Monthly Irrigation Requirement

(Unit: mm)

Month	Dry Season Paddy		Wet Season Paddy		Upland Crops	
	Average Year	Dry Year	Average Year	Dry Year	Average Year	Dry Year
Jan.	118.2	170.3	-	-	0	0
Feb.	93.3	143.9	-	-	7.7	61.5
Mar.	42.6	55.8	-	-	73.8	137.3
Apr.	-	-	-	-	0.8	4.3
May	-	-	15.4	17.7	-	-
Jun.	-	-	193.1	207.8	-	-
Jul.	-	-	172.9	193.4	-	-
Aug.	-	-	133.1	173.5	-	-
Sep.	-	-	57.2	90.0	-	-
Oct.	11.4	13.1	11.9	13.3	-	-
Nov.	156.9	173.6	-	-	-	-
Dec.	119.8	156.6	-	-	0	0
Total	542.2	713.3	583.6	695.7	82.3	203.1

1/: See TABLE F1-37 to TABLE F1-39.

4.5.2. Domestic Water Requirements

As stated in the previous Paragraph 3.3.2 "Water Use", Ubay Poblacion having the population of about 2,300 persons at present, has been suffering from the water shortages of domestic usages for drinking. In the project, such domestic water was included in the water demand to be supplied by the Capayas reservoir.

Annual domestic water requirements were calculated at 0.30 MCM on the following assumptions;

TABLE 4-11 CONSUMPTIVE USE OF UPLAND CROPS

Month	ETo	Mungbeans	Peanut	Corn	Vegetable
Dec. III	3.24		1.75 (-)	1.75 (-)	
Jan. I	3.60		2.05 (1.94)	2.05 (1.94)	
II	3.60		2.27 (2.05)	2.34 (2.05)	
III	3.60	1.87 (-)	2.70 (2.27)	2.88 (2.34)	1.80 (-)
Feb. I	3.94	2.21 (2.05)[1/]	3.43 (2.96)	3.74 (3.15)	2.25 (1.97)
II	3.94	2.76 (2.21)	3.74 (3.43)	4.14 (3.74)	2.76 (2.25)
III	3.94	3.43 (2.76)	3.82 (3.74)	4.26 (4.14)	3.47 (2.76)
Mar. I	4.66	4.47 (4.05)	4.43 (4.52)	4.96 (5.03)	4.52 (4.10)
II	4.66	4.52 (4.47)	4.10 (4.43)	4.85 (4.99)	4.47 (4.52)
III	4.66	4.24 (4.52)	2.56 (4.10)	4.43 (4.85)	4.47 (4.47)
Apr. I	4.94	3.96 (4.50)	- (2.72)	- (4.69)	2.47 (4.74)
II	4.94	- (4.20)			(2.47)
III					

Note: 1/ : Figures in parenthesis show the consumptive use in case of planting lag of crops.

TABLE 4-12 10-DAYS CONSUMPTIVE USE OF WATER FOR EACH CROP

(Unit: mm)

		Paddy				Upland Crops			
		Dry Season		Wet Season					
		Paddy (1)1/	Paddy (2)2/	Paddy (1)	Paddy (2)	Mungbean	Peanuts	Corn	Vegetable
Oct.	I			21.8	36.3				
	II			7.3	21.8				
	III	30.0	30.0		7.8				
Nov.	I	42.5	42.5						
	II	49.9	49.9						
	III	64.6	64.6						
Dec.	I	46.3	46.3						
	II	47.3	47.3						
	III	58.4	58.4				9.5	9.5	
Jan.	I	63.0	63.0				20.0	20.0	
	II	63.0	63.0				21.6	22.0	
	III	68.3	68.3			10.3	27.3	28.7	10.1
Feb.	I	60.0	60.0			21.1	31.6	34.1	21.1
	II	52.5	60.0			24.6	35.5	39.0	24.8
	III	31.3	43.8			24.5	30.0	33.2	24.6
Mar.	I	25.9	43.1			43.0	45.1	50.0	43.5
	II	8.6	25.9			45.4	43.0	49.6	45.4
	III		9.4			48.6	37.0	57.4	41.6
Apr.	I					32.8	13.5	23.3	28.2
	II					10.5			12.3
	III								
May	I								
	II								
	III			37.5	37.5				
Jun.	I			52.5	52.5				
	II			60.9	60.9				
	III			77.6	77.6				
Jul.	I			55.6	55.6				
	II			56.9	56.9				
	III			70.5	70.5				
Aug.	I			66.0	66.0				
	II			66.0	66.0				
	III			71.6	71.6				
Sep.	I			58.0	58.0				
	II			50.8	58.0				
	III			36.3	50.8				
Total		711.6	775.5	789.3	847.8	260.8	314.1	361.3	251.6

1/: Paddy (1) ..... Transplanting Paddy

Paddy (2) ..... Direct Sowing Paddy

Detail calculation of consumptive use are shown in Annex F, paragraph 1.1.1, e)

TABLE 4-15 10-DAYS RAINFALL AND ITS EFFECTIVE RAINFALL FOR PADDY IN SELECTED DRY YEAR (PHARE II AREA)

(Unit: mm)

Cropping Period	1957 - 1958		1959 - 1960		1965 - 1966		1972 - 1973		1978 - 1979		1982 - 1983		Average	
	Rain-fall	Effective Rainfall	Rain-fall	Effective Rainfall	Rain-fall	Effective Rainfall	Rain-fall	Effective Rainfall	Rain-fall	Effective Rainfall	Rain-fall	Effective Rainfall	Rain-fall	Effective Rainfall
1st Crop														
Oct. III	0	0	16.2	16.2	18.0	18.0	79.8	79.8	13.1	13.1	10.6	10.6	23.0	23.0
Nov. I	46.0	46.0	32.8	32.8	16.6	16.6	52.3	52.3	57.9	57.9	37.1	37.1	40.5	40.5
II	29.8	29.8	17.8	17.8	25.9	25.9	20.3	20.3	56.3	56.3	26.1	26.1	29.4	29.4
III	9.3	9.3	38.1	38.1	33.4	33.4	57.9	57.9	6.6	6.6	15.3	15.3	26.8	26.8
Dec. I	21.0	21.0	29.7	29.7	39.4	39.4	102.7	40.7	104.1	100.7	42.2	42.2	56.5	45.6
II	63.5	63.5	8.3	8.3	80.5	80.5	14.1	14.1	39.1	36.2	41.3	41.3	41.1	40.7
III	9.6	9.6	64.3	64.3	22.7	22.7	8.1	8.1	26.3	26.3	13.4	13.4	24.1	24.1
Jan. I	47.6	47.6	4.0	4.0	24.5	24.5	76.3	76.3	32.4	32.4	39.2	39.2	37.3	37.3
II	34.2	34.2	41.7	41.7	41.1	41.1	0	0	3.9	3.9	17.2	17.2	23.0	23.0
III	39.8	39.8	110.6	110.6	36.1	36.1	0	0	50.9	50.6	2.3	2.3	40.0	39.9
Feb. I	23.7	23.7	43.6	43.6	7.5	7.5	22.2	22.2	43.1	43.1	19.3	19.3	26.6	26.6
II	67.4	67.4	12.1	12.1	21.3	21.3	54.6	54.6	12.8	12.8	0.5	0.5	28.1	28.1
III	19.1	19.1	37.8	37.8	57.7	57.7	0	0	6.7	6.7	9.8	9.8	21.9	21.9
Mar. I	71.9	71.9	2.6	2.6	17.4	17.4	9.3	9.3	39.6	39.6	26.6	26.6	27.9	27.9
II	1.5	1.5	42.2	42.2	56.9	56.9	1.8	1.8	0.4	0.4	0.8	0.8	17.3	17.3
III	23.5	23.5	18.2	18.2	0	0	62.8	62.8	16.6	16.6	1.0	1.0	20.4	20.4
Apr. I	0.5	0.5	15.5	15.5	0.8	0.8	27.2	27.2	16.8	16.8	0	0	10.1	10.1
Total	508.4	508.4	535.5	535.5	499.8	499.8	589.4	527.4	526.6	520.0	302.7	302.7	493.7	482.3

Cropping Period	1956 - 1957		1954 - 1965		1967 - 1968		1975 - 1976		1980 - 1981		1983 - 1984		Average	
	Rain-fall	Effective Rainfall	Rain-fall	Effective Rainfall	Rain-fall	Effective Rainfall	Rain-fall	Effective Rainfall	Rain-fall	Effective Rainfall	Rain-fall	Effective Rainfall	Rain-fall	Effective Rainfall
2nd Crop														
May III	5.7	5.7	26.0	26.0	15.3	15.3	22.9	22.9	37.8	37.8	13.5	13.5	20.2	20.2
June I	106.9	70.1	88.7	88.7	43.5	43.5	25.0	25.0	33.2	33.2	57.5	57.5	59.1	53.0
II	72.3	72.1	86.8	52.9	6.0	6.0	91.3	91.3	12.2	12.2	26.9	26.9	49.3	43.6
III	14.9	14.9	18.4	18.4	77.4	77.4	39.0	39.0	56.1	56.1	18.5	18.5	37.4	37.4
July I	149.0	99.2	61.7	61.7	78.1	78.1	34.2	34.2	100.5	89.7	23.2	23.2	74.5	64.4
II	70.7	45.4	34.3	34.3	24.7	24.7	30.8	30.8	43.2	27.7	33.1	33.1	39.5	32.7
III	16.9	16.9	35.1	35.1	8.6	8.6	41.8	41.8	52.4	52.4	99.9	99.9	42.5	42.5
Aug. I	67.2	67.2	10.1	10.1	98.2	98.2	53.4	53.4	4.1	4.1	46.5	46.5	46.6	46.6
II	32.2	32.2	63.2	63.2	5.9	5.9	121.2	119.5	9.0	9.0	11.8	11.8	40.6	40.3
III	38.0	38.0	32.5	32.5	5.3	5.3	8.5	8.5	40.0	40.0	27.0	27.0	25.2	25.2
Sep. I	7.2	7.2	7.1	7.1	3.1	3.1	91.3	81.0	0	0	132.8	75.6	40.3	29.0
II	40.6	40.6	56.3	56.3	138.2	118.2	21.8	21.8	25.7	25.7	9.3	9.3	48.7	45.3
III	71.7	64.0	82.1	82.1	10.1	10.1	9.9	9.9	77.9	77.9	39.5	39.5	48.5	47.3
Oct. I	96.5	45.7	39.0	29.2	68.6	68.6	2.9	2.9	65.3	65.3	68.1	54.4	56.7	44.4
II	46.9	46.9	73.2	73.2	88.8	76.4	28.5	28.5	54.8	36.1	66.6	66.6	59.8	54.6
III	0	0	18.0	18.0	16.4	16.4	52.4	52.4	41.6	41.6	27.6	27.6	26.0	28.0
Nov. I	46.0	46.0	16.6	16.6	17.9	17.9	38.0	38.0	78.3	78.2	66.9	66.9	44.0	43.9
Total	882.7	712.1	749.1	705.4	706.1	673.7	712.9	700.9	732.1	687.0	768.7	697.8	758.6	696.2

