1.5 Reservoir Plan in Lam Dom Yai (Middle and Lower) Sub-Basin

The sub-basin at the middle and lower-basin of the Lam Dom Yai is located in the lowest basin of the Lam Dom Yai basin, and is the flat and rainfed agricultural area. Presently, there are only three smaller medium-scale reservoir sites and one weir site in this area.

The water to be developed in these sites will not enough to irrigate an agricultural land of 13,000 ha (81.3 thousand rai) in this sub-basin. Therefore the agricultural land in the sub-basin must be arranged for irrigation which will use water from the reservoir of D-28.

CHAPTER II. WATER BALANCE STUDY AT POTENTIAL DAM SITE AND THE PROJECT FEATURES FOR POTENTIAL PROJECTS

2.1 Water Balance Study at Potential Dam Site

The water balance study at 39 potential damsite including the projects under construction and to be constructed by RID is made, and the dimensins estimated for water resources development are sammarized in Table E-1.

2.2 Project Features for Potential Projects

Based on the 1/50,000 topographic maps, the dam axis profiles actually surved by RID during the study period, and 1/10,000 reservoir area plane figures, the dimensions of dam and pump facility of the respective project areas are determinded as shown in Table E-2.

TABLE E-1 (1) WATER BALANCES AT POTENTIAL DAM SITES

Project Site		Direct Catchment Area (sq.km)	Annual Inflow (RP=1/5) (MCM) ①	Reservoir Dimension					Water Demand (MCM) ③	Reservoir Loss (MCM) ④	Spill Water (MCM) ⑤	Irrigation Area (ha) ⑥	Ratio to Annual Runoff				
				Reservoir Sur. Area (sq.km)	River Bed (m in EL)	Reservoir Effe.Cap. (MCM) ②	NWL (m in EL)	LWL (m in EL)					Reservoir Effe.Cap. (%) ②/①	Water Demand (%) ③/①	Reservoir Loss (%) ④/①	Spill Water (%) ⑤/①	Irrigation Area (ha/MCM) ⑥/①
1. Lam Dom Yai Upper Basin																	
1.1 RID Small-Medium																	
D-5	Huai Bon(U)	25.0	10.0	0.5		5.9	209.5	190.0	4.6	0.9	4.4	850	59	46	9	44	85
D-18	Huai Wang Yai	35.4	14.1	1.8		9.2	178.6	168.4	6.6	2.9	4.7	1,200	65	46	20	33	85
D-19	Huai Yang	20.0	8.0	1.0		5.2	178.2	168.1	3.6	1.6	2.8	650	65	44	20	35	81
D-20	Huai Chanla	54.0	21.5	3.2		16.9	170.0	160.5	12.6	5.1	3.9	2,300	79	58	24	18	107
D-8	Huai Phalan Sua	114.7	45.7	9.5		32.4	170.0	163.5	6.0	14.6	25.1	1,100	71	13	32	55	24
D-13	Huai Luang	65.0	25.9	2.5		16.5	185.0	174.5	11.5	4.1	10.4	2,100	64	44	16	40	81
	Sub-total	314.1	125.2	18.5		86.1	-	-	44.8	29.0	51.3	8,200	69	36	23	41	65
1.2 Proposed Small-Medium																	
J-7	Huai Bon(L)	116.3	51.2	2.7	162	3.7	165.4	163.0	10.8	4.0	36.0	1,970	7	21	8	70	38
D-15	Huai Chaluai	15.0	6.0	0.9	193	2.4	200.0	194.0	4.6	1.3	0.0	850	40	77	22	0	142
D-16	Huai Chaluai Noi	10.2	4.0	0.2	200	1.5	220.0	201.0	3.2	0.7	0.1	590	38	81	18	3	148
D-17	Huai Om	10.2	4.1	0.3	207	1.6	220.0	208.0	3.6	0.5	0.0	650	38	87	12	1	159
D-22	Huai Hin Lat	44.8	17.9	3.8	155	7.5	160.0	156.0	12.2	5.6	0.1	2,240	42	68	31	0	125
J-4	Huai Thiam Yai	21.0	8.4	1.8	155	3.6	160.0	156.0	4.4	2.7	1.3	1,130	43	52	32	16	135
	Sub-total	217.5	91.6	9.7	-	20.2	-	-	38.8	14.7	37.6	7,430	22	42	16	41	81
Small-Medium Total		531.6	216.8	28.2		106.3	-	-	83.6	43.8	88.9	15,630	49	39	20	41	72
1.3 Proposed Large																	
D-7	Lam Dom Yai (U)	261.7	104.3	5.3	158	100.8	197.0	164.2	93.5	10.6	0.2	24,200	97	90	10	0	232
D-23	Lam Dom Yai (M)	395.9	207.2	21.9		88.0	159.0	150.3	114.3	34.0	57.9	29,600	42	55	16	28	143
D-28(A)	Lam Dom Yai (L)	767.6	485.6	39.1		104.6	139.5	134.5	213.1	59.1	213.5	30,970	22	44	12	44	64
D-28(B)	Lam Dom Yai (L)	633.4	462.2	39.1		104.6	139.5	134.5	213.1	59.1	213.5	25,570	23	46	13	46	55
Total(A)		1,560.9	622.1	72.6		311.7	-	-	213.1	113.4	213.5	70,800	50	34	18	34	114
Total(B)		1,560.9	622.1	89.2		299.0	-	-	213.1	136.8	213.5	70,800	48	34	22	34	114
2. Lam Som Basin																	
2.1 RID Small-Medium																	
D-3-A	Huai Kha Noon	31.9	12.7	2.3		7.3	200.0	193.5	3.0	3.5	6.2	550	57	24	28	49	43
D-31	Huai Phalan	6.0	2.4	0.8		1.6	188.3	184.5	1.1	1.2	0.1	210	67	48	50	2	88
	Sub-total	37.9	15.1	3.1		8.9	-	-	4.2	4.7	6.5	760	59	27	31	43	50
2.2 Proposed Small-Medium																	
D-30-B	Huai Tanot	52.2	20.8	1.4	158	1.1	160.0	159.0	2.1	2.0	16.7	380	5	10	10	80	18
D-1-A	Huai Tung(U)	33.7	13.4	1.4	181	5.0	190.0	182.0	10.9	2.1	0.4	2,000	37	81	16	3	149
D-2	Huai Hin Dan	10.0	4.0	0.3	178	1.6	190.0	179.0	3.4	0.5	0.0	630	630	86	13	1	158
D-1-B	Huai Tung(M)	28.3	12.0	1.3	168	1.0	170.0	169.0	1.1	1.9	8.7	210	9	10	16	72	18
D-3-B	Huai Dan	19.5	14.3	0.9	173	2.5	180.0	174.0	5.2	1.4	7.7	950	18	36	10	54	67
D-4-A	Huai Chong	16.0	6.4	0.1	280	2.2	320.0	281.0	5.7	0.3	0.4	1,050	35	90	4	6	165
D-33	Huai Salao	18.5	7.4	1.6	156	2.6	160.0	157.0	4.0	2.4	1.0	740	35	55	32	13	100
D-35-A	Huai Fang Deang(U)	30.3	12.1	1.6	165	3.2	170.0	166.0	6.0	2.4	3.7	1,100	26	50	20	30	91
D-35-B	Huai Manao	26.4	10.5	1.1	163	3.1	170.0	164.0	6.6	1.7	2.3	1,200	29	62	16	22	114
D-35-C	Huai Fang Deang(M)	16.7	11.8	1.2	149.7	5.0	160.0	150.7	8.1	1.9	1.8	1,490	42	69	16	15	126
	Sub-total	251.6	100.3	10.9		27.3	-	-	53.3	16.5	30.5	9,750	27	53	16	30	97
Small-Medium Total		289.5	115.4	14.0		36.2	-	-	57.4	21.2	37.0	10,510	31	50	18	32	91
2.3 Proposed Large-Medium																	
D-24	Lam Son(M)	605.9	276.0	6.5		7.0	141.0	139.8	18.4	9.5	248.4	4,770	3	7	3	90	17
Total		895.4	356.8	20.5		43.2	-	-	75.8	30.7	248.4	15,280	12	21	9	70	43

TABLE E-1 (2) WATER BALANCES AT POTENTIAL DAM SITES

Project Site	Direct Catchment Area (sq.km)	Annual Inflow (RP=1/5) (MCM) ①	Reservoir Dimension					Water Demand (MCM) ③	Reservoir Loss (MCM) ④	Spill Water (MCM) ⑤	Irrigation Area (ha) ⑥	Ratio to Annual Runoff				
			Reservoir Sur. Area (sq.km)	River Bed (m in EL)	Reservoir Effe.Cap. (MCM) ②	NWL (m in EL)	LWL (m in EL)					Reservoir Effe.Cap. (%) ②/①	Water Demand (%) ③/①	Reservoir Loss (%) ④/①	Spill Water (%) ⑤/①	Irrigation Area (ha/MCM) ⑥/①
3. Huai Ari Basin																
3.1 Proposed Large-Medium																
D-25 Huai Ari	223.4	89.0	8.5	129.5	18.8	140.0	136.1	27.7	12.7	48.6	7,160	21	31	14	55	80
Total	223.4	89.0	8.5	129.5	18.8	140.0	136.1	27.7	12.7	48.6	7,160	21	31	14	55	80
4. Huai Khao San Basin																
4.1 Proposed Small-Medium																
D-26-A Huai Khao San(U)	29.5	11.8	4.2	146	6.7	150.0	147.0	4.8	5.3	1.7	1,240	57	41	45	14	105
D-26-B Huai Khao San(M)	48.6	19.9	2.3	138	1.8	140.0	139.0	1.5	3.3	15.0	380	9	7	17	76	19
D-43 Huai Duan	32.1	12.8	1.8	138	1.4	140.0	139.0	0.9	2.6	9.3	240	11	7	20	72	19
D-49 Rong Saeng	17.7	7.1	0.9	125	1.8	130.0	126.0	2.4	1.4	3.2	630	26	34	20	46	89
D-50 Huai San	26.5	10.6	1.3	116	2.1	120.0	117.0	2.5	1.9	6.2	650	20	24	18	58	62
Total	154.4	62.0	10.5	-	13.9	-	-	12.1	14.5	35.4	3,140	22	20	23	57	51
5.Lam Dom Yai Middle and Lower Basin																
5.1 Proposed Small-Medium																
D-48 Huai Hin Siu	13.7	5.5	1.4	147	1.7	150.0	148.0	1.4	2.1	2.0	370	31	26	38	36	67
D-27 Huai Chong	43.5	17.3	1.0	127	1.2	130.0	128.0	1.9	1.5	14.0	490	7	11	8	81	28
D-51 Huai Saen Phran	22.4	8.9	1.2	113	3.4	120.0	114.0	4.2	1.8	2.9	1,090	38	47	20	32	122
W-1 Lam Dom Yai Weir	1,252.0	499.0	-		-	115.0	112.3	9.7	-	489.3	2,500	-	2	-	98	5
Total	1331.6	530.7	3.6	-	6.2	-	-	17.2	5.4	508.1	4,450	1	3	1	96	8
Grand Total(A)	4,165.7	1,660.7	115.7	-	393.9	-	-	345.9	176.8	1054.0	100,830	24	21	11	63	61
Grand Total(B)	4,165.7	1,660.7	132.3		381.1	-	-	345.9	200.1	1054.0	100,830	23	21	12	63	61
Grand Total(A) %	84.9	-	-	-	-	-	-	16.6	-	-	43.4	-	-	-	-	-
Grand Total(B) %	84.9	-	-	-	-	-	-	16.6	-	-	43.4	-	-	-	-	-
Basin Total	4,905.0	2,080.0	-	-	-	-	-	-	-	-	232,200	-	-	-	-	-

TABLE E-2 (1) PROJECT FEATURES FOR POTENTIAL PROJECTS

Project	J-7 Huai Bon(L)	D-15 Huai Chaluai	D-16 Huai Chaluai Noi	D-17 Huai Om	D-22 Huai Hin Lat
Location					
- Changwat	Ubon	Ubon	Ubon	Ubon	Ubon
- Amphoe	Nam Yun	Nachaluai	Nachaluai	Nachaluai	Det Udom
- Tambon	Sri Wichien	Nachaluai	Nachaluai	Nachaluai	
- Muban	Sum Wai	Takoa	Takoa	Takoa	
River Basin	Lam Dom Yai(U)	Lam Dom Yai(U)	Lam Dom Yai(U)	Lam Dom Yai(U)	Lam Dom Yai(U)
- Catchment Area (sq.km)	116.3	15.0	10.2	10.2	44.8
- Mean Annual Rainfall (mm)	1,356	1,503	1,503	1,503	1,503
- Annual Inflow (R.P.=1/5) (MCM)	51.2	6.0	4.0	4.1	17.9
Reservoir					
- Res. Surface Area(sq.km)	2.7	0.9	0.2	0.3	3.8
- Total Storage Capa. (MCM)	5.1	3.8	14.5	5.3	9.5
- Dead Storage Capa. (MCM)	1.4	0.2	0.1	0.1	1.5
- Effec. Storage Capa. (MCM)	3.7	3.6	14.4	5.2	8.0
- High Water Level (m)	166.40	201.00	221.00	221.00	161.00
- Normal Water Level (m)	165.40	200.00	220.00	220.00	160.00
- Low Water Level (m)	158.20	194.00	201.00	208.00	156.00
Dam					
- Crest Elevation (m)	168.40	203.00	223.00	223.00	163.00
- Width of Dam (m)	6.0	6.0	8.0	6.0	6.0
- Length of Dam (m)	590	500	800	800	900
- E.L. of River Bed (m)	157.20	193.00	200.00	207.00	155.00
- Hight of Dam (m)	16.20	15.00	28.00	21.00	13.00
- Embankment Volume (1000cu.m)	94	45	149	199	45
- C. Area for Flood (sq.km)	141.3	15	10.2	10.2	55.0
- Design Discharge(cu.m/s)					
Desigh Flood Discharge	240	41	30	30	118
Spillway Design Capacity	235	25	26	24	63
Pump Facility					
- No. of Pumping Station (pls)	-	-	-	-	-
- Location of Pumping Station	-	-	-	-	-
- Design Discharge (cu.m/sec)	-	-	-	-	-
- No. of Pump	-	-	-	-	-
- Pump Bore (mm)	-	-	-	-	-
- Total Head (m)	-	-	-	-	-
- Moter Power(kw) / Unit	-	-	-	-	-
Irrigation System					
- Irrigable Area (ha)	1,970	850	590	650	2,240

TABLE E-2 (2) PROJECT FEATURES FOR POTENTIAL PROJECTS

Project	J- 4 Huai Thiam Yai	D-7 Lam Dom Yai (U)	D-23 Lam Dom Yai (Middle)	D-28(A) Lam Dom Yai (Lower)	D-28(B) Lam Dom Yai (Lower)
Location					
- Changwat	Ubon	Ubon	Ubon	Ubon	Ubon
- Amphoe	Nachaluai	Nam Yun	Nam Yun	Det Udom	Det Udom
- Tambon	Sonsaeng	Dom Pradit	Dom Pradit	Top Hu	Top Hu
- Muban	Phon Aeo Khan	Phu Ang	Tha Saen Khun	Kham Tao	Kham Tao
River Basin	Lam Dom Yai(U)	Lam Dom Yai(U)	Lam Dom Yai(U)	Lam Dom Yai(U)	Lam Dom Yai(U)
- Catchment Area (sq.km)	21.0	261.7	395.9	767.6	633.4
- Mean Annual Rainfall (mm)	1,503	1,356	1,356	1,416	1,416
- Annual Inflow (R.P.=1/5) (MCM)	8.4	104.3	207.2	487.9	464.5
Reservoir					
- Res. Surface Area(sq.km)	1.8	5.3	21.9	29.5	29.5
- Total Storage Capa. (MCM)	7.0	103.4	92.0	77.5	77.5
- Dead Storage Capa. (MCM)	0.2	2.6	4.0	7.7	6.3
- Effec. Storage Capa. (MCM)	6.8	100.8	88.0	69.8	71.2
- High Water Level (m)	161.00	198.00	160.00	140.30	140.30
- Normal Water Level (m)	160.00	197.00	159.00	139.30	139.30
- Low Water Level (m)	156.00	159.00	150.30	135.17	134.99
Dam					
- Crest Elevation (m)	163.00	200.00	162.00	142.30	142.30
- Width of Dam (m)	6.0	10.0	8.0	8.0	8.0
- Length of Dam (m)	1,000	300	1,930	980	980
- E.L. of River Bed (m)	155.00	158.00	141.60	125.70	125.70
- Hight of Dam (m)	13.00	47.00	25.40	21.60	21.60
- Embankment Volume (1000cu.m)	49	656	946	405	405
- C. Area for Flood (sq.km)	21.0	261.7	646.6	1,560.9	1,560.9
- Design Discharge(cu.m/s)					
Desigh Flood Discharge	53	393	776	1,087	1,087
Spillway Design Capacity	25	342	590	641	641
Pump Facility					
- No. of Pumping Station (pls)	-	2	2	2	2
- Location of Pumping Station	-	D-28 and D-24 Res.	D-28 and D-24 Res.	D-28 Res.	D-28 Res.
- Design Discharge (cu.m/sec)	-	24.200 24.200	29.600 29.600	7.970 23.000	6.570 19.000
- No. of Pump	-	15 15	18 18	5 16	4 12
- Pump Bore (mm)	-	900 900	1,000 1,000	900 900	900 900
- Total Head (m)	-	13.5 17.6	13.5 17.6	16.5 26.5	12.8 12.8
- Moter Power(kw) / Unit	-	370 450	370 500	400 600	400 700
Irrigation System					
- Irrigable Area (ha)	1,130	24,200	29,600	30,970	25,570

TABLE E-2 (3) PROJECT FEATURES FOR POTENTIAL PROJECTS

Project	D-30-B Huai Tanot	D-1-A Huai Tung(U)	D- 2 Huai Hin Dan	D-1-B Huai Tung(M)	D-3-B Huai Dan
Location					
- Changwat	Sri Sa Khet	Sri Sa Khet	Sri Sa Khet	Sri Sa Khet	Sri Sa Khet
- Amphoe	Kantaraluk	Kantaraluk	Kantaraluk	Kantaraluk	Kantaraluk
- Tambon	Khanon	Bung Mulu	Sao Tong Chai	Non Samran	Sao Tong Chai
- Muban			Koo Kham Pom		Dan Nua
River Basin	Lam Som	Lam Som	Lam Som	Lam Som	Lam Som
- Catchment Area (sq.km)	52.2	33.7	10.0	28.3	19.5
- Mean Annual Rainfall (mm)	1,356	1,356	1,356	1,356	1,356
- Annual Inflow (R.P.=1/5) (MCM)	20.8	13.4	4.0	12.0	14.3
Reservoir					
- Res. Surface Area(sq.km)	1.4	1.4	0.3	1.3	0.9
- Total Storage Capa. (MCM)	1.6	6.4	6.7	1.3	3.9
- Dead Storage Capa. (MCM)	0.5	0.3	1.4	0.3	1.4
- Effec. Storage Capa. (MCM)	1.1	6.1	5.3	1.0	2.5
- High Water Level (m)	161.00	191.00	191.00	171.00	181.00
- Normal Water Level (m)	160.00	190.00	190.00	170.00	180.00
- Low Water Level (m)	159.00	182.00	179.00	169.00	174.00
Dam					
- Crest Elevation (m)	163.00	193.00	193.00	173.00	183.00
- Width of Dam (m)	6.0	6.0	8.0	6.0	6.0
- Length of Dam (m)	700	350	600	500	450
- E.L. of River Bed (m)	158.00	181.00	178.00	168.00	173.00
- Hight of Dam (m)	10.00	17.00	20.00	10.00	15.00
- Embankment Volume (1000cu.m)	10	50	142	8	41
- C. Area for Flood (sq.km)	52.2	33.7	10.0	72.0	57.4
- Design Discharge					
Desigh Flood Discharge	110	78	29	140	118
Spillway Design Capacity	89	56	23	123	105
Pump Facility					
- No. of Pumping Station (pls)	-	-	-	-	-
- Location of Pumping Station	-	-	-	-	-
- Design Discharge (cu.m/sec)	-	-	-	-	-
- No. of Pump	-	-	-	-	-
- Pump Bore (mm)	-	-	-	-	-
- Total Head (m)	-	-	-	-	-
- Moter Power(kw) / Unit	-	-	-	-	-
Irrigation System					
- Irrigable Area (ha)	380	2,000	630	210	950

TABLE E-2 (4) PROJECT FEATURES FOR POTENTIAL PROJECTS

Project	D-4-A Huai Chong	D-33 Huai Salao	D-35-A Huai Fang Deang(U)	D-35-B Huai Manao	D-35-C Huai Fang Deang (M)
Location					
- Changwat	Ubon	Ubon	Ubon	Ubon	Ubon
- Amphoe	Nam Yun	Nam Yun	Nam Yun	Nam Yun	Nam Yun
- Tambon	Chong	Ta Kao	Chong	Chong	Ta Kao
- Muban					Non Hom
River Basin	Lam Som	Lam Som	Lam Som	Lam Som	Lam Som
- Catchment Area (sq.km)	16.0	18.5	30.3	26.4	16.7
- Mean Annual Rainfall (mm)	1,356	1,356	1,356	1,356	1,356
- Annual Inflow (R.P.=1/5) (MCM)	6.4	7.4	12.1	10.5	11.8
Reservoir					
- Res. Surface Area(sq.km)	0.1	1.6	1.6	1.1	1.2
- Total Storage Capa. (MCM)	17.8	2.8	3.5	3.4	8.0
- Dead Storage Capa. (MCM)	0.2	0.2	0.3	0.3	0.2
- Effec. Storage Capa. (MCM)	17.6	2.6	3.2	3.1	7.8
- High Water Level (m)	321.00	161.00	171.00	171.00	161.00
- Normal Water Level (m)	320.00	160.00	170.00	170.00	160.00
- Low Water Level (m)	281.00	157.00	166.00	164.00	150.70
Dam					
- Crest Elevation (m)	323.00	163.00	173.00	173.00	163.00
- Width of Dam (m)	10.0	6.0	6.0	6.0	6.0
- Length of Dam (m)	500	550	750	500	1740
- E.L. of River Bed (m)	280.00	156.00	165.00	163.00	149.70
- Hight of Dam (m)	48.00	12.00	13.00	15.00	18.30
- Embankment Volume (1000cu.m)	1,088	21	38	27	224
- C. Area for Flood (sq.km)	16.0	18.5	30.3	26.4	73.4
- Design Discharge(cu.m/s)					
Desigh Flood Discharge	43	48	71	63	143
Spillway Design Capacity	42	23	47	45	127
Pump Facility					
- No. of Pumping Station (pls)	-	-	-	-	-
- Location of Pumping Station	-	-	-	-	-
- Design Discharge (cu.m/sec)	-	-	-	-	-
- No. of Pump	-	-	-	-	-
- Pump Bore (mm)	-	-	-	-	-
- Total Head (m)	-	-	-	-	-
- Moter Power(kw) / Unit	-	-	-	-	-
Irrigation System					
- Irrigable Area (ha)	1,050	740	1,100	1,200	1,490

TABLE E-2 (5) PROJECT FEATURES FOR POTENTIAL PROJECTS

Project	D-24 Lam Som	D-25 Huai Ari	D-26-A Huai Khao San(U)	D-26-B Huai Khao San(M)	D-43 Huai Duan
Location					
- Changwat	Ubon	Ubon	Ubon	Ubon	Ubon
- Amphoe	Det Udom	Det Udom	K.A.Samrong	K.A.Samrong	Warin Chamrap
- Tambon	Kaeng	Na Khasem	Khok Sawang	Khok Sawang	Sra Saming
- Muban	Fuai-tak	Nong Bua Luang			
River Basin	Lam Son	Huai Ari	Huai Khao San	Huai Khao San	Huai Khao San
- Catchment Area (sq.km)	605.9	223.4	29.5	48.6	32.1
- Mean Annual Rainfall (mm)	1,331	1,522	1,597	1,597	1,597
- Annual Inflow (R.P.=1/5) (MCM)	276.0	89.0	11.8	19.9	12.8
Reservoir					
- Res. Surface Area(sq.km)	6.5	8.5	4.2	2.3	1.8
- Total Storage Capa. (MCM)	13.1	21.0	7.0	2.3	1.7
- Dead Storage Capa. (MCM)	6.1	2.2	0.3	0.5	0.3
- Effec. Storage Capa. (MCM)	7.0	18.8	6.7	1.8	1.4
- High Water Level (m)	142.00	141.00	151.00	141.00	141.00
- Normal Water Level (m)	141.00	140.00	150.00	140.00	140.00
- Low Water Level (m)	139.83	136.05	147.00	139.00	139.00
Dam					
- Crest Elevation (m)	144.00	143.00	153.00	143.00	143.00
- Width of Dam (m)	6.0	6.0	6.0	6.0	6.0
- Length of Dam (m)	1,090	2,050	650	500	350
- E.L. of River Bed (m)	133.30	129.50	146.00	138.00	138.00
- Hight of Dam (m)	15.70	18.50	12.00	10.00	10.00
- Embankment Volume (1000cu.m)	137	310	24	8	8
- C. Area for Flood (sq.km)	895.4	223.4	29.5	78.1	32.1
- Design Discharge(cu.m/s)					
Desigh Flood Discharge	985	346	69	148	74
Spillway Design Capacity	916	253	17	117	46
Pump Facility					
- No. of Pumping Station (pls)	1	1	-	-	-
- Location of Pumping Station	D-24 Res.	D-25 Res.	-	-	-
- Design Discharge (cu.m/sec)	4.800	7.100	-	-	-
- No. of Pump	3	5	-	-	-
- Pump Bore (mm)	900	900	-	-	-
- Total Head (m)	17.6	14.0	-	-	-
- Moter Power(kw) / Unit	450	300	-	-	-
Irrigation System					
- Irrigable Area (ha)	4,770	7,160	1,240	380	240

