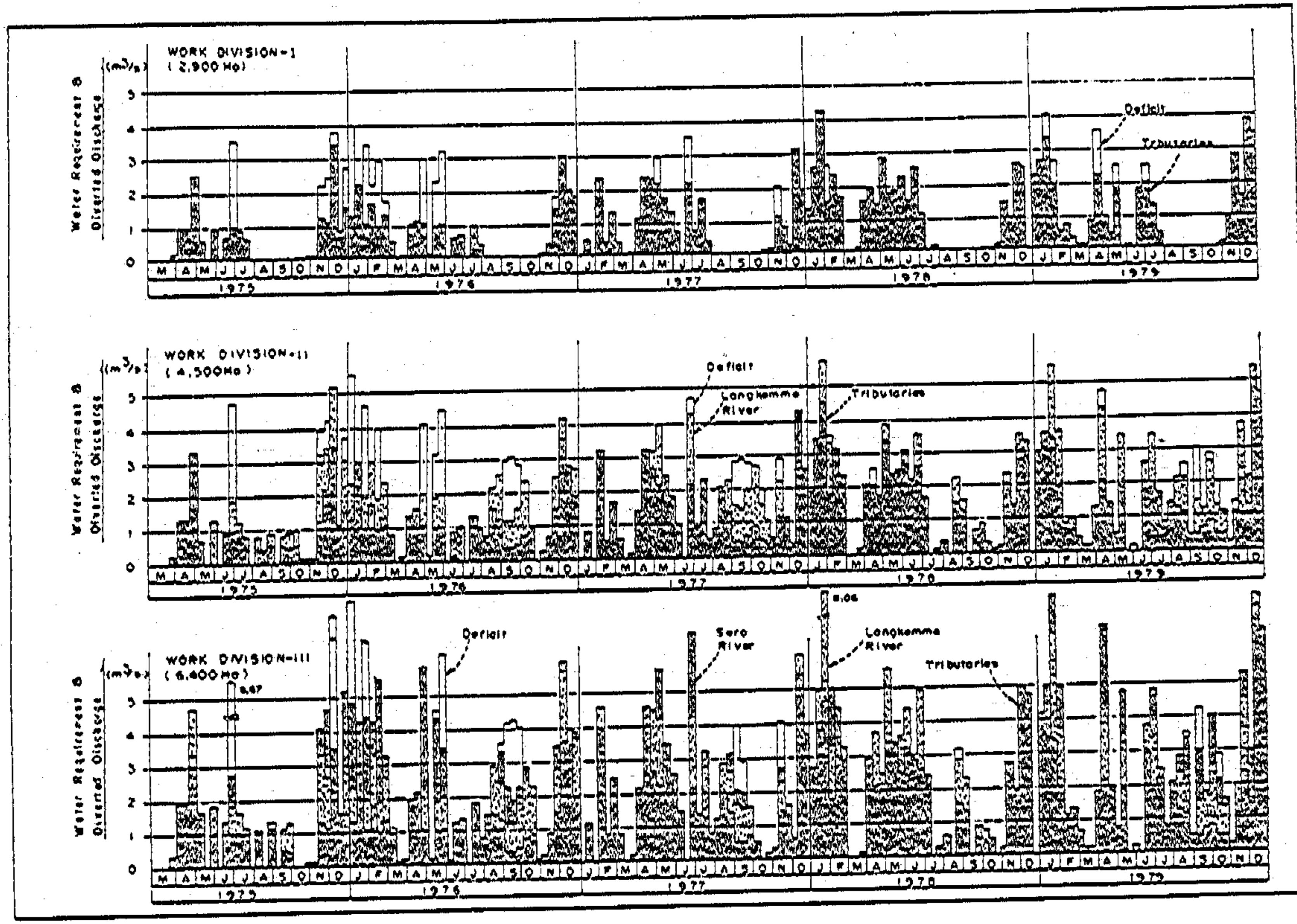


Fig. 4.1.8 SEASONAL FLUCTUATION OF DIVERSION REQUIREMENT AND INTAKE DISCHARGE

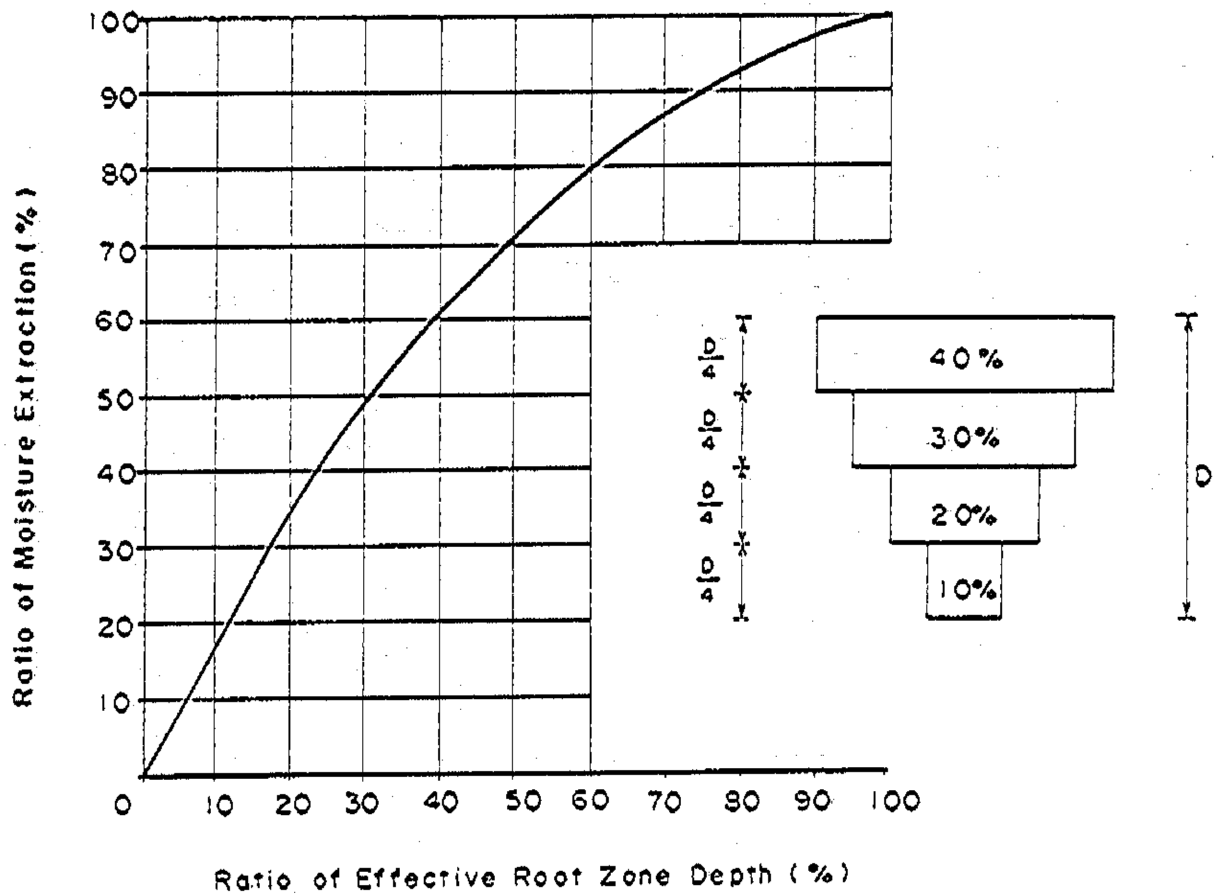


Fig. 4.1.9 BASIC MOISTURE EXTRACTION PATTERN

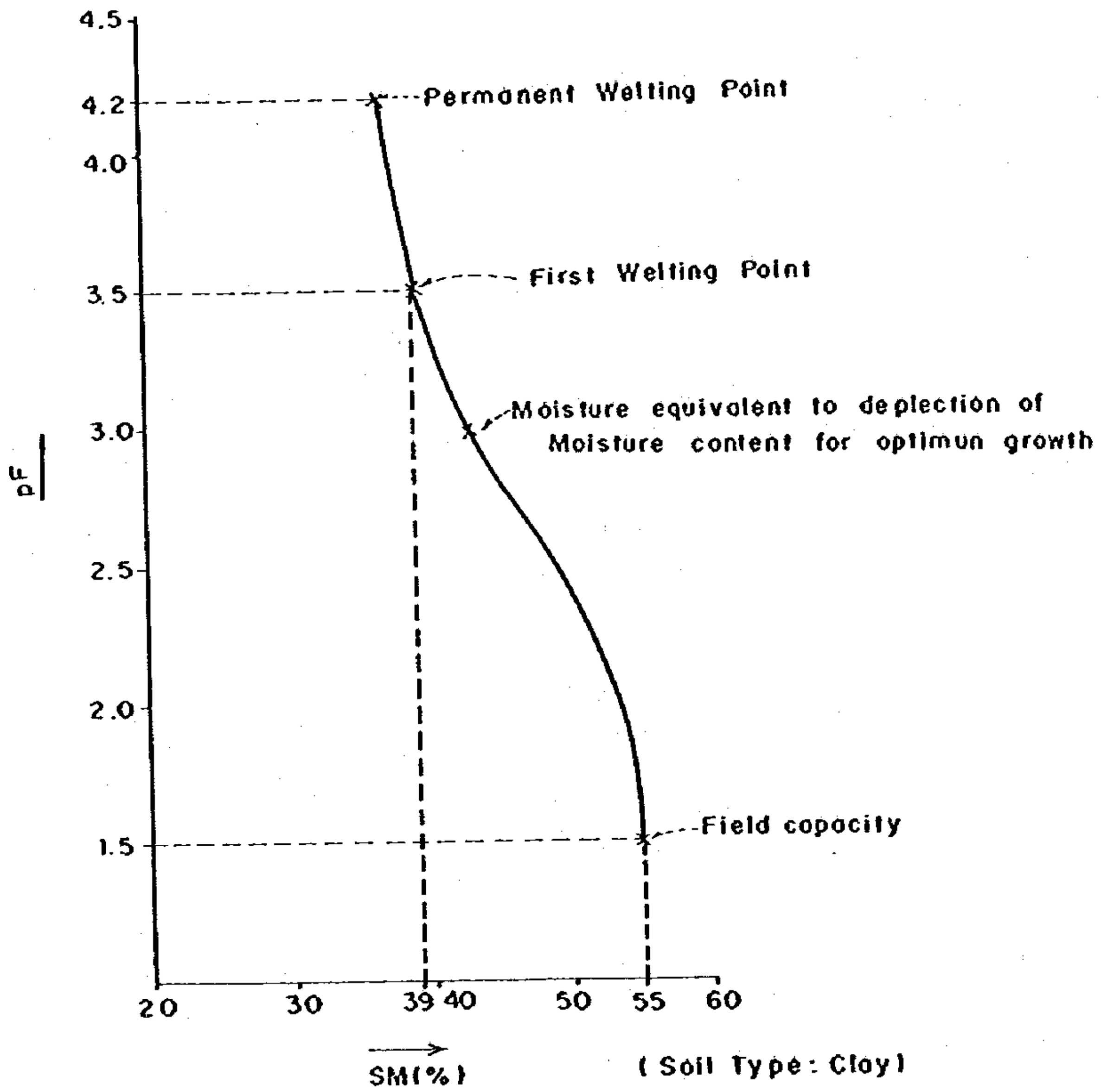