TABLE 4-14 10-DAYS RAINFALL AND ITS EFFECTIVE RAINFALL FOR UPLAND CROPS IN SELECTED DRY YEAR (PHASE II AREA)

(Unit: mm)

Cropping Period	1957 - 1968		1968 - 1969		1972 - 1973		1978 - 1979		1979 - 1980		1982 - 1983		Average	
	Rain-fall	Effective Rainfall	Rain-fall	Effective Rainfall	Rain-fall	Effective Rainfall	Rain-fall	Effective Rainfall	Rain-fall	Effective Rainfall	Rain-fall	Effective Rainfall	Rain-fall	Effective Rainfall
Dec. III	2.5	2.5	65.4	65.4	8.1	8.1	26.3	26.3	30.1	30.1	13.4	13.4	24.3	24.3
Jan. I	25.1	25.1	30.6	30.6	76.3	65.4	32.4	32.4	52.2	47.0	39.2	39.2	42.6	40.0
II	28.7	28.7	41.9	41.9	0.0	0.0	3.9	3.9	49.5	44.6	17.2	17.2	23.5	22.7
III	60.9	60.9	3.5	3.5	0.0	0.0	50.9	50.9	140.9	57.8	2.3	2.3	43.1	29.2
Feb. I	43.3	43.3	50.4	50.4	22.2	22.2	43.1	43.1	32.0	32.0	19.3	19.3	35.1	35.1
II	7.2	7.2	1.4	1.4	54.6	54.6	12.8	12.8	176.8	62.2	0.5	0.5	42.2	23.1
III	33.5	33.5	14.0	14.0	0.0	0.0	6.7	6.7	0.0	0.0	9.8	9.8	10.7	10.7
Mar. I	67.5	67.5	85.3	57.1	9.3	9.3	39.6	39.6	0.0	0.0	26.6	26.6	38.1	33.4
II	24.7	24.7	9.3	9.3	1.8	1.8	0.4	0.4	16.6	16.6	0.8	0.8	8.9	8.9
III	5.1	5.1	2.1	2.1	62.8	62.8	16.6	16.6	18.9	18.9	1.0	1.0	17.8	17.8
Apr. I	0.0	0.0	0.0	0.0	27.2	27.2	16.8	16.8	22.1	22.1	0.0	0.0	11.0	11.0
II	63.8	63.8	0.0	0.0	22.9	22.9	57.3	57.3	3.2	3.2	4.2	4.2	25.2	25.2
III	0.0	0.0	69.7	69.7	14.2	14.2	0.0	0.0	26.5	26.5	0.0	0.0	18.4	18.4
Total	362.3	362.3	373.6	345.4	299.4	288.5	306.8	306.8	568.8	361.0	134.3	134.3	340.9	299.7

TABLE 4-15 IRRIGATION WATER REQUIREMENTS IN EACH CROPPING INTENSITY (PHASE II AREA)

(Unit: MCM)

Year	C.I. = 160%			C.I. = 170%			C.I. = 180%			C.I. = 190%			C.I. = 200%		
	Capayas	Bayongan	Total	Capayas	Bayongan	Total	Capayas	Bayongan	Total	Capayas	Bayongan	Total	Capayas	Bayongan	Total
1956 - 1957	8.54	30.55	30.09	8.89	31.82	40.71	9.27	33.17	42.44	9.62	34.64	44.26	10.00	35.83	45.83
1957 - 1958	9.58	34.33	43.91	10.08	36.13	46.21	10.63	38.08	48.71	11.12	40.17	51.29	11.67	41.88	53.55
1958 - 1959	8.08	28.95	37.03	8.48	30.43	38.91	8.93	32.04	40.97	9.34	33.76	43.10	9.79	35.17	44.96
1959 - 1960	8.15	29.20	37.35	8.64	30.99	39.63	9.19	32.90	42.09	9.67	34.97	44.64	10.21	36.66	46.87
1960 - 1961	7.81	27.92	35.73	8.15	29.16	37.31	8.52	30.47	38.99	8.86	31.89	40.75	9.23	33.05	42.28
1961 - 1962	4.73	16.90	21.63	5.05	18.06	23.11	5.39	19.24	24.63	5.70	20.55	26.25	6.04	21.61	27.65
1962 - 1963	6.91	24.72	31.63	7.25	25.97	33.22	7.62	27.26	34.88	7.96	28.69	36.65	8.33	29.84	38.17
1963 - 1964	8.61	30.89	39.50	9.12	32.75	41.87	9.69	34.74	44.43	10.20	36.90	47.10	10.77	38.66	49.43
1964 - 1965	7.98	28.53	36.51	8.25	29.53	37.78	8.55	30.59	39.14	8.83	31.75	40.58	9.13	32.69	41.82
1965 - 1966	9.84	35.24	45.08	10.38	37.20	47.58	10.97	39.27	50.24	11.50	41.53	53.03	12.09	43.37	55.46
1966 - 1967	8.37	29.90	38.27	8.68	31.06	39.74	9.03	32.26	41.29	9.34	33.58	42.92	9.69	34.64	44.33
1967 - 1968	11.69	41.84	53.53	12.19	43.67	55.86	12.75	45.63	58.38	13.25	47.74	60.99	13.80	49.47	63.27
1968 - 1969	9.61	34.38	43.99	10.20	36.53	46.73	10.84	38.76	49.60	11.42	41.21	52.63	12.06	43.20	55.26
1969 - 1970	7.87	28.19	36.06	8.28	29.71	37.99	8.74	31.33	40.07	9.16	33.09	42.25	9.62	34.52	44.14
1970 - 1971	7.14	25.55	32.69	7.52	26.96	34.48	7.95	28.47	36.42	8.34	30.10	38.44	8.76	31.42	40.18
1971 - 1972	7.92	28.36	36.28	8.31	29.79	38.10	8.75	31.32	40.07	9.14	32.97	42.11	9.57	34.32	43.89
1972 - 1973	9.16	32.80	41.96	9.75	34.98	44.73	10.41	37.30	47.71	11.01	39.81	50.82	11.66	41.86	53.52
1973 - 1974	8.48	30.38	38.86	8.88	31.83	40.71	9.32	33.39	42.71	9.72	35.07	44.79	10.16	36.44	46.60
1974 - 1975	7.00	24.99	31.99	7.27	25.96	33.23	7.55	26.96	34.51	7.82	28.06	35.88	8.10	28.95	37.05
1975 - 1976	9.63	34.44	44.07	10.07	36.06	46.13	10.56	37.76	48.32	11.00	39.62	50.62	11.48	41.12	52.60
1976 - 1977	6.02	21.49	27.51	6.31	22.57	28.88	6.63	23.68	30.31	6.92	24.91	31.83	7.24	25.90	33.14
1977 - 1978	7.26	25.97	33.23	7.67	27.48	35.15	8.12	29.07	37.19	8.53	30.80	39.33	8.99	32.21	41.20
1978 - 1979	9.43	33.75	41.18	9.97	35.73	45.70	10.56	37.82	48.38	11.10	40.09	51.19	11.70	41.94	53.64
1979 - 1980	6.47	23.09	29.56	6.89	24.67	31.56	7.36	26.29	33.65	7.79	28.09	35.88	8.25	29.53	37.78
1980 - 1981	10.02	35.79	45.81	10.32	36.92	47.24	10.66	38.10	48.76	10.97	39.39	50.36	11.30	40.43	51.73
1981 - 1982	8.28	29.76	38.04	8.75	31.44	40.19	9.27	33.31	42.58	9.73	35.28	45.01	10.25	36.91	47.16
1982 - 1983	9.74	34.85	44.59	10.48	37.57	48.05	11.29	40.41	51.70	12.03	43.52	55.55	12.84	46.04	58.88
1983 - 1984	8.61	30.74	39.35	8.81	31.50	40.31	9.04	32.29	41.33	9.24	33.15	42.39	9.47	33.85	43.32
Average	8.32	29.77	38.09	8.74	31.30	40.04	9.20	32.92	42.12	9.62	34.69	44.31	10.08	36.13	46.21

Note: 1) Detailed estimation of irrigation water requirement in each case is shown in Annex F, TABLE F1-22 to TABLE F1-36.
2) Cropping areas in each cropping intensity are indicated as follows:

Cropping Intensity (%)	Capayas System (ha)	Bayongan System (ha)	Total (ha)
160	1,860	6,630	8,490
170	1,970	7,040	9,010
180	2,090	7,450	9,540
190	2,200	7,910	10,110
200	2,320	8,280	10,600

Note: Detail cropping area in each cropping intensity is shown in TABLE 4-16.

TABLE 4-16 CROPPING AREA IN EACH CROPPING INTENSITY

(Unit: ha)

Area	Case	Cropping Intensity (%)	Total Cropping Area	Wet Season			Dry Season								
								Rice			Diversified Crops				
				Total	Trans-Planted	Direct Seeded	Total	Sub-total	Trans-Planted	Direct seeded	Sub-total	Mung-bean	Peanut	Corn	Vegeta-bles
Boyongan (A=4,140)	1	160	6,630	4,140	3,310	830	2,490	1,690	1,180	510	800	200	200	200	200
	2	170	7,040	4,140	3,310	830	2,900	1,940	1,360	580	960	240	240	240	240
	3	180	7,450	4,140	3,310	830	3,310	2,230	1,560	670	1,080	270	270	270	270
	4	190	7,910	4,140	3,310	830	3,770	2,530	1,770	760	1,240	310	310	310	310
	5	200	8,280	4,140	3,310	830	4,140	2,780	1,950	830	1,360	340	340	340	340
Capayas (A=1,160)	1	160	1,860	1,160	930	230	700	460	320	140	240	160	60	60	60
	2	170	1,970	1,160	930	230	810	530	370	160	280	70	70	70	70
	3	180	2,090	1,160	930	230	930	610	430	180	320	80	80	80	80
	4	190	2,200	1,160	930	230	1,040	680	480	200	360	90	90	90	90
	5	200	2,320	1,160	930	230	1,160	760	540	220	400	100	100	100	100
Total (A=5,300)	1	160	8,490	5,300	4,240	1,060	3,190	2,150	1,500	650	1,040	260	260	260	260
	2	170	9,040	5,300	4,240	1,060	3,710	2,470	1,730	740	1,240	310	310	310	310
	3	180	9,540	5,300	4,240	1,060	4,240	2,840	3,290	850	1,400	350	350	350	350
	4	190	10,110	5,300	4,240	1,060	4,810	3,210	2,250	960	1,600	400	400	400	400
	5	200	10,600	5,300	4,240	1,060	5,300	3,540	2,490	1,050	1,760	440	440	440	440

- Present population of 2,300 persons will be increased to be 3,200 persons at the 20 years latter with an annual growth of 1.6 percent.