TABLE E-2 (6) PROJECT FEATURES FOR POTENTIAL PROJECTS

Project	D-49 Rong Saeng	D-50 Huai San	D-48 Huai Hin Siu	D-27 Huai Chong	D-51 Huai Saen Phran
Location					
- Changwat	Ubon	Ubon	Ubon	Ubon	Ubon
- Amphoe	Warin Chamrap	Warin Chamrap	Det Udom	Det Udom	Warin Chamrap
- Tambon	Kham Kwang	Tha Chang	Bua Ngam	Kudpratai	Sawang
- Muban				Sansuk	
River Basin	Huai Khao San	Huai Khao San	Lam Dom Yai(M&L)	Lam Dom Yai(M&L)	Lam Dom Yai(M&L)
- Catchment Area (sq.km)	17.7	26.5	13.7	43.5	22.4
- Mean Annual Rainfall (mm)	1,730	1,730	1,597	1,597	1,730
- Annual Inflow (R.P.=1/5) (MCM)	7.1	10.6	5.5	17.3	8.9
Reservoir					
- Res. Surface Area(sq.km)	0.9	1.3	1.4	1.0	1.2
- Total Storage Capa. (MCM)	2.0	2.4	1.8	1.6	3.6
- Dead Storage Capa. (MCM)	0.2	0.3	0.1	0.4	0.2
- Effec. Storage Capa. (MCM)	1.8	2.1	1.7	1.2	3.4
- High Water Level (m)	131.00	121.00	151.00	131.00	121.00
- Normal Water Level (m)	130.00	120.00	150.00	130.00	120.00
- Low Water Level (m)	126.00	117.00	148.00	128.00	114.00
Dam					
- Crest Elevation (m)	133.00	123.00	153.00	133.00	123.00
- Width of Dam (m)	6.0	6.0	6.0	6.0	6.0
- Length of Dam (m)	400	250	500	350	400
- E.L. of River Bed (m)	125.00	116.00	147.00	127.00	113.00
- Hight of Dam (m)	13.00	12.00	11.00	11.00	15.00
- Embankment Volume (1000cu.m)	22	11	13	10	37
- C. Area for Flood (sq.km)	17.7	26.5	13.7	43.5	22.4
- Design Discharge(cu.m/s)					
Desigh Flood Discharge	48	64	38	96	56
Spillway Design Capacity	32	44	15	82	36
Pump Facility					
- No. of Pumping Station (pls)	-	-	-	-	-
- Location of Pumping Station	-	-	-	-	-
- Design Discharge (cu.m/sec)	-	-	-	-	-
- No. of Pump	-	-	-	-	-
- Pump Bore (mm)	-	-	-	-	-
- Total Head (m)	-	-	-	-	-
- Moter Power(kw) / Unit	-	-	-	-	-
Irrigation System					
- Irrigable Area (ha)	630	650	370	490	1,090

TABLE E-2 (7) PROJECT FEATURES FOR POTENTIAL PROJECTS

Project	W-1 Lam Dom Yai Weir				
Location					
- Changwat	Ubon				
- Amphoe	Det Udom				
- Tambon	Na Di				
- Muban					
River Basin	Lam Dom Yai(M&L)				
- Catchment Area (sq.km)	1,252.0				
- Mean Annual Rainfall (mm)	1,598				
- Annual Inflow (R.P.=1/5) (MCM)	525.2				
Reservoir					
- Res. Surface Area(sq.km)	-				
- Total Storage Capa. (MCM)	-				
- Dead Storage Capa. (MCM)	-				
- Effec. Storage Capa. (MCM)	-				
- High Water Level (m)	115.60				
- Normal Water Level (m)	115.00				
- Low Water Level (m)	112.30				
Dam					
- Crest Elevation (m)	115.00				
- Width of Dam (m)	-				
- Length of Dam (m)	50				
- E.L. of River Bed (m)	112.00				
- Hight of Dam (m)	3.00				
- Embankment Volume (1000cu.m)	-				
- C. Area for Flood (sq.km)	-				
- Design Discharge(cu.m/s)					
Desigh Flood Discharge	-				
Spillway Design Capacity	-				
Pump Facility					
- No. of Pumping Station (pls)	1				
- Location of Pumping Station	W-1 Weir				
- Design Discharge (cu.m/sec)	2.500				
- No. of Pump	2				
- Pump Bore (mm)	400				
- Total Head (m)	23.0				
- Moter Power(kw) / Unit	110				
Irrigation System					
- Irrigable Area (ha)	2,500				

ANNEX F. IRRIGATION AND DRAINAGE

ANNEX F. IRRIGATION AND DRAINAGE

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PART-I. (OVERALL BASIN STUDY)

1.1 Existing Irrigation Projects

According to the field works and collected data on the Lam Dom Yai Irrigation Project, the total cultivation area in the basin is estimated at about 254,530 ha, which is equivalent to 51.9 percent of the total basin area of 490,500 ha.

The agricultural farming in most of land is rainfed conditions relying upon rainfall mainly concentrating in the rainy season from May to October, and irrigated farming land is estimated at only about 10,600 ha, of which executing agencies are RID, ARD, NEA, DOLA and ALRO as shown below;

Projects	Present Irrigation Project			
	No. of Schemes	Irrigation Area		Canal Length
		Wet Season (ha)	Dry Season (ha)	(km)
RID Project				
Medium-Scale	3	3,930	930	54
Small-Scale	52	4,220	-	-
Sub-total	55	8,150	930	54
DLD Project	7	500	100	-
ARD Project	30	350	-	-
NEA Project	4	1,050	200	12
DOLA Project 1/	34	(380)	(170)	-
ALRO Project 2/	-	200	70	-
Total	130	10,630	1,470	66

Note; 1/ Area in parenthesis shows a part of 35 projects
2/ ALRO Projects include groundwater projects.

The detailed descriptions of the above projects are tabulated in Table F-1 to Table F-6.

TABLE F-1 OUTLINE OF COMPLETED SMALL IRRIGATION PROJECT (UBON RATCHATHANI) (1)

No	Name of Projects	Locatopn Amphoe Tumbon	Comple-ted Yeaar	Const. Cost (mill.B.)	Project Features								
					No. of Beneficiary (household)	Irrigat. Area		Planted Crop		Irrigation Facilities			Annual O/M Cost (mil.B
						Wet S. (ha)	Dry S. (ha)	Wet S. (ha)	Dry S. (ha)	Dam Capacity (MCM)	Canal Length (km)	Canal Max. Q (m^3 /s)	
1.	Huai Duan (W)	Warin Chamr. Sra Saming	1979	0.83	200	122	-				-	-	-
2.	Huai Pai (W)	Phibun Mang. Rai Tai	1980	1.44	150	80	-				-	-	-
3.	Huai Kua (W)	Warin Chamr. Sawang	1980	0.63	100	160	-		Vegetable, Peanuts, Corn, Watermelon, Cassava and Kenaf	0.20	-	-	-
4.	Huai San (T)	Na Chaluai Na Chaluai	1981	2.41	2,400	48	-	Rice		0.80	-	-	-
5.	Huai Om (T)	Na Chaluai Na Chaluai	1981	2.06	40	32	-			0.38	-	-	-
6.	Huai A-Rong (W)	Det Udom Kut Prathai	1981	2.00	650	24	-			-	-	-	-
7.	Huai Hin Sew (RW)	Det Udom Kut Prathai	1981	3.13	280	32	-			0.11	-	-	-
8.	Huai Bon (W)	Nam Yun Chong	1981	3.82	220	24	-			0.14			
9.	Huai A-Rong (W)	Det Udom Som Sa-at	1982	1.69	534	80	-			-	-	-	-
10	Huai Lok (T)	Na Chaluai Na Chaluai	1982	2.39	240	3	-			0.35	-	-	-
11	Huai Khaen (RW)	Det Udom Na Suang	1983	1.98	170	16	-			-	-	-	-

Note; W : Weir RD : Rubber Dam T : Tank (Dam)

TABLE F-1 OUTLINE OF COMPLETED SMALL IRRIGATION PROJECT (UBON RATCHATHANI) (2)

No	Name of Projects	Locatopn Amphoe Tumbon	Comple-ted Year	Const. Cost (mill.B.)	Project Features								
					No. of Beneficiary (household)	Irrigat. Area		Planted Crop		Irrigation Facilities			Annual O/M Cost (mil.B
						Wet S. (ha)	Dry S. (ha)	Wet S. (ha)	Dry S. (ha)	Dam Capacity (MCM)	Canal Length (km)	Canal Max. Q (m^3 /s)	
12	Huai Khaen (RW)	Det Udom Na Suang	1983	1.97	664	16	-			-	-	-	-
13	Huai Bua (RW)	Det Udom Klang	1983	2.11	300	19	-			-	-	-	-
14	Huai Song (T)	Nam Yun Chong	1983	1.05	250	48	-		Vegetable, Peanuts, Corn, Watermelon, Cassava and Kenaf	0.15			
15	Huai Hin Sew (RW)	Det Udom Muang Det	1983	2.65	250	32	-	Rice		-	-	-	-
16	Huai Cha Luai(T)	Na Chaluai Na Chaluai	1983	3.38	400	192	-			1.10	-	-	-
17	Huai Sunnuen (T)	Na Chaluai Na Chaluai	1983	3.04	130	72	-			0.53	-	-	-
18	Huai Pun (T)	Na Chaluai Ban Tum	1983	3.42	300	32	-			1.35	-	-	-
19	Huai Yang (T)	Nam Yun Ta kao	1984	2.40	200	48	-			1.59	-	-	-
20	Huai Rong Tan (T)	Na Chaluai Na Chaluai	1984	3.89	83	40	-			0.20	-	-	-
21	Huai Pun (T)	Na Chaluai Na Chaluai	1984	3.42	100	32	-			1.35	-	-	-
22	Huai Dam Rong(T)	Nam Yun khi Lek	1984	3.65		40	-			1.46	-	-	-
23	Huai Som (W)	Det Udom Kaeng	1984	3.57	400	32	-			-	-	-	-

TABLE F-1 OUTLINE OF COMPLETED SMALL IRRIGATION PROJECT (UBON RATCHATHANI) (3)

No	Name of Projects	Locatopn Amphoe Tumbon	Comple-ted Year	Const. Cost (mill.B.)	Project Features								
					No. of Beneficiary (household)	Irrigat. Area		Planted Crop		Irrigation Facilities			Annual O/M Cost (mil.B
						Wet S. (ha)	Dry S. (ha)	Wet S. (ha)	Dry S. (ha)	Dam Capacity (MCM)	Canal Length (km)	Canal Max. Q (m^3 /s)	
24	Huai kut Ng-ong (T)	Det Udom Muang Det	1984	2.28	200	8	-			0.68	-	-	-
25	Huai Sa Dao (T)	Det Udom Na Yia	1984	3.31	79	40	-			1.58	-	-	-
26	Huai Bua (RW)	Det Udom Klang	1985	3.99	126	19	-		Vegetable, Peanuts, Corn, Watermelon, Cassava and Kenaf	-	-	-	-
27	Huai A-Ree (W)	Det Udom Nong Om	1985	1.86	110	8	-	Rice		-	-	-	-
28	Huai kaeng Kom (T)	Det Udom Na Rueng	1985	2.48	200	32	-			0.41	-	-	-
29	Huai Om (T)	Na Chaluai Na Chaluai	1985	7.02		160	-			0.85	-	-	-
30	Huai Rad (T)	Nam Yun Bu Pluai	1986	2.84	100	32	-			0.42	-	-	-
31	Huai Som (T)	Nam Yun Ta Kao	1987	4.41	700	160	-			0.42	-	-	-
32	Huai Dom Yai (RW)	Det Udom Muang Det	1987	8.63		640	-			-	-	-	-
33	Huai Pun (T)	Na Chaluai Non Sombun	1988	3.87	200	80	-			1.04	-	-	-
34	Huai Cha Luai(T)	Na Chaluai Ban Tum	1988	3.98	500	32	-			0.50	-	-	-
35	Huai Som (W)	Det Udom Kut Rua	1989	6.81	310	320	-			-	-	-	-

TABLE F-1 OUTLINE OF COMPLETED SMALL IRRIGATION PROJECT (UBON RATCHATHANI) (4)

No	Name of Projects	Locatopn Amphoe Tumbon	Completed Year	Const. Cost (mil.B.)	Project Features								
					No. of Beneficiary (household)	Irrigat. Area		Planted Crop		Irrigation Facilities			Annual O/M Cost (mil.B
						Wet S. (ha)	Dry S. (ha)	Wet S. (ha)	Dry S. (ha)	Dam Capacity (MCM)	Canal Length (km)	Canal Max. Q (m^3 /s)	
36	Huai Takoy (T)	Nam Yun Song	1989	8.06	200	128	-			0.91	-	-	-
37	Huai Thiam (W)	Na Chaluai Non Sombun	1990	3.50			-		Vegetable, Peanuts, Corn, Watermelon, Cassava and Kenaf	-	-	-	-
38	Huai Chan (T)	Det Udom Na Rueng	1990	3.00			-			0.27	-	-	-
39	Huai Sannua (T)	Na Chaluai Na Chaluai	1991	3.04	130	72		Rice		0.53	-	-	-
40	Huai Song (T)	Nam Yun Song	1991	1.05	-	45	-			0.15	-	-	-
41	Huai Pong Thren (T)	Na Chaluai Na Chaluai	1991	3.89	80	40	-			0.20	-	-	-
42	Huai Om (T)	Na Chaluai Na Chaluai	1991	7.02	-	160	-			0.85	-	-	-
Total				137.97		3,200							

TABLE F-2 OUTLINE OF COMPLETED SMALL IRRIGATION PROJECT (SI SA KET)

No	Name of Projects	Locatopn Amphoe Tumbon	Comple-ted Year	Const. Cost (mil.B.)	Project Features								
					No. of Beneficiary (household)	Irrigat. Area		Planted Crop		Irrigation Facilities			Annual O/M Cost (mil.B
						Wet S. (ha)	Dry S. (ha)	Wet S. (ha)	Dry S. (ha)	Dam Capacity (MCM)	Canal Length (km)	Canal Max. Q (m^3 /s)	
1.	Huai Sam Yaek(T)	Kantaralak Kud Salao	1981	1.91	68	96	-			0.10			
2.	Huai Sao Tong Chai (T)	Kantaralak Sao Thong C.	1982	3.47	260	160	-			0.35			
3.	Huai Sok kam Pom (T)	kantaralak Sao Thong C.	1983	1.19	68	160	-			0.18			
4.	Huai Nong Wa (T)	Kantaralak Sao Thong C.	1983	1.99	199	80	-			0.19			
5.	Huai Sim (W)	Kantaralak Sao Thong C.	1987	2.19	98	80	-			-			
6.	Huai Sa Tong (T)	Kantaralak Bung Malu	1987	3.97	368	80	-			0.25			
7.	Huai Non Sam Bun (T)	Kantaralak Khanun	1987	3.88	172	192	-			-			
8.	Huai Non Sam Ran (W)	Kantaralak Non Samran	1988	2.21	140	64	-			0.11			
9.	Huai Kud Salao (T)	Kantaralak Kud Salao	1989	3.11	470	80	-			-			
10	Huai Non Rua (T)	kantaralak Suan Kuai	1989	3.20	96	24	-			0.15			
Total				27.12	1,939	1,016							

Rice

Vegetable, Peanuts, Corn, Watermelon, Cassava and Kenaf

TABLE F-3 LIST OF TANK AND WEIR CONSTRUCTED BY DEPARTMENT OF LAND DEVELOPMENT

No	Name of Project (Muban)	Tambon	Amphoe	Completed Year	Const. Cost (1,000 Baht)	Irrigation Area		Capacity (cu.m)
						Wet Sea. (ha)	Dry Sea. (ha)	
Existing Tank and Weir								
1.	Non Do (T)	Non Don	Det Udom	1983	360	3	2	9,800
2.	Nong Yao Swamp (W)	Tung Tueng	Det Udom	1983	1,229	28	16	107,000
3.	Coke Tian (W)	Noensambun	Na Chaluai	1984	474	32	24	-
4.	Tung Tueng (T)	Tung Tueng	Det Udom	1986	2,603	320	24	160,000
5.	Nong Yao (W)	Tung Tueng	Det Udom	1987	496	32	8	-
6.	Na Du (W)	Som Sa-ad	Det Udom	1977	770	80	24	-
7.	Nong Pan (W)	Na Yia	Det Udom	1987	579	Domestic, Livestock		48,000
Total					6,511	495	98	
Proposed Tank and								
1.	Na Rueng Weir	Na Rueng	Det Udom	1991	2,000	Domestic, Livestock		-
2.	Pho Sa-nga Weir	Tha Pho Si	Det Udom	1991	2,000	70	24	-
3.	Na Kra Saeng Tank	Na Kra Saeng	Det Udom	1991	2,000	Livestock		-
4.	Huay Bua Weir	Khlang	Det Udom	1992	-	-	-	-
5.	Nong Sanom Weir	Bua Ngam Weir	Det Udom	1992	-	-	-	-
6.	Noen Yang Weir	Ta kao	Nam Yun	1992	-	-	-	-
7.	kam Sa-ad Weir	Yang Yai	Nam Yun	1992	-	-	-	-
8.	Koeng Sawang Weir	Noen Sawan	Na Chaluai	1992	-	-	-	-
9.	Huay Sin Tai Weir	Na Chaluai	Na Chaluai	1992	-	-	-	-

TABLE F-4 LIST OF TANK AND WEIR CONSTRUCTED BY ACCELERATED RURAL DEVELOPMENT DEPARTMENT (1)

No	Name of Project (Muban)	Tambon	Amphoe	Completed Year	Project Area (ha)	Const. Cost (1,000 Baht)	Capacity (1,000 cu.m)
1	Huai Aree (P)	Tung Tueng	Det Udom	1971	-	20	3
2	Na Ta Tae (P)	Chong	Nam Yun	1972	-	20	3
3	Huai San (T)	Na Chaluai	Na Chaluai	1977	8	625	33
4	Huai Po (T)	Chong	Nam Yun	1977	16	306	10
5	Non Yang (P)	Ta Kao	Nam Yun	1980	3	93	3
6	Nong Krok (P)	Dom Pradit	Nam Yun	1980	-	93	3
7	Kud Chiong Noan-1 (P)	Dom Pradit	Nam Yun	1980	3	93	3
8	Kut Chiong Noan-2 (P)	Dom Pradit	Nam Yun	1980	3	93	3
9	Wat Pa Sina Lang(P)	Tung Tueng	Det Udom	1980	8	335	30
10	Kaeng Ruang-1 (P)	Na Chaluai	Na Chaluai	1980	3	93	3
11	kaeng Ruang-2 (P)	Na Chaluai	Na Chaluai	1980	3	93	3

Note : P : Pond T : Tank W : Weir

TABLE F-4 LIST OF TANK AND WEIR CONSTRUCTED BY ACCELERATED RURAL DEVELOPMENT DEPARTMENT (2)

No	Name of Project (Muban)	Tambon	Amphoe	Completed Year	Project Area (ha)	Const. Cost (1,000 Baht)	Capacity (1,000 cu.m)
12	Kae Don-1 (P)	Dom Pradit	Nam Yun	1981	3	107	3
13	Kae Don-2 (P)	Dom Pradit	Nam Yun	1981	3	107	3
14	Khor (P)	Dom Pradit	Nam Yun	1981	3	107	3
15	Jan La (P)	Dom Pradit	Nam Yun	1981	3	107	3
16	Non Sueng (P)	Dom Pradit	Nam Yun	1981	3	107	3
17	Nong Sanom (P)	Nong Om	Det Udom	1982	8	86	38
18	Nong Kaeng (P)	Top Hu	Det Udom	1984	6	116	12
19	Pla Kao (P)	Yang	Nam Yun	1984	10	260	15
20	Huai Fang Pae (W)	Na Chaluai	Na Chaluai	1984	16	1,784	-
21	Nong Wang (P)	Sok Saeng	Na Chaluai	1985	5	260	20
22	Huai Chan Hom (W)	Non Samran	Kantaralak	1987	240	7,882	-

TABLE F-4 LIST OF TANK AND WEIR CONSTRUCTED BY ACCELERATED RURAL DEVELOPMENT DEPARTMENT (3)

No	Name of Project (Muban)	Tambon	Amphoe	Completed Year	Project Area (ha)	Const. Cost (1,000 Baht)	Capacity (1,000 cu.m)
23	Nong Suan Kluai (P)	Suan Kluai	Kantaralak	1990	-	1,512	48
24	Huai Aree (W)	Tung Tueng	Det Udom	1990	-	6,918	-
25	Na Cha Roen (P)	Na Charoen	Det Udom	1990	-	2,339	95
26	Nong Bua Dang (P)	Na Charoen	Det Udom	1990	-	858	28
27	Nong Bua Luang (P)	Som Sa-At	Det Udom	1990	-	1,191	48
28	Nong Sean Eam (P)	Muang Det	Det Udom	1990	-	1,198	41
29	Nong Yai (P)	Phon Ngam	Det Udom	1990	-	1,102	55
30	Nong Ta Ong (P)	khilek	Nam Yun	1990	-	1,442	57
Total					347	29,347	

TABLE F-5 EXISTING ELECTRIC PUMP IRRIGATION BY NEA

No	Name of Project	Location	Comple-ted Year	Project Area	Irrigation Area		Project Facility		Water Charge
		Ampho Tambol Muban		(ha)	Wet S. (ha)	Dry S. (ha)	Pump Capacity (cu.m/s)	Canal Length (km)	(Baht/ ha)
1.	Ban Sang Kaew	Phibun Mungsahan Pho Sai Sang Kaew	1980	576 (338)	338	112	0.057 x 2 units	8.5	181
2.	Ban Tha Pho Si	Det Udom Tha Pho Si Tha Pho Si	1984	640 (235)	235	88	0.057 x 1 unit	3.9	513
3.	Ban Na Yia	Det Udom Na Yia Na Yai	1990	240	under const-ruction		-	-	-
4.	Ban Na Ruang	Det Udom Na Rueng Na Rueng	1990	240	under const-ruction		-	-	-
5.	Ban Kang Dom	Warin Chamrap Sa Wang kang Dom	1991	-	Proposed		-	-	-
Total				1,051	573	200	-	-	

Note : 1/ The figures in parenthesis of project area show an actual areas developed.
2/ Water charge (electric charge), which will be burdened at the rate of about 50 to 50 percent by farmer and NEA shows the cost in case of dry season cropping in 1991.