Fig. 4.1.10 MOISTURE CONTENT-pF CURVE

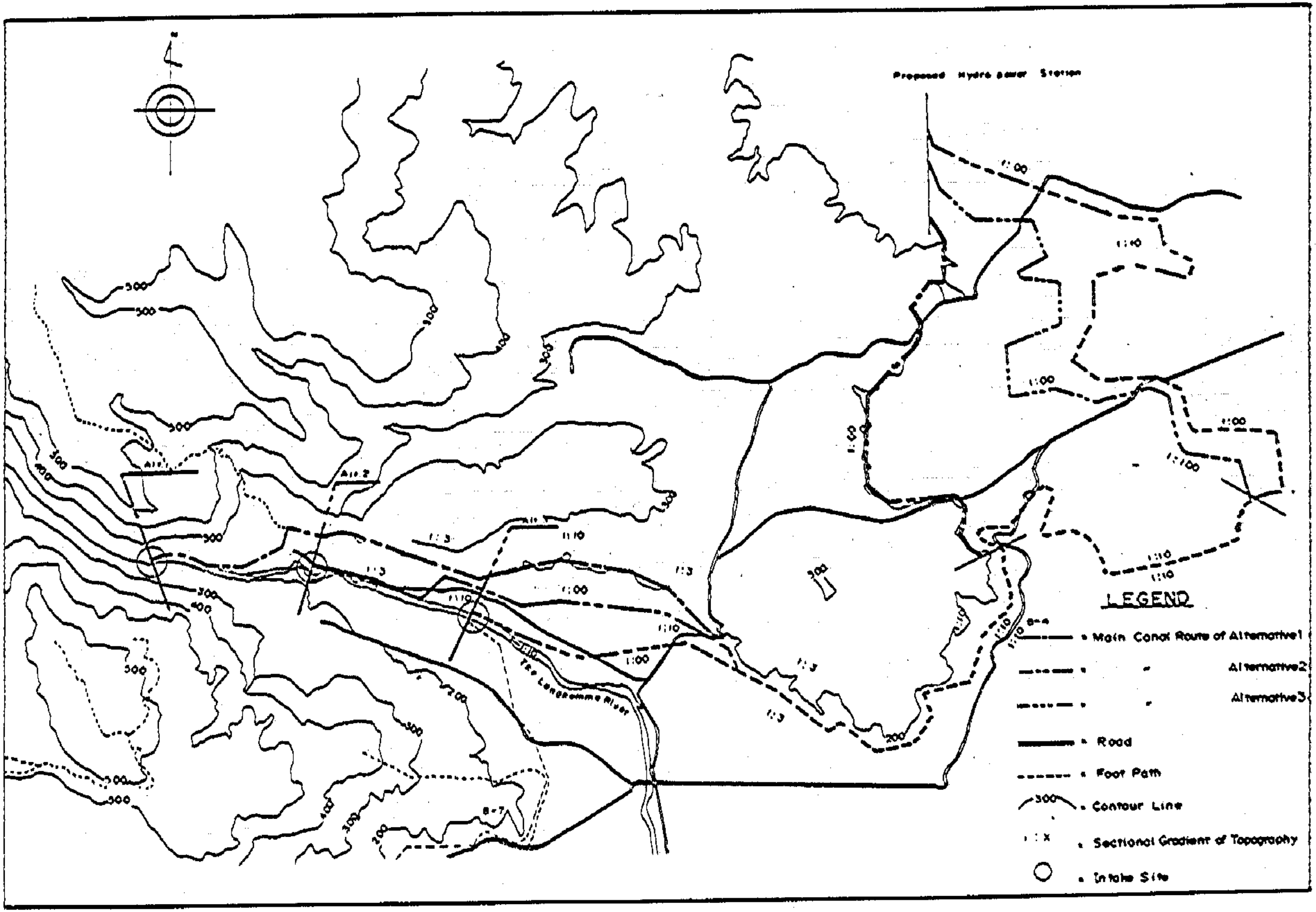


Fig. 4.2.1 ALTERNATIVE SITES OF INTAKE

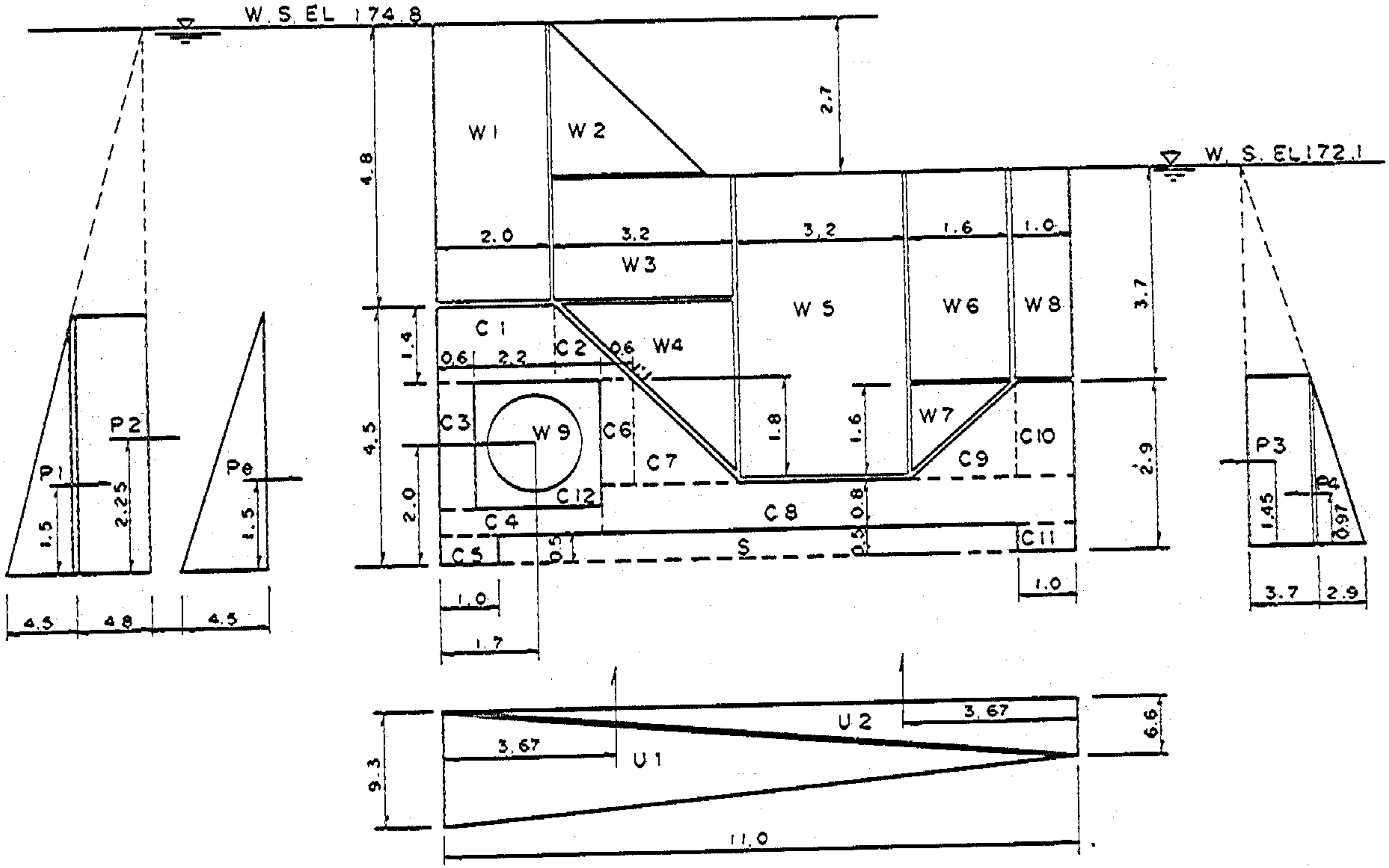


Fig. 4.2.2 LOADING CONDITION OF FLOOD TIME
(LANGKEMME INTAKE WEIR)