- Drinking water could be estimated at 0.18 MCM at the target year with daily consumption of 150 lit./day-capita.

- Other miscellaneous domestic water of 0.12 MCM was counted in estimating domestic water requirements.

4.5.3. Irrigation Water Supply Plan

a) Proposed Irrigation Systems

Total irrigation area of 5,300 ha can be divided largely into two systems, the Bayongan system and the Capayas system, depending on irrigation water sources and topographic conditions. The former system covers 4,140 ha with stored water source in the Bayongan reservoir and the latter system covers the area of 1,160 ha with Capayas water source.

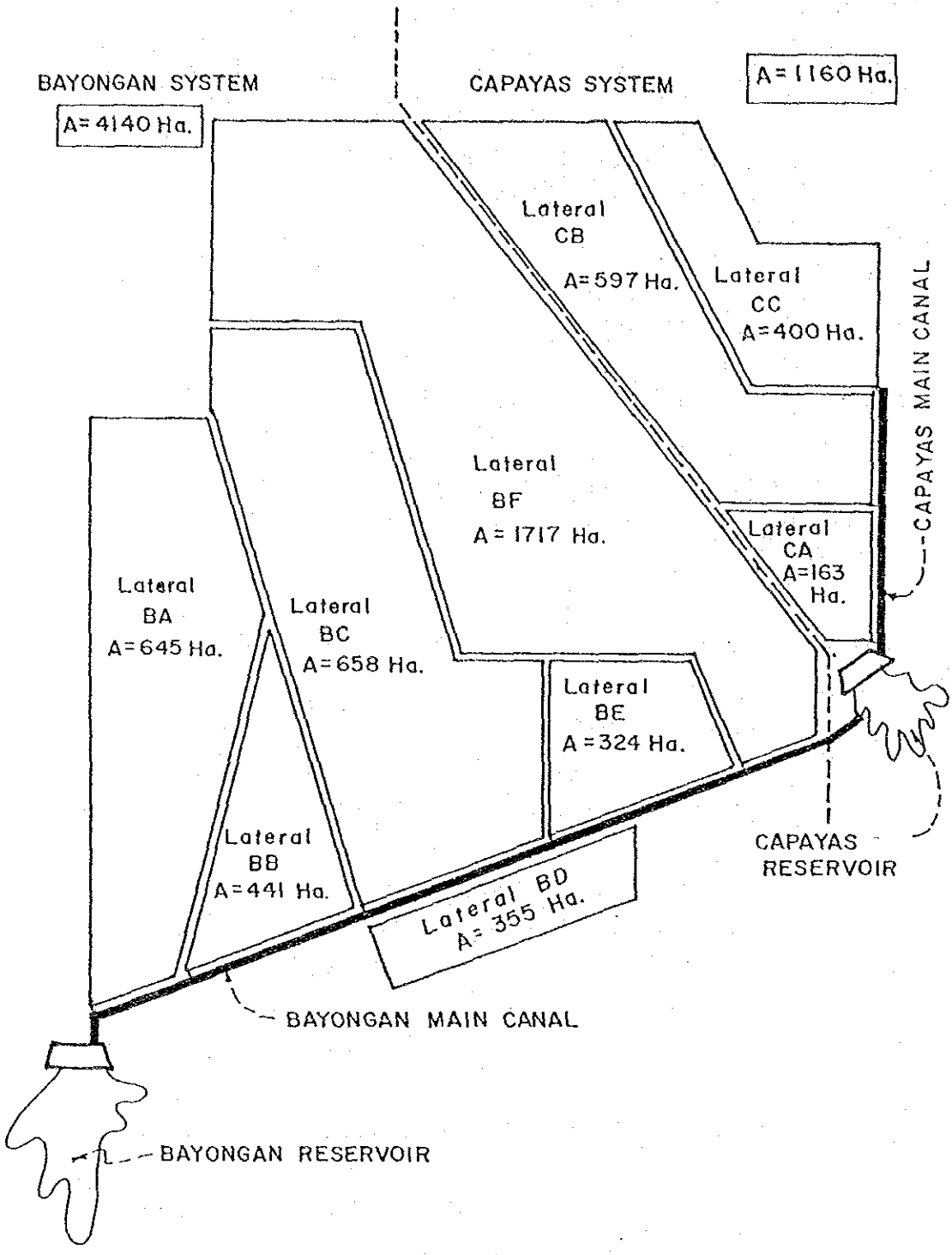
Furthermore, the both systems are subdivided into several lateral irrigation systems as shown FIGURE 4-8.

Proposed irrigation systems for the both areas are prepared in diagram as shown in FIGURE 4-9, to FIGURE 4-10, in accordance with proposed main and lateral canal alignment and demarcation of each service unit of about 30 ha to 40 ha on average, which is one irrigation unit to be covered by lateral canals.

b) Irrigation Requirements in Each System

The distribution of irrigation water is planned with a criterion to supply the irrigation water of 1.422 lit./sec./ha at the peak irrigation requirements during paddy growing period of the