TABLE F-6 LIST OF TANK AND WEIR CONSTRUCTED BY DEPARTMENT OF LOCAL ADMINISTRATION (1)

No	Name of Projects	Locatopn Amphoe Tumbon	Completed Yeaar	Constion Cost (1,000 Bhat)	No. of Beneficiary (household)	Irrigat. Area		Planted Crop		Facilities		Executing Agency
						Wet S. (ha)	Dry S. (ha)	Wet S. (ha)	Dry S. (ha)	Tank Capacity ('000cu.m)	Canal Length (km)	
1	Ban Suk Som Bun (W)	Warin Chamrap Tha Chang	1986	-								DOLA
2	Ban Pa Ka (W)	Warin Chamrap	1986	98								DOLA
3	Ban Nong Sanom	Det Udom Bua Ngam	1986	144								DOLA
4	Pra Cha Arsa (W)	Warin Chamrap Sra Saming	1987	124								DOLA
5	Pra Cha Arsa (W)	Det Udom Na Rueng	1987	144								DOLA
6	Pra Cha Arsa (W)	Phuibun Mang. Na Pho	1987	119								DOLA
7	Na Pi Man (W)	Warin Chamrap Sra Saming	1988	156	160	80	48			108	-	DOLA
8	Pra Cha Arsa (W)	Warin Chamrap Sra Saming	1988	130								DOLA
9	Pra Cha Arsa	Phibun Mang. Pho Sai	1988	91								DOLA
10	Pra Cha Arsa (W)	Det Udom Na kasaeng	1988	149								New Zealand
11	Huai Hin Lat (W)	Det Udom Na Rueng	1988	233								Khor Sor Chor
12	Hin Kor (W)	Det Udom Kham khrang	1988	237								Khor Sor Chor

TABLE F-6 LIST OF TANK AND WEIR CONSTRUCTED BY DEPARTMENT OF LOCAL ADMINISTRATION (2)

No	Name of Projects	Locatopn Amphoe Tumbon	Comple-ted Yeaar	Constion Cost (1,000 Bhat)	No. of Beneficiary (household)	Irrigat. Area		Planted Crop		Facilities		Executing Agency
						Wet S. (ha)	Dry S. (ha)	Wet S. (ha)	Dry S. (ha)	Tank Capacity ('000cu.m)	Canal Length (km)	
13	Huai Yai (W)	Det Udom Muang Det	1988	286								Khor Sor Chor
14	Huai Dam Ngoa (W)	Det Udom Na Charoen	1988	288								Khor Sor Chor
15	Na Suang (W)	Det Dom Na Suang	1988	110								DOLA
16	Pra Cha Arsa (W)	Det Udom Na Kasaeng	1988	158								New Zealand
17	Pra Cha Arsa (W)	King A Samrong Khok Sawang	1988									New Zealand
18	Pra Cha Arsa (W)	King A Samrong Khok Sawang	1988									New Zealand
19	Pra Cha Arsa (W)	King A Samrong Khok Sawang	1988									New Zealand
20	Huai Kamen (W)	Nam Yun Dom Pradit	1988	397								Khor Sor Chor
21	Huai Hin Dum (W)	Nam Yun Yang	1988	391								khor Sor Chor
23	Huai Sa Lao(W)	Nam Yun Khi Lek	1988	296								Khor Sor Chor
24	Huai Kra Ton (W)	Na Chaluai Porn Sawam	1988	361								Khor Sor Chor
25	Na Huai Kan(W)	Det Udom Na Suang	1989	190	115	24	16			116	-	DOLA

TABLE F-6 LIST OF TANK AND WEIR CONSTRUCTED BY DEPARTMENT OF LOCAL ADMINISTRATION (3)

No	Name of Projects	Locatopn Amphoe Tumbon	Comple-ted Yeaar	Constion Cost (1,000 Bhat)	No. of Beneficiary (household)	Irrigat. Area		Planted Crop		Facilities		Executing Agency -
						Wet S. (ha)	Dry S. (ha)	Wet S. (ha)	Dry S. (ha)	Tank Capacity ('000cu.m)	Canal Length (km)	
26	Nong Hai (W)	Det Udom Na kra Sang	1989	222	90	32	16			70	-	DOLA
27	Nong Bua (W)	Warin Chamrap Sra Saming	1989	142	190	24	16			120	-	DOLA
28	Sra Saming (W)	Warin Chamrap Sra Saming	1989	130	120	32	24			72	-	DOLA
29	Nong Ta Pu (W)	Warin Chamrap Sra Saming	1989	238	300	48	32			135	-	DOLA
30	Wang Kog (W)	King A Samrong Kok Sawang	1989	206	160	19	8			30	-	DOLA
31	Obmung (W)	king A Samrong Kok Sawang	1989	190	140	19	8			36	-	DOLA
32	Kum (W)	King A Samrong Kok Sawang	1989	238	277	24	8			70	-	DOLA
33	Kra-aq (W)	King A Samrong Kok Sawang	1989	234	325	32	11			75	-	DOLA
34	Sra Dog Ged(W)	King A Samrong Kok Sawang	1989	192	120	21	11			46	-	DOLA

PART-II (FEASIBILITY STUDY)

CHAPTER I. IRRIGATION PLAN

1.1 Irrigation for Paddy

1.1.1 Irrigation Water Requirement

1) Reference Crop Evapotranspiration (ETo)

The reference crop evaporation (ETo). generally recognized as fairly reliable index in calculating consumptive use, can be determined by a number of methods like the evaporation measurement with evaporation pan and the application of empirical formula based on the climatological data. In the project, the ETo values are estimated by the modified Penman Method on the monthly basis, using the climatological data observed at Ubon Ratchathani observation station for the period of 30 years(1961-1990).

The estimated monthly ETo is as follows;

Reference Crop Evapotranspiration (ETo)

Month	ETo (mm)	Month	ETo (mm)
Jan.	4.3	July	4.5
Feb.	5.2	Aug.	4.3
Mar.	5.8	Sept.	4.0
Apr.	6.1	Oct.	4.3
May	5.4	Nov.	4.5
June	4.5	Dec.	4.1
		Ave.	5.0

2) Consumptive Use of Crop

Consumptive use of crop (actual crop evaporation, ETa) can be calculated by multiplying the Eto value by crop coefficient (Kc) corresponding to growth of crops.

The crop coefficients adopted for the project study are shown

in Table F-7, which is obtained from the Water Requirement Research, Irrigated Agricultural Section, O/M Division, 1990.

For the presentation of the crop coefficient, the crop growing season can be divided into four stages; initial growth, crop development, mid-season growth and late-season growth. The typical generalized crop coefficient curves are illustrated in Figure F-1, together with planting dates, length of growing season and duration of each stage.

The four principal stages of crop development are defined as follows;

Initial Growth Stage
This stage covers the initial planting, transplanting shock and early growth period when the crop only partially covers the soil. The consumptive use is low and fairly constant during this period.

Crop Development Stage
This stage covers the period from the end of the initial growth stage to attainment of full ground cover, or the period of rapid leaf development. The consumptive use increases rapidly during this stage.

Mid-Season Stage
This stage covers the period from attainment of effective ground cover, or full leaf development, to the start of maturing. The Kc value remains fairly constant during this period.

Late-Season Stage
This stage covers the maturing period of the crop and finishes with full maturity or harvest.

Estimated consumptive use of crop is given in Table F-8.

3) Crop Water Requirement

a) Percolation Rate

Since there exist no available data on percolation rate in paddy field, 2.0 mm/day of percolation rate is assumed in the project.

b) Additional Water Supply for Land Preparation for Paddy Field

(1) Land Soaking and Preparation

Paddy field requires well-puddled and well prepared soil to;

- provide a soil surface that is weed free, soft and level to make transplanting easier,
- mix organic matter (rice straw, stubble and weeds) with soil and encourage decomposition,
- level the filed for uniform distribution of irrigation water, fertilizers and pesticides,
- prevent or minimize water seepage from the field.

If those organic matter is not well decomposed by the time of transplanting, the seedling are likely to suffer from toxic substances given off during the decomposition. From these reasons, land preparation should be started at least two weeks before planting.

Plowing

- Flood the field two to seven days before plowing depending on the hardness of the soil. Keep the surface of the soil just covered with water; this will help keep the soil from sticking to the plow.
- Keep the soil flooded with about 1.0 cm of water until harrowing, a duration of about seven days if possible. This provided time to soften the soil clods further and allows weeds to sprout, while plowed fresh organic materials undergo decomposition.

Harrowing

- Keep enough water in the field to prevent the soil from drying and hardening. If possible, wait for seven to ten days before harrowing to allow more weed seeds to germinate before they are finally turned under the soil and to give more time to plow fresh organic matter to decompose.

Provision and Repair of Levee

Before preparing the land, levees should be repaired to help reduce seepage from the paddy field. Paddy fields that are properly repaired and plastered with mud are unfavorable to rats and make it difficult for weeds and host plants of insect to get established.

The best time to fix levees is after the first plowing because the upturned soil near the levees can be used in the work. Levees should be repaired before harrowing so the weeds cut from the levees can be incorporated in the soil well before the rice is planted.

- Clean the Levee
  . On the top and both sides of the levee cut the weeds close to the roots. This will also trim off thick portions of the levee.

- Repair the Levee
  . Destroy all rats by placing cyanide dust in their holes, or break up and rebuild the portion of the levee containing rat holes.

  . Use soil that has been broken up by the first plowing for patching up soft spots and cracks.

- Plaster the Levee
  Use additional mud and water, if necessary, to smooth levee with hands. Give special attention to the sides to make sure that all cracks are sealed properly, otherwise water in the plot may seep the other plots.

Irrigation Schedule during Land Preparation

In accordance with above mentioned procedures as well as current practices of land soaking and land preparation around the Study Area, following irrigation schedule is planned in the project (refer to Figure F-2).

- 1st irrigation which is to be supplied with two times will be made at the beginning of land soaking and land preparation eight to three days before plowing. Amount of water should be enough for saturation of top soil and supply for evaporation and percolation for 11 days until 2nd irrigation.

- 2nd irrigation will be made just before cleaning and repairing the levee.

- 3rd irrigation will be made just after harrowing.

(2) Water Requirement for Land Soaking and Land Preparation

Total water supply for land soaking and land preparation periods was computed as shown in Table F-9 in accordance with the irrigation schedules, and the results are summarized as shown below;

1st Irrigation	:	150mm
2nd Irrigation	:	39
3rd Irrigation	:	61
Total	:	250

Table F-10 and Table F-11 shows the crop water requirement on the basis of the proposed cropping pattern of Type-I and Type-II.

4) Diversion Water Requirement

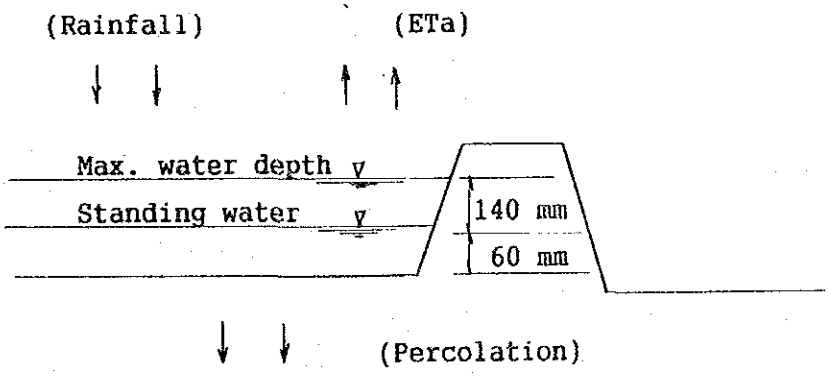
The diversion water requirement can be calculated by adding effective rainfall and irrigation efficiency to the crop water requirement, which was estimated on the basis of proposed cropping pattern. The criteria for calculation of the effective rainfall and irrigation efficiency are as follows;

Effective Rainfall

Effective rainfall for paddy field is estimated by analyzing daily water balance study between the rainfall and crop water requirement based on the following conditions;

- The minimum standing water in the field is 60 cm.
- The rainfall in the water depth more than 200 mm (a notch of levee is placed at the height of 200 mm) in the field will be drained as waste water.
- Irrigation water will be supplied to the depth of 80 mm in the field. If water depth become lower than the minimum standing water depth of 60 cm.

Illustration of Water Balance in Paddy Field



For the effective rainfall for upland crops, TRAM (total readily available moisture) value of 25 mm is applied as the maximum

depth of effective rainfall, based on the soil physical test conducted during field works.

Irrigation Efficiency

The irrigation efficiency would be determined on the basis of the prevailing topography, irrigation method and so forth. In the project, the following irrigation efficiency are adopted;

Irrigation Efficiency

	Paddy Field (%)	Upland Field (%)
Application efficiency	80	70
Operation efficiency	80	80
Conveyance efficiency	85	90
Overall efficiency	55	50

In accordance with the above mentioned procedures, 10 day basis of diversion water requirement are estimated for 30 years(1961-1990). as shown in Table F-12(Type-I) and Table F-13(Type-II).

1.1.2 Designed Water Requirement for Main and Lateral Canals

Unit water requirement (duty of water) for designing irrigation facilities can be largely classified into following two types of water requirement;

i) Water requirement for main canal. and

ii) Water requirement for lateral, sub-lateral canals and related structures.

1) Designed Water Requirement for Main Canal

The unit water requirement for designing the main canal is decided based on the following basic consideration;

i) To add the effective rainfall in fields for the estimation of the unit water requirement, because the maximum irrigation

water requirement will occur for land soaking and land preparation period from the beginning of June to the middle of August, in which so much rainfall can usually be expected in the area.

ii) To provide canal capacity to meet the water requirement in the drought year of return period 1/10-year basically.

According to these considerations, 10-days basis of peak irrigation water requirement at the land soaking and preparation stage was estimated by water balance study for the period 30 years, 1991 to 1990. And its results is given in Table F-14. From the estimation, it was revealed that the peak irrigation water requirement was estimated at 0.93 lit./sec/ha in the return period of 1/10-year. Consequently, the designed irrigation water requirement for main canal, which will cover the Section Area of about 5,000 to 6,500 ha, was decided at 1.00 lit./sec/ha, considering the domestic use water requirement.

2) Deigned Water Requirement for Lateral /Sub-Lateral Canals

According to the proposed irrigation systems, irrigation areas covered by one lateral canal has wide ranges in size, such as from about 6,500 ha to 200 ha. Under the conditions, the basic concept for designing canal capacity of lateral canal is planned as follows;

i) Irrigation area can be typically classified as shown below;

Section Area	:	more than 1,000 ha
Zone Area	:	1,000 ha
Irrigation Block	:	200 ha (1,000 ha x 1/5)
Irrigation Unit	:	40 ha (200 ha x 1/5)
Rotation Unit	:	20 ha (40 ha x 1/2)

ii) Land preparation period from the start to the end of the land soaking and preparation works will depend on the size of the irrigation area covered by each lateral canal. In the calculation of unit water requirement,the following land preparation period are planned (see Figure F-2);

more than 2,000 ha	:	60 days
1,000 - 200	:	38
200 - 40	:	34

iii) Factors of effective rainfall are not taken into consideration in planning of canal capacity

For planning the lateral and sub-lateral canal capacity to meet paddy cultivation, the weighted average crop water on the 10-days basis is calculated, based on the proposed cropping pattern (Type-I), irrigation schedule and water requirement for land soaking and preparation. Table F-15 to Table F-25 show the weighted crop water requirement of paddy in the section, zone and block areas, respectively.

The following indicates the summary of these calculations;

Section Area (more than 1,000 ha)	:	1.50 lit./sec/ha
Zone Area (1,000 - 200 ha)	:	2.10
Block Area (200 - 40 ha)	:	2.90

TABLE F-7 CROP COEFFICIENT (KC)

Month	Wet Season Crop			Dry Season Crop					Perennial Crop
	Paddy		Vegetable	Groundnut	Soybean	Water-melon	Chilli	String-bean	
	H.Y.V	L.V							
Jan.				0.99	1.16	0.96	0.99	1.19	0.90
Feb.				1.05	1.20	1.00	1.05	1.20	0.90
Mar.				0.71	0.83	0.79	0.71	0.83	0.85
Apr.				0.46	0.65	0.65	0.46	0.65	0.85
May				-	-	-	-	-	0.85
Jun.	-	-	0.65	-	-	-	-	-	0.85
Jul.	0.88	0.96	1.18	-	-	-	-	-	0.85
Aug.	1.20	1.24	1.18	-	-	-	-	-	0.85
Sep.	1.31	1.33	0.80	-	-	-	-	-	0.85
Oct.	0.76	1.01	0.65	-	-	-	-	-	0.85
Nov.	-	0.76	-	-	-	-	-	-	0.85
Dec.				0.65	0.67	0.65	0.65	0.67	0.85

TABLE F-8 CONSUMPTIVE USE OF CROP (ETA)

Month	ETo	Wet Season Crop			Dry Season Crop					Perennial Crop
		Paddy		Vegetable	Groundnut	Soybean	Water-melon	Chilli	String-bean	
		H.Y.V	L.V							
Jan.	4.3				4.3	5.0	4.1	4.3	5.1	3.9
Feb.	5.2				5.5	6.2	5.2	5.5	6.2	4.7
Mar.	5.8				4.1	4.8	4.6	4.1	4.8	4.9
Apr.	6.1				2.8	4.0	4.0	2.8	4.0	5.2
May	5.4				-	-	-	-	-	4.6
Jun.	4.5	-	-	2.9	-	-	-	-	-	3.8
Jul.	4.5	4.0 (-)	4.3	5.3	-	-	-	-	-	3.8
Aug.	4.3	5.2 (3.8)	5.3	5.1	-	-	-	-	-	3.7
Sep.	4.0	5.2 (4.8)	5.3	3.2	-	-	-	-	-	3.4
Oct.	4.3	3.3 (5.6)	4.4	2.8	-	-	-	-	-	3.7
Nov.	4.5	- (3.4)	3.4	-	-	-	-	-	-	3.8
Dec.	4.1				2.7	2.7	2.7	2.7	2.7	3.5

Note ; Figures in parenthesis shows the consumptive use for time-lagged crop planting

TABLE F-9 IRRIGATION WATER REQUIREMENT FOR LAND SOAKING AND LAND PREPARATION

1st Irrigation (P_2)

1. Saturation of Top Soil	:	150 mm x 0.35 x (1-0.07)	=	49 mm
Saturation Depth x Porosity x (1-Soil Moisture)				
2. Evaporation for 11 days	:	4.5 mm x 11 days	=	49
3. Percolation for 11 days	:	2.0 mm x 11 days	=	22
4. Standing Water			=	30
Sub-Total				150

Total 1st irrigation water of 150 mm will be supplied with two times at 75 mm each time on the date of eight to three days before plowing.

2nd Irrigation (P_1)

1. Evaporation for six days	:	4.5 mm x 6 days	=	27 mm
2. Percolation for six days	:	2.0 mm x 6 days	=	12
Sub-Total				39

3rd Irrigation (P)

1. Evaporation for seven days	:	4.5 mm x 7 days	=	31 mm
2. Percolation for seven days	:	2.0 mm x 7 days	=	14
3. Supplemental Irrigation	:	(4.5 + 2.0) x 2.5 days	=	16
Sub-total				61
Total				250

TABLE F-10 CROP WATER REQUIREMENT FOR CROPPING PATTERN OF TYPE-I

(unit : mm)

Month	Paddy Rice (96.3%)									Upland Crops (15%)															Perennial Crop (3.7%) (Mango)
	High Yield Variety (90.0%)				Local Variety (10.0%)					Groundnut (67.0%)			Soybean (22.0%)			Watermelon (7.0%)			Chilli (1.0%)			Stringbean (3.0%)				
	L.P	ETa	Pe	Total	L.P	ETa	Pe	Total	Average	P.I	ETa	Total	P.I	ETa	Total	P.I	ETa	Total	P.I	ETa	Total	P.I	ETa	Total	Average	ETa
Dec. 1										26.7	4.5	31.2	26.7	4.5	31.2	26.7	4.5	31.2	26.7	4.5	31.2	26.7	4.5	31.2	31.2	35.0
2										26.7	13.5	40.2	26.7	13.5	40.2	26.7	13.5	40.2	26.7	13.5	40.2	26.7	13.5	40.2	40.2	35.0
3										26.7	22.5	49.2	26.7	22.5	49.2	26.7	22.5	49.2	26.7	22.5	49.2	26.7	22.5	49.2	49.2	35.0
Jan. 1											43.0	43.0		50.0	50.0		41.0	41.0		43.0	43.0		51.0	51.0	44.6	39.0
2											43.0	43.0		50.0	50.0		41.0	41.0		43.0	43.0		51.0	51.0	44.6	39.0
3											43.0	43.0		50.0	50.0		41.0	41.0		43.0	43.0		51.0	51.0	44.6	39.0
Feb. 1											55.0	55.0		62.0	62.0		52.0	52.0		55.0	55.0		62.0	62.0	56.5	47.0
2											55.0	55.0		62.0	62.0		52.0	52.0		55.0	55.0		62.0	62.0	56.5	47.0
3											55.0	55.0		62.0	62.0		52.0	52.0		55.0	55.0		62.0	62.0	56.5	47.0
Mar. 1											41.0	41.0		48.0	48.0		46.0	46.0		41.0	41.0		48.0	48.0	43.1	49.0
2											41.0	41.0		48.0	48.0		46.0	46.0		41.0	41.0		48.0	48.0	43.1	49.0
3											34.2	34.2		40.0	40.0		38.3	38.3		34.2	34.2		40.0	40.0	35.9	49.0
Apr. 1											14.0	14.0		20.0	20.0		20.0	20.0		14.0	14.0		20.0	20.0	15.9	52.0
2											4.7	4.7		6.7	6.7		6.7	6.7		4.7	4.7		6.7	6.7	5.3	52.0
3																										52.0
May 1																										46.0
2																										46.0
3																										46.0
June 1					35.0	-	-	35.0	3.5																	38.0
2	12.5	-	-	12.5	53.9	-	-	53.9	16.6																	38.0
3	60.0	-	-	60.0	77.2	-	-	77.2	61.7																	38.0
July 1	52.0	-	-	52.0	48.3	7.2	3.3	58.8	52.7																	38.0
2	70.8	1.7	0.6	73.3	29.4	21.5	10.0	60.9	72.1																	38.0
3	35.8	13.3	6.7	55.8	6.1	35.8	16.7	58.6	56.1																	38.0
Aug. 1	18.9	32.3	13.3	64.5		53.0	20.0	73.0	65.4																	37.0
2		43.4	19.2	62.6		53.0	20.0	73.0	63.6																	37.0
3		45.0	20.0	65.0		53.0	20.0	73.0	65.8																	37.0
Sept. 1		50.0	20.0	70.0		53.0	20.0	73.0	70.3																	34.0
2		50.0	20.0	70.0		53.0	20.0	73.0	70.3																	34.0
3		50.0	20.0	70.0		53.0	20.0	73.0	70.3																	34.0
Oct. 1		39.0	16.7	55.7		44.0	20.0	64.0	56.5																	37.0
2		27.0	10.0	37.0		42.2	19.2	61.3	39.5																	37.0
3		9.4	3.3	12.7		29.3	13.3	42.7	15.7																	37.0
Nov. 1						11.3	6.7	18.0	1.8																	38.0
2						1.4	0.9	2.3	0.2																	38.0
3																										38.0
Total	250.0	361.1	150.0	761.1	250.0	510.7	210.0	970.8	782.2	80.1	469.3	549.4	80.1	539.2	619.3	80.1	476.5	556.6	80.1	469.3	549.4	80.1	542.2	622.3	567.5	1,470.0

Note : L.P : Land Preparation
ETa : Consumptive Use of Paddy
Pe : Percolation
P.I : Pre-Irrigation

TABLE F-11 CROP WATER REQUIREMENT FOR CROPPING PATTERN OF TYPE-II

(unit : mm)