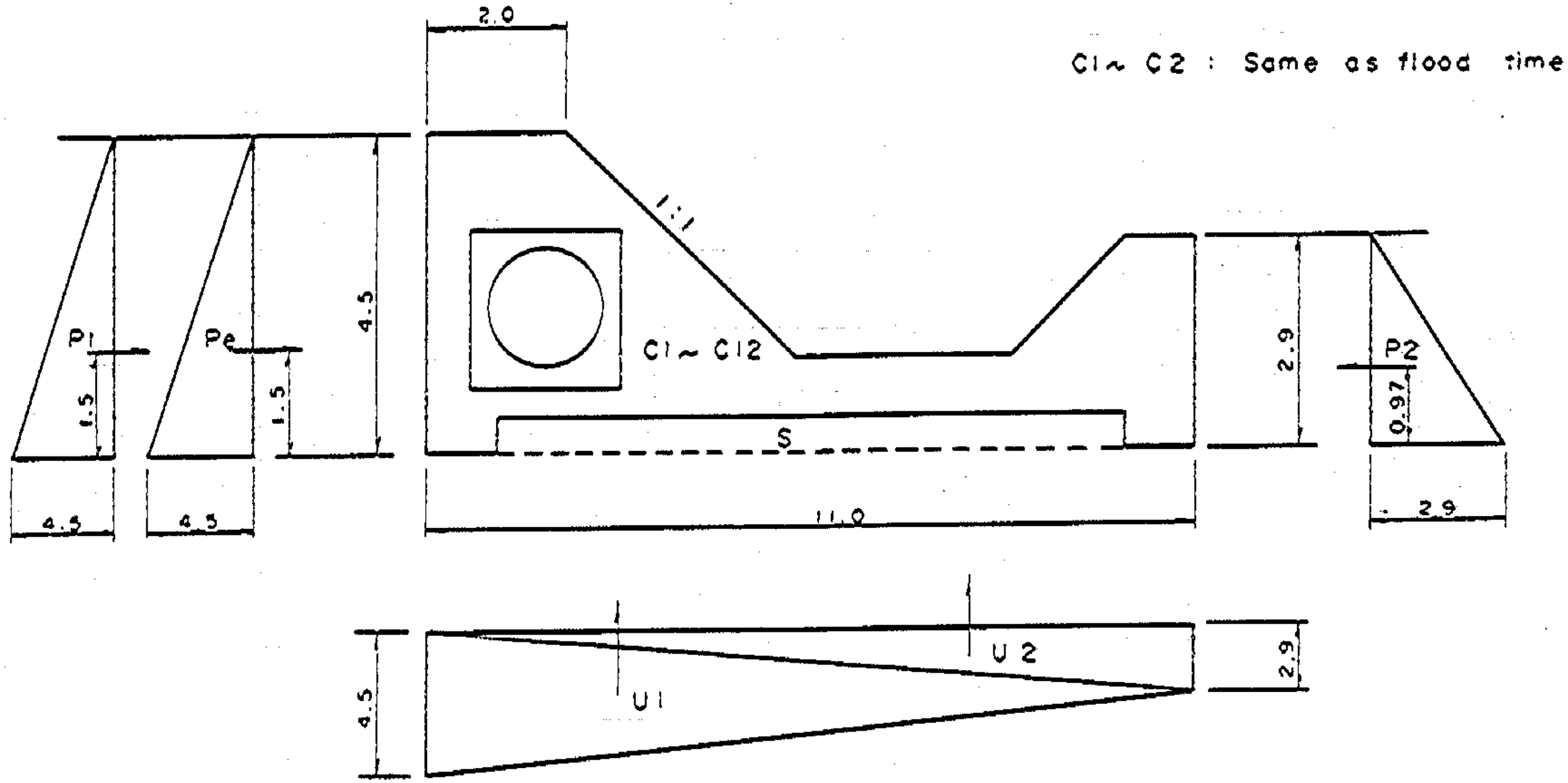


Fig. 4.2.3 LOADING CONDITION OF NORMAL TIME
(LANGKEMME INTAKE WEIR)

C1～C16 : Same at normal time.

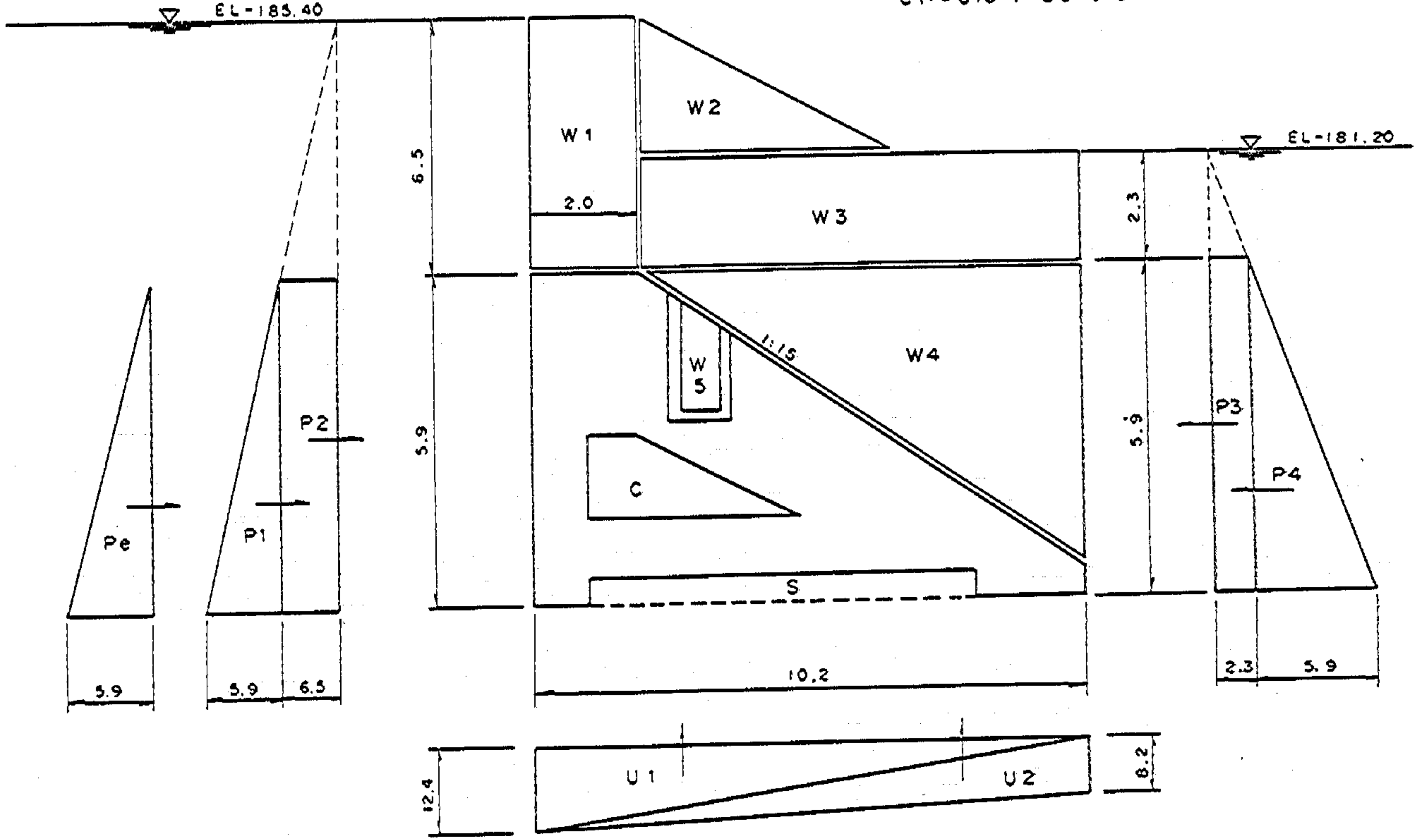


Fig. 4.2.4 LOADING CONDITION OF FLOOD TIME
(JUPANG INTAKE WEIR)

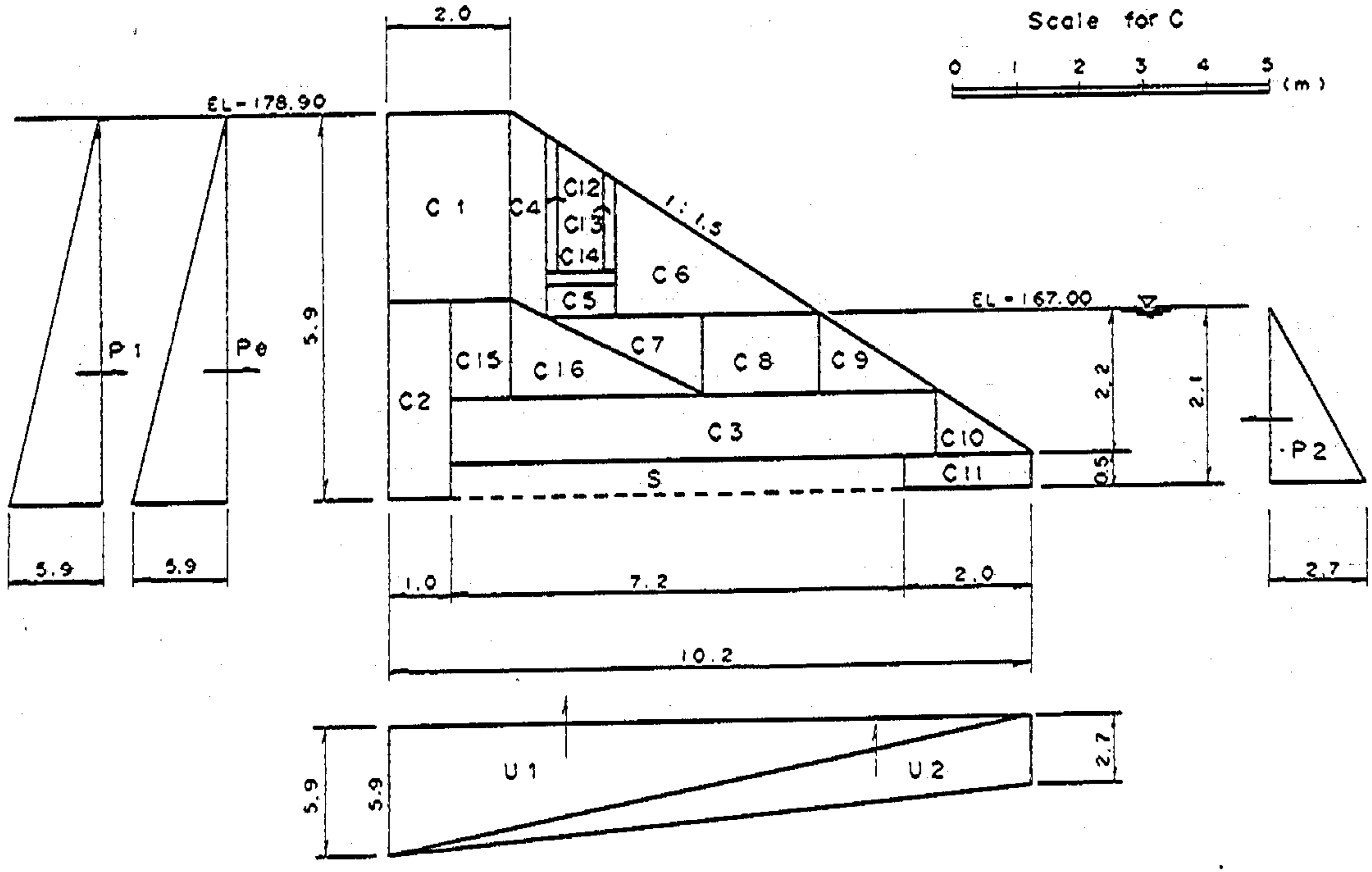


Fig. 4.2.5 LOADING CONDITION OF NORMAL TIME
(JUPANG INTAKE WEIR)