FIGURE 4-8 PROPOSED IRRIGATION SYSTEMS IN LATERAL CANAL



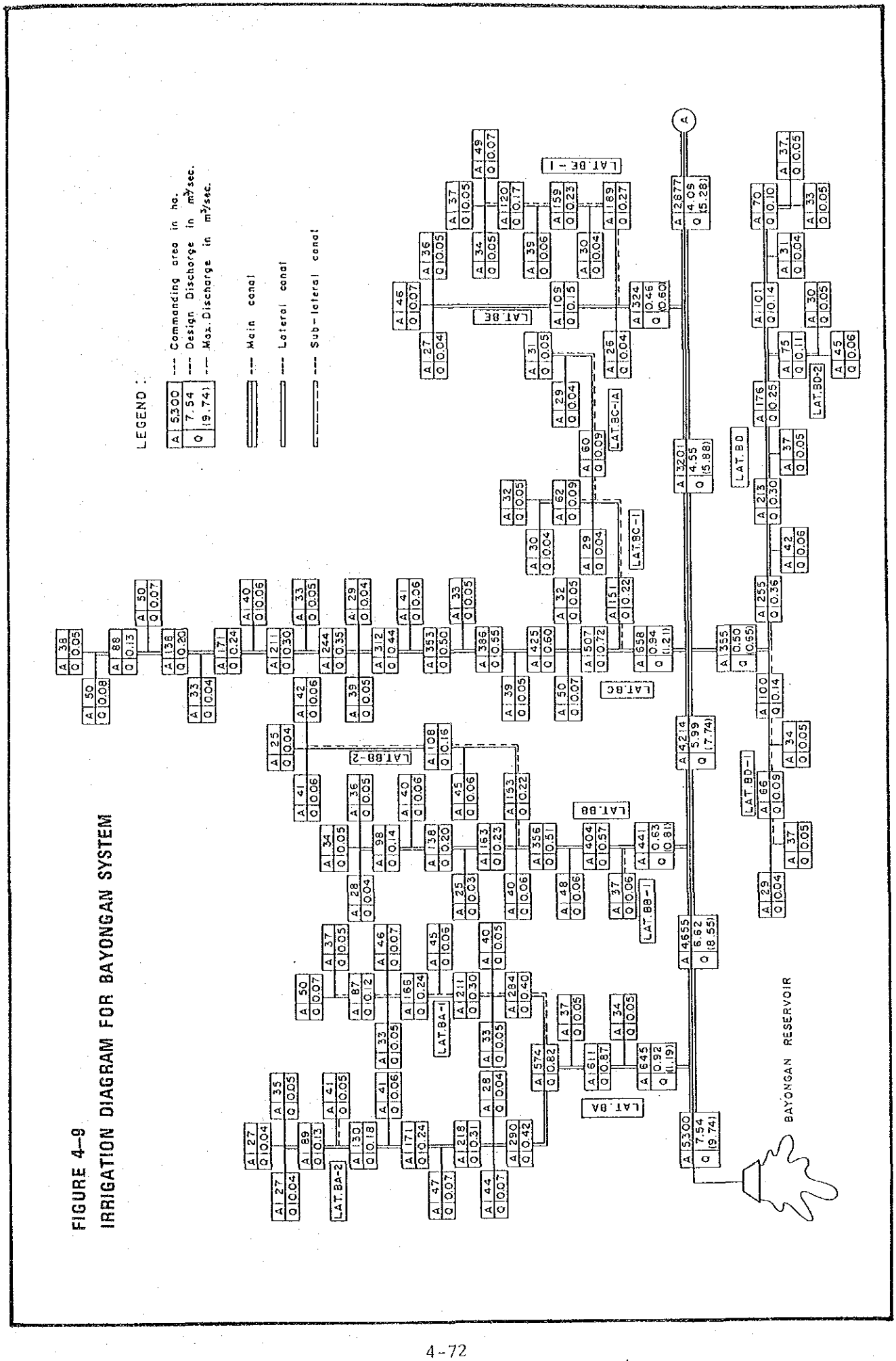


FIGURE 4-9
IRRIGATION DIAGRAM FOR BAYONGAN SYSTEM

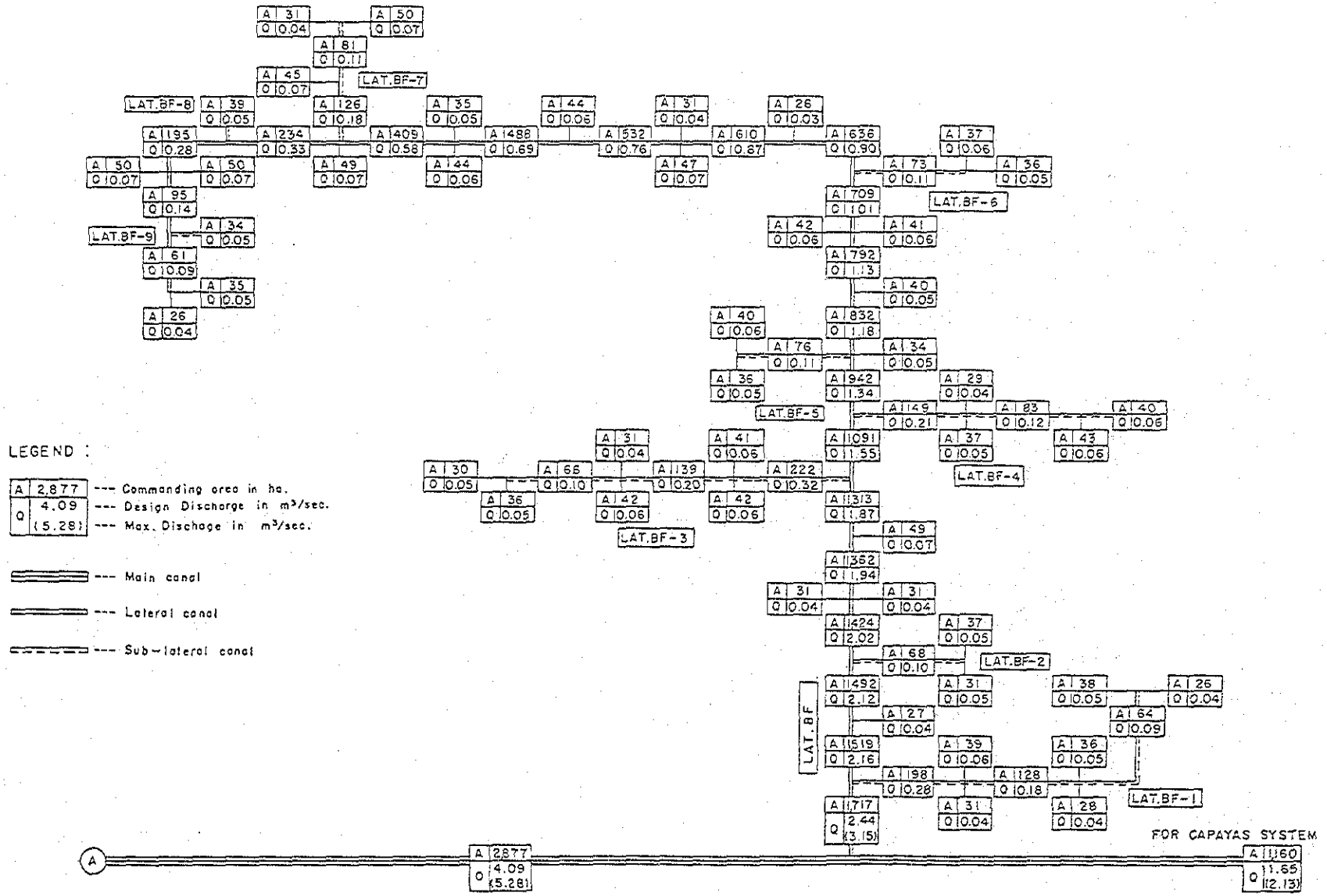
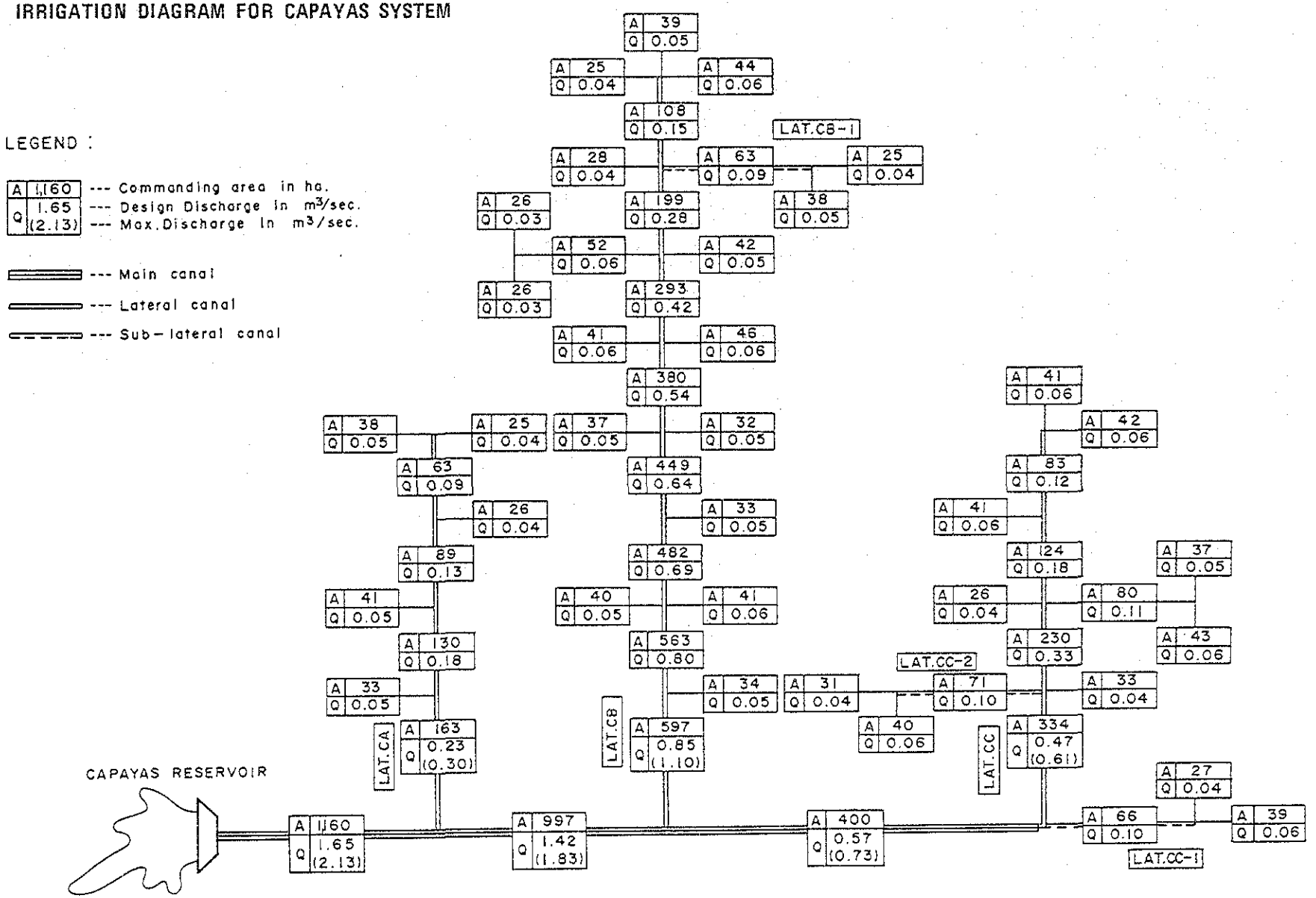

LEGEND :
A 2.877 --- Commanding area in ha.
Q 4.09 --- Design Discharge in m³/sec.
(5.28) --- Max. Dischage in m³/sec.
--- Main canal
--- Lateral canal
--- Sub-lateral canal
LAT.BF-1
LAT.BF-2
LAT.BF-3
LAT.BF-4
LAT.BF-5
LAT.BF-6
LAT.BF-7
LAT.BF-8
LAT.BF-9
LAT.BF
FOR CAPAYAS SYSTEM
A 2877 Q 4.09 (5.28)
A 1160 Q 11.65 (12.13)

FIGURE 4–10

IRRIGATION DIAGRAM FOR CAPAYAS SYSTEM



wet season paddy as shown in FIGURE 4-9 and FIGURE 4-10, and maximum design discharge of irrigation canal at diversion point of the Bayongan and Capayas dams are estimated at 7.54 cu.m/sec and 1.65 cu.m/sec respectively. However, design discharge of outlet facilities of Bayongan and Capayas dams are estimated at 9.74 cu.m/sec and 2.13 cu.m/sec respectively, which correspond to maximum irrigation requirements of 1.837 1/sec/ha.

c) Irrigation Method for Paddy Cultivation

1) Irrigation Method

Water distribution method for paddy cultivation, in general, will be selected and decided in accordance with available water resources, rotational area, cropping pattern and stages of crops, crop water requirements and irrigation facilities on the systems. In general, two types of water supply methods are practicing for paddy cultivation at present, such as simultaneous water supply and rotational water supply.

i) Rotational irrigation method on the level of supplementary farm ditches during land soaking and land preparation stage and when amount of available water is scarce.

ii) Simultaneous irrigation method during crop growing stage and when amount of available water is abundant. However, once when the water sources are quite seriously limited, water supply method will be shifted to the rotation method.

2) Design Water Requirements for Main and Lateral Canals

Unit water requirements (duty of water) for designing main and lateral canals are decided based on the following considerations;

- Cropping pattern and growing period : see FIGURE 4-11.

- Land preparation period from the start to the end of land soaking and preparation works is decided at 65 days for the whole project area, and that in one rotation unit are decided at 25 days.

- Water requirements during land soaking and land preparation period and crop growing period for paddy are as follows;

Land Preparation Periods	Dry Season Paddy (mm)	Wet Season Paddy (mm)
1st Irrigation	114	132
2nd Irrigation	27	29
3rd Irrigation	33	45
Total	170 (174)	210 (206)

Crop Growing Periods	Dry Season Paddy (mm/day)	Wet Season Paddy (mm/day)
Oct.	5.8	-
Nov.	5.9	-
Dec.	5.4	-
Jan.	6.3	-
Feb.	6.0	-
Mar.	6.9	-
Apr.	-	-
May	-	7.6
Jun.	-	6.7
Jul.	-	6.5
Aug.	-	6.6
Sep.	-	5.8
Oct.	-	5.8

For planning the canal capacity for main and lateral canals in case of paddy cultivation, weighted crop water requirements on the 10 day basis are calculated, based on cropping pattern, irrigation schedule and water requirements for land soaking and land preparation and crop growing period. TABLE 4-17 to and TABLE 4-18 and FIGURE 4-12 show the details of these calculations.

According to the above calculation, the maximum irrigation water requirements per hectare during the land soaking and land preparation and crop growing stages are estimated at 1.837 l/sec/ha and 1.422 l/sec/ha respectively in the wet season paddy, as shown in TABLE 4-18.