Month	Wet Season Paddy Rice(93.2%)									Wet Season Upland Crop			Upland Crops(16%)															Perennial Crop(3.7%) (Mango)
	High Yield Variety(89.7%)				Local Variety(10.3%)					Vegetable(3.1%)			Groundnut(69.1%)			Soybean(20.6%)			Watermelon(6.6%)			Chilli(0.9%)			Stringbean(2.8%)				
	L.P	ETa	Pe	Total	L.P	ETa	Pe	Total	Average	P.I	ETa	Total	P.I	ETa	Total	P.I	ETa	Total	P.I	ETa	Total	P.I	ETa	Total	P.I	ETa	Total	Average	ETa
Dec. 1													26.7	4.5	31.2	26.7	4.5	31.2	26.7	4.5	31.2	26.7	4.5	31.2	26.7	4.5	31.2	31.0	35.0
2													26.7	13.5	40.2	26.7	13.5	40.2	26.7	13.5	40.2	26.7	13.5	40.2	26.7	13.5	40.2	40.0	35.0
3													26.7	22.5	49.2	26.7	22.5	49.2	26.7	22.5	49.2	26.7	22.5	49.2	26.7	22.5	49.2	49.0	35.0
Jan. 1														43.0	43.0		50.0	50.0		41.0	41.0		43.0	43.0		51.0	51.0	44.5	39.0
2														43.0	43.0		50.0	50.0		41.0	41.0		43.0	43.0		51.0	51.0	44.5	39.0
3														43.0	43.0		50.0	50.0		41.0	41.0		43.0	43.0		51.0	51.0	44.5	39.0
Feb. 1														55.0	55.0		62.0	62.0		52.0	52.0		55.0	55.0		62.0	62.0	56.4	47.0
2														55.0	55.0		62.0	62.0		52.0	52.0		55.0	55.0		62.0	62.0	56.4	47.0
3														55.0	55.0		62.0	62.0		52.0	52.0		55.0	55.0		62.0	62.0	56.4	47.0
Mar. 1														41.0	41.0		48.0	48.0		46.0	46.0		41.0	41.0		48.0	48.0	43.0	49.0
2														41.0	41.0		48.0	48.0		46.0	46.0		41.0	41.0		48.0	48.0	43.0	49.0
3														34.2	34.2		40.0	40.0		38.3	38.3		34.2	34.2		40.0	40.0	35.8	49.0
Apr. 1														14.0	14.0		20.0	20.0		20.0	20.0		14.0	14.0		20.0	20.0	15.8	52.0
2														4.7	4.7		6.7	6.7		6.7	6.7		4.7	4.7		6.7	6.7	5.3	52.0
3																													52.0
May 1																													46.0
2																													46.0
3																													46.0
June 1					35.0	-	-	35.0	3.6	26.7	4.8	31.5																	38.0
2	12.5	-	-	12.5	53.9	-	-	53.9	16.8	26.7	14.5	41.2																	38.0
3	60.0	-	-	60.0	77.2	-	-	77.2	61.8	26.7	24.2	50.9																	38.0
July 1	52.0	-	-	52.0	48.3	7.2	3.3	58.8	52.7		53.0	53.0																	38.0
2	70.8	1.7	0.8	73.3	29.4	21.5	10.0	60.9	72.1		53.0	53.0																	38.0
3	35.8	13.3	6.7	55.8	6.1	35.8	16.7	58.6	56.1		53.0	53.0																	38.0
Aug. 1	18.9	32.3	13.3	64.5		53.0	20.0	73.0	65.4		51.0	51.0																	37.0
2		43.4	19.2	62.6		53.0	20.0	73.0	63.7		51.0	51.0																	37.0
3		45.0	20.0	65.0		53.0	20.0	73.0	65.8		51.0	51.0																	37.0
Sept. 1		50.0	20.0	70.0		53.0	20.0	73.0	70.3		32.0	32.0																	34.0
2		50.0	20.0	70.0		53.0	20.0	73.0	70.3		32.0	32.0																	34.0
3		50.0	20.0	70.0		53.0	20.0	73.0	70.3		26.7	26.7																	34.0
Oct. 1		39.0	16.7	55.7		44.0	20.0	64.0	56.5		14.0	14.0																	37.0
2		27.0	10.0	37.0		42.2	19.2	61.3	39.5		4.7	4.7																	37.0
3		9.4	3.3	12.7		29.3	13.3	42.7	15.8																				37.0
Nov. 1						11.3	6.7	18.0	1.9																				38.0
2						1.4	0.9	2.3	0.2																				38.0
3																													38.0
Total	250.0	361.1	150.0	761.1	250.0	510.7	210.1	970.8	782.8	80.1	464.8	544.9	80.1	469.3	549.4	80.1	539.2	619.3	80.1	476.5	556.6	80.1	469.3	549.4	80.1	542.2	622.3	565.6	1,470.0

Note : L.P : Land Preparation
ETa : Consumptive Use of Paddy
Pe : Percolation
P.I : Pre-Irrigation

TABLE F-12 MONTHLY DIVERSION WATER REQUIREMENT OF TYPE-I

DRY SEASON UPLAND CROP 5100 ha
WET SEASON PADDY 32750 ha
PERENNIAL CROP 1250 ha

UNIT : MCM

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1961	19.69	18.93	14.85	6.25	1.72	30.23	5.70	0.56	0.00	1.67	2.84	15.16	117.60
1962	17.24	18.81	12.68	3.12	2.36	26.30	6.28	0.00	0.00	1.67	2.84	17.77	109.06
1963	17.24	18.81	14.91	6.11	1.77	2.05	0.00	0.00	0.00	1.67	1.71	17.14	81.41
1964	17.24	18.81	14.86	5.21	0.00	28.39	9.72	0.00	0.60	1.67	2.28	17.14	115.91
1965	17.24	16.27	17.11	2.58	2.33	1.88	1.14	0.55	3.55	54.93	2.29	17.77	137.64
1966	17.24	18.81	12.11	5.14	0.00	25.26	0.57	0.00	0.60	32.83	2.84	17.77	133.16
1967	17.24	18.81	17.25	3.21	1.73	3.14	0.58	0.56	0.00	1.65	2.83	17.22	84.22
1968	17.24	18.81	16.91	3.22	1.64	1.20	0.00	0.00	0.00	2.30	2.85	17.22	81.38
1969	17.24	18.81	17.25	3.73	2.24	3.68	1.14	0.56	0.00	1.14	2.82	17.14	85.76
1970	17.24	18.81	17.25	3.25	2.25	0.42	0.57	0.00	0.60	48.24	2.84	17.14	128.63
1971	17.24	18.81	17.25	3.21	1.15	0.63	0.57	0.57	0.60	5.73	2.84	17.77	86.37
1972	17.24	18.81	17.71	2.77	2.85	0.99	0.57	0.54	0.60	1.11	2.32	17.14	82.64
1973	17.24	18.81	17.25	3.15	0.52	27.23	6.85	0.00	0.00	2.29	2.89	17.76	114.00
1974	17.24	18.81	12.28	5.10	1.15	0.99	1.76	0.00	1.15	1.73	1.69	17.77	79.67
1975	16.77	17.05	17.10	3.65	1.71	0.63	1.71	0.56	0.54	1.16	1.70	15.47	78.05
1976	17.33	19.14	14.70	3.19	1.15	12.12	0.56	0.00	0.00	1.13	2.29	14.52	86.13
1977	17.24	18.81	14.26	5.73	2.35	16.39	27.76	27.15	0.00	17.74	2.72	17.77	167.93
1978	17.24	18.81	11.73	4.65	1.15	42.47	49.72	0.56	3.19	42.10	1.73	17.14	210.49
1979	17.24	18.81	17.25	3.20	1.77	3.65	17.19	12.82	27.05	2.50	4.03	17.14	142.66
1980	17.24	18.81	17.71	3.11	2.35	7.64	0.61	13.10	0.00	1.18	2.31	17.14	101.19
1981	17.24	18.81	17.25	2.80	2.32	4.00	1.14	0.00	0.61	2.20	2.28	17.78	86.43
1982	17.24	18.81	15.06	3.17	2.88	1.79	0.57	0.00	0.00	1.66	2.27	17.14	80.58
1983	17.24	18.81	17.25	3.73	2.33	1.63	1.68	0.57	67.56	0.60	2.85	17.14	151.39
1984	17.24	18.81	14.66	5.00	1.22	50.44	25.18	21.13	0.00	1.11	2.32	17.14	174.24
1985	17.24	18.81	15.06	4.45	1.16	8.60	18.06	0.00	0.57	27.52	2.45	17.77	131.69
1986	17.24	18.81	15.06	5.62	1.72	3.65	0.57	0.56	0.60	1.15	2.37	17.77	85.12
1987	17.24	18.81	15.10	6.27	2.32	7.18	0.61	0.56	0.00	1.67	1.14	17.14	88.04
1988	17.24	18.81	17.71	2.07	1.15	0.74	28.44	13.39	43.66	14.57	2.85	17.22	177.85
1989	17.24	18.81	12.79	2.69	2.22	9.67	1.71	1.67	7.57	17.24	2.84	17.77	112.21
1990	17.24	18.81	9.38	3.25	1.17	6.61	0.00	1.11	0.00	1.71	2.32	17.14	78.74
AVG.	17.31	18.68	15.39	3.95	1.69	10.99	7.03	3.22	5.30	9.79	2.48	17.17	113.01

TABLE F-13 MONTHLY DIVERSION WATER REQUIREMENT OF TYPE-II

DRY SEASON UPLAND CROP 5440 ha
WET SEASON UPLAND CROP 1050 ha
WET SEASON PADDY 31700 ha
PERENNIAL CROP 1250 ha

UNIT : MCM

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1961	20.77	20.00	15.60	6.42	1.72	31.26	6.87	1.53	0.48	1.67	2.84	15.97	125.11
1962	18.15	19.87	13.28	3.12	2.36	27.78	6.50	0.91	0.00	1.67	2.84	18.76	115.23
1963	18.15	19.87	15.66	6.27	1.77	2.91	0.89	0.52	0.00	1.67	1.71	18.12	87.54
1964	18.15	19.87	15.61	5.37	0.00	29.08	11.25	0.43	1.11	1.67	2.28	18.12	122.94
1965	18.15	17.16	18.01	2.58	2.33	2.34	2.92	1.93	3.96	53.25	2.29	18.76	143.66
1966	18.15	19.87	12.71	5.31	0.00	26.48	1.49	0.50	1.08	31.85	2.84	18.76	139.04
1967	18.15	19.87	18.16	3.21	1.73	4.51	1.49	0.99	0.00	1.65	2.83	18.20	90.80
1968	18.15	19.87	17.79	3.22	1.64	2.63	0.89	0.44	0.00	2.30	2.85	18.20	87.99
1969	18.15	19.87	18.16	3.73	2.24	4.11	2.49	1.85	0.00	1.14	2.82	18.12	92.69
1970	18.15	19.87	18.16	3.25	2.25	0.40	1.87	0.42	1.11	46.75	2.84	18.13	133.22
1971	18.15	19.87	18.16	3.21	1.15	0.61	1.89	1.00	0.60	5.61	2.84	18.76	91.83
1972	18.15	19.87	18.60	2.77	2.85	2.40	2.37	1.47	1.09	1.11	2.32	18.13	91.13
1973	18.15	19.87	18.16	3.15	0.52	28.34	7.54	0.43	0.00	2.27	2.89	18.75	120.06
1974	18.15	19.87	12.90	5.27	1.15	2.45	3.98	0.86	1.15	1.73	1.69	18.76	87.95
1975	17.69	17.98	18.01	3.65	1.71	0.61	4.39	1.41	0.54	1.16	1.70	16.30	85.16
1976	18.25	20.23	15.44	3.19	1.15	13.22	2.32	0.85	0.00	1.13	2.29	15.33	93.39
1977	18.15	19.87	15.01	5.90	2.35	17.29	28.67	27.68	0.00	17.26	2.70	18.76	173.64
1978	18.15	19.87	12.31	4.82	1.15	42.14	49.94	1.47	3.08	40.82	1.73	18.13	213.63
1979	18.15	19.87	18.16	3.20	1.77	4.08	19.39	14.23	26.71	2.50	4.00	18.13	150.19
1980	18.15	19.87	18.60	3.11	2.35	7.94	1.53	15.31	0.00	1.18	2.31	18.12	108.48
1981	18.15	19.87	18.16	2.80	2.32	4.83	2.10	0.86	1.12	2.20	2.28	18.76	93.44
1982	18.15	19.87	15.82	3.17	2.88	2.71	1.99	0.43	0.00	1.66	2.27	18.12	87.07
1983	18.15	19.87	18.16	3.73	2.33	3.11	4.37	1.42	65.90	0.60	2.85	18.12	158.61
1984	18.15	19.87	15.40	5.16	1.22	50.35	27.08	21.32	0.00	1.11	2.32	18.12	180.09
1985	18.15	19.87	15.82	4.61	1.16	9.79	18.84	0.43	1.06	26.71	2.42	18.75	137.62
1986	18.15	19.87	15.82	5.79	1.72	4.07	1.45	1.87	1.07	1.15	2.37	18.76	92.09
1987	18.15	19.87	15.87	6.44	2.32	7.88	1.50	1.88	0.00	1.67	1.14	18.13	94.83
1988	18.15	19.87	18.60	2.07	1.15	1.64	29.83	14.27	42.80	14.14	2.85	18.20	183.57
1989	18.15	19.87	13.40	2.69	2.22	11.28	3.49	2.95	7.87	16.69	2.84	18.76	120.20
1990	18.15	19.87	9.85	3.25	1.17	6.94	1.31	1.97	0.00	1.71	2.32	18.13	84.67
AVG.	18.23	19.73	16.18	4.01	1.69	11.77	8.35	4.05	5.36	9.53	2.47	18.14	119.53

TABLE F-14 MAXIMUM IRRIGATION WATER REQUIREMENT DURING LAND PREPARATION

(unit:mm/10-day)

Year	June			July			Aug.		Max. Irrigation Water Requirement		Remarks
	1	2	3	1	2	3	1	2	(mm/10-day)	(l/sec/ha)	
1961	0.00	1.69	1.69	0.00	1.69	0.00	1.67	0.00	1.69	0.02	
1962	0.00	11.63	57.93	18.45	0.00	0.00	0.00	0.00	57.93	0.67	
1963	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0.00	
1964	0.00	32.44	43.21	0.00	1.69	26.89	0.00	0.00	43.21	0.50	
1965	0.00	0.00	0.00	1.69	1.69	0.00	0.00	0.00	1.69	0.02	
1966	0.00	32.44	32.41	1.69	0.00	0.00	0.00	0.00	32.44	0.38	
1967	0.00	1.69	1.69	1.73	0.00	0.00	1.65	0.00	1.73	0.02	
1968	0.00	0.00	1.69	0.00	0.00	0.00	0.00	0.00	1.69	0.02	
1969	0.00	2.91	0.00	1.69	1.69	0.00	0.00	0.00	2.91	0.03	
1970	0.00	0.00	0.00	0.00	0.00	1.69	0.00	0.00	1.69	0.02	
1971	0.00	0.00	0.00	0.00	0.00	1.69	1.68	0.00	1.69	0.02	
1972	0.00	0.00	1.69	0.00	0.00	1.69	0.00	1.61	1.69	0.02	
1973	0.00	7.50	64.90	18.45	0.00	1.69	0.00	0.00	64.9	0.75	
1974	0.00	0.00	1.69	1.69	1.69	1.83	0.00	0.00	1.69	0.02	
1975	0.00	0.00	0.00	1.69	0.00	3.37	0.00	0.00	3.37	0.04	
1976	0.00	27.85	0.00	1.65	0.00	0.00	0.00	0.00	27.85	0.32	
1977	0.00	17.44	23.01	38.76	32.61	10.28	47.49	30.74	47.49	0.55	
1978	0.00	30.72	86.42	45.74	100.49	0.00	0.00	0.00	100.49	1.16	
1979	0.00	2.91	0.00	0.00	3.37	47.19	36.04	0.00	47.19	0.55	
1980	0.00	14.53	0.00	0.00	1.81	0.00	3.45	35.10	35.1	0.41	
1981	0.00	5.64	0.00	0.00	1.69	1.69	0.00	0.00	5.64	0.07	
1982	0.00	0.00	0.00	0.00	1.69	0.00	0.00	0.00	1.69	0.02	
1983	0.00	1.75	0.00	1.69	1.61	1.69	1.69	0.00	1.75	0.02	
1984	0.00	30.75	109.75	27.68	1.69	44.70	62.12	0.00	109.75	1.27	
1985	0.00	17.44	0.00	0.00	0.00	53.12	0.00	0.00	53.12	0.61	
1986	0.00	2.91	0.00	1.69	0.00	0.00	1.66	0.00	2.91	0.03	
1987	0.00	11.63	1.69	0.00	1.81	0.00	1.64	0.00	11.63	0.13	
1988	0.00	0.00	1.58	1.72	1.69	80.27	0.00	0.00	80.27	0.93	1/10-return period 1/
1989	0.00	22.31	0.00	1.69	3.37	0.00	1.64	1.64	22.31	0.26	
1990	0.00	11.63	0.00	0.00	0.00	0.00	0.00	1.64	11.63	0.13	
Ave.	0.00	9.59	14.31	5.59	5.34	9.26	5.36	2.36	25.90	0.30	

1/ : Probable Max. Water Requirement

Return Period	Water Requirement
1/2-year	7.4 mm/10-day
1/5	34.4
1/10	80.2
1/20	162.5

q = 80.27 x 10,000/(10 days x 86,400)
= 0.929 l/sec/ha

TABLE F-15 CROP WATER REQUIREMENT OF PADDY IN SECTION AREA

(unit : mm/10 day)

Month	Paddy (High Yield Variety : 90 %)				Paddy (Local Variety :10 %)				Average
	L.P	ETa	Pe	Total	L.P	ETa	Pe	Total	
June 1	-	-	-	0.0	35.0	-	-	35.0	3.5
2	12.5	-	-	12.5	53.9	-	-	53.9	16.6
3	60.0	-	-	60.0	77.2	-	-	77.2	61.7
July 1	52.0	-	-	52.0	48.3	7.2	3.3	58.8	52.7
2	70.8	1.7	0.8	73.3	29.4	21.5	10.0	60.9	72.1
3	35.8	13.3	6.7	55.8	6.2	35.8	16.7	58.7	56.1
Aug. 1	18.9	32.3	13.3	64.5		53.0	20.0	73.0	65.4
2		43.4	19.2	62.6		53.0	20.0	73.0	63.6
3		45.0	20.0	65.0		53.0	20.0	73.0	65.8
Sep. 1		50.0	20.0	70.0		53.0	20.0	73.0	70.3
2		50.0	20.0	70.0		53.0	20.0	73.0	70.3
3		50.0	20.0	70.0		53.0	20.0	73.0	70.3
Oct. 1		39.0	16.7	55.7		44.0	20.0	64.0	56.5
2		27.0	10.0	37.0		42.2	19.1	61.3	39.4
3		9.4	3.3	12.7		29.3	13.4	42.7	15.7
Nov. 1		-	-	-		11.3	6.7	18.0	1.8
						1.4	0.9	2.3	0.2
									0.0
Total	250.0	361.1	150.0	761.1	250.0	510.7	210.1	970.8	782.1

Note; L.P : Land Preparation (mm/10-day)
Eta : Consumptive Use of Paddy (mm/10-day)
Pe : Percolation (mm/10-day)

Max. crop water requirement ; 72.1 mm/10-day
= 1.515 lit/sec/ha

TABLE F-16 CALCULATION OF WEIGHTED CROP WATER REQUIREMENT (CWR) FOR PADDY (HYV)

No.	Month		Equation for Calculation of Weighted 10-day CWR	Weighted 10-day CWR (mm / 10-day)		Irrigation Water Requirement (lit/sec/ha)	
1	June	2	$WR = P_2 \times 5/30$	$75 \times 5/30$	= 12.5	0.263	
2		3	$WR = P_2 \times 24/30$	$75 \times 24/30$	= 60.0	1.263	
3	July	1	$WR = P_2 \times 15/30 + P_1 \times 8/30 + P \times 2/30$	$75 \times 15/30 + 39 \times 8/30 + 61 \times 2/30$	= 52.0	1.094	
4		2	$WR = P_2 \times 15/30 + P_1 \times 10/30 + P \times 10/30 + W_1 \times 1.25/30$	$75 \times 15/30 + 39 \times 10/30 + 61 \times 10/30 + 60 \times 1.25/30$	= 73.3	1.542	(max.) 1/
5		3	$WR = P_2 \times 1/30 + P_1 \times 10/30 + P \times 10/30 + W_1 \times 10/30$	$75 \times 1/30 + 39 \times 10/30 + 61 \times 10/30 + 60 \times 10/30$	= 55.8	1.174	
6	Aug.	1	$WR = P_1 \times 2/30 + P \times 8/30 + W_2 \times 15/30 + Y_1 \times 5/30$	$39 \times 2/30 + 61 \times 8/30 + 72.0 \times 15/30 + 58 \times 5/30$	= 64.5	1.357	
7		2	$WR = W_2 \times 15/30 + Y_1 \times 13.75/30$	$72 \times 15/30 + 58 \times 13.75/30$	= 62.6	1.317	
8		3	$WR = W_2 \times 15/30 + Y_1 \times 15/30$	$72 \times 15/30 + 58 \times 15/30$	= 65.0	1.368	
9	Sept.	1	$WR = W_3 \times 15/30 + Y_2 \times 15/30$	$72 \times 15/30 + 68 \times 15/30$	= 70.0	1.473	(max.) 2/
10		2	$WR = W_3 \times 15/30 + Y_2 \times 15/30$	$72 \times 15/30 + 68 \times 15/30$	= 70.0	1.473	
11		3	$WR = W_3 \times 15/30 + Y_2 \times 15/30$	$72 \times 15/30 + 68 \times 15/30$	= 70.0	1.473	
12	Oct.	1	$WR = W_4 \times 10/30 + Y_2 \times 15/30$	$53 \times 10/30 + 76 \times 15/30$	= 55.7	1.172	
13		2	$WR = W_4 \times 1.25/30 + Y_3 \times 13.75/30$	$53 \times 1.25/30 + 76 \times 13.75/30$	= 37.0	0.779	
14		3	$WR = Y_3 \times 5/30$	$76 \times 5/30$	= 12.7	0.267	
	Total				761.1		

Land Soaking and Land Preparation Water ;

P_2 = 150 mm/2 = 75.0 mm
p_2 = 39.0 mm
p = 61.0
Total 250.0

10-day Crop Water Requirement ;

W_1 = 60.0 mm Y_1 = 58.0 mm
W_2 = 72.0 Y_2 = 68.0
W_3 = 72.0 Y_3 = 76.0
W_4 = 53.0 Y_4 = 54.0

1/ : Maximum Irrigation Water Requirement ; (Land Preparation Stage)

$$q = \frac{73.3 \times 10^{-3} \times 1.0\,ha \times 10^4 \times 10^3}{10\,days \times 86{,}400 \times 0.55} = 1.542\ lit/sec/ha$$

2/ : Maximum Irrigation Water Requirement ; (Crop Growing Water Requirement)

$$q = \frac{70.0 \times 10^{-3} \times 1.0\,ha \times 10^4 \times 10^3}{10\,days \times 86{,}400 \times 0.55} = 1{,}473\ lit/sec/ha$$

TABLE F-17 CALCULATION OF WEIGHTED CROP WATER REQUIREMENT (CWR) FOR PADDY (LV)

No.	Month		Equation for Calculation of Weighted 10-day CWR	Weighted 10-day CWR (mm / 10-day)			Irrigation Water Requirement (lit/sec/ha)	
1	June	1	$WR = P_2 \times 14/30$	$75 \times 14/30$	=	35.0	0.737	
2		2	$WR = P_2 \times 20/30 + P_1 \times 3/30$	$75 \times 20/30 + 39 \times 3/30$	=	53.9	1.134	
3		3	$WR = P_2 \times 20/30 + P_1 \times 10/30 + P \times 7/30$	$75 \times 20/30 + 39 \times 10/30 + 61 \times 7/30$	=	77.2	1.625	(max.) 1/
4	July	1	$WR = P_2 \times 6/30 + P_1 \times 10/30 + P \times 10/30 + W_1 \times 5/30$	$75 \times 6/30 + 39 \times 10/30 + 61 \times 10/30 + 63 \times 5/30$	=	58.8	1.016	
5		2	$WR = P_1 \times 7/30 + P \times 10/30 + W_1 \times 15/30$	$39 \times 7/30 + 61 \times 10/30 + 63 \times 15/30$	=	60.9	1.282	
6		3	$WR = P \times 3/30 + W_1 \times 25/30$	$61 \times 3/30 + 63 \times 25/30$	=	58.6	1.233	
7	Aug.	1	$WR = W_2 \times 30/30$	$73 \times 30/30$	=	73.0	1.536	
8		2	$WR = W_2 \times 30/30$	$73 \times 30/30$	=	73.0	1.536	(max.) 2/
9		3	$WR = W_2 \times 30/30$	$73 \times 30/30$	=	73.0	1.536	
10	Sept.	1	$WR = W_3 \times 30/30$	$73 \times 30/30$	=	73.0	1.536	
11		2	$WR = W_3 \times 30/30$	$73 \times 30/30$	=	73.0	1.536	
12		3	$WR = W_3 \times 30/30$	$73 \times 30/30$	=	73.0	1.536	
13	Oct.	1	$WR = W_4 \times 30/30$	$64 \times 30/30$	=	64.0	1.347	
14		2	$WR = W_4 \times 28.75/30$	$64 \times 28.75/30$	=	61.3	1.290	
15		3	$WR = W_4 \times 20/30$	$64 \times 20/30$	=	42.7	0.899	
16	Nov.	1	$WR = W_5 \times 10/30$	$54 \times 10/30$	=	18.0	0.379	
17		2	$WR = W_5 \times 1.25/30$	$54 \times 1.25/30$	=	2.3	0.048	
	Total					970.8		

Land Soaking and Land Preparation Water ;
- P_2 = 150 mm/2 = 75.0 mm
- p_2 = 39.0 mm
- p = 61.0
- Total 250.0

10-day Crop Water Requirement ;
- W_1 = 63.0 mm
- W_2 = 73.0
- W_3 = 73.0
- W_4 = 64.0
- W_5 = 54.0

1/ : Maximum Irrigation Water Requirement ; (Land Preparation Stage)

$$q = \frac{77.2 \times 10^{-3} \times 1.0\ ha \times 10^4 \times 10^3}{10\ days \times 86{,}400 \times 0.55} = 1.625\ lit/sec/ha$$

2/ : Maximum Irrigation Water Requirement ; (Crop Growing Water Requirement)

$$q = \frac{73.0 \times 10^{-3} \times 1.0\ ha \times 10^4 \times 10^3}{10\ days \times 86{,}400 \times 0.55} = 1{,}536\ lit/sec/ha$$