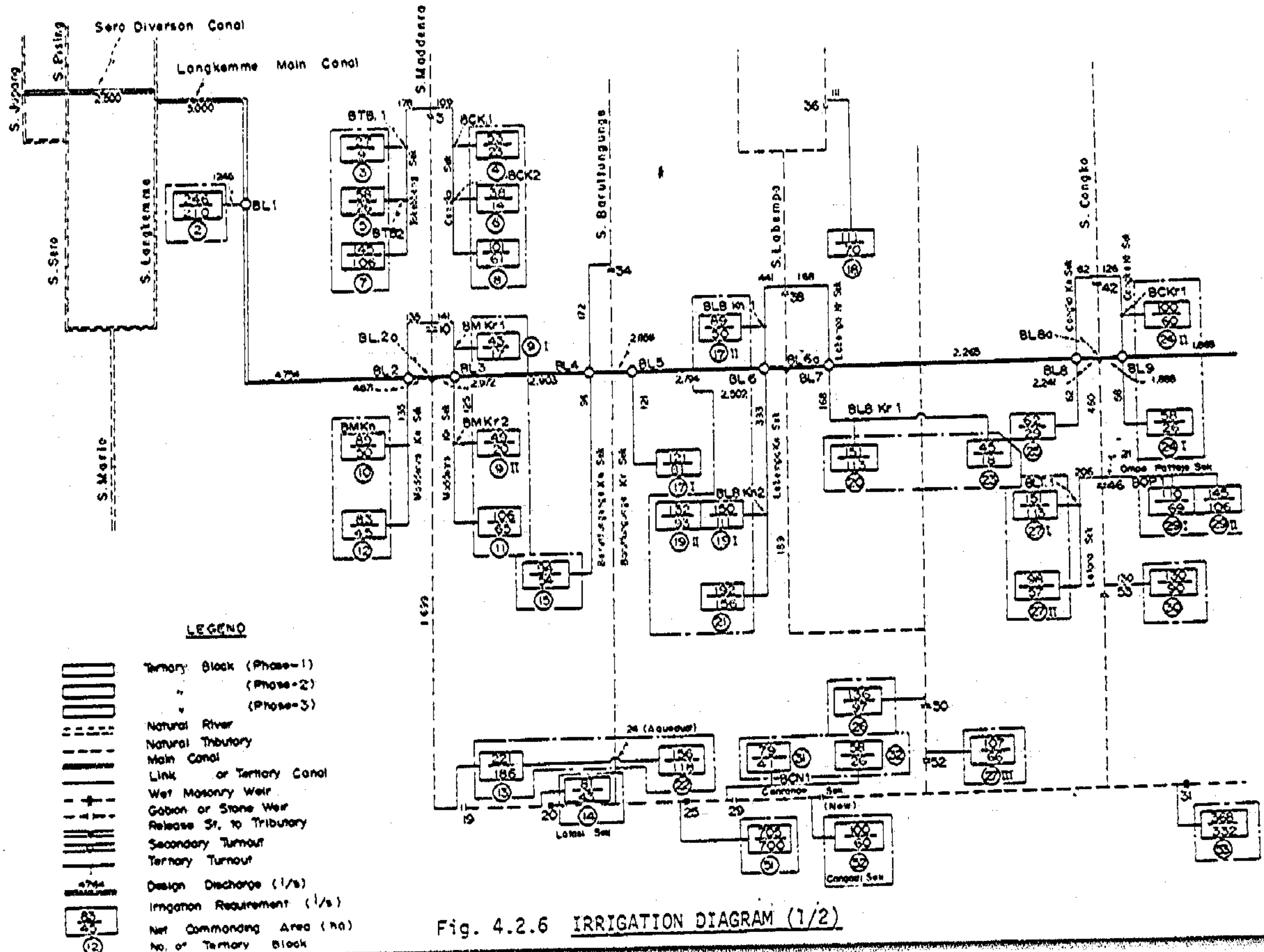


Fig. 4.2.6 IRRIGATION DIAGRAM (1/2)

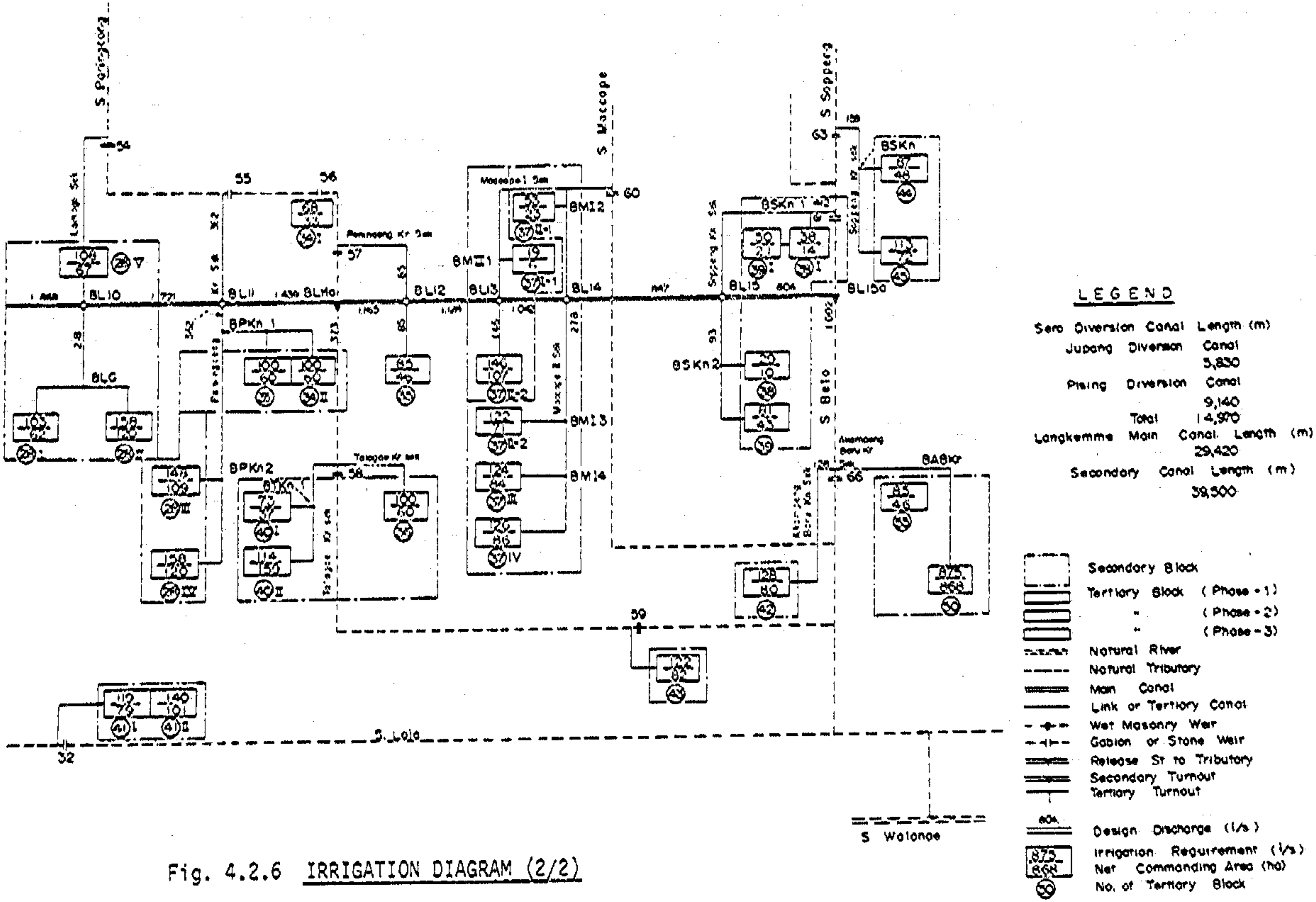


Fig. 4.2.6 IRRIGATION DIAGRAM (2/2)

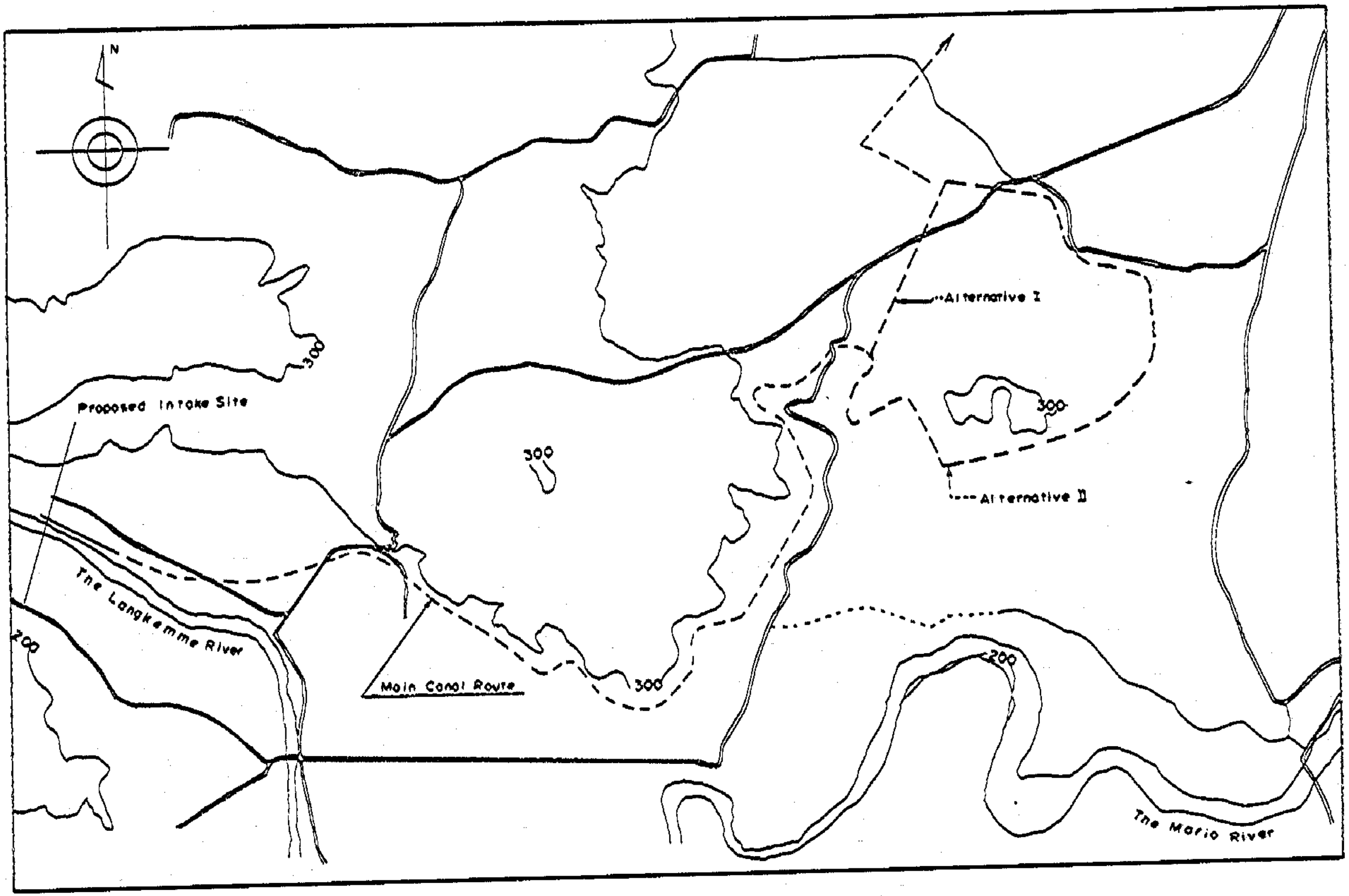


Fig. 4.2.7 ALTERNATIVE ROUTE OF LANGKEMME MAIN CANAL.