TABLE 4-17 CALCULATION OF WEIGHTED IRRIGATION WATER REQUIREMENT
(DRY SEASON PADDY)

No.	Month	Equation for Calculation of WCWR	Weighted 10-day CWR		Irrigation Water Requirement per Hactare
1	Oct. III	$WR = 19P_2/40$	$(19x57)/40 =$	27.1	0.511
2	Nov. I	$WR = (20P_2+9P_1+3P)/40$	$(20x57+9x27+3x33)/40 =$	37.1	0.769
3	II	$WR = (20P_2+10P_1+10P+5W_2)/40$	$(20x57+10x27+10x33+5x59)/40 =$	50.9	1.055
4	III	$WR = (20P_2+10P_1+10P+20W_2)/40$	$(20x57+10x27+10x33+20x59)/40 =$	73.0	1.513 1/
5	Dec. I	$WR = (P_2+10P_1+10P+20W_2+10W_3)/40$	$(57+10x27+10x33+20x59+10x54)/40 =$	59.4	1.231
6	II	$WR = (P_1+7P+20W_2+20W_3)/40$	$(27+7x33+20x59+20x54)/40 =$	63.0	1.306
7	III	$WR = (15W_2+30W_3)/40$	$(15x59+30x54)/40 =$	62.6	1.297
8	Jan. I	$WR = (30W_3+10W_4)/40$	$(30x54+10x63)/40 =$	56.3	1.167
9	II	$WR = (20W_3+20W_4)/40$	$(20x54+20x63)/40 =$	58.5	1.212
10	III	$WR = (10W_3+30W_4)/40$	$(10x54+30x63)/40 =$	60.8	1.260
11	Feb. I	$WR = (30W_4+10W_5)/40$	$(30x63+10x60)/40 =$	62.3	1.291 2/
12	II	$WR = (20W_4+20W_5)/40$	$(20x63+20x60)/40 =$	61.5	1.275
13	III	$WR = (10W_4+20W_5)/40$	$(10x63+20x60)/40 =$	45.8	0.949
14	Mar. I	$WR = 20W_5/40$	$(20x60)/40 =$	30.0	0.622
15	II	$WR = 10W_5/40$	$(10x60)/40 =$	15.0	0.311

Land soaking and land preparation water;

$P_2 = 114/2 = 57$ mm

$P_1 = 27$ mm

$P = 33$ mm

10-day crop water requirement;

$W_1 = 58.0$ mm $W_4 = 63.0$ mm

$W_2 = 59.0$ mm $W_5 = 60.0$ mm

$W_3 = 54.0$ mm $W_6 = 69.0$ mm

1/ : Maximum irrigation water requirement; (land preparation stage)

$$q = \frac{73.0x10^{-3} x\ 1.0ha\ x\ 10^4\ x\ 10^3}{86,400(1-0.27)x(1-0.15)x(1-0.10)} = 1.513\ 1/sec/ha$$

2/ : Maximum irrigation water requirement; (Crop growing stage)

$$q = \frac{62.3x10^{-3} x\ 1.0ha\ x\ 10^4\ x\ 10^3}{86,400x(1-0.27)x(1-0.15)x(1-0.10)} = 1.291\ 1/sec/ha$$

TABLE 4-18 CALCULATION OF WEIGHTED IRRIGATION WATER REQUIREMENT
(WET SEASON PADDY)

No.	Month	Equation for Calculation of WCWR	Weighted 10-day CWR		Irrigation Water Requirement per Hectare
1	May III	$WR = 19P_2/40$	$(19x66)/40 =$	31.4	0.679
2	Jun. I	$WR = (20P_2+9P_1+3P)/40$	$(20x66+9x29+3x45)/40 =$	42.9	0.927
3	II	$WR = (20P_2+10P_1+10P+5W_2)/40$	$(20x66+10x29+10x45+5x67)/40 =$	59.9	1.295
4	III	$WR = (20P_2+10P_1+10Px20W_2)/40$	$(20x66+10x29+10x45+20x67)/40 =$	85.0(max.)	1.837 1/
5	Jul. I	$WR = (P_2+10P_1+10P+20W_2+10W_3)/40$	$(66+10x29+10x45+20x67+10x65)/40 =$	69.9	1.511
6	II	$WR = (P_1+7P+20W_2+20W_3)/40$	$(29+7x45+20x67+20x65)/40 =$	74.6	1.612
7	III	$WR = (15W_2+30W_3)/40$	$(15x67+30x65)/40 =$	73.9	1.597
8	Aug. I	$WR = (30W_3+10W_4)/40$	$(30x65+10x66)/40 =$	65.3	1.412
9	II	$WR = (20W_3+20W_4)/40$	$(20x65+20x66)/40 =$	65.5	1.416
10	III	$WR = (10W_3+30W_4)/40$	$(10x65+30x66)/40 =$	65.8	1.422 2/
11	Sep. I	$WR = (30W_4+10W_5)/40$	$(30x66+10x58)/40 =$	64.0	1.383
12	II	$WR = (20W_4+20W_5)/40$	$(20x66+20x58)/40 =$	62.0	1.340
13	III	$WR = (10W_4+20W_5)/40$	$(10x66+20x58)/40 =$	45.5	0.983
14	Oct. I	$WR = 20W_5/40$	$(20x58)/40 =$	29.0	0.627
15	II	$WR = 10W_5/40$	$(10x58)/40 =$	14.5	0.313

Land soaking and land preparation water;

P_2 = 132/2 = 66 mm

P_1 = 29 mm

P = 45 mm

10-day crop water requirement;

W_1 = 76.0 mm W_4 = 66.0 mm

W_2 = 67.0 mm W_5 = 58.0 mm

W_3 = 65.0 mm W_6 = 58.0 mm

1/ : Maximum irrigation water requirement; (land preparation stage)

$$q = \frac{8.5x10^{-3} x\ 1.0ha\ x\ 10^4\ x\ 10^3}{86,400(1-0.3)x(1-0.15)x(1-0.10)} = 1.837\ 1/sec/ha$$

2/ : Maximum irrigation water requirement; (Crop growing stage)

$$q = \frac{6.58x10^{-3} x\ 1.0ha\ x\ 10^4\ x\ 10^3}{86,400x(1-0.3)x(1-0.15)x(1-0.10)} = 1.422\ 1/sec/ha$$

FIGURE 4-11 PROPOSED CROPPING PATTERN FOR THE PROJECT

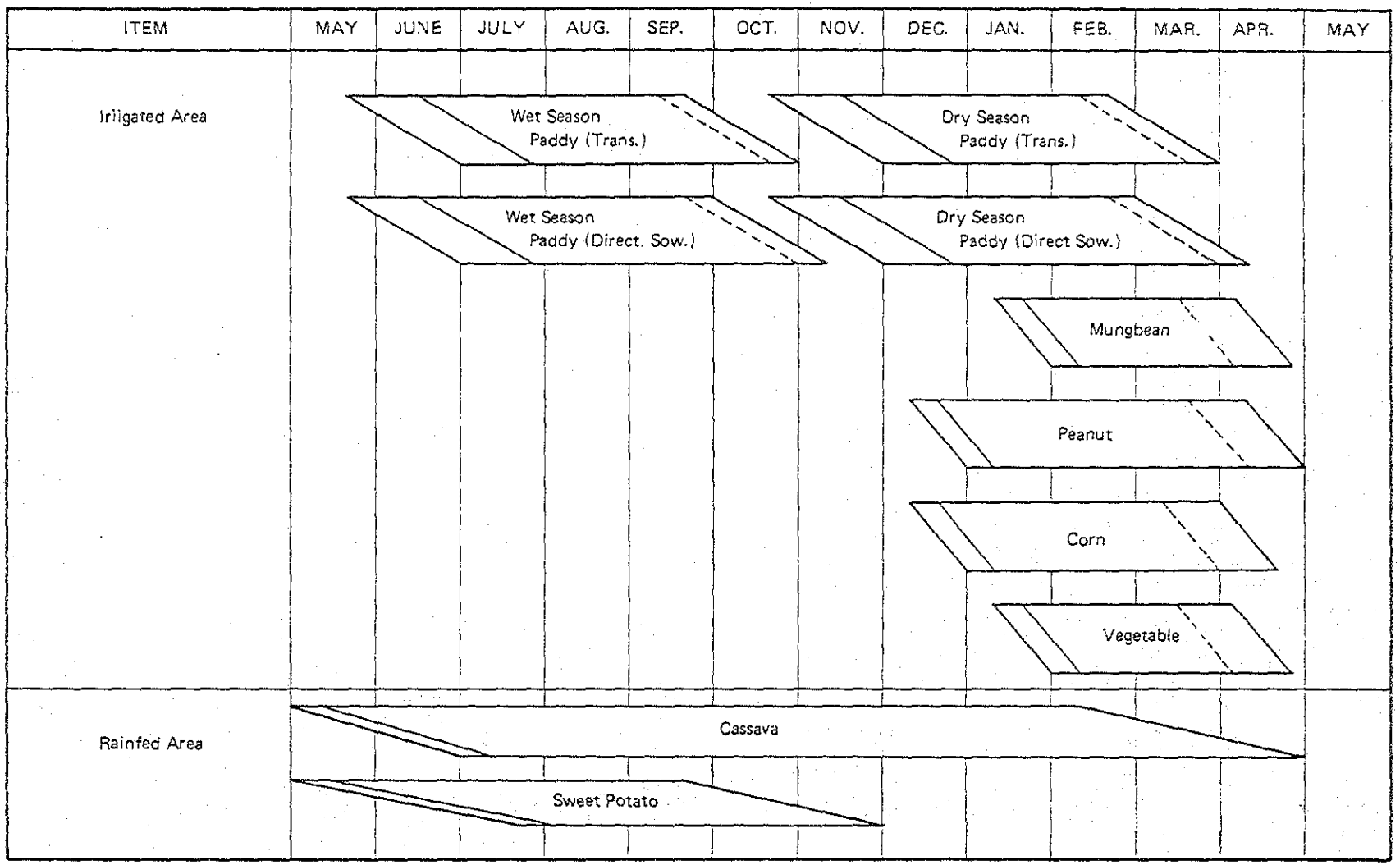
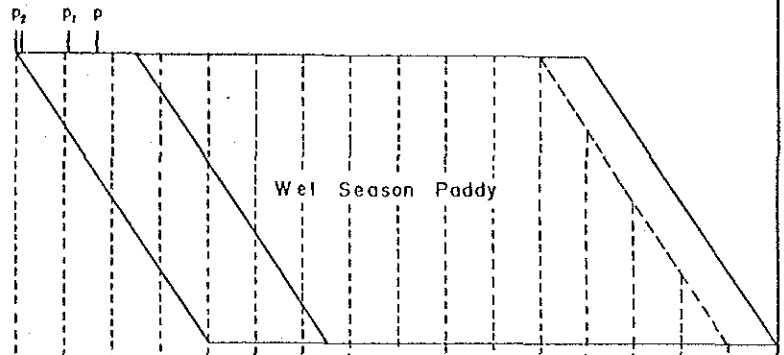


FIGURE 4-12 IRRIGATION SCHEDULE AND WEIGHTED CROP WATER REQUIREMENT FOR WET AND DRY SEASON PADDY

MONTH	MAY	JUNE	JULY	AUG.	SEP.	OCT.
10-DAY CROP WATER REQUIREMENT (mm)	W_1 = 76.0	W_2 = 67.0	W_3 = 65.0	W_4 = 66.0	W_5 = 58.0	W_6 = 58.0