TABLE F-18 CROP WATER REQUIREMENT OF PADDY IN ZONE AREA

(unit : mm/10 day)

Month	Paddy (High Yield Variety : 90 %)				Paddy (Local Variety :10 %)				Average
	L.P	ETa	Pe	Total	L.P	ETa	Pe	Total	
June 1	-	-	-	-	110.6	-	-	110.6	11.1
2	47.8	-	-	47.8	54.0	-	-	54.0	48.4
3	102.2	-	-	102.2	80.0	-	-	80.0	100.0
July 1	53.5	-	-	53.5	5.4	24.0	12.0	41.4	52.3
2	46.5	6.5	3.3	56.3		40.0	20.0	60.0	56.7
3		33.5	16.8	50.3		40.0	20.0	60.0	51.3
Aug. 1		52.0	20.0	72.0		52.0	20.0	72.0	72.0
2		52.0	20.0	72.0		52.0	20.0	72.0	72.0
3		52.0	20.0	72.0		52.0	20.0	72.0	72.0
Sep. 1		52.0	20.0	72.0		52.0	20.0	72.0	72.0
2		52.0	20.0	72.0		52.0	20.0	72.0	72.0
3		52.0	20.0	72.0		52.0	20.0	72.0	72.0
Oct. 1		13.2	8.0	21.2		33.0	20.0	53.0	24.4
2		-	-	-		27.6	16.8	44.4	4.4
3						5.4	3.2	8.6	0.9
Nov. 1									
2									
3									
Total	250.0	365.2	148.1	763.3	250.0	482.0	212.0	944.0	781.4

Note; L.P : Land Preparation (mm/10-day)
Eta : Consumptive Use of Paddy (mm/10-day)
Pe : Percolation (mm/10-day)

Max. crop water requirement : 100.0 mm/10-day
= 2.104 lit/sec/ha

TABLE F-19 CALCULATION OF WEIGHTED CROP WATER REQUIREMENT (CWR) FOR PADDY (HYV) ZONE AREA

No.	Month	Equation for Calculation of Weighted 10-day CWR	Weighted 10-day CWR (mm / 10-day)		Irrigation Water Requirement (lit/sec/ha)	
1	June 2	$WR = P_2 \times 5.1/8$	$75 \times 5.1/8$	= 47.8	1.006	
2	3	$WR = P_2 \times 10.9/8$	$75 \times 10.9/8$	= 102.2	2.151	(max.) 1/
3	July 1	$WR = P_1 \times 8/8 + P \times 1.9/8$	$39 \times 8.0/8 + 61.0 \times 1.9/8$	= 53.5	1.126	
4	2	$WR = P \times 6.1/8 + W_1 \times 1.3/8$	$61 \times 6.1/8 + 60 \times 1.3/5$	= 56.3	1.185	
5	3	$WR = W_1 \times 6.7/8$	$60 \times 6.7/8$	= 50.3	1.059	
6	Aug. 1	$WR = W_2$	72.0	= 72.0	1.515	(max.) 2/
7	2	$WR = W_2$	72.0	= 72.0	1.515	
8	3	$WR = W_2$	72.0	= 72.0	1.515	
9	Sept. 1	$WR = W_3$	72.0	= 72.0	1.515	
10	2	$WR = W_3$	72.0	= 72.0	1.515	
11	3	$WR = W_3$	72.0	= 72.0	1.515	
12	Oct. 1	$WR = W_4 \times 3.2/8$	$53.0 \times 3.2/8$	= 21.2	0.446	
	Total			763.3		

Land Soaking and Land Preparation Water ;
- P_2 = 150 mm/2 = 75.0 mm
- p_2 = 39.0 mm
- p = 61.0
- Total 250.0

10-day Crop Water Requirement ;
- W_1 = 60.0 mm
- W_2 = 72.0
- W_3 = 72.0
- W_4 = 53.0

1/ : Maximum Irrigation Water Requirement ; (Land Preparation Stage)

$$q = \frac{102.2 \times 10^{-3} \times 1.0\,ha \times 10^4 \times 10^3}{10\,days \times 86{,}400 \times 0.55} = 2{,}151\ lit/sec/ha$$

2/ : Maximum Irrigation Water Requirement ; (Crop Growing Water Requirement)

$$q = \frac{72.0 \times 10^{-3} \times 1.0\,ha \times 10^4 \times 10^3}{10\,days \times 86{,}400 \times 0.55} = 1{,}515\ lit/sec/ha$$

TABLE F-20 CALCULATION OF WEIGHTED CROP WATER REQUIREMENT (CWR) FOR PADDY (LV) ZONE AREA

No.	Month	Equation for Calculation of Weighted 10-day CWR	Weighted 10-day CWR (mm / 10-day)		Irrigation Water Requirement (lit/sec/ha)
1	June 1	$WR = P_2 \times 11.8/8$	$75.0 \times 11.8/8$	= 110.6	2.327 (max.) 1/
2	2	$WR = P_2 \times 4.2/8 + P_1 \times 3.0/8$	$75.0 \times 4.2/8 + 39 \times 3.0/8$	= 54.0	1.136
3	3	$WR = P_1 \times 5.0/8 + P \times 7.3/8$	$39.0 \times 5.0/8 + 61 \times 7.8/8$	= 80.0	1.684
4	July 1	$WR = P \times 0.7/8 + W_1 \times 4.8/8$	$60.0 \times 0.7/8 + 60 \times 4.8/8$	= 41.3	0.869
5	2	$WR = W_1$	60.0	= 60.0	1.263
6	3	$WR = W_1$	60.0	= 60.0	1.263
7	Aug. 1	$WR = W_2$	72.0	= 72.0	1.515 (max.) 2/
8	2	$WR = W_2$	72.0	= 72.0	1.515
9	3	$WR = W_2$	72.0	= 72.0	1.515
10	Sept. 1	$WR = W_3$	72.0	= 72.0	1.515
11	2	$WR = W_3$	72.0	= 72.0	1.515
12	3	$WR = W_3$	72.0	= 72.0	1.515
13	Oct. 1	$WR = W_4$	53.0	= 53.0	1.115
14	2	$WR = W_4 \times 6.7/8$	$53.0 \times 6.7/8$	= 44.4	0.934
15	3	$WR = W_4 \times 1.3/8$	$53.0 \times 1.3/8$	= 8.6	0.181
	Total			944.0	

Land Soaking and Land Preparation Water ;
- P_2 = 150 mm/2 = 75.0 mm
- p_2 = 39.0 mm
- p = 61.0
- Total 250.0

10-day Crop Water Requirement ;
- W_1 = 60.0 mm
- W_2 = 72.0
- W_3 = 72.0
- W_4 = 53.0

1/ : Maximum Irrigation Water Requirement ; (Land Preparation Stage)

$$q = \frac{110.6 \times 10^{-3} \times 1.0\ ha \times 10^4 \times 10^3}{10\ days \times 86{,}400 \times 0.55} = 2{,}327\ lit/sec/ha$$

2/ : Maximum Irrigation Water Requirement ; (Crop Growing Water Requirement)

$$q = \frac{72.0 \times 10^{-3} \times 1.0\ ha \times 10^4 \times 10^3}{10\ days \times 86{,}400 \times 0.55} = 1{,}515\ lit/sec/ha$$

TABLE F-21 CROP WATER REQUIREMENT OF PADDY IN BLOCK AREA

(unit : mm/10 day)

Month	Paddy (High Yield Variety : 90 %)				Paddy (Local Variety :10 %)				Average
	L.P	ETa	Pe	Total	L.P	ETa	Pe	Total	
June 1	-	-	-	-	139.5	-	-	139.5	14.0
2	75.0	-	-	75.0	33.9	-	-	33.9	70.9
3	75.0	-	-	75.0	76.6	-	-	76.6	75.2
July 1	63.4	-	-	63.4		29.6	14.8	44.4	61.5
2	36.6	10.4	5.2	52.2		40.0	20.0	60.0	53.0
3		40.0	20.0	60.0		40.0	20.0	60.0	60.0
Aug. 1		52.0	20.0	72.0		52.0	20.0	72.0	72.0
2		52.0	20.0	72.0		52.0	20.0	72.0	72.0
3		52.0	20.0	72.0		52.0	20.0	72.0	72.0
Sep. 1		52.0	20.0	72.0		52.0	20.0	72.0	72.0
2		52.0	20.0	72.0		52.0	20.0	72.0	72.0
3		52.0	20.0	72.0		52.0	20.0	72.0	72.0
Oct. 1		8.6	5.2	13.8		33.0	20.0	53.0	17.7
2						24.4	14.8	39.2	3.9
3									
Nov. 1									
2									
3									
Total	250.0	371.0	150.4	771.4	250.0	479.0	209.6	938.6	788.1

Note; L.P : Land Preparation (mm/10-day)
Eta : Consumptive Use of Paddy (mm/10-day)
Pe : Percolation (mm/10-day)
Pe : Percolation (mm/10-day)

Max. crop water requirement (average) ; 75.2 mm/10-day
= 1.582 lit./sec/ha
Max. crop water requirement (by crop) ; 139.5 mm/10-day
= 2.935 lit./sec/ha

TABLE F-22 CALCULATION OF WEIGHTED CROP WATER REQUIREMENT (CWR) FOR PADDY (HYV) BLOCK AREA

No.	Month	Equation for Calculation of Weighted 10-day CWR	Weighted 10-day CWR (mm / 10-day)		Irrigation Water Requirement (lit/sec/ha)	
1	June 2	$WR = P_2 \times 5/5$	$75.0 \times 5/5$	= 75.0	1.578	
2	3	$WR = P_2 \times 5/5$	$75.0 \times 5/5$	= 75.0	1.578	(max.) 1/
3	July 1	$WR = P_1 \times 5/5 + P \times 2/5$	$39.0 \times 5/5 + 65 \times 2/5$	= 63.4	1.334	
4	2	$WR = P \times 3/5 + W_1 \times 1.3/5$	$61.0 \times 3/5 + 60 \times 1.3/5$	= 52.2	1.149	
5	3	$WR = W_1$	60.0	= 60.0	1.263	
6	Aug. 1	$WR = W_2$	72.0	= 72.0	1.515	(max.) 2/
7	2	$WR = W_2$	72.0	= 72.0	1.515	
8	3	$WR = W_2$	72.0	= 72.0	1.515	
9	Sept. 1	$WR = W_3$	72.0	= 72.0	1.515	
10	2	$WR = W_3$	72.0	= 72.0	1.515	
11	3	$WR = W_3$	72.0	= 72.0	1.515	
12	Oct. 1	$WR = W_4 \times 1.3/5$	$53.0 \times 1.3/5$	= 13.8	0.290	
	Total			771.4		

Land Soaking and Land Preparation Water ;
- P_2 = 150 mm/2 = 75.0 mm
- p_2 = 39.0 mm
- p = 61.0
- Total 250.0

10-day Crop Water Requirement ;
- W_1 = 60.0 mm
- W_2 = 72.0
- W_3 = 72.0
- W_4 = 53.0

1/ : Maximum Irrigation Water Requirement ; (Land Preparation Stage)

$$q = \frac{75.0 \times 10^{-3} \times 1.0\,\text{ha} \times 10^4 \times 10^3}{10\,\text{days} \times 86{,}400 \times 0.55} = 1{,}578\ \text{lit/sec/ha}$$

2/ : Maximum Irrigation Water Requirement ; (Crop Growing Water Requirement)

$$q = \frac{72.0 \times 10^{-3} \times 1.0\,\text{ha} \times 10^4 \times 10^3}{10\,\text{days} \times 86{,}400 \times 0.55} = 1{,}515\ \text{lit/sec/ha}$$

TABLE F-23 CALCULATION OF WEIGHTED CROP WATER REQUIREMENT (CWR) FOR PADDY (LV) BLOCK AREA

No.	Month		Equation for Calculation of Weighted 10-day CWR	Weighted 10-day CWR (mm / 10-day)		Irrigation Water Requirement (lit/sec/ha)	
1	June	1	$WR = P_2 \times 9.3/5$	$75.0 \times 9.3/5$	= 139.5	2.936	(max.) 1/
2		2	$WR = P_2 \times 0.7/5 + P \times 3.0/5$	$75.0 \times 0.7/5 + 39 \times 3/5$	= 33.9	0.713	
3		3	$WR = P_1 \times 2.0/5 + P \times 5.0/5$	$39.0 \times 2.0/5 + 61 \times 5/5$	= 76.6	1.612	
4	July	1	$WR = W_1 \times 3.7/5$	$60.0 \times 3.7/5$	= 44.4	0.934	
5		2	$WR = W_1$	60.0	= 60.0	1.263	
6		3	$WR = W_1$	60.0	= 60.0	1.263	
7	Aug.	1	$WR = W_2$	72.0	= 72.0	1.515	(max.) 2/
8		2	$WR = W_2$	72.0	= 72.0	1.515	
9		3	$WR = W_2$	72.0	= 72.0	1.515	
10	Sept.	1	$WR = W_3$	72.0	= 72.0	1.515	
11		2	$WR = W_3$	72.0	= 72.0	1.515	
12		3	$WR = W_3$	72.0	= 72.0	1.515	
13	Oct.	1	$WR = W_4$	53.0	= 53.0	1.115	
14		2	$WR = W_4 \times 3.7/5$	$53.0 \times 3.7/5$	= 39.2	0.825	
	Total				938.6		

Land Soaking and Land Preparation Water ;
- P_2 = 150 mm/2 = 75.0 mm
- p_2 = 39.0 mm
- p = 61.0

10-day Crop Water Requirement ;
- W_1 = 60.0 mm
- W_2 = 72.0
- W_3 = 72.0
- W_4 = 53.0

1/ : Maximum Irrigation Water Requirement ; (Land Preparation Stage)

$$q = \frac{139.5 \times 10^{-3} \times 1.0\,ha \times 10^4 \times 10^3}{10\,days \times 86{,}400 \times 0.55} = 2{,}936\ lit/sec/ha$$

2/ : Maximum Irrigation Water Requirement ; (Crop Growing Water Requirement)

$$q = \frac{72.0 \times 10^{-3} \times 1.0\,ha \times 10^4 \times 10^3}{10\,days \times 86{,}400 \times 0.55} = 1{,}515\ lit/sec/ha$$

TABLE F-24 CROP WATER REQUIREMENT OF UPLAND CROPS

(unit : mm/10-day)

Month	Groundnut (67 %)			Soybean (22 %)			Watermelon (7 %)		
	P.I	ETa	Total	P.I	ETa	Total	P.I	ETa	Total
Dec. 1	26.7	4.5	31.2	26.7	4.5	31.2	26.7	4.5	31.2
2	26.7	13.5	40.2	26.7	13.5	40.2	26.7	13.5	40.2
3	26.7	22.5	49.2	26.7	22.5	49.2	26.7	22.5	49.2
Jan. 1		43.0	43.0		50.0	50.0		41.0	41.0
2		43.0	43.0		50.0	50.0		41.0	41.0
3		43.0	43.0		50.0	50.0		41.0	41.0
Feb. 1		55.0	55.0		62.0	62.0		52.0	52.0
2		55.0	55.0		62.0	62.0		52.0	52.0
3		55.0	55.0		62.0	62.0		52.0	52.0
Mar. 1		41.0	41.0		48.0	48.0		46.0	46.0
2		41.0	41.0		48.0	48.0		46.0	46.0
3		34.2	34.2		40.0	40.0		38.3	38.3
Apr. 1		14.0	14.0		20.0	20.0		20.0	20.0
2		4.7	4.7		6.7	6.7		6.7	6.7
3									
Total	80.1	469.4	549.5	80.1	539.2	619.3	80.1	476.5	556.6

Month	Chilli (1 %)			Stringbean (3 %)			Average		
	P.I	ETa	Total	P.I	ETa	Total	P.I	ETa	Total
Dec. 1	26.7	4.5	31.2	26.7	4.5	31.2	26.7	4.5	31.2
2	26.7	13.5	40.2	26.7	13.5	40.2	26.7	13.5	40.2
3	26.7	22.5	49.2	26.7	22.5	49.2	26.7	22.5	49.2
Jan. 1		43.0	43.0		51.0	51.0		44.6	44.6
2		43.0	43.0		51.0	51.0		44.6	44.6
3		43.0	43.0		51.0	51.0		44.6	44.6
Feb. 1		55.0	55.0		62.0	62.0		56.5	56.5
2		55.0	55.0		62.0	62.0		56.5	56.5
3		55.0	55.0		62.0	62.0		56.5	56.5
Mar. 1		41.0	41.0		48.0	48.0		43.1	43.1
2		41.0	41.0		48.0	48.0		43.1	43.1
3		34.2	34.2		40.0	40.0		35.9	35.9
Apr. 1		14.0	14.0		20.0	20.0		15.9	15.9
2		4.7	4.7		6.7	6.7		5.3	5.3
3									
Total	80.1	469.4	549.5	80.1	542.2	622.3	80.1	487.4	567.5

Note : P.I : Pre-Irrigation
ETa : Consumptive Use of Upland Crop

Max. crop water requirement (average) : 56.5 mm/10-day
= 1.308 lit./sec/ha

F-25 CALCULATION OF WEIGHTED CROP WATER REQUIREMENT (CWR) FOR UPLAND AND PERENNIAL CROPS

No	Month	Crop Water Requirement for Dry Season Upland Crops												Crop Water Requirement for Dry Season Upland Crops				CWR for Peremial Crop	
		Equation	Groundnut		Soybean		Watermelon		Chilli		Stringbean		Average (mm/10-day)	Average (lit/sec/ha)	Equation	Groundnut	(mm/10day)	(Lit/sec/ha)	(mm/10day)	(Lit/sec/ha)
1	Dec 1	$WR = P \times 10/30 + W_1 \times 5/30$	$80 \times 10/30 + 27 \times 5/30$	= 31.2	$80 \times 10/30 + 27 \times 5/30$	= 31.2	$80 \times 10/30 + 27 \times 5/30$	= 31.2	$80 \times 10/30 + 27 \times 5/30$	= 31.2	$80 \times 10/30 + 27 \times 5/30$	= 31.2	31.2	0.722					35.0	0.810
2	2	$WR = P \times 10/30 + W_1 \times 15/30$	$80 \times 10/30 + 27 \times 15/30$	= 40.2	$80 \times 10/30 + 27 \times 15/30$	= 40.2	$80 \times 10/30 + 27 \times 15/30$	= 40.2	$80 \times 10/30 + 27 \times 15/30$	= 40.2	$80 \times 10/30 + 27 \times 15/30$	= 40.2	40.2	0.931					35.0	0.810
3	3	$WR = P \times 10/30 + W_1 \times 25/30$	$80 \times 10/30 + 27 \times 25/30$	= 49.2	$80 \times 10/30 + 27 \times 25/30$	= 49.2	$80 \times 10/30 + 27 \times 25/30$	= 49.2	$80 \times 10/30 + 27 \times 25/30$	= 49.2	$80 \times 10/30 + 27 \times 25/30$	= 49.2	49.2	1.139					35.0	0.810
4	Jan 1	$WR = W_2 \times 30/30$	$43 \times 30/30$	= 43.0	$50 \times 30/30$	= 50.0	$41 \times 30/30$	= 41.0	$43 \times 30/30$	= 43.0	$51 \times 30/30$	= 51.0	44.6	1.032					39.0	0.903
5	2	$WR = W_2 \times 30/30$	$43 \times 30/30$	= 43.0	$50 \times 30/30$	= 50.0	$41 \times 30/30$	= 41.0	$43 \times 30/30$	= 43.0	$51 \times 30/30$	= 51.0	44.6	1.032					39.0	0.903
6	3	$WR = W_2 \times 30/30$	$43 \times 30/30$	= 43.0	$50 \times 30/30$	= 50.0	$41 \times 30/30$	= 41.0	$43 \times 30/30$	= 43.0	$51 \times 30/30$	= 51.0	44.6	1.032					39.0	0.903
7	Feb 1	$WR = W_3 \times 30/30$	$55 \times 30/30$	= 55.0	$62 \times 30/30$	= 62.0	$52 \times 30/30$	= 52.0	$55 \times 30/30$	= 55.0	$62 \times 30/30$	= 62.0	56.5	1.308 (max.)					47.0	1.088
8	2	$WR = W_3 \times 30/30$	$55 \times 30/30$	= 55.0	$62 \times 30/30$	= 62.0	$52 \times 30/30$	= 52.0	$55 \times 30/30$	= 55.0	$62 \times 30/30$	= 62.0	56.5	1.308					47.0	1.088
9	3	$WR = W_3 \times 30/30$	$55 \times 30/30$	= 55.0	$62 \times 30/30$	= 62.0	$52 \times 30/30$	= 52.0	$55 \times 30/30$	= 55.0	$62 \times 30/30$	= 62.0	56.5	1.308					47.0	1.088
10	Mar 1	$WR = W_4 \times 30/30$	$41 \times 30/30$	= 41.0	$48 \times 30/30$	= 48.0	$46 \times 30/30$	= 46.0	$41 \times 30/30$	= 41.0	$48 \times 30/30$	= 48.0	43.1	0.998					49.0	1.134
11	2	$WR = W_4 \times 30/30$	$41 \times 30/30$	= 41.0	$48 \times 30/30$	= 48.0	$46 \times 30/30$	= 46.0	$41 \times 30/30$	= 41.0	$48 \times 30/30$	= 48.0	43.1	0.998					49.0	1.134
12	3	$WR = W_4 \times 25/30$	$41 \times 25/30$	= 34.2	$48 \times 25/30$	= 40.0	$46 \times 25/30$	= 38.3	$41 \times 25/30$	= 41.0	$48 \times 25/30$	= 40.0	35.9	0.831					49.0	1.134
13	Apr 1	$WR = W_5 \times 15/30$	$28 \times 15/30$	= 14.0	$40 \times 15/30$	= 20.0	$40 \times 15/30$	= 20.0	$28 \times 15/30$	= 14.0	$40 \times 15/30$	= 20.0	15.9	0.368					52.0	1.204 (max.)
14	2	$WR = W_5 \times 5/30$	$28 \times 5/30$	= 4.7	$40 \times 5/30$	= 6.7	$40 \times 5/30$	= 6.7	$28 \times 5/30$	= 4.7	$40 \times 5/30$	= 6.7	5.3	0.123					52.0	1.204
15	3																		52.0	1.204
16	May 1																		46.0	1.065
17	2																		46.0	1.065
18	3																		46.0	1.065
19	June 1														$WR = P \times 10/30 + W_1 \times 5/30$	$80 \times 10/30 + 29 \times 5/30$	= 31.5	31.5	0.729	38.0	0.880
20	2														$WR = P \times 10/30 + W_1 \times 15/30$	$80 \times 10/30 + 29 \times 15/30$	= 41.2	41.2	0.954	38.0	0.880
21	3														$WR = P \times 10/30 + W_1 \times 25/30$	$80 \times 10/30 + 29 \times 25/30$	= 50.8	50.8	1.176	38.0	0.880
22	July 1														$WR = W_2 \times 30/30$	$53 \times 30/30$	= 53.0	53.0	1.227 (max.)	38.0	0.880
23	2														$WR = W_2 \times 30/30$	$53 \times 30/30$	= 53.0	53.0	1.227	38.0	0.880
24	3														$WR = W_2 \times 30/30$	$53 \times 30/30$	= 53.0	53.0	1.227	38.0	0.880
25	Aug. 1														$WR = W_3 \times 30/30$	$51 \times 30/30$	= 51.0	51.0	1.181	37.0	0.856
26	2														$WR = W_3 \times 30/30$	$51 \times 30/30$	= 51.0	51.0	1.181	37.0	0.856
27	3														$WR = W_3 \times 30/30$	$51 \times 30/30$	= 51.0	51.0	1.181	37.0	0.856
28	Sept. 1														$WR = W_4 \times 30/30$	$32 \times 30/30$	= 32.0	32.0	0.741	34.0	0.787
29	2														$WR = W_4 \times 30/30$	$32 \times 30/30$	= 32.0	32.0	0.741	34.0	0.787
30	3														$WR = W_4 \times 25/30$	$32 \times 25/30$	= 26.7	26.7	0.618	34.0	0.787
31	Oct 1														$WR = W_5 \times 15/30$	$28 \times 15/30$	= 14.0	14.0	0.324	37.0	0.856
32	2														$WR = W_5 \times 5/30$	$28 \times 5/30$	= 4.7	6.7	0.109	37.0	0.856
33	3																		37.0	0.856
34	Nov. 1																		38.0	0.880
35	2																		38.0	0.880
36	3																		38.0	0.880
	Total			549.5		619.3		556.6		549.5		622.3	567.2				544.9	544.9	1,470.0		

1/ : 10-day crop water requirement (w) ;