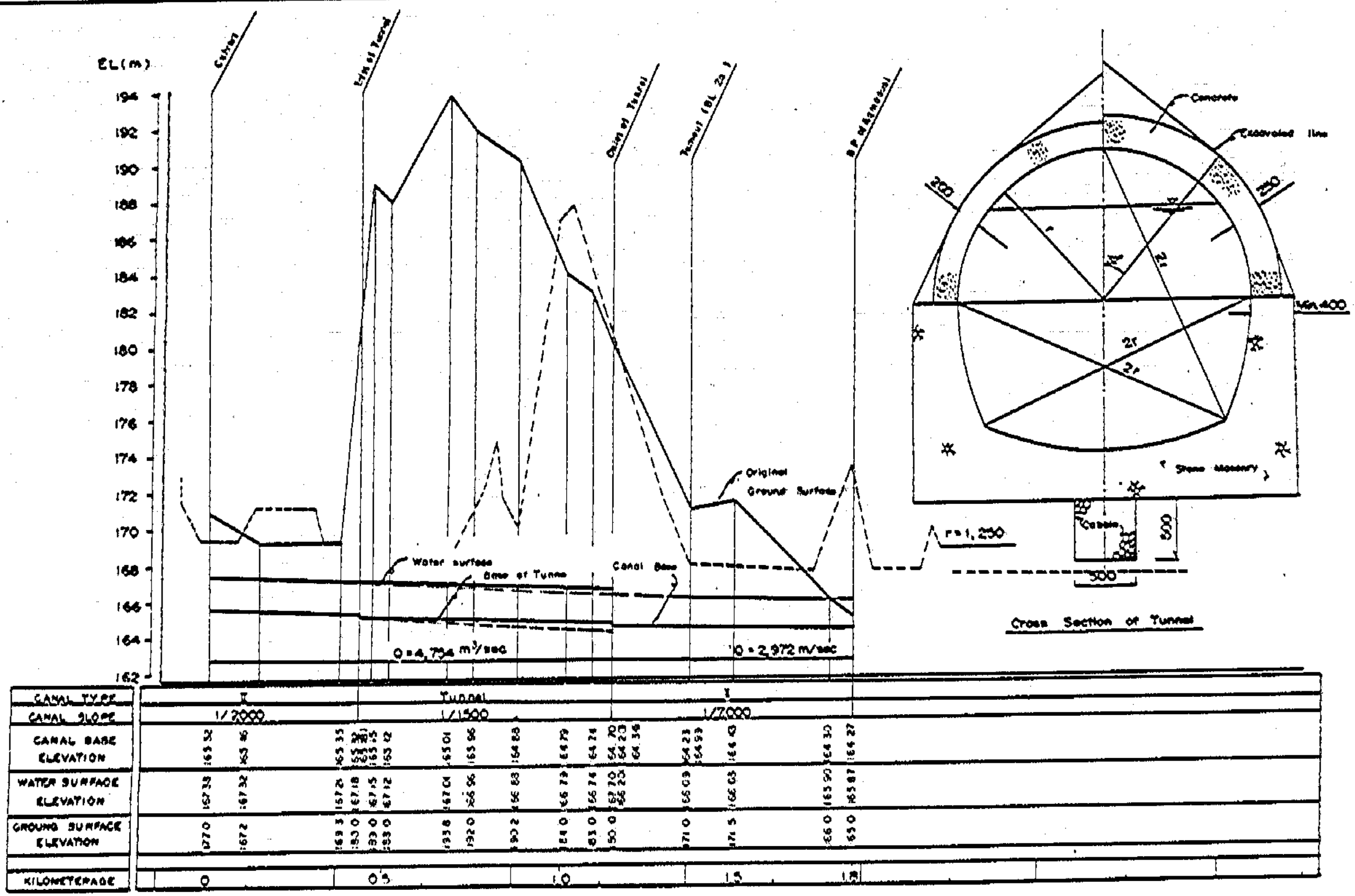


Fig. 4.2.8 LONGITUDINAL SECTION FOR ALTERNATIVE I
(MAIN CANAL ROUTE)

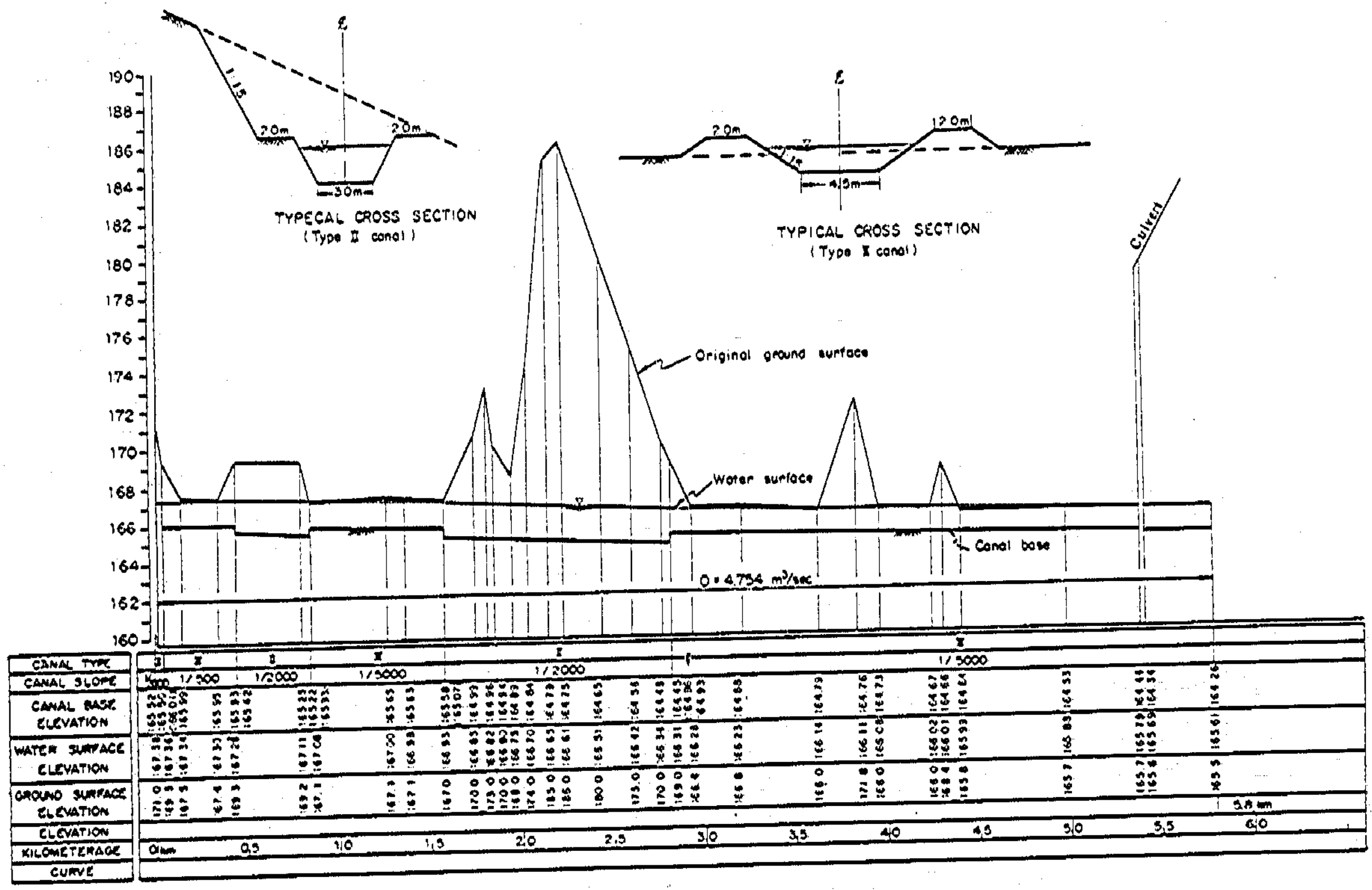


Fig. 4.2.9 LONGITUDINAL SECTION FOR ALTERNATIVE II (MAIN CANAL ROUTE)

CHAPTER V CONSTRUCTION PLAN

CHAPTER V CONSTRUCTION PLAN

5.1 GENERAL

As mentioned below, whole project works would be executed by splitting three Work Divisions, taking into account of existing irrigation system and dependable water resources,

(1) WORK DIVISION - I

- Integration and rehabilitation of intake weirs of Desa irrigation schemes,

- Construction of link canals for integrated schemes, and

- Tertiary development

(2) WORK DIVISION - II

- Construction of Langkemme irrigation canal system including intake weir, main canal and related structures,

- Construction of link canals for integrated schemes, and

- Tertiary Development

(3) WORK DIVISION - III

- Construction of Sero diversion canal system including three intake weirs, diversion canal, and related structures,

- Construction of link canal, and

- Tertiary development

Construction works of the project are almost occupied by earth works. Due attention must be paid on earth moving plan. The earth works along canal alignments are classified into earth excavation, soft and weathered rock excavation, and hard rock excavation, based on the outcomes of geological and soil mechanic investigation along the proposed canal routes.

Major works of the Langkemme irrigation canal and the Sero diversion canal system would be executed by heavy construction machinery. The remaining minor works would be implemented by manpowers to increase the employment opportunity of the local people in and around the project area.

5.2 BASIC ASSUMPTION OF CONSTRUCTION PLANNING

5.2.1 Conversion Rate of Earth Volume

Earth volume is changeable according to the condition as it is. Naturally placed earth increases its volume after excavation and decreases after compaction. These changes of earth volume should be considered for arrangement of construction machinery and earth moving plan. The conversion rate of earth volume is assumed as follows;

Class of earth	in place	in loose	in compaction
sand	1.00	1.11	0.95
soil (ordinary)	1.00	1.25	0.90
soil included stones and gravel	1.00	1.13	1.03
solid rock	1.00	1.65	1.22

5.2.2 Classification of Excavation Work

Excavation work would be classified into three types according to geological and soil mechanical condition:

Excavation Type - 1

This type excavation would be proposed in the area bedded with hard rocks and be executed by blasting.

Excavation Type - 2

This type excavation would be mainly proposed in the area covered with naturally compacted soils and gravels, and be made by manpower only, manpower with pick-hummer or Back-Hoe shovel.

Excavation Type - 3

This type excavation would be proposed for loosed normal soils which are easily excavated by manpower or excavation equipment.