GROWING STAGE OF PADDY

IRRIGATION SCHEDULE



CALCULATION OF WEIGHTED CROP WATER REQUIREMENT

(1) $WR = 19P_2/40$

(2) $WR = (20P_2 + 9P_1 + 3P)/40$

(3) $WR = (20P_2 + 10P_1 + 10P + 5W_2)/40$

(4) $WR = (20P_2 + 10P_1 + 10P + 20W_2)/40$

(5) $WR = (P_2 + 10P_1 + 10P + 20W_2 + 10W_3)/40$

(6) $WR = (P_1 + 7P + 20W_2 + 20W_3)/40$

(7) $WR = (15W_2 + 30W_3)/40$

(8) $WR = (30W_3 + 10W_4)/40$

(9) $WR = (20W_3 + 20W_4)/40$

(10) $WR = (10W_3 + 30W_4)/40$

(11) $WR = (30W_4 + 10W_5)/40$

(12) $WR = (20W_4 + 20W_5)/40$

(13) $WR = (10W_4 + 20W_5)/40$

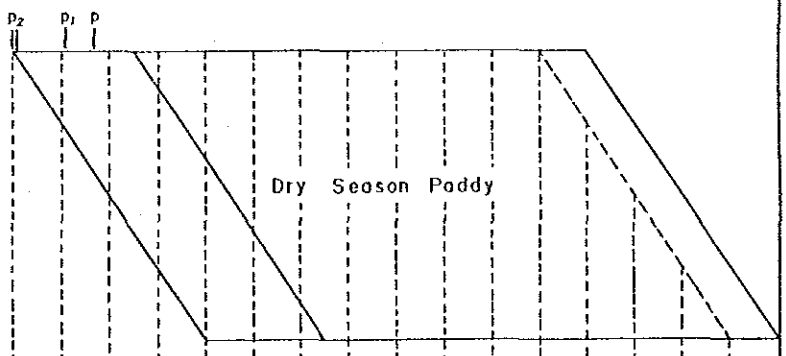
(14) $WR = 20W_5/40$

(15) $WR = 10W_5/40$

MONTH	OCT.	NOV.	DEC.	JAN.	FEB.	MAR.
10-DAY CROP WATER REQUIREMENT (mm)	W_1 = 58.0	W_2 = 59.0	W_3 = 54.0	W_4 = 63.0	W_5 = 60.0	W_6 = 69.0

GROWING STAGE OF PADDY

IRRIGATION SCHEDULE



CALCULATION OF WEIGHTED CROP WATER REQUIREMENT

(1) $WR = 19P_2/40$

(2) $WR = (20P_2 + 9P_1 + 3P)/40$

(3) $WR = (20P_2 + 10P_1 + 10P + 5W_2)/40$

(4) $WR = (20P_2 + 10P_1 + 10P + 20W_2)/40$

(5) $WR = (P_2 + 10P_1 + 10P + 20W_2 + 10W_3)/40$

(6) $WR = (P_1 + 7P + 20W_2 + 20W_3)/40$

(7) $WR = (15W_2 + 30W_3)/40$

(8) $WR = (30W_3 + 10W_4)/40$

(9) $WR = (20W_3 + 20W_4)/40$

(10) $WR = (10W_3 + 30W_4)/40$

(11) $WR = (30W_4 + 10W_5)/40$

(12) $WR = (20W_4 + 20W_5)/40$

(13) $WR = (10W_4 + 20W_5)/40$

(14) $WR = 20W_5/40$

(15) $WR = 10W_5/40$

Note; Detail descriptions of water supply and works for land soaking and land preparation periods are shown in Annex F, TABLE F1-3.

In the project, unit water requirements are decided at 1.422 l/sec/ha, equivalent to about 6.6 mm/day, for main and lateral canals, while the required canal capacity to meet the maximum water requirements of 1.837 l/sec/ha will be coped with the height of free board of canals.

According to the examine of irrigation water requirements on the 10-day basis in the both periods, land soaking and preparation periods and crops growing periods, it was revealed that the number of year with irrigation water requirements larger than the design discharge of 1.422 l/sec/ha is three times out of water balance study periods of 28 years, as shown in Annex F, TABLE F1-40. And, their water requirements are in the ranges from 1.426 l/sec/ha to 1.634 l/sec/ha, which is smaller than the maximum irrigation water requirements of 1.837 l/sec/ha. Namely, main and lateral canals to be provided with irrigation water requirements of 1.422 l/sec/ha have enough capacity to meet the required discharge estimated based on the maximum water requirements.

3) Design Water Requirements for On-farm (Terminal) Facilities

The design capacity for on-farm facilities is determined considering the maximum water requirements at a peak stage which usually occurs in the period of land soaking and land preparation stage. The maximum water requirements are scheduled in the 1st - irrigation for land soaking with 132 mm for the wet season paddy.

Assuming that this amount of water will be supplied within 10-days in the one rotation unit of about five hectares, the design water requirements for on-farm facilities can be calculated at 2.183 l/sec/ha[1/]. Consequently, design capacity of turnout is decided at 65.5 l/sec in the typical rotational area of 30 ha.

1/: $\frac{132 \text{ mm} \times 10^{-3} \times 1.0 \text{ ha} \times 10^{4} \times 10^{3}}{86{,}400 \times (1-0.3) \times 10 \text{ days}} = 2.183 \text{ l/sec/ha}$

d) Irrigation Method for Upland Crops

1) Proposed Upland Area and Crops

Major upland crops to be introduced in the Phase II area are mungbean, peanut, corn and vegetables, and their cropping areas in each system are summarized as follows;

Upland Cropping Area

(unit: ha)

Crops	Bayongan System	Capayas System	Total
Mungbean	340	100	440
Peanut	340	100	440
Corn	340	100	440
Vegetables	340	100	440
Total	1,360	400	1,760

2) Depth and Interval of Irrigation Application for Upland Crops

a) Measurement of Intake Rate

Intake rates were measured by using a cylinder infiltrometers at six sites in the project area under the wet and dry conditions (see Annex F, FIGURE F1-5), in order to plan an adequate irrigation method and water amounts to be supplied to the crop. The dry conditions mean existing conditions of the field without any water supply and the wet conditions mean the field condition keeping the water holding capacity after 24 hours of soil saturation.

The following table gives the obtained basic intake rate, based on the observation of the intake rate.

Obtained Basic Intake Rate (Ib)

Location	Ib (mm/hr)	Remarks
1. Cambangay Norte, San Miguel	-	-
2. La Union, Trinidad	70.0	Wet Conditions
3. Mahagbo, Ubay	18.3	- do -
4. Bayang, Ubay	1.7	- do -
5. Hambabauran, Ubay	106.8	Dry Conditions
6. Corazon, San Miguel	160.2	- do -
7. Gabi, Ubay	35.7	Wet Conditions

Note: See Annex F, FIGURE F1-6 to FIGURE F1-11.

In parallel with such measurements of the intake rate, soil samples in the depth of 50 cm with an interval of 10 cm depth were taken at seven sites to analyze the physical properties of the soils in the field, such as specific gravity, porosity, field capacity and wilting point.

The analysis results of soils under the wet conditions are summarized as follows:

Physical Properties of Soils[1/]

Depth (cm)	Real Specific Gravity (Sr) (g/cm^3)	Apparent Specific Gravity (Sa) (g/cm^3)	Porosity[2/] (P) (%)	Field Capacity (Fc) (%)	Wilting[3/] Point (Wp) (%)
10	2.63	1.48	43.73	12.63	5.98
20	2.68	1.46	45.42	13.10	6.15
30	2.67	1.40	47.56	15.50	7.65
40	2.65	1.37	48.30	17.07	7.90
50	2.65	1.37	48.30	19.29	9.43

1/: Average of six samples
2/: P = (Sr - Sa) x 100/Sr
Details are given in Annex F, TABLE F1-41.

From the above figures, furrow and basin irrigation method would be suitable for water supply to the upland crops during the growing season of them, although further studies on upland irrigation will be needed.

b) Depths and Interval of Irrigation Application

Depth and interval of irrigation application are determined in the following procedure:

i) Determination of effective root zone;

ii) Determination of a moisture extraction pattern;

iii) Calculation of available moisture of each soil layer within the effective root zone;

iv) Calculation of the total readily available moisture (TRAM); and

v) Determination of depth and interval of irrigation application;

i) Depth of Effective Root Zone

The depth of the effective root zone was determined on the basis of field survey and collected data on the root zone, and is shown below:

Crops	Depth of Effective Root Zone (cm)
Mungbean	80
Peanut	60
Corn	120
Vegetables	40

ii) Moisture Extraction Pattern

The consumptive rate of soil moisture is the so-called "moisture extraction pattern" which will be determined based upon the field investigation.

Due to the lack of such data concerned, the following pattern was applied.

Percent of Depth (%)	Ratio of Moisture Extraction (%)
0 - 25	40
25 - 50	30
50 - 75	20
75 - 100	10

iii) Available Moisture in Each Soil Layer within Effective Root Zone

Available moisture (AM) is obtained from the following equation:

$$AM = \frac{1}{100} \cdot (Fc - Wp) \cdot Sa \cdot d \ (mm)$$

where: Fc: Water holding capacity after 24 hours of soils saturation (%)
Wp: Moisture ratio at wilting point (%)
Sa: Apparent specific gravity (g/cm^3)
d: Depth of soil in each soil layer (mm)

iv) Total Readily Available Moisture (TRAM)

In the soil layer concerned, Consumed Moisture = $\frac{\text{Available Moisture}}{\text{Ratio of Moisture Extraction}}$

The layer presenting the minimum value obtained from the above equation is the restricting layer of moisture, and its value becomes the Total Readily Available Moisture (TRAM), that is, the net amount of water to be replaced, which is given in Annex F, TABLE F1-42 to TABLE F1-45.

v) Interval of Irrigation Application

The interval of irrigation application is obtained by dividing the TRAM by the maximum crop evapotranspiration as follows:

Upland Crop	TRAM (mm)	Maximum Evapotranspiration (mm/day)	Irrigation Interval (day)
Mungbean	57.6	4.9	11
Peanut	43.3	4.5	9
Corn	86.3	5.7	15
Vegetables	28.8	4.5	6

From the viewpoint of water management, the same irrigation interval of water supply is favorable, therefore, seven days of irrigation interval was planned for the whole areas.

4.5.4. Drainage Plan

Major drainage rivers in the project area are the Trinidad river and the Soom river, and so many creeks and tributaries are connected with these major rivers. In addition to these existing drainage creeks and rivers, existing paddy fields located on the lower area between hilly lands play the function as drainage purpose at present.

According to the drainage study on the runoff capacity for the existing drainage creeks and rivers, it is found out that these rivers have enough capacity, 80 mm/hr to 6.0 mm/hr (see Annex F, TABLE F2-1), against the required runoff discharge of 3.0 mm/hr to 5.0 mm/hr. Therefore, the existing drainage creeks and rivers are planned to be used without any improvement. However, some connecting drainage canals to convey the drainage discharge from reclaimed paddy fields to the existing drainage creeks and rivers, will be provided in the project.

a) Drainage Modulus

Design Rainfall

There exist three rainfall observation stations, Ubay Central, Ubay Bayang and Ubay Gabi, in the project area.