(unit : mm/10-day)

w	Dry Season Upland Crops					Wet Season Upland Crops
	Groundnut	Soybean	Watermelon	Chilli	Stringbean	Vegetable
P	80	80	80	80	80	80
W_1	27	27	27	27	27	29
W_2	43	50	41	43	51	53
W_3	55	62	52	55	62	51
W_4	41	48	46	41	48	32
W_5	28	40	40	28	40	28

2/ : Cropping ratio of dry season upland crops (Type-1) ;

Groundnut	:	67 %
Soybean	:	22 %
Watermelon	:	7 %
Chilli	:	1 %
Stringbean	:	3%

FIGURE F-1 COEFFICIENT OF KC VALUES FOR CROPS (1)

Crop : Paddy Rice (HYV) ---(Wet Season)

- Wind : Light to moderate (0-5 m/sec)
- Mid-Summer RH min. : 70-80 %
- Irrigation Frequency Initial Period assumed :

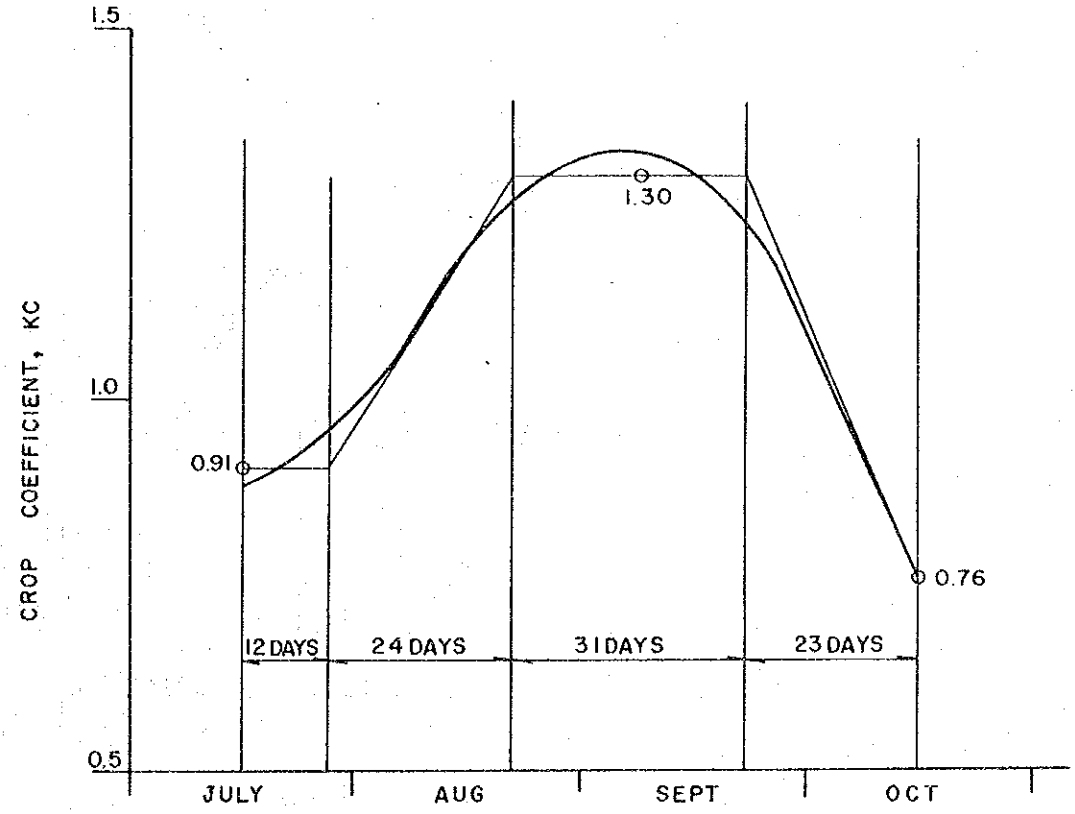
I. Planting Date : June to August

II. Length of Growth Stage

- Initial	:	12 days	(13 %)
- Crop Development	:	24	(27)
- Mid-Season	:	31	(34)
- Late-Season	:	23	(26)
Total		90	(100)

III. Kc Values

- Kc Initial Stage : 0.91 1/
- Kc Mid-Season : 1.30
- Kc Late-season Stage : 0.76



1/ Data source ; Water Requirement Research, Irrigated Agricultural Section, O/M Division RID, October, 1990

FIGURE F-1 COEFFICIENT OF KC VALUES FOR CROPS (2)

Crop : Paddy Rice (LV) ---(Wet Season)

- Wind : Light to moderate (0-5 m/sec)
- Mid-Summer RH min. : 70-80 %
- Irrigation Frequency Initial Period assumed :

I. Planting Date : June to July

II. Length of Growth Stage

- Initial	:	15 days	(13 %)
- Crop Development	:	32	(27)
- Mid-Season	:	41	(34)
- Late-Season	:	31	(26)
Total		120	(100)

III. Kc Values

- Kc Initial Stage : 0.90
- Kc Mid-Season : 1.30
- Kc Late-season Stage : 0.76

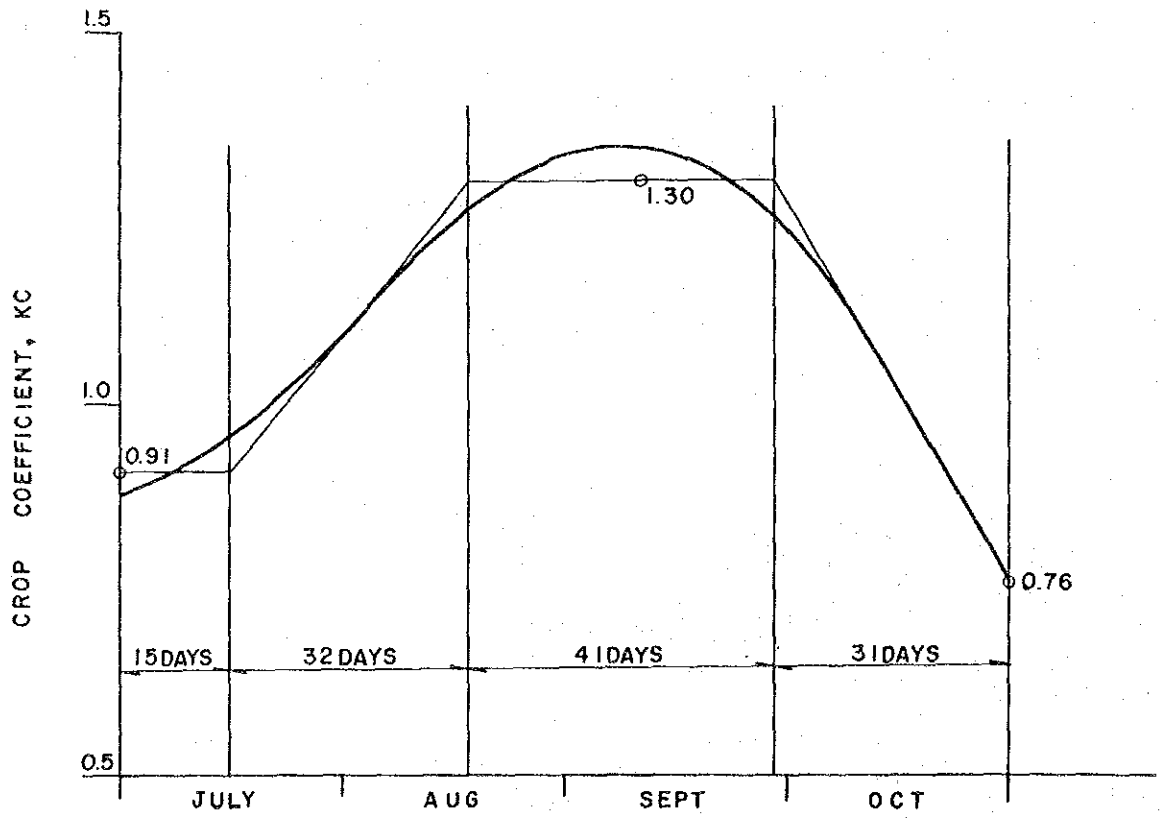


FIGURE F-1 COEFFICIENT OF KC VALUES FOR CROPS (3)

Crop : Vegetable ---(Wet Season)

- Wind : Light to moderate (0-5 m/sec)
- Mid-Summer RH min. : 70-80 %
- Irrigation Frequency Initial Period assumed :

I. Planting Date : June

II. Length of Growth Stage

- Initial	:	17 days	(14 %)
- Crop Development	:	25	(21)
- Mid-Season	:	35	(29)
- Late-Season	:	43	(36)
Total		120	(100)

III. Kc Values

- Kc Initial Stage : 0.60
- Kc Mid-Season : 1.20
- Kc Late-season Stage : 0.65

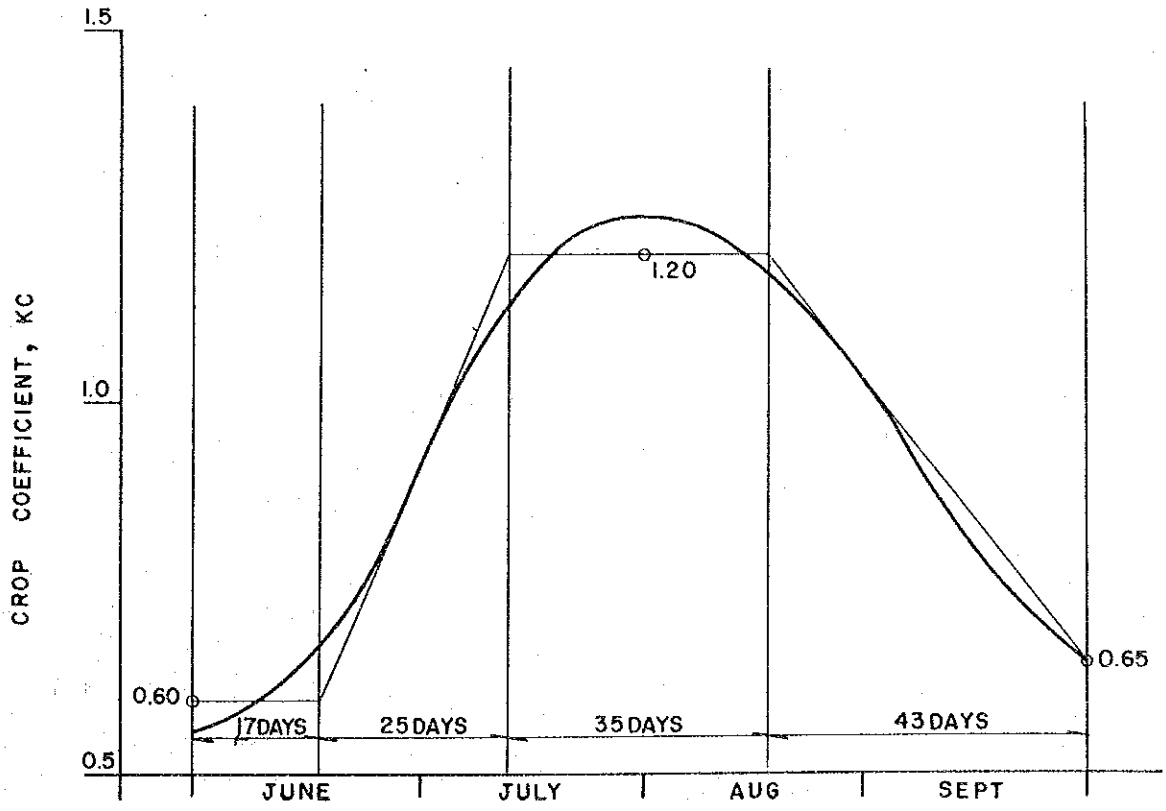


FIGURE F-1 COEFFICIENT OF KC VALUES FOR CROPS (4)

Crop : Groundnut, Chilli --- (Dry Season)

- Wind : Right to moerate (0-5 m/sec)
- Mid-Summer RH min. : 60-75 %
- Irrigation Frequency Initial Period assumed :

I. Planting Date : December

II. Length of Growth Stage

- Initial	:	16 days	(13 %)
- Crop Development	:	24	(20)
- Mid-Season	:	48	(40)
- Late-Season	:	32	(27)
Total		120	(100)

III. Kc Values

- Kc Initial Stage : 0.58
- Kc Mid-Season : 1.00
- Kc Late-season Stage : 0.48

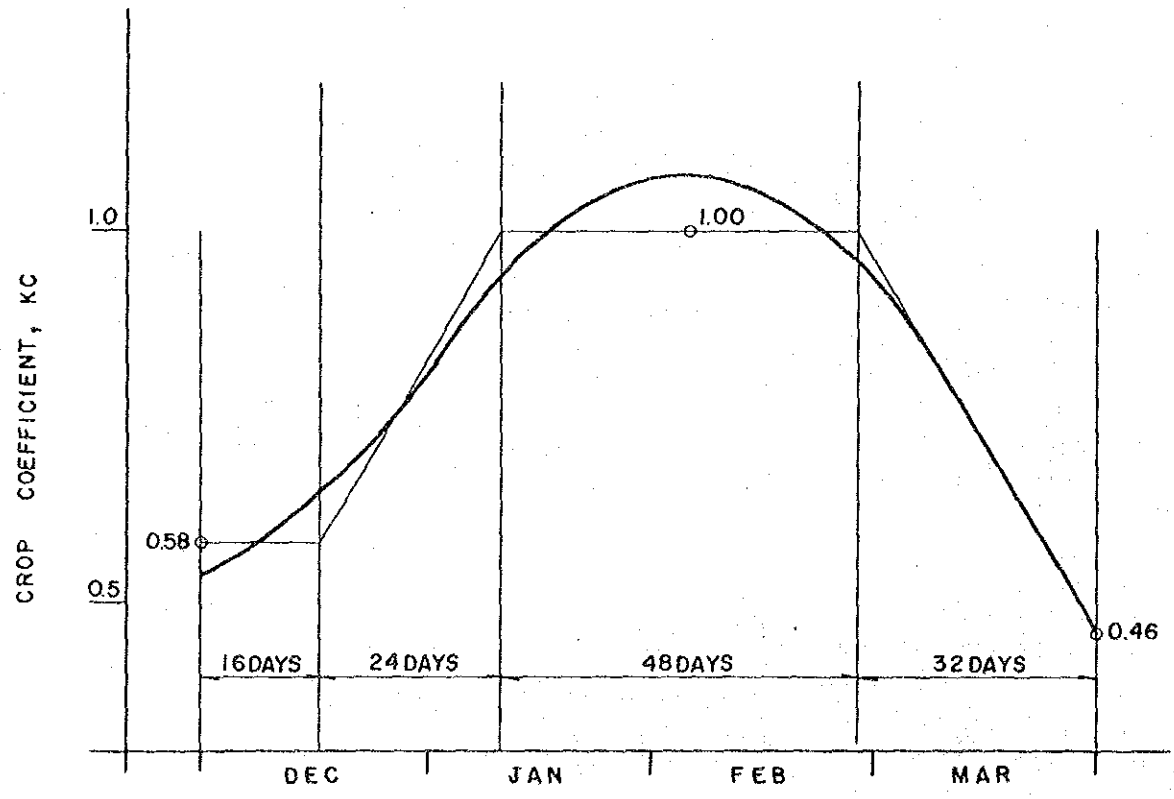


FIGURE F-1 COEFFICIENT OF KC VALUES FOR CROPS (5)

Crop : Soybean --- (Dry Season)

- Wind : Light to moderate (0-5 m/sec)
- Mid-Summer RH min. : 60-75 %
- Irrigation Frequency Initial Period assumed :

I. Planting Date : December

II. Length of Growth Stage

- Initial	:	17 days	(14 %)
- Crop Development	:	25	(21)
- Mid-Season	:	35	(29)
- Late-Season	:	43	(36)
Total		120	(100)

III. Kc Values

- Kc Initial Stage : 0.60
- Kc Mid-Season : 1.20
- Kc Late-season Stage : 0.65

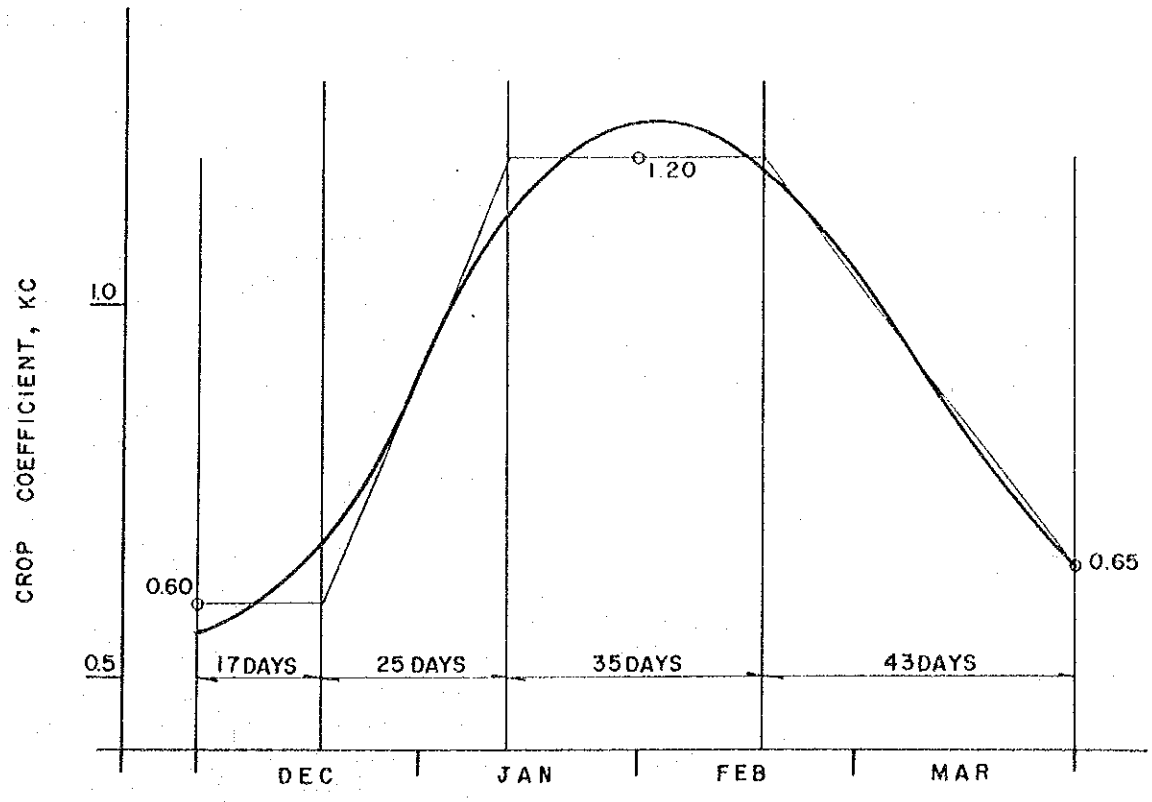


FIGURE F-1 COEFFICIENT OF KC VALUES FOR CROPS (6)

Crop : watermelon --- (Dry Season)

- Wind : Light to moderate (0-5 m/sec)
- Mid-Summer RH min. : 60-75%
- Irrigation Frequency Initial Period assumed :

I. Planting Date : December

II. Length of Growth Stage

- Initial	:	16 days	(13 %)
- Crop Development	:	24	(20)
- Mid-Season	:	48	(40)
- Late-Season	:	32	(27)
Total		120	(100)

III. Kc Values

- Kc Initial Stage : 0.60
- Kc Mid-Season : 0.95
- Kc Late-season Stage : 0.65

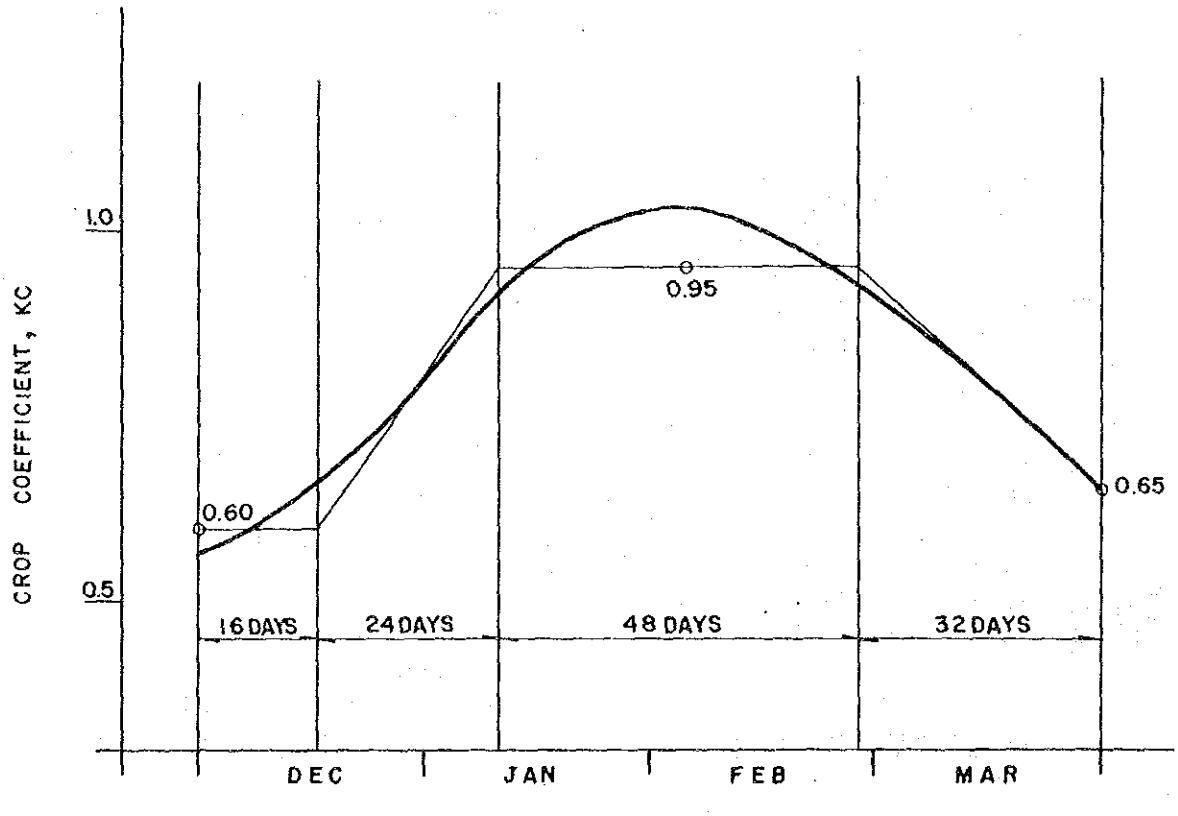


FIGURE F-1 COEFFICIENT OF KC VALUES FOR CROPS (7)

Crop : Stringbean --- (Dry Season)

- Wind : Light to moderate (0-5 m/sec)
- Mid-Summer RH min. : 60-75 %
- Irrigation Frequency Initial Period assumed :

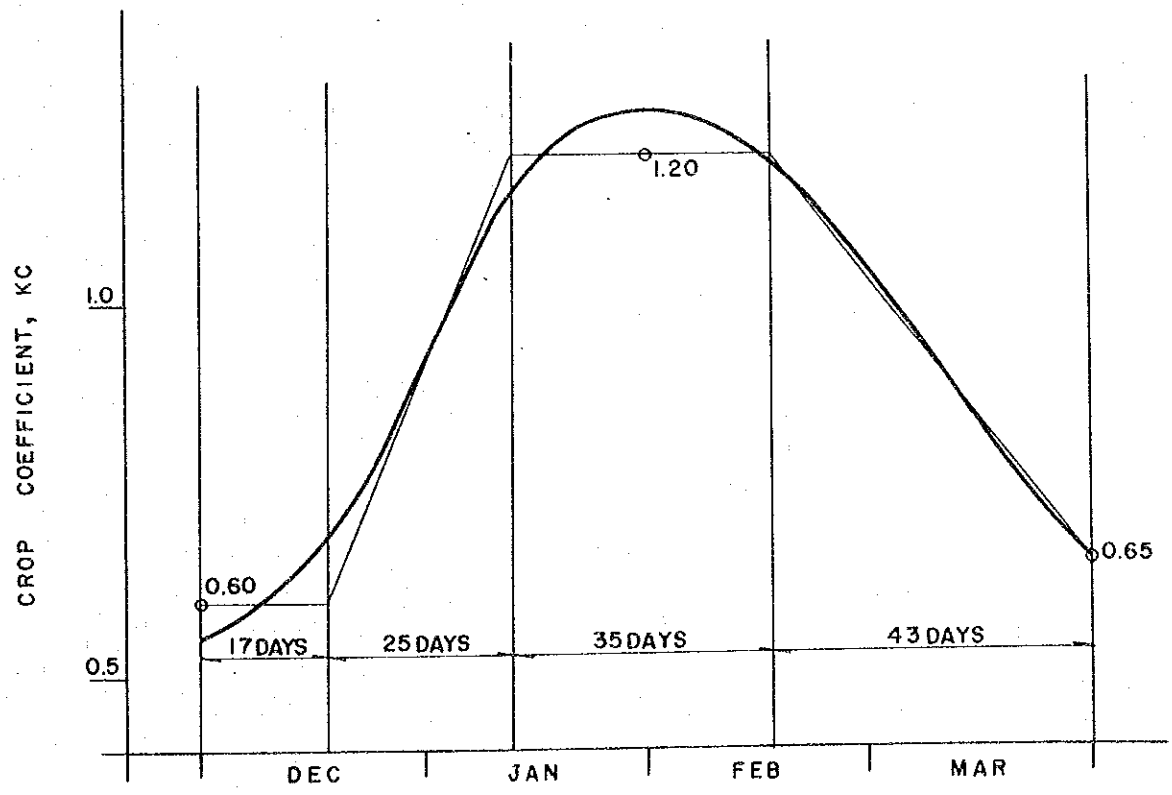
I. Planting Date : December

II. Length of Growth Stage

- Initial	:	17 days	(14 %)
- Crop Development	:	25	(21)
- Mid-Season	:	35	(29)
- Late-Season	:	43	(36)
Total		120	(100)