5.2.3 Workable Days

Earth work is mostly affected by rainfall. Suspension of earth work caused by heavy rainfall would be assumed as follows according to daily rainfall intensity.

Daily Rainfall Intensity (mm/day)	Suspension of Work (day)
0 to 10	Workable
10 to 30	1 day suspension
30 to 50	2 "
50 to 100	3 "
More than 100	4 "

Annual mean workable days are estimated on the basis of the above criteria and the rainfall records in Watan Soppeng for recent 10 years. Seven national holidays and annual Sundays are excluded out of the estimted workable days. The annual mean workable days of 256 days are finally estimated as shown in Table 5.2.1. The monthly mean workable days range from 19 days to 23 days, averaging 21 days. The rainfall distribution in the project area is relatively favourable for execution of earth work throughout a year.

5.3 CONSTRUCTION SCHEDULE

The whole project works would be broadly segmented into three Work Divisions in accordance with the development grade of existing Desa irrigation schemes and the dependability of respective water source.

The Work Division-I would cover up-grading works of the non-technical Desa irrigation area of 2,900 ha. The area would be up-graded to semi-technical level through the excution of the Work Division-I. To set up construction schedule, the Work Division-I is further sub-divided into three working blocks i.e. D-1, D-2 and D-3.

The Work Division-II would comprise up-grading work of semi-technical Desa irrigation area of 4,500 ha including 2,900 ha of the area up-graded in the Work Division-I and construction of Langkemme irrigation canal system. The construction of the lengthy Langkemme main canal would be executed by dividing into three working blocks i.e. L-1, L-2 and L-3.

The Work Division-III would consist of up-grading work of the Semi-technical DPU irrigation scheme area of 1,900 ha and construction of the Sero diversion canal system. The diversion canal is also divided into two working blocks i.e. S-1, S-2. (See Fig. 5.3.1). The working blocks of the respective Work Divisions can be summarized below;

Work Division-I :

i) D-1 tertiary development (Up-grading work from non-technical to semi-technical level, 370 ha), including integration of existing weir and construction of link canal.

ii) D-2 tertiary development (Up-grading work from non-technical to semi-technical level, 1,270 ha), including integration of existing weir and construction of link canal.

iii) D-3 tertiary development (Up-grading work from non-technical to semi-technical level, 1,260 ha), including integration of existing weir and construction of link canal.

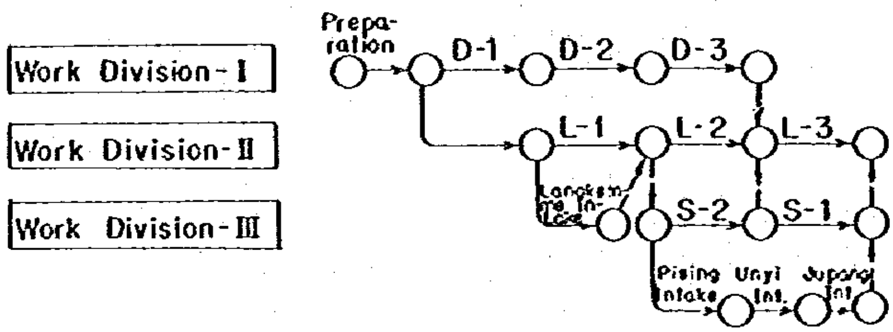
Work Division-II :

i) Construction of Langkemme intake weir
ii) L-1 (Upper reach of Langkemme main canal, 8.29 km)
iii) L-2 (Middle reach of Langkemme main canal, 9.38 km)
iv) L-3 (Lower reach of Langkemm main canal, 11.75 km)
v) Tertiary development (Up-grading work from semi-technical level to technical level, (4,500 ha) including construction of link canal

Work Division-III:

i) S-1 (Upper reach of Sero diversion canal, 5.83 km)
ii) S-2 (Lower reach of Sero diversion canal, 9.14 km)
iii) Construction of Pising intake weir
iv) Construction of Unyi intake weir
v) Construction of Jupang intake weir
vi) Tertiary development (Up-grading work from semi-technical level to technical level, 1,900 ha, including construction of link canal.

The working blocks subdivided above would be broadly networked for effective construction work as shown below.



To network the above schedule, due attention is paid as follows;

i) Construction of working block D-1 and the Langkemme intake weir would concurrently commence at the beginning of dry season, 1983, immediately after conclusion of contracts,

ii) The working block D-2 and the construction of Langkemme intake weir and tunnel will be terminated at the same time of the completion of the working block L-1,

iii) At the moment of the completion of the working block L-2, tertiary development works, D-1 and D-2 and tertiary development in Work Division II ended. In addition, the working block S-2 and the construction of Pising and Unyi Intake Weirs would also come to end. Then, irrigation water diverted at the Pising and Langkemme Intake Weirs will be distributed over about 3,000 ha.

iv) The remaining working blocks under respective Work Division would be simultaneously completed as far as possible.

v) The construction for the whole project works would be executed within five years after arrangement of construction fund.

According to the construction method mentioned in the succeeding section, working days required for major work items are calculated as shown in Table 5.3.1 and detailed construction schedule is finalized by Critical Path Method (CPM) as shown in Fig. 5.3.2. The bold arrow lne in Fig. 5.3.2 shows a critical path of the construction schedule. The non-critical path indicated by fine arrow line has some spare times for the execution of assignment works. The Fig. 5.3.2 is converted into a bar-chart as shown in Fig. 5.3.3 to prepare annual disbursement schedule of the construction cost.

5.4 CONSTRUCTION METHOD OF MAJOR WORKS

5.4.1 Langkemme Main Canal and Sero Diversion Canal

The construction of both canals are the major works among the project works. The Langkemme main canal would be constructed from upper reach to lower reach. On the contrary, the Sero diversion canal would be excavated from lower reach to upper reach to early use the water resources in the Sero river system.

(1) Re-use Plan of Excavated Materials

In principle, filling and embankment would be made be excvated materials as far as possible. Actually, however, the excavated materials along the canal routes might contain considerable amount of pebbles and cobbles. Full volume of the excavated materials is, therefore, not available for the filling and embankment.

As a result of soil mechanical and geological investigation along the both canal routes, the re-useable ratio is estimated at about 65% of total excavated volume at the site of the working block S-1, S-2, L-1 and L-2, and about 70%, at the site of the working block L-3. Furthermore, about 10% and 20% losses of volume must be taken into account under the condition of direct re-use at the excavated site and re-use after stock-piling, respectively. The conversion rate of earth volume previously mentioned is also considered for setting up the re-use plan of earth materials. The Table 5.4.1 shows the re-use plan of the excavated materials along the Langkemme Main Canal and the Sero diversion canal.

(2) Excavation and Filling

In steep hilly area, stripping and surface excavation would be mainly made by bull-dozer, and sub-surface and deep excvation, by back-hoe shovel depending on the soil condition at the working site. Excavation of rocks, which are excessively hard beyond the capacity of equipments above, would be made by pick-hummer or rock-blasting. Manpower would contribute to the finishing work of canal section. The excavation material in excess of filling requirement would be spoil-banked by bull-dozer at the appropriate space along the canal route.

While, at the flat field, back-hoe shovel would be recommended for an effective excavation equipment. Materials excavated by back-hoe shovel are directly used for canal embankment. Excessive materials would be piled in the stock-yard for re-using or spoiled by dump truck.

Spreading of embankment materials would be mainly made by bull-dozer and supplementary, by manpower. Compaction of filling materials is also made by manpower with use of simple compactor.

5.4.2 Major Intake Weirs

(1) Langkemme Intake Weir

The construction works of the weir would be executed during drought season in due consideration of magnitude of flooding in the Langkemme river. Coffer dam is mounded with cobble and pebble to enclose the site of the left half of the intake weir and to divert riverflow into opposite side of the river channel. About half length of weir, sand sluice and intake structures would be constructed in the site enclosed by the coffer dam. These works would be completed by the end of drought season and the coffer dam would be drawn before the onset of flood season.

On the beginning of the subsequent drought season, second river diversion is made by mounding coffer dam at the right half side of intake weir. The riverflow is diverted through the sand sluice which has been constructed at the period of first river diversion. The remaining half portion of intake weir is also constructed by the end of the drought season.

Excavation method is dependent upon geological condition of the river bed. Soil and pebble layer are mainly excavated by back-hoe shovel, supplemented by manpower. Bedded solid rocks are excavated mainly by blasting. Blasted rocks are loaded and hauled by back-hoe, shovel. Excess materials are spread over the riverbed by bulldozer or spoiled in appropriate space by dump truck. Cobble masonry and reinforced concrete works for the weir and intake structures are carried-out mainly by skillful manpower.

(2) Jupang Intake Weir

Construction procedure of the Jupang intake weir is almost same as the Langkemme intake weir. The Jupang intake weir is of tirol type which is not provided with sand sluice. During the second diversion period, riverflow is guided into desilting chamber. After completion of whole construction works, the temporary entrance of the chamber is shut up by double stop logs and concrete blockade.

5.4.3 Tunnel

A tunnel of about 720 m long and with a diameter of about 2.5 m is constructed at the end portion of the working block L-1. The tunnel excavation concurrently commences at its inlet and outlet to shorten the construction period.

(1) Excavation

The full section of tunnel is simultaneously excavated since the section is relatively small. The excavation is executed by rock blasting. Two sets of legdrill and one set of pick-hummer are jointly used for rock blasting. The blasted materials are hauled outside of the tunnel by trolleys which are pulled by a winch, and dumped in appropriate deposit area. The work progress of tunnel excavation is estimated at 4.0 m/day based on the calculation of one cycle time as shown in Table 5.4.2.

(2) Lining

After completion of excavation, lining works for the tunnel section also start at its inlet and outlet. The invert and both side-walls of tunnel are lined with pebble masonry and the crown, with concrete. Wooden forms are used for the concrete lining of the tunnel crown. The lining works start at the invert and side walls, followed by the lining of crown. The daily work progress of the lining works is estimated to be the longitudinal four meters of the tunnel.

5.5 ARRANGEMENT OF CONSTRUCTION EQUIPMENTS

According to the construction schedule previously mentioned, the maximum numbers of construction equipments are decided as follows, in due consideration of capability of each equipment.

Equipment	Specification	Nos.
1. Bulldozer	11-ton class	4 sets
2. Bulldozer	21-ton class	3 sets
3. Backhoe shovel	0.4 - 0.6 m^3	6 sets
4. Dump truck	6-ton	50 sets
5. Pick hummer	0.1 m^3/min	21 sets
6. Leg-drill	24 kg class	8 sets
7. Compressor	37 kW	7 sets
8. Drainage pump	0.3 m3/min	9 sets

To effectively use all of the selected construction equipments throughout the construction period, an operation schedule of the equipments is worked out as illustrated in Fig. 5.5.1.