Following table indicates the probable 1-day, 2-day and 3-day consecutive rainfalls, based on the 28 year (1956 to 1984) records.

Probable Rainfall for Drainage Study

(Unit: mm)

Stations	1-Day Rainfall		2-Day Rainfall		3-Day Rainfall	
	1/5	1/10	1/5	1/10	1/5	1/10
Ubay (Central)	79.0	92.0	107.6	129.2	118.7	146.3
Ubay (Bayang)	93.0	102.3	114.7	130.2	130.1	143.7
Ubay (Gabi)	101.1	111.0	151.1	179.7	160.4	188.7

Design Drainage Modulus

Following consideration are made to estimate the design modulus for drainage.

- All of service areas are to be utilized for paddy field during the wet season.

- From the viewpoint of plant growth of paddy, two days inundation can be permissible even in the rooting stage immediate after the transplanting of paddy.

- 5-years return period will be taken as the design year for studying the drainage plan.

- Rainfall records observed at Ubay (Central) are excluded to determine the design rainfall, because observation station of Ubay (Central) is located in the coastal area of the project area, and it can not be considered one of the representative stations.

Based on the above considerations, design drainage modulus were decided at 5.61 l/sec/ha (see Annex F, Paragraph 4.5.4). This modulus will be used to decide the runoff discharge for planning of newly constructed drainage canals. In applying the above modulus, no consideration of area-reduction factor is planned, since such newly constructed drainage canals cover relatively small catchment areas.

b) Drainage System

Many creeks and streams are existing in the lowest places between hilly areas and flow from the south to north direction in the project area. These creeks and streams have enough capacity to release the runoff caused by the rainfall in the project area and could be used for the main drainage canal in the project without any improvement. Some lateral drainage canal connecting the main drainage will be required and designed to cover the area of 50 to 60 ha per each canal. The drainage modulus of 5.61 lit./sec/ha is adopted to the design capacity of the lateral drainage.

FIGURE 4-13 indicates the proposed drainage diagram for the project.

4.6. Agricultural Development Plan

4.6.1. Agriculture Production

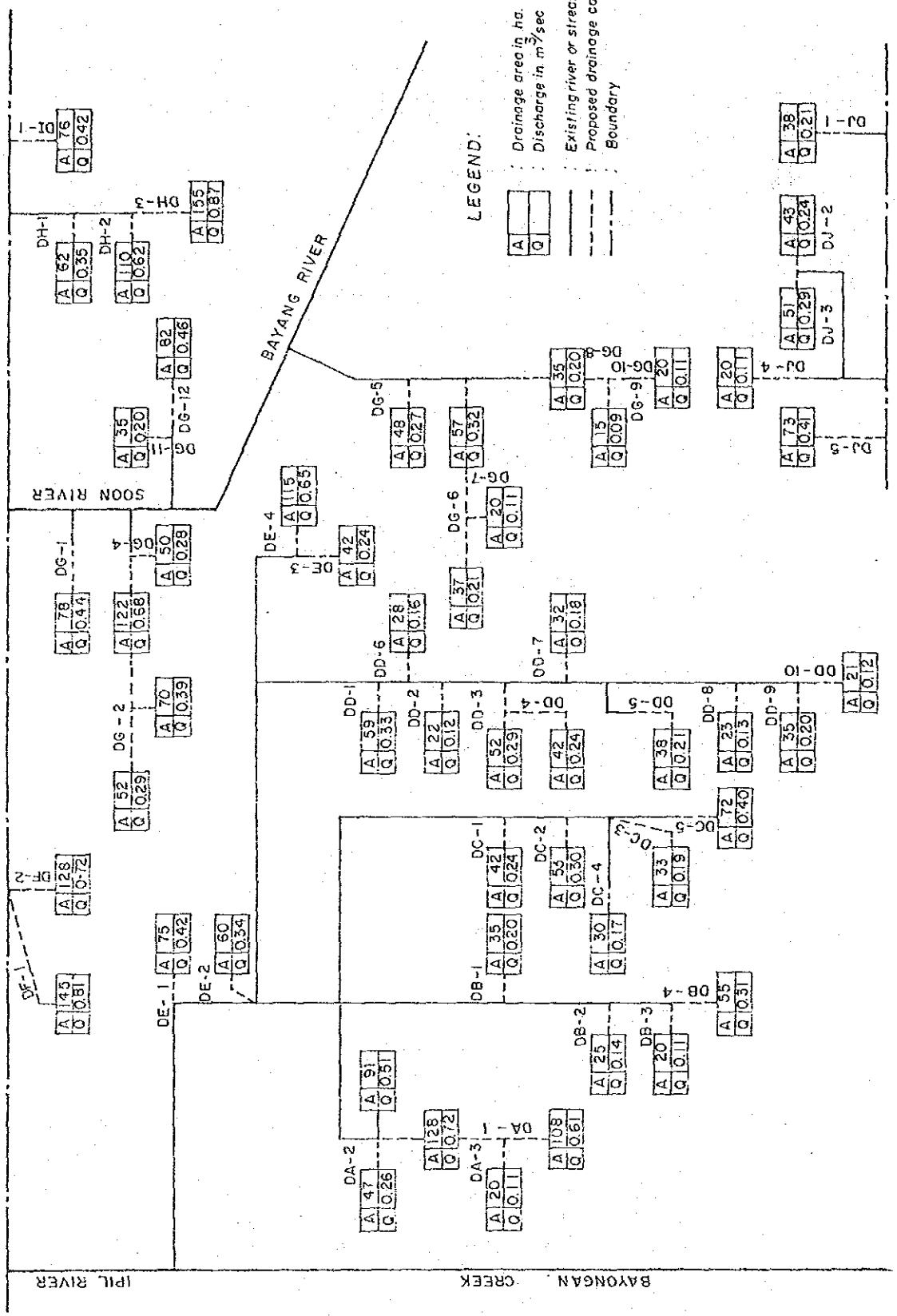
a) Proposed Crops

The proposed crops to be introduced in the irrigated agricultural development plan are rice and upland crops. Rice is the basic and security crop taking into account the following conditions and is proposed to be planted in both wet and dry seasons.

i) Rice is presently planted in the existing farm land and the most familiar crop to the farmer.

ii) Rice is the most suitable crop for the climate and soil conditions in the service area and the productivity will reach more than 4 ton/ha, when the stable irrigation is supplied and the modern farming practice is introduced. The Ubay pilot farm newly established in 1983 has succeeded to get the rice yield of about 4 ton/ha with one year's experience.

FIGURE 4-13 DRAINAGE DIAGRAM FOR THE PROJECT



iii) Bohol province has a high potential market to supply the rice product to the Central Visayas which has only a few rice fields due to topographical limitation and is always suffered from rice shortage.

iv) The farmer's income is mostly supported with the rice production, because the market price of rice is stable compared with the price of upland crops.

Plantation of upland crops is recommended recently in the national agriculture policy as the diversified crops in order to obtain the protein, fat and vitamin sources from the upland crops. However, upland crop plantation in the wet season is rather difficult due to much rainfall which brings many diseases to crops. Plantation of upland crops in this project should be introduced only in the dry season between January to May and in the hilly land without drainage problem so as to avoid the diseases problem.

The following upland crops are selected in the project taking into account soil suitability, availability of irrigation water and marketing possibility in Bohol province and to the Central Visayas.

Beans

Mungbean is the most prevailing bean which has been planted in the hilly land of the project area, and have a high marketability in Bohol province. In addition, leguminous crops have wide soil adaptability and effect of soil amendment.

Corn and Feed Grains

Corn is one of the main food grains in stead of rice in Bohol province and the Central Visayas. Rural people in Bohol province has used corn mixed with rice as main food. In addition, feed grains like yellow corn and sorghum drops presently in a big shortage not only in Bohol province but the whole Philippines, and the one of national agriculture

policy is setting up to increase the productivity of feed grains. Therefore, corn and feed grains is also selected to be introduced in the project, although the land condition consisting of acid soil has a little problem to plant corn and feed grains.

Vegetables

Vegetable production in Bohol province is limited and various vegetables are imported at considerable large amount from outside the island, mainly Cebu. In order to improve these marketing conditions in Bohol province and also to supply sufficient vegetables for home consumption, vegetable production should be promoted especially in the dry season.

Sweet Potato and Cassava

Sweet potato and cassava are presently planted in many places in the service area. Sweet potato is used for home consumption for rural inhabitant and cassava is sold to the existing factory in Bohol province. These crops are sufficiently grown under the present rainfall conditions without any irrigation. The modernized farming practice, however, should be required to increase the productivity. These crops are also considered adequate at the existing hilly area except the proposed irrigation area.

b) Cropping Pattern in Future (Without Project)

There are no available statistical data for the time-series cropping pattern in the project area or even on the project municipality level. The Study Team checked the present cropping area and cropping pattern in the selecting sample areas and compared with the cropping area shown on the topographical maps prepared by aerial photograph in 1970. As the result of comparison, no

remarkable change is found in the cropping area and pattern between the past and the present. The reason for no remarkable change for cropping area is assumed that the farmer can not cultivate new land except the existing cultivation area due to insufficient water and costly land preparation in hilly area. The present cropping area in the project service area is assumed as follows;

Paddy field area:	1,810 ha
Upland crop area:	3,900 ha

c) Proposed Cropping Pattern with Project

Two cropping patterns are proposed for the irrigated agriculture plan in this project. One is rice double croppings in wet and dry seasons for the depression area with lower elevation and the other one is rice croppings in wet season and mixed cropping of rice and upland crops in dry season which are introduced in the hilly area with higher elevation and without drainage problems.

The annual cropping intensity will be 200 percent in the ordinary and wet year which has sufficient irrigation water, although its intensity will drop in the dry year due to insufficient irrigation water. According to the water balance study, it was found out that an annual cropping intensity was estimated at 177 percent, 94 percent for dry season and 83 percent for wet season, from viewpoint of water availability, while 200 percent of cropping intensity will be attainable with the frequency of 23 years during past 28 years. Namely, an annual cropping area is 9,400 ha, 4,980 ha in the dry season and 4,420 ha in the wet season.

Even in case that available water is reduced in such dry year, 200 percent cropping intensity can be attained without reduction of irrigation area except the critical dry year.

Hereinafter, the crop-land relationship and the area allotment in the proposed cropping pattern will be shown on the basis of the above 177 percent of average annual cropping intensity.

FIGURE 4-14 shows the Proposed Cropping Pattern.

1) Rice-Rice

The application of rice double cropping will be concentrated on the existing rice fields or the depressed portions of the reclaimed lands to new rice fields, where drainage conditions are inferior to plant the upland crops. About 3,530 ha is allocated to the rice double cropping area.