III. Kc Values

- Kc Initial Stage : 0.60
- Kc Mid-Season : 1.20
- Kc Late-season Stage : 0.65



Block	Irrigation Unit	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
I-1	A Unit	P2					P2			PL	PL							P1	RL	L			H	P				Po			TP										
	B Unit		P2					P2			PL	PL							P1	RL	L			H	P				Po			TP										
	C Unit			P2					P2			PL	PL							P1	RL	L			H	P				Po			TP										
	D Unit				P2					P2			PL	PL							P1	RL	L			H	P				Po			TP										
	E Unit					P2					P2			PL	PL							P1	RL	L			H	P				Po			TP										
I-2	A Unit		P2					P2			PL	PL							P1	RL	L			H	P				Po			TP										
	B Unit			P2					P2			PL	PL							P1	RL	L			H	P				Po			TP										
	C Unit				P2					P2			PL	PL							P1	RL	L			H	P				Po			TP										
	D Unit					P2					P2			PL	PL							P1	RL	L			H	P				Po			TP										
	E Unit						P2					P2			PL	PL							P1	RL	L			H	P				Po			TP									
I-3	A Unit			P2					P2			PL	PL							P1	RL	L			H	P				Po			TP										
	B Unit				P2					P2			PL	PL							P1	RL	L			H	P				Po			TP										
	C Unit					P2					P2			PL	PL							P1	RL	L			H	P				Po			TP									
	D Unit						P2					P2			PL	PL							P1	RL	L			H	P				Po			TP									
	E Unit							P2					P2			PL	PL							P1	RL	L			H	P				Po			TP								
I-4	A Unit				P2					P2			PL	PL							P1	RL	L			H	P				Po			TP									
	B Unit					P2					P2			PL	PL							P1	RL	L			H	P				Po			TP									
	C Unit						P2					P2			PL	PL							P1	RL	L			H	P				Po			TP								
	D Unit							P2					P2			PL	PL							P1	RL	L			H	P				Po			TP							
	E Unit								P2					P2			PL	PL							P1	RL	L			H	P				Po			TP						
I-5	A Unit					P2					P2			PL	PL							P1	RL	L			H	P				Po			TP								
	B Unit						P2					P2			PL	PL							P1	RL	L			H	P				Po			TP								
	C Unit							P2					P2			PL	PL							P1	RL	L			H	P				Po			TP							
	D Unit								P2					P2			PL	PL							P1	RL	L			H	P				Po			TP						
	E Unit									P2					P2			PL	PL							P1	RL	L			H	P				Po			TP					

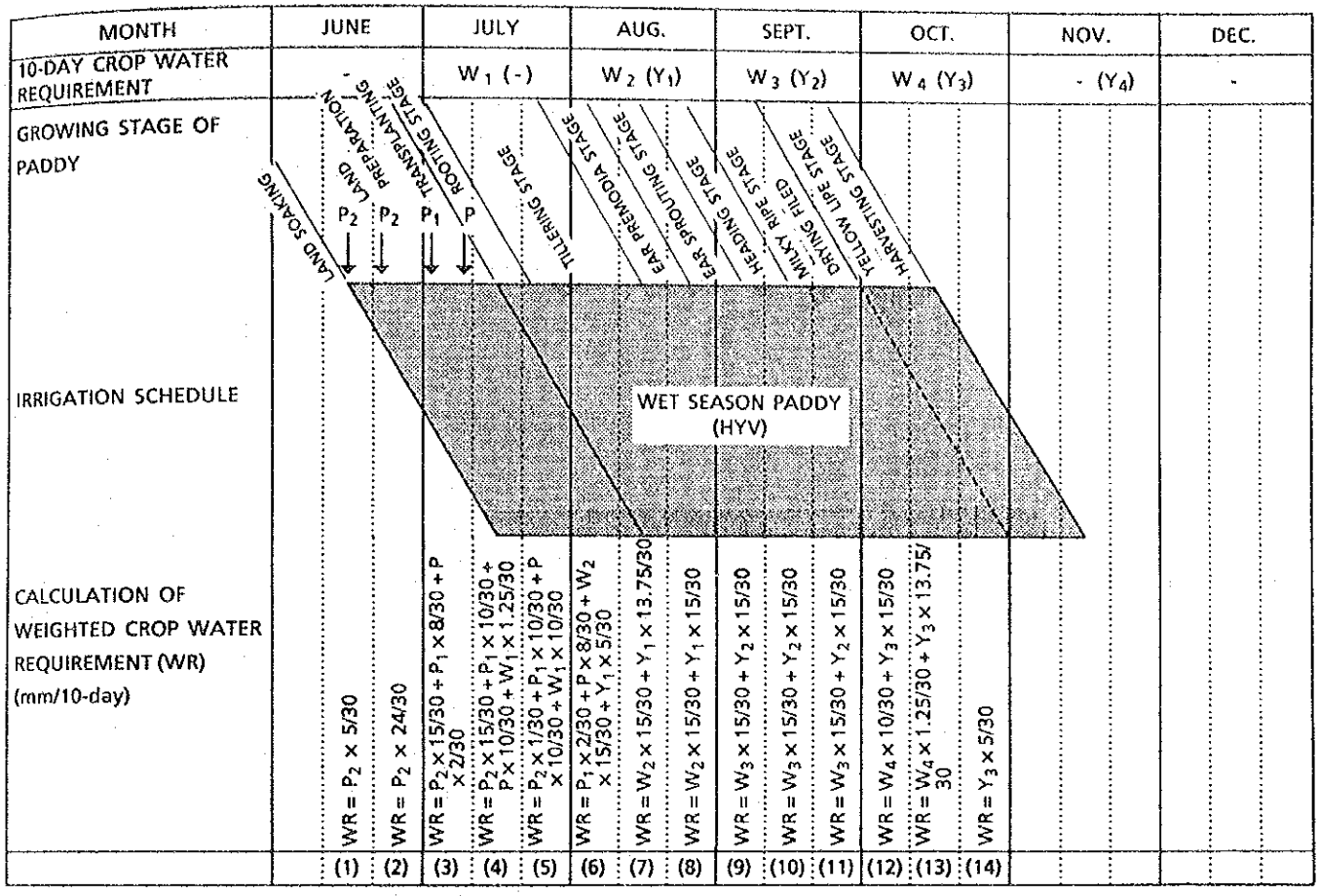
NOTE :

P2 : 1st Irrigation
P1 : 2nd Irrigation
P : 3rd Irrigation
Po : Supplemental Irrigation

PL : Plowing
RL : Clean and Repair of levee
L : Plaster of levee
H : Harrowing
TP : Transplanting

FIGURE F-2 SCHEDULE OF LAND PREPARATION WORKS AND WATER SUPPLY

FIGURE F-3 ESTIMATION OF 10-DAY CROP WATER REQUIREMENT (ETa) FOR PADDY RICE



Note ; P_2 : First Irrigation Supply
P_1 : Second Irrigation Supply
P : Third Irrigation Supply

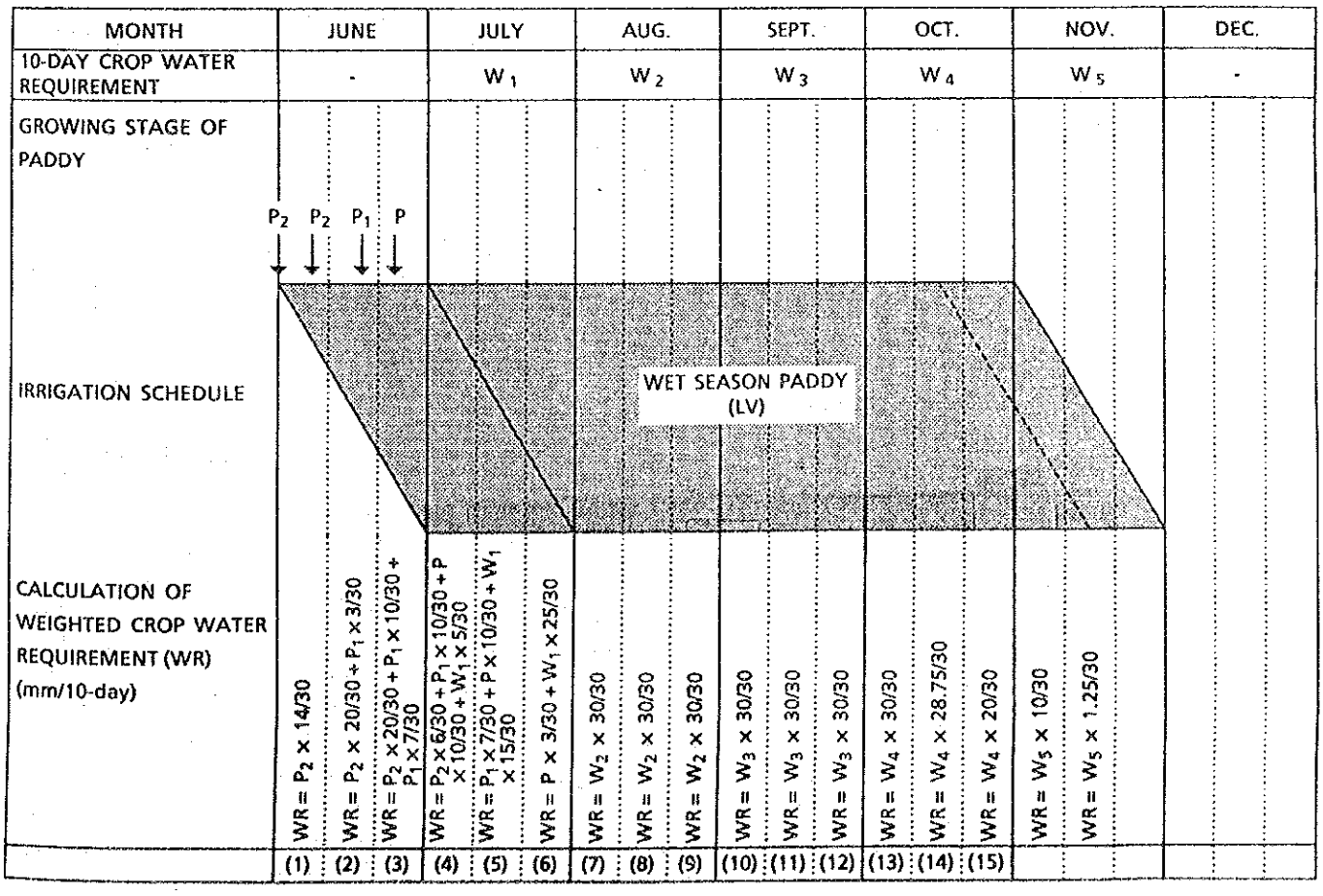
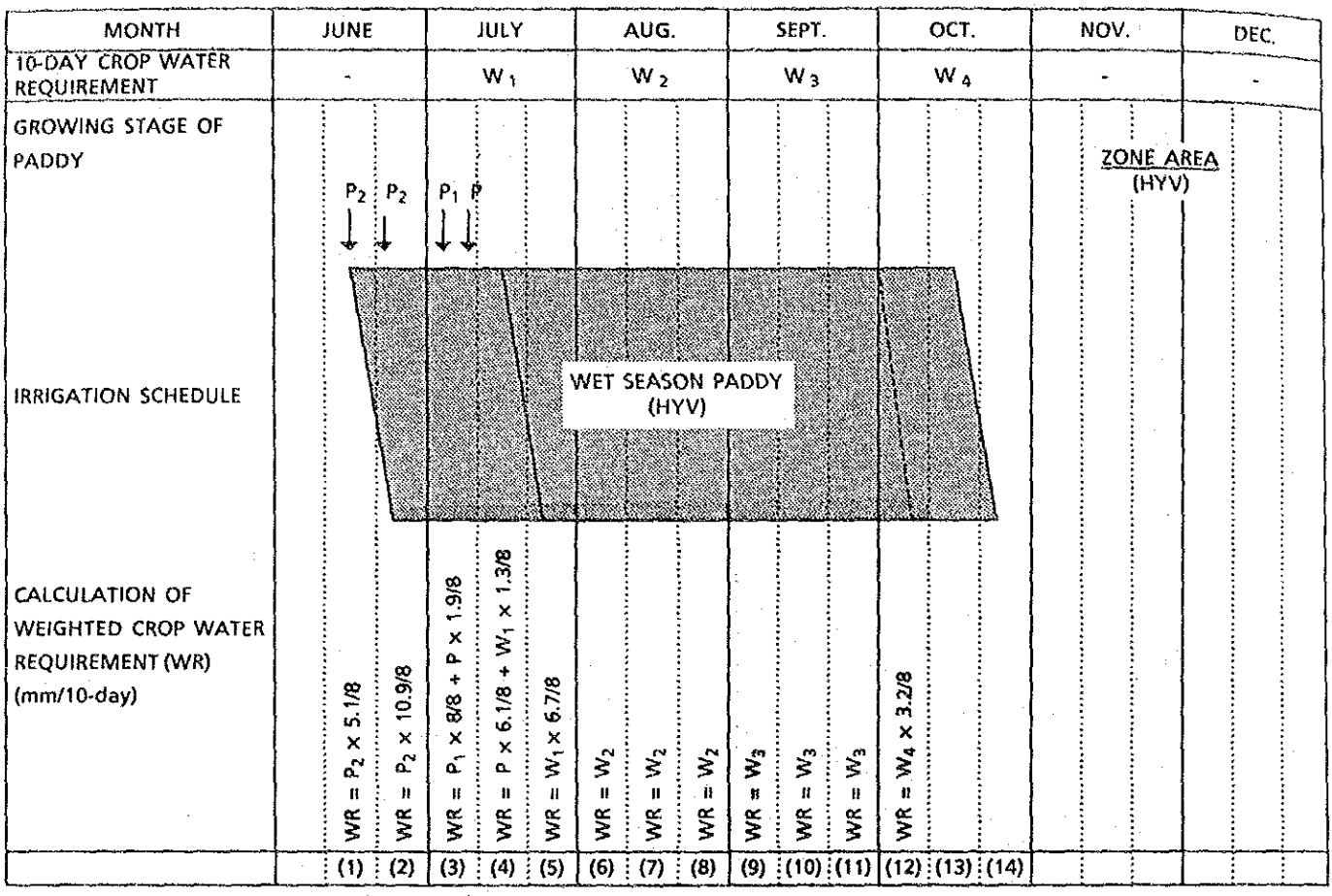


FIGURE F-4 ESTIMATION OF 10-DAY CROP WATER REQUIREMENT (ETa) FOR PADDY RICE



Note ; P_2 : First Irrigation Supply
P_1 : Second Irrigation Supply
P : Third Irrigation Supply

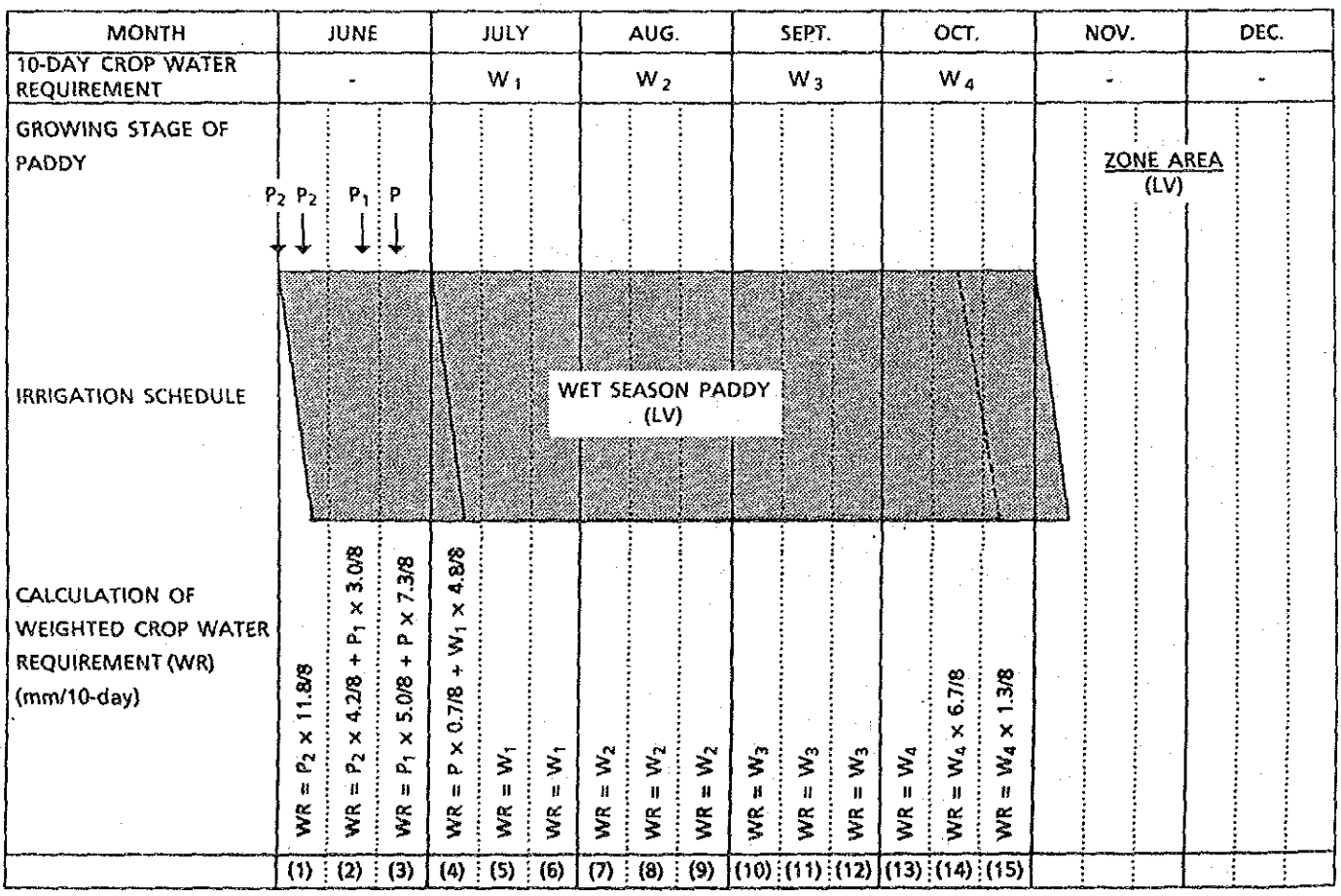
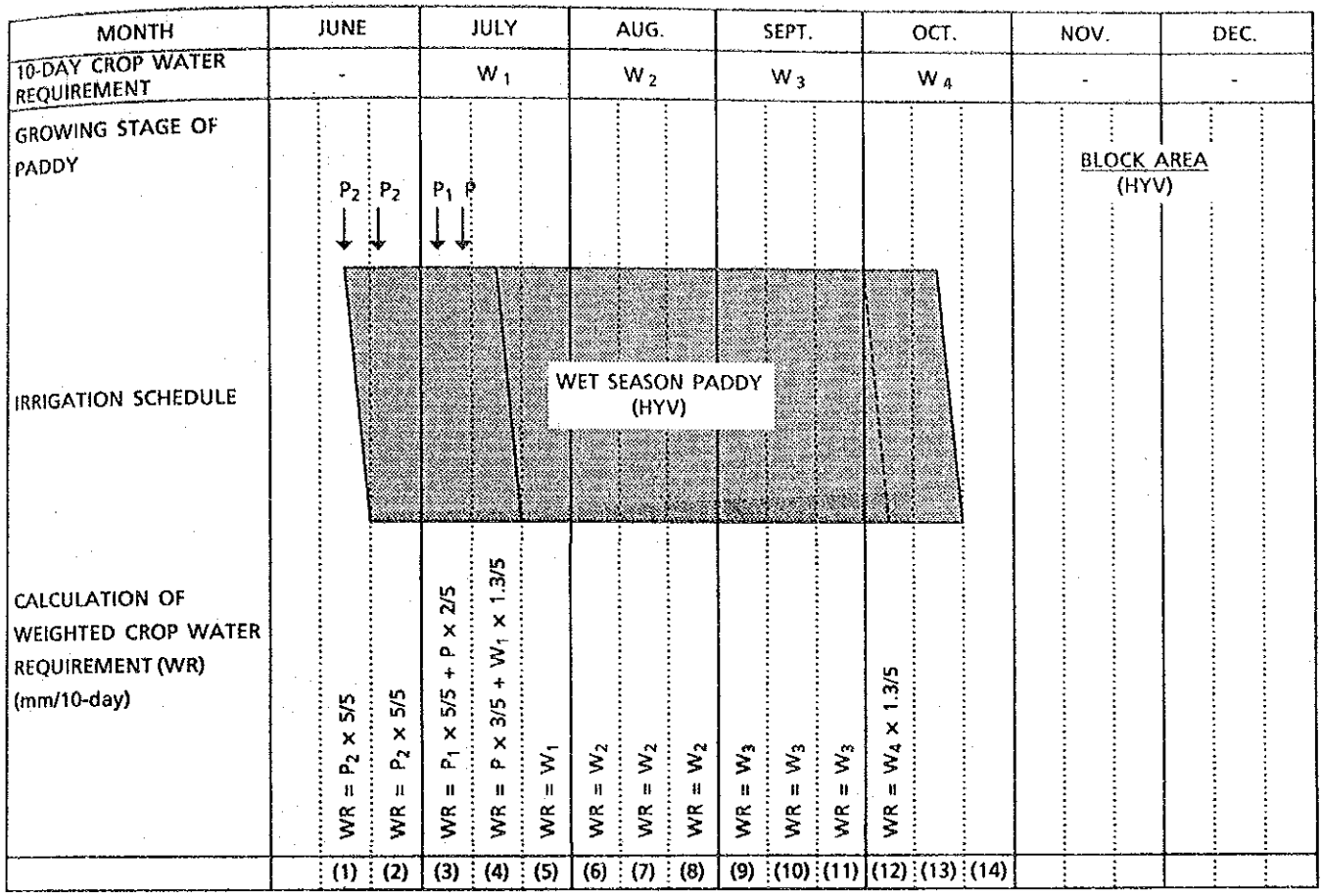


FIGURE F-5 ESTIMATION OF 10-DAY CROP WATER REQUIREMENT (ETa) FOR PADDY RICE



Note ; P_2 : First Irrigation Supply
P_1 : Second Irrigation Supply
P : Third Irrigation Supply