Table 5.2.1 Summary of Workable Day

Year	1	2	3	4	5	6	7	8	9	10	11	12	
1970	26	24	24	21	21	19	23	23	26	26	20	27	280
1971	23	21	27	25	18	18	19	19	20	19	23	23	255
1972	17	22	25	21	20	26	26	23	26	25	26	20	277
1973	15	17	24	13	15	14	16	20	18	22	18	21	213
1974	18	20	20	21	23	23	22	23	24	16	24	23	257
1975	23	24	22	16	19	14	17	21	19	22	22	21	240
1976	26	22	25	20	21	21	21	23	26	22	19	23	269
1977	15	21	24	19	22	18	24	23	26	25	22	21	260
1978	23	22	18	17	24	26	18	22	18	17	21	19	245
1979	22	22	22	20	19	14	26	24	22	26	23	22	262
Total	208	215	231	193	202	193	212	221	225	220	218	220	2,558
Average	21	22	23	19	20	19	21	22	23	22	22	22	256

Table 5.3.1 Calculation of Construction Days

Name	Sub Name	Item	Quantity	Production per day	Net days	Change rate	Const. Days per set	No. Days set	Proposed Const. Days		Remarks	
Sero Diversion Canal	S-1	Exca. Soil	62,400	172.9	361	30/21	516	2		258	B.D	Bull-dozer
		Soil	41,600	179.4	232		331	1	165 }	183	BHS	Back-Hoe Shovel
		Rock (U)	2,000	157.5	13		18	1	18 }		-do-	
		Rock (L)	3,000	55.0	55		78	1		78	P	5 party of Pick-hummer
		H.R	7,000	40.0	175		250	3		84	BST	Blasting
		Embankment	25,800	376.6	69		98	1		98	SPD	Spreading
	S-2	Exca. Soil	80,400	172.9	465		664	2		332	B.D	
		Soil	53,600	179.4	299		427	1	427 }	550	BHS	
		Rock (U)	13,600	157.5	86		123	1	123 }		BHS	
		Rock (L)	20,400	55.0	371		530	3		177	P	
		H.R	25,000	40.0	625		893	3		298	DST	
		Embankment	43,400	376.6	115		165	1		165	SPD	
Langkemme Main Canal	L-1	Exca. Soil	88,200	172.9	492		702	2		351	B.D	
		Soil	58,800	179.4	328		468	2	234 }	415	BHS	
		Rock (U)	20,000	157.5	127		181	1	181 }		BHS	
		Rock (L)	30,000	55.0	545		780	3		260	P	
		H.R	4,000	40.0	100		143	1		143	BST	
		Embankment	46,400	376.6	124		176	1		176	SPD	
	L-2	Exca. Soil	73,800	172.9	427		610	1		610	B.D	
		Soil	54,000	179.4	301		430	1	430 }	510	BHS	
		Rock (U)	8,800	157.5	56		80	1	80 }		BHS	
		Rock (L)	35,200	55.0	640		915	2		458	P	
		Embankment	23,100	376.6	61		87	1		87	SPD	
	L-3	Exca. Soil	54,000	179.4	301		430	2	215 }	216	B.D	
		Rock (U)	200	157.5	1		2	2	1 }		BHS	
		Rock (L)	800	55.0	4		6	1		6	P	
		Embankment	30,600	376.6	82		116	2	58 }	112	SPD	
		Embankment	28,000	376.6	74		107	2	54 }		SPD	
Tunnel	L-1	Exca.	720 m	8.0	90		128	1		128	Both side of 4.0m/day	
		Lining Stone M.	720	8.0	90		128	1		128	- do - . 4.0m/day	
		Concrete	720	8.0	90		128	1				

Table 5.4.1 Re-use Plan of Earth Materials

Name of Main Canal	Job Allotment	Earth Condition	Excavation	Filling S-1	Filling S-2	Filling L-1	Filling L-2	Filling L-3	Filling Deposit	Remarks
			732,000	(25,800)	(43,400)	(46,400)	(23,100)	(58,600)	484,000	
Sero Diversion Canal	S-1	Soil	104,000	31,900 (25,800)					72,100	25,800 ÷ 0.9 ÷ 0.9 = 31,900
		Rock	5,000						5,000	
		Hard Rock	7,000						7,000	
	S-2	Soil	134,000		53,600 (43,400)				80,400	43,400 ÷ 0.9 ÷ 0.9 = 53,600
		Rock	34,000						34,000	
		Hard Rock	25,000						25,000	
Langkemme Main Canal	L-1	Soil	147,000			57,300 (46,400)			89,700	46,400 ÷ 0.9 ÷ 0.9 = 57,300
		Rock	50,000						50,000	
		Hard Rock	4,000						4,000	
	L-2	Soil	123,000				28,500 (23,100)	38,900 (28,000)	55,600	23,100 ÷ 0.9 ÷ 0.9 = 28,500 28,000 ÷ 0.8 ÷ 0.9 = 38,900
		Rock	44,000						44,000	
	L-3	Soil	54,000					37,800 (30,600)	16,200	54,000 x 0.3 = 16,200 37,000 ÷ 0.9 ÷ 0.9 = 30,600
		Rock	1,000						1,000	

Table 5.4.2 Cycle Time of Tunnel Excavation

(min)

Work Item	Cycle Time
1. Excavation	
preparation	20
drilling	60
blasting	30
ventilation	20
chipping	20
others	10
Sub-total	160
2. Transporting of Muck	
preparation	10
transporting	120
arrangement	10
survey and check	10
extension of rale	30
others	10
Sub-total	190
3. Assembling of tunnel support	
preparation	10
assembling	60
others	10
Sub-total	80
Miscellaneous	20
Total	450

One day's progress = 1.5m x 1.200min/450min = 4.0m/day

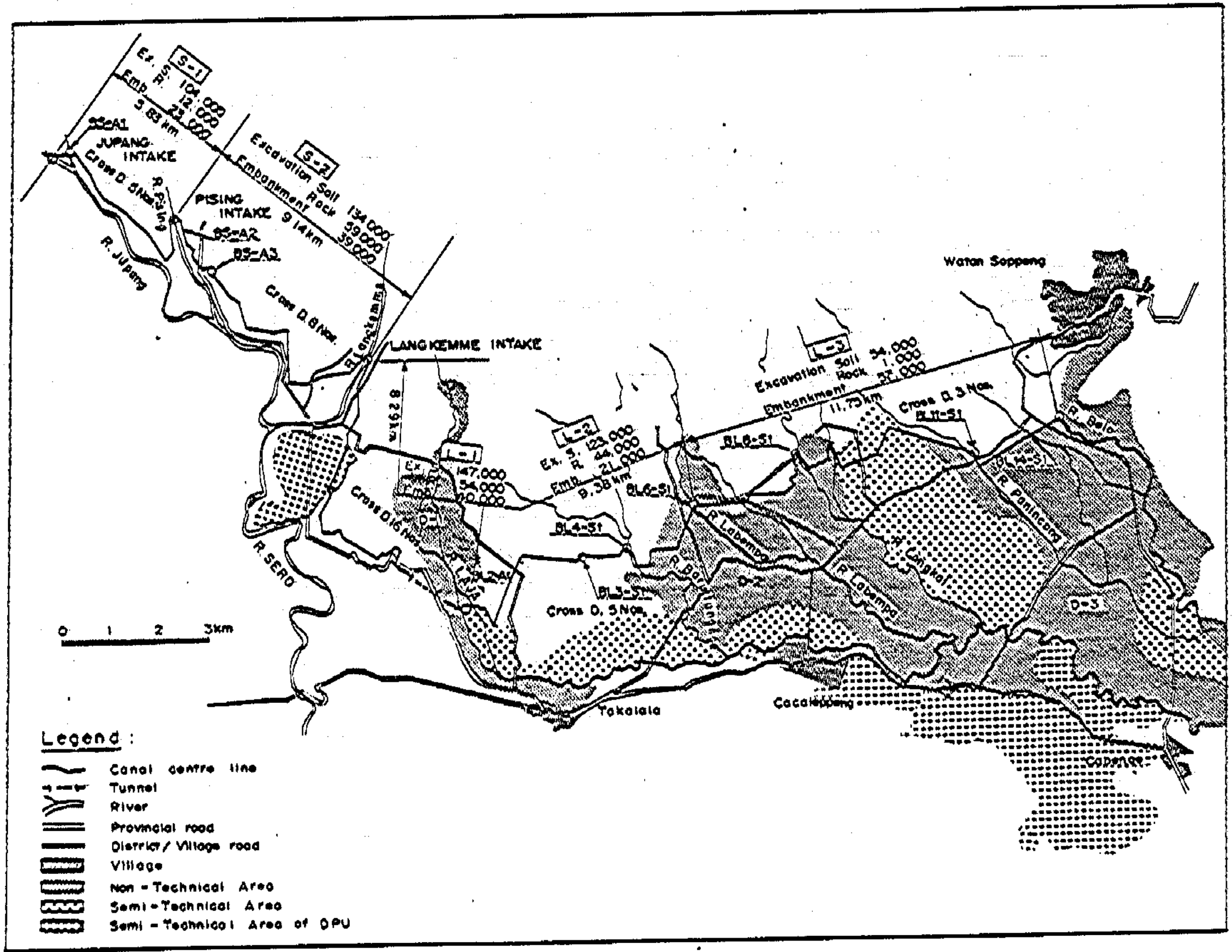


Fig. 5.3.1 GENERAL MAP FOR CONSTRUCTION PLANNING

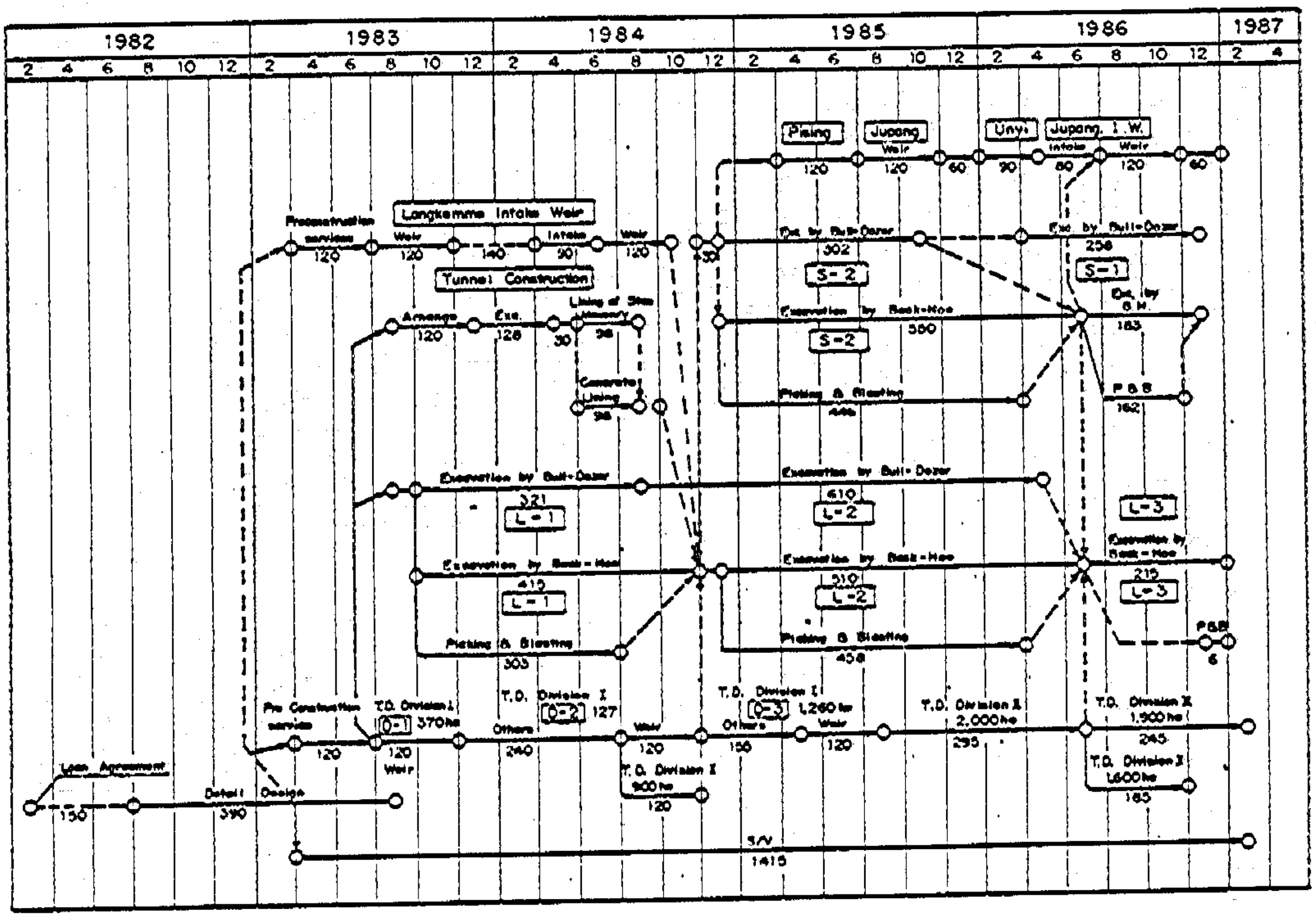


Fig. 5.3.2 IMPLEMENTATION SCHEDULE OF LANGKEMME IRRIGATION PROJECT

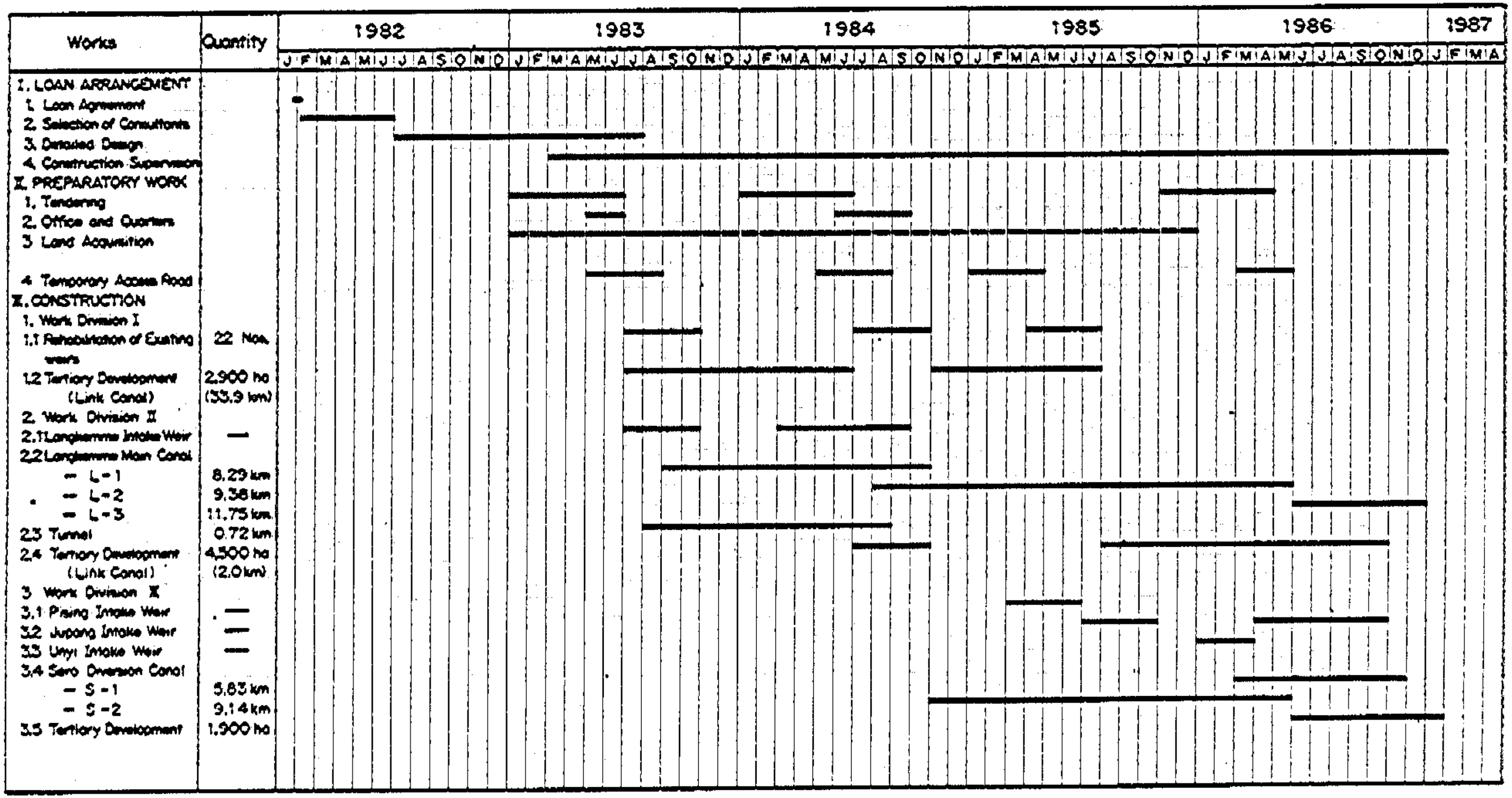


Fig. 5.3.3 CONSTRUCTION TIME SCHEDULE

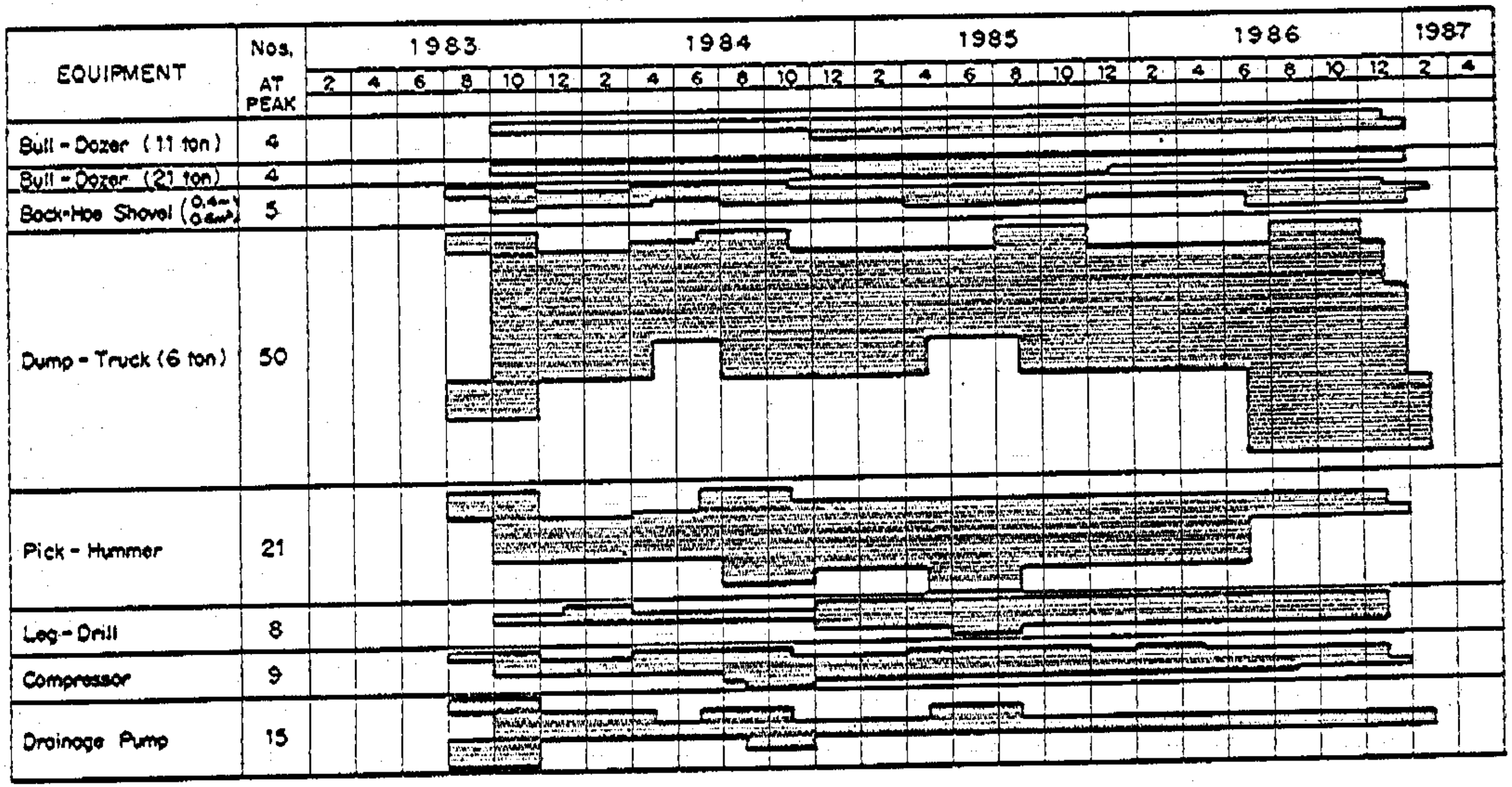


Fig. 5.5.1 OPERATION SCHEDULE OF CONSTRUCTION EQUIPMENT

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