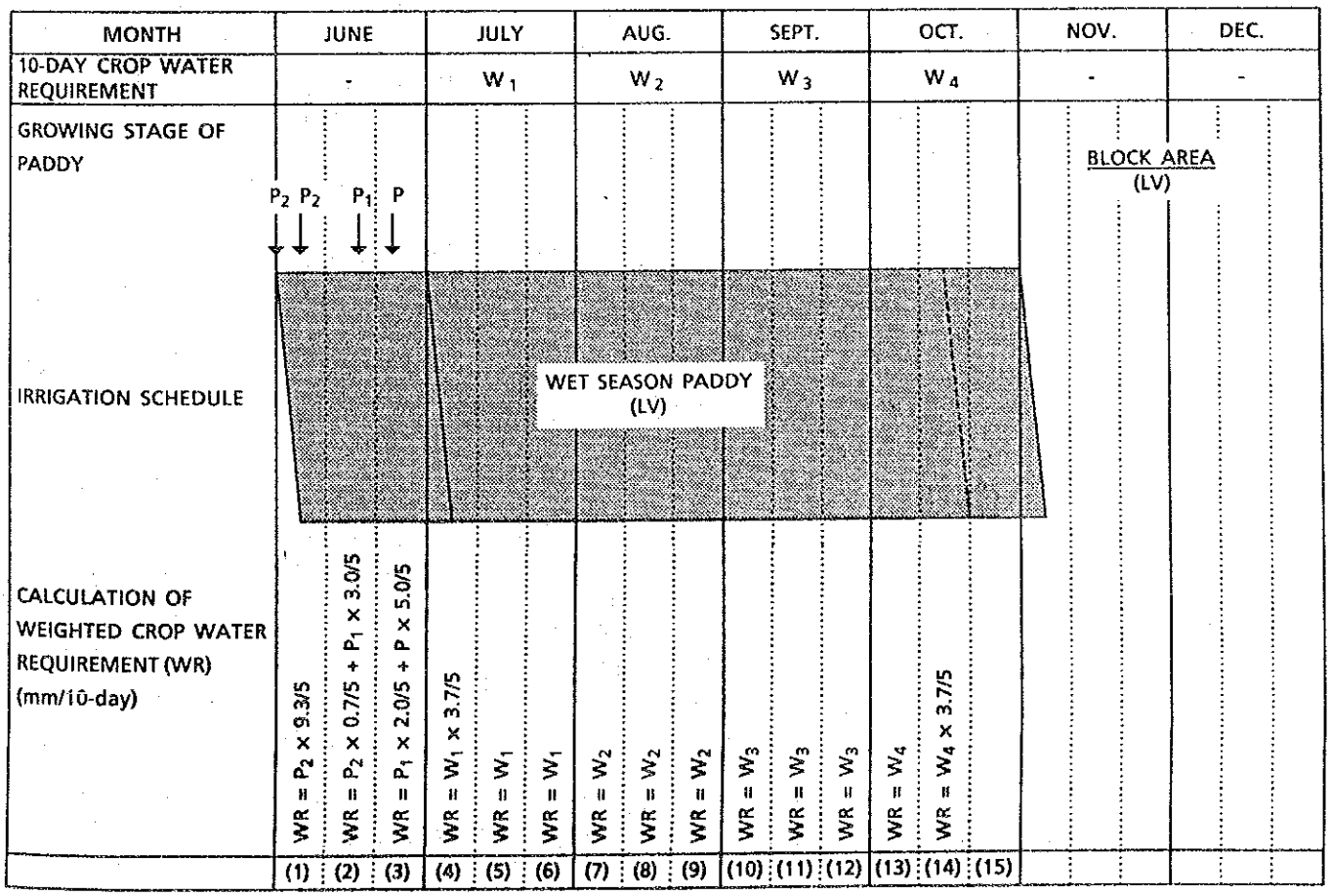
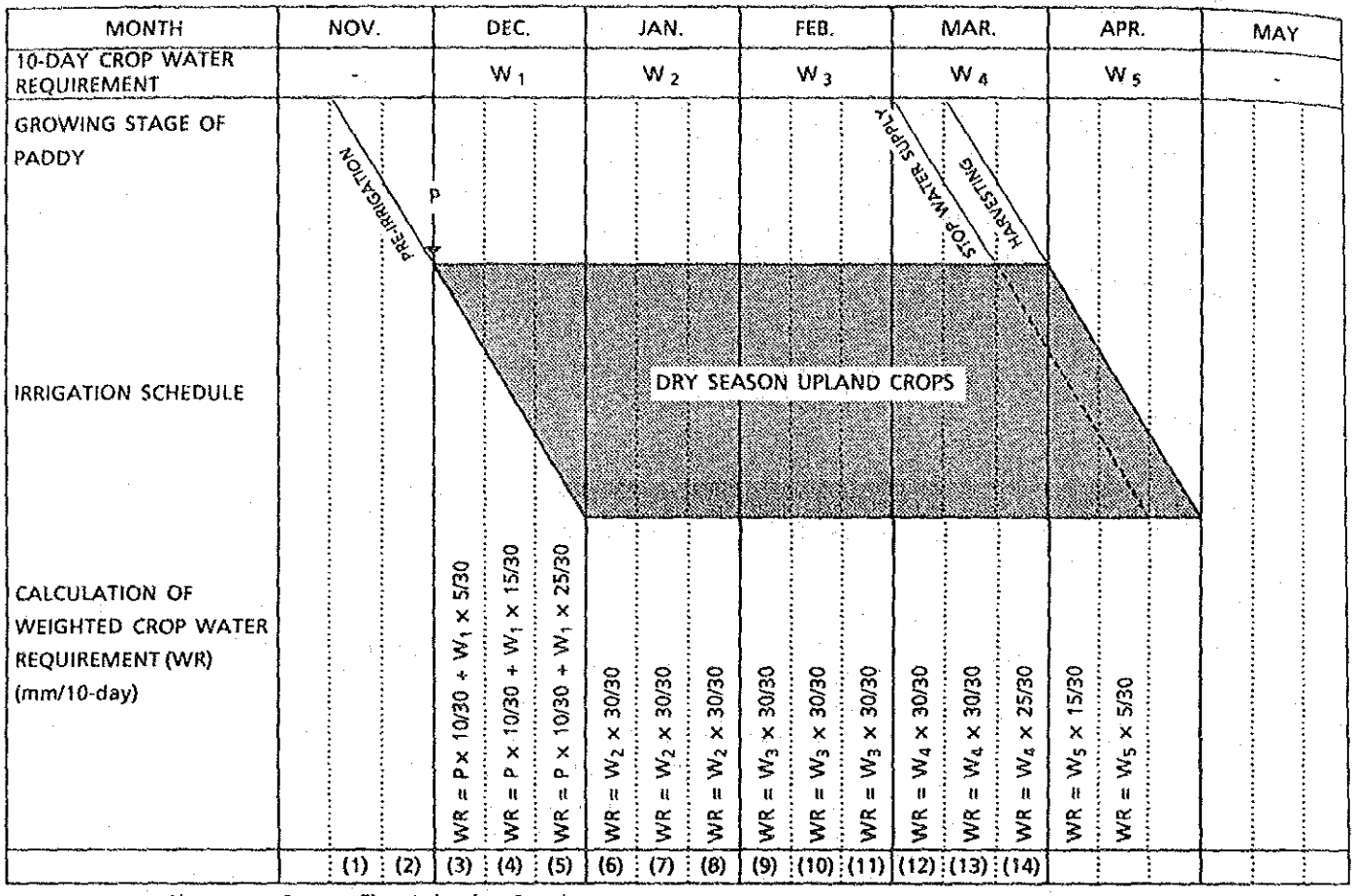
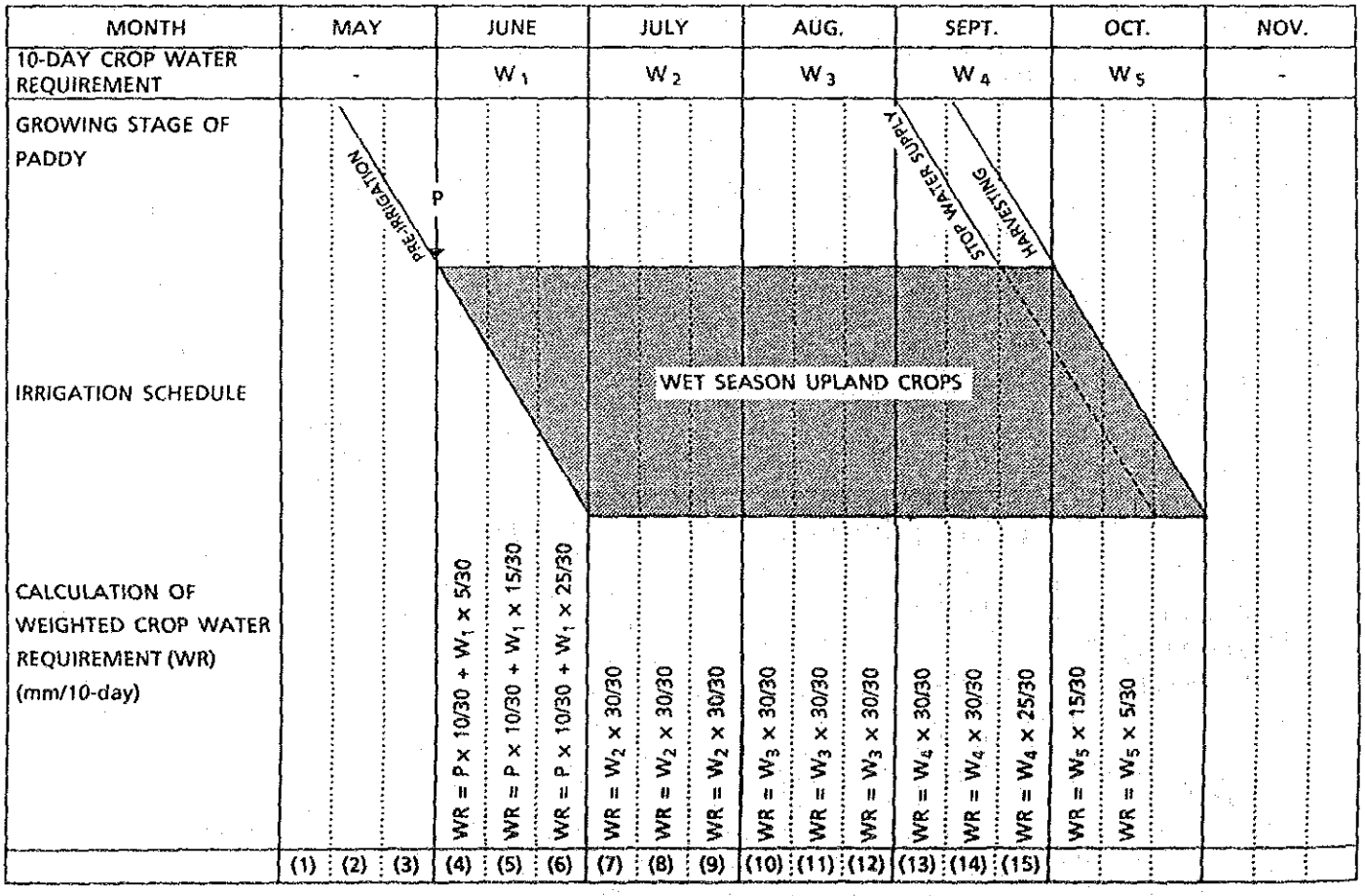


FIGURE F-6 ESTIMATION OF 10-DAY CROP WATER REQUIREMENT (ETa) FOR UPLAND CROP



Note ; P_2 : First Irrigation Supply
P_1 : Second Irrigation Supply
P : Third Irrigation Supply



1.2 Irrigation for Upland Crops

1.2.1 Measurement of Intake Rate

The intake rates of upland crop were measured at seven sites in and around the Study Area, in order to make a plan of an adequate irrigation method and amount of water to be supplied to the crop.

The following table gives the obtained basic intake rates, based on the observed rate.

Obtained Basic Intake Rate (Ib)

Location	Ib
	(mm/hr)
1. Ban Rai Tai	14.7
2. Ban Nachan	4.8
3. Ban Kaon Charoon	33.1
4. Ban Mai Pattana	15.1
5. Ban Wari Udom	15.6
6. Ban Non	54.1
7. Ban Nong Khu	16.4
Average	25.6

Location of measuring sites and detailed calculation of basic intake rate (Ib) are shown in Figure F-7.

1.2.2 Depth and Interval of Irrigation Application

In parallel with the intake rate measurements mentioned above, soil samples in the depth of 70 cm with an interval of 20 cm depth were taken at even sites to analyze the physical properties of the soil like particle size, soil texture, specific gravity, porosity, field capacity and wilting point. Table F-26 shows the results of soil tests.

Based on the obtained soil analysis data, i) available moisture of each soil layer within effective root zone, ii) total readily available moisture (TRAM) and iii) depth and interval of irrigation application were calculated as shown in Table F-27 and Table F-28.

TABLE F-26 PHYSICAL FEATURES OF SOIL FOR UPLAND IRRIGATION

Location	Conditions	Soil Depth (cm)	Particle Size Sand (%)	Silt (%)	Clay (%)	Soil Texture	Real Specific Features (Sr) (g/cm3)	Aparent Specific Gravity (Sa) (g/cm3)	Porocity (P) (%)	Field Capacity (Fc) (%)	Wilting Capacity (Wp) (%)	Available Moisture (AM) (%)
1. Ban Rai Tai	Dry Con.	10	72.0	23.0	5.0	SL	2.61	1.79	31.6	7.6	2.4	5.2
		30	65.0	23.0	12.0	SL	2.65	1.89	28.8	11.8	5.2	6.6
		50	63.0	17.4	19.6	SL	2.87	1.95	31.9	18.6	10.3	8.3
		70	18.0	22.4	59.6	C	2.71	1.97	26.9	34.4	20.9	13.5
2. Ban Nachan	Dry Con.	10	69.0	20.4	10.6	SL	2.73	1.99	27.2	11.3	4.9	6.4
		30	49.0	13.4	37.6	SC	2.78	1.91	31.3	25.1	14.2	10.9
		50	16.0	19.4	64.6	C	2.70	1.99	26.2	35.8	21.2	14.6
		70	19.0	20.4	60.6	C	2.73	1.94	28.8	36.7	21.1	15.6
3. Ban Kaon Charoon	Dry Con.	10	49.0	41.4	9.6	L	2.62	1.99	24.1	13.7	4	9.7
		30	49.0	37.4	13.6	L	2.74	1.94	29.2	15.4	5.6	9.8
		50	51.0	31.4	17.6	L	2.64	1.91	27.5	17.2	7.1	10.1
		70	50.0	31.4	18.6	L	2.71	1.90	29.9	18.6	7.5	11.1
4. Ban Mai Pattana	Dry Con.	10	47.4	18.0	14.6	SL	2.72	1.70	37.4	11.1	6.1	5.0
		30	66.4	16.0	17.6	SL	2.70	1.62	40.0	12.8	7.3	5.5
		50	65.4	16.0	18.6	SL	2.59	1.66	35.9	12.3	7.1	5.2
		70	65.4	16.0	18.6	SL	2.66	1.66	37.5	11.9	7.2	4.7
5. Ban Wari Udom	Dry Con.	10	71.4	24.0	4.6	SL	2.75	1.70	38.2	6.6	2.5	4.1
		30	68.4	24.6	7.0	SL	2.61	1.65	37.0	6.5	3.2	3.3
		50	71.4	22.0	6.6	SL	2.75	1.60	42.0	6.6	3.3	3.3
		70	70.0	19.4	10.6	SL	2.74	1.86	32.3	10.2	5.4	4.8
6. Ban Non	Dry Con.	10	77.0	22.4	0.6	LS	2.70	1.85	31.5	4.2	1.5	8.1
		30	75.0	23.4	1.6	LS	2.75	1.82	33.8	7.9	1.4	6.5
		50	81.0	17.0	2.0	LS	2.70	1.81	32.8	7.8	1.2	6.6
		70	36.0	24.0	40.0	C.CL	2.77	1.95	29.6	26.8	15.3	11.5
7. Ban Nong Khu	Dry Con.	10	69.0	29.0	3.0	SL	2.62	1.50	38.8	6.9	1.6	5.3
		30	59.0	28.0	13.0	SL	2.66	1.83	31.2	14.3	5.6	8.7
		50	62.0	25.0	15.0	SL	2.64	1.79	32.2	15.6	5.9	9.7
		70	-	-	-	-	-	-	-	-	-	-
		10	65.0	25.5	6.9		2.68	1.80	32.7	8.8	3.3	6.3
		30	61.7	23.7	14.6		2.70	1.81	33.0	13.4	6.1	7.3
	Average	50	58.5	21.2	20.6		2.70	1.82	32.6	16.3	8.0	8.3
		70	43.1	22.3	34.7		2.72	1.88	30.8	23.1	12.9	10.2

TABLE F-27 NET AMOUNT OF WATER TO BE REPLACED FOR CROPS

(Design Moisture Extraction Depth : 40 cm)

(1)	(2)	(3)	(4)	(5)	(6)	(7)
Depth	Available Moisture (AM) 1/	Ratio Moisture Extraction	(2)/(3)	Restricting Layer of Moisture	TRAM 2/	Net Amount of water to be Replaced
(cm)	(cm)		(mm)		(mm)	(mm)
0 - 10.0	10.1	0.4	25.3	*	25.3	25.3
10.0 - 20.0	11.8	0.3	39.3			
20.0 - 30.0	13.4	0.2	67.0			
30.0 - 40.0	14.1	0.1	141.0			

Note; 1/ : AM = 1/100 x (FC-Wp) x Sa x D

Fc : Field Capacity (%)

Wp : Wilting Point (%)

Sa : Apparent Specific Capacity (g/cu.cm)

D : Depth (mm)

2/ : Total Readily Available Moisture

TABLE F-28 NET AMOUNT OF WATER TO BE REPLACED FOR CROPS

(Design Moisture Extraction Depth : 60 cm)

(1)	(2)	(3)	(4)	(5)	(6)	(7)
Depth	Available Moisture (AM)	Ratio Moisture Extraction	(2)/(3)	Restricting Layer of Moisture	TRAM	Net Amount of water to be Replaced
(cm)	(cm)		(mm)		(mm)	(mm)
0 - 15.0	16.3	0.4	40.8	*	40.8	40.8
15.0 - 30.0	19.3	0.3	64.3			
30.0 - 45.0	22.1	0.2	110.5			
45.0 - 60.0	24.8	0.1	248.0			

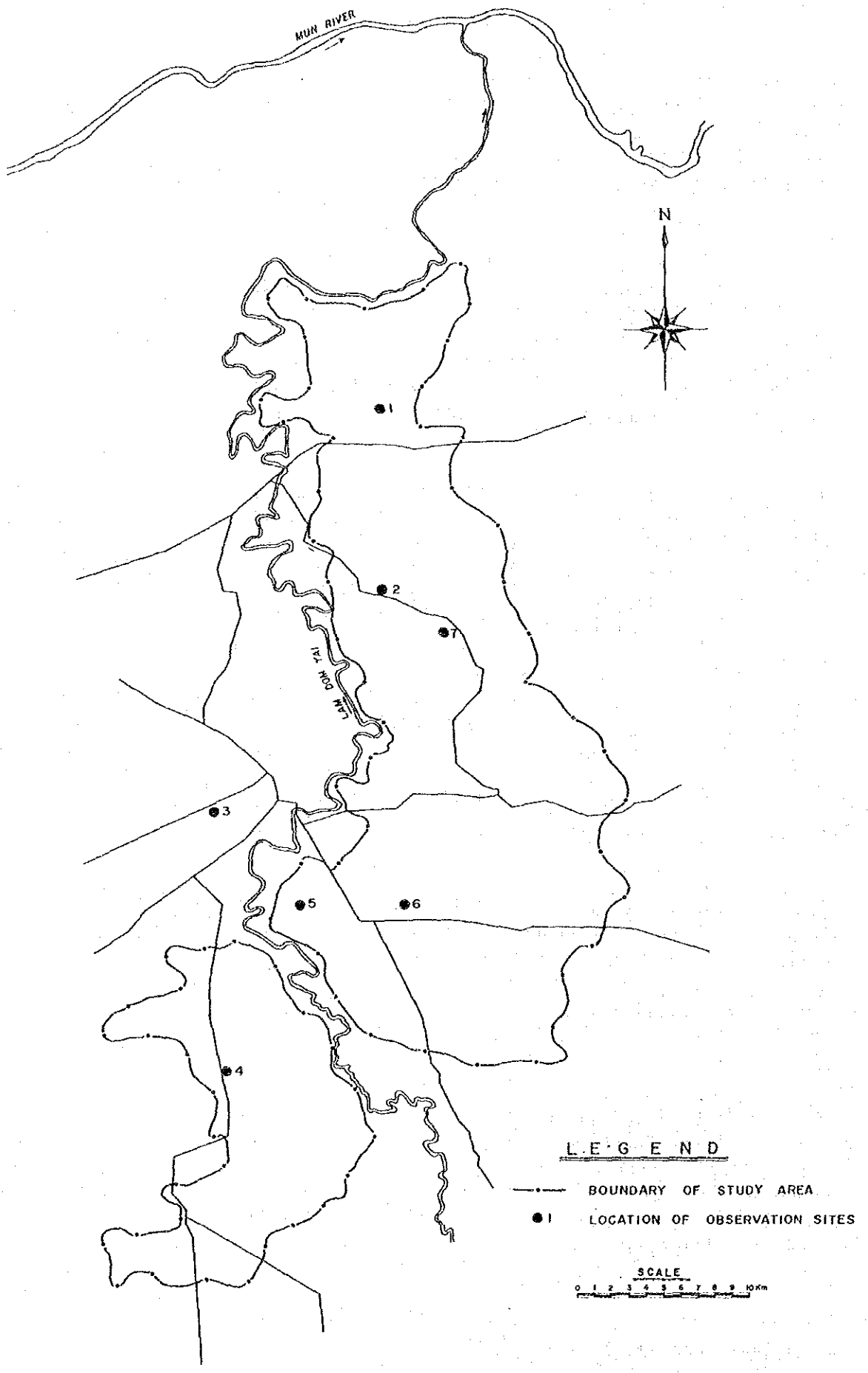


FIGURE F-7 LOCATION OF INTAKE RATE MEASUREMENT

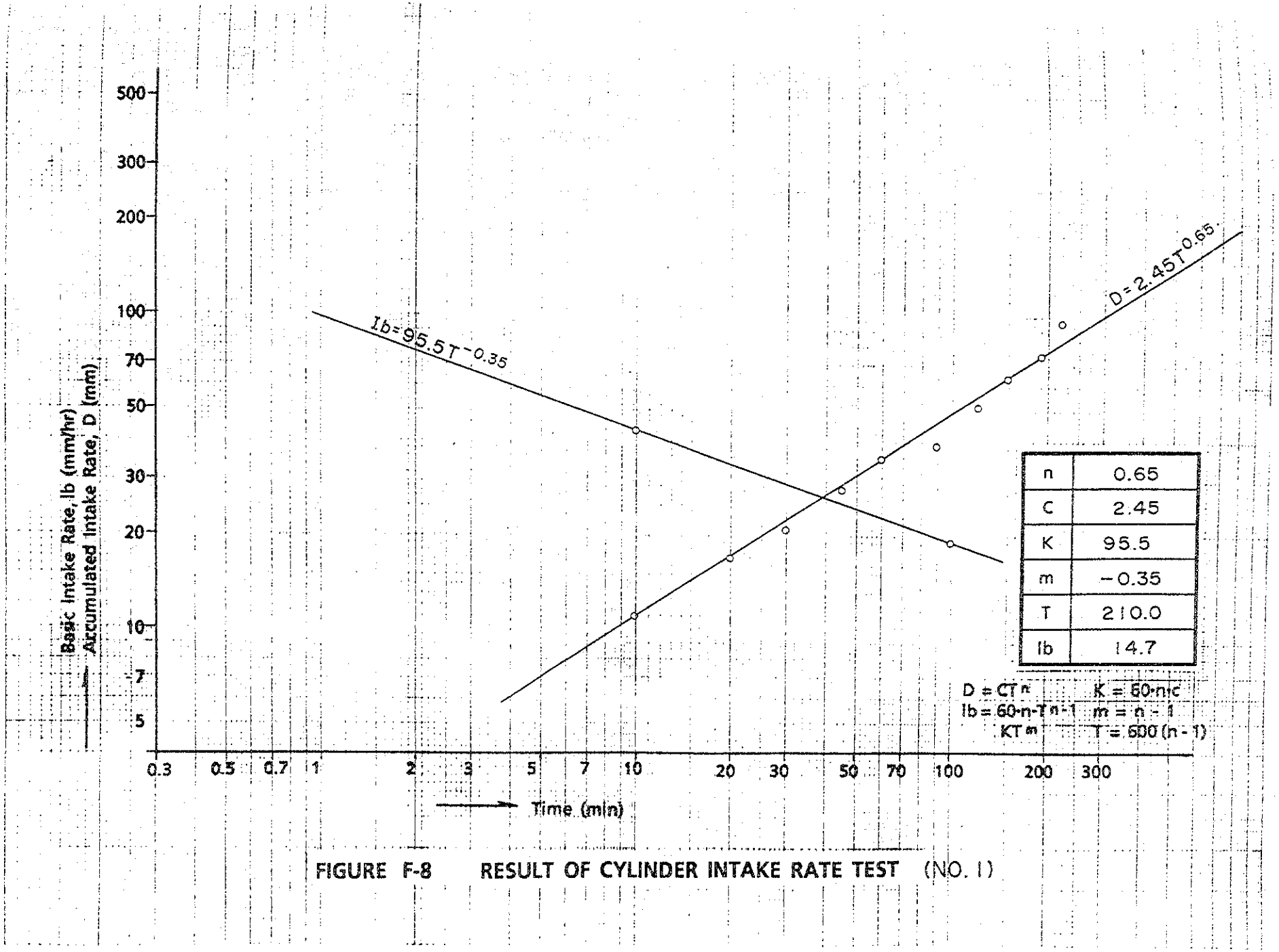


FIGURE F-8 RESULT OF CYLINDER INTAKE RATE TEST (NO. 1)