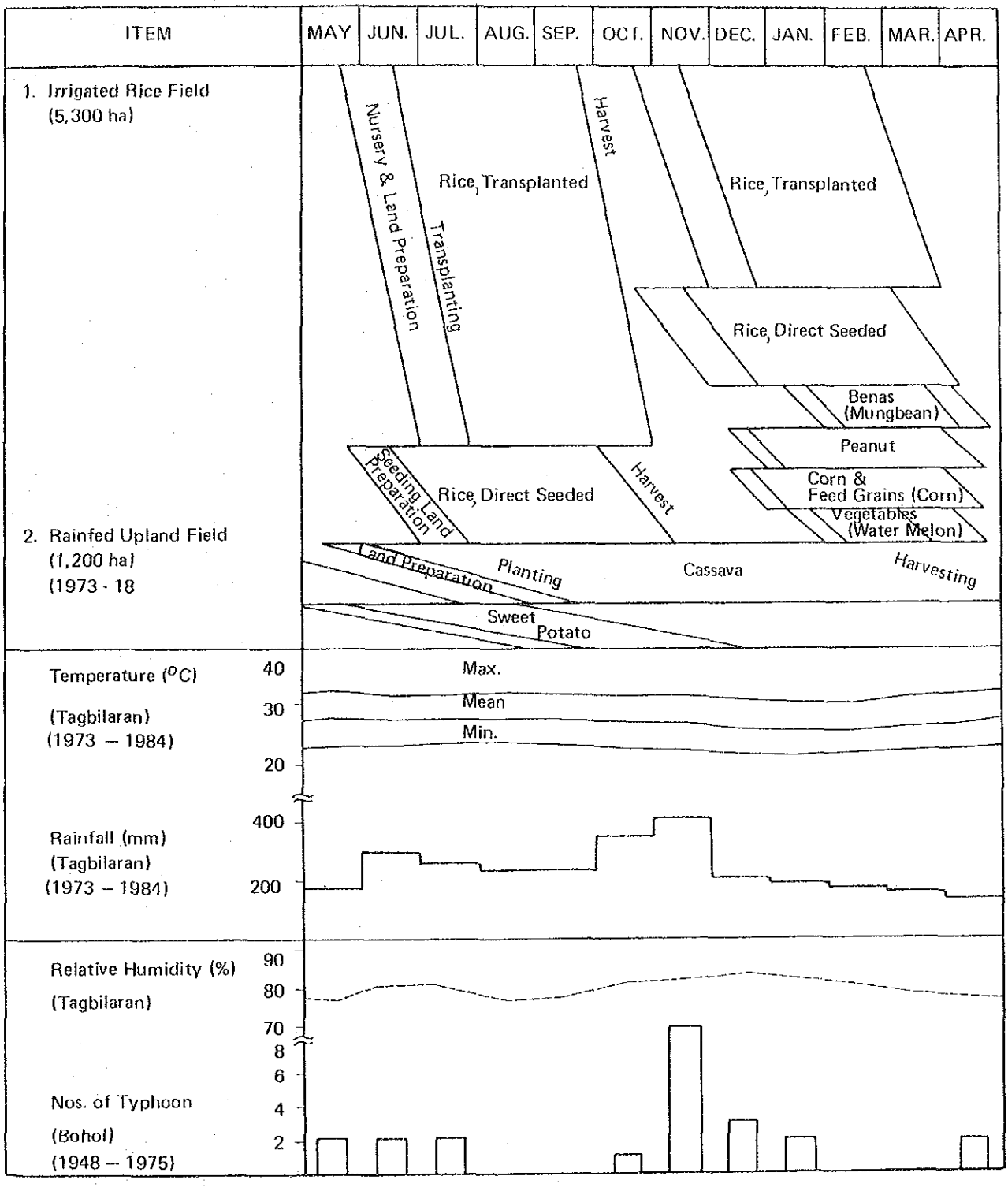
2) Rice - Diversified Crops

This type of cropping pattern will be applied in the remaining area of the irrigated rice fields (1,730 ha), where the drainage conditions may be comparatively favorable to grow such proposed upland crops, namely, beans (mungbean etc.), peanut, corn and feed grains (corn etc.) and fruit crops/vegetables (watermelon etc.). It is planned that each of the proposed upland crops will have equal share in area allotment in this pattern.

The proposed cropping calendar of above-said patterns are prepared on the basis of the proper growth period of recommendable varieties of the project crops (see Annex G). The direct seeding for the rice cultivation is considered to save the labour force. The proportion of transplanting area to the direct seeding area is planned at 80:20 for the wet season cropping and at 70:30 for the dry season cropping respectively.

The upland crops are planned to be cultivated from January to May in the dry season to avoid the disease problem and get the high productivity.

FIGURE 4–14 PROPOSED CROPPING PATTERN



The same cropping pattern as the existing one is planned for the sweet potato and cassava cultivation.

4.6.2. Proposed Crop Production

a) Farming Practices and Farm Inputs

The full development year in the crop production after completion of project is assumed at fifth year for the existing cultivated area and at eighth year for the areas newly developed. The proposed improvement of the existing farming practices and usage of farm inputs are shown in Annex G, TABLE G3-3 and TABLE G3-11. The certified or quality seeds of 50 kg/ha are sowed in 400 sq.m of striped wet seedbed in case of transplanting method and 100 kg/ha in case of direct-seeded method. Both rice cultivation methods of transplanting and direct seeding require fertilizer application with 60-40-0 and 70-40-0 per hectare, respectively in the wet and dry seasons. Use of insecticides and herbicides on the minimum level would be inevitable to avoid any side effect of agrochemicals for fish culture. It is considered that above said chemicals would be used safely, but further careful study would be needed.

b) Crop Yield

Annual increase ratio of the crop production during eight years from the project completion year to the full development year are estimated at 6.5 percent, 6.6 percent and 6.6 percent, respectively for rice, sweet potato and cassava.

The target yield of rice in the full development year are estimated at 4.2 ton/ha for the wet season crop and 4.5 ton/ha for the dry season crop. No significant difference of yields between transplanted and direct seeded rice would be expected. The target yields of the upland crops are estimated at 1.0 ton/ha for mungbean,

1.7 ton/ha for peanut, 2.7 ton/ha for corn and 8.9 ton/ha for vegetables respectively. On the other hand, the target yields of the rainfed upland crops of cassava and sweet potato are estimated at 14.2 ton/ha and 10.8 ton/ha respectively.

Full development year is set up at the fifth and eighth year after project completion respectively in the existing cultivation area and in the newly developed area. A total of the rice production at the full development year is estimated at about 33,400 ton per year, which is about 10.2 times of the estimated production without project. The production of other crops is shown in the following table.

Crop Production in the Full Development Year (Average Year)

Crop	W/O Project		W/ Project 1/	
	Harvested Area (ha)	Production (ton)	Harvested Area (ha)	Production (ton)
Rice				
- Irrigated	-	-	7,720	33,414
- Rainfed	2,490	3,286		
Upland Crops (Irrigated)				
- Mungbean	-	-	420	420
- Peanut	-	-	420	714
- Corn	-	-	420	1,134
- Vegetables	-	-	420	3,738
Subtotal			1,680	6,006
Upland crops (Un-irrigated)				
- Sweet potato	430	869	480	5,184
- Cassava	570	6,840	720	10,224

1/: Details are given in TABLE 4-19.

c) Demand and Supply Balance

1) Rice

Total consumption of rice in Bohol province in 2000 year is assumed at about 156,000 tons of paddy in case of annual per capita

TABLE 4-19 CROP PRODUCTION WITH PROJECT (AVERAGE CROPPING INTENSITY)

Crop	Total			Bayongan			Capayas		
	Area (ha)	Yield (ton/ha)	Production (ton)	Area (ha)	Yield (ton/ha)	Production (ton)	Area (ha)	Yield (ton/ha)	Production (ton)
1. Rice Field, Irrigated									
(1) Rice, wet season	4,420	4.2	18,564	3,450	4.2	14,490	970	4.2	4,074
(2) Rice, dry season	3,300	4.5	14,850	2,580	4.5	11,610	720	4.5	3,240
Sub-total	7,720		33,414	6,030		26,100	1,690		7,314
(3) Beans	420	1.0	420	330	1.0	330	90	1.0	90
(4) Peanut	420	1.7	714	330	1.7	561	90	1.7	153
(5) Feed grains	420	2.7	1,134	330	2.7	891	90	2.7	243
(6) Fruit crops/vegetables	420	8.9	3,738	330	8.9	2,937	90	8.9	801
Sub-total	1,680		6,006	1,320		4,719	360		1,287
2. Upland Field, Rainfed									
(1) Cassava	720	14.2	10,224	590	14.2	8,378	130	14.2	1,846
(2) Sweet potato	480	10.8	5,184	390	10.8	4,212	90	10.8	972
Sub-total	1,200		15,408	980		12,590	220		2,818
Total	10,600		54,828	8,330		43,409	2,270		11,419

consumption at 130 kg of rice and rice eating population ratio of 70 percent. On the other hand, total production of rice in Bohol province including Phase I and Phase II project will be as follows;

	W/O Project (ton)	W/Project (ton)	Incremental (ton)
Phase I	5,216	42,200	36,984
Phase II	3,286	33,414	30,128
Total	8,502	75,614	67,112

In 2000 years, total production of paddy in Bohol province is forecasted at about 181,900 tons which is totalized by 114,800 tons without the project and 67,100 tons of incremental volume. Surplus paddy of 25,900 tons will be exported outside Bohol province.

2) Corn

Corn product under the full development in the project area will be 1,385 tons due to small cultivation area and only cover the consumption of the inhabitants in the project service area.

3) Other Crops

Production of mungbean and vegetable under the full development can cover the demand of the project service area and have some allowance to supply the market in Bohol province. As for peanut, supply amount is over the provincial demand, but the surplus is almost equal to the projected deficit on the regional level.

Cassava production is promoded in the NFAC Bohol Cassava Production Program. Currently, the Philippine Starch Industrial Corporation (Phil. Starch) has faced the shortage of fresh cassava tube supply. The corporation has a plan to expand the existing factory capacity up to 800 ton of cassava fresh tube/day under the above said program. Accordingly cassava product in the project area will be completely transported to the factory.

4.6.3. Farm Management Plan

a) Land Holding Size

The rice field will be expanded from 1,780 ha to 5,300 ha under the project and, rainfed upland field will be reduced from 1,900 ha to 1,200 ha. The coconut land of 1,230 ha will be maintained, while 3,090 ha of grass land will be converted to 2,170 ha of rice field and 920 ha of upland field. The special land allocation to the expansion of cultivation area should be considered, so that the landless farmers and farmers outside the project area will be settled in the area newly developed, especially in the estate farm areas where most of lands are left idle at present.

It is assumed that the existing average farm size of 2.7 ha will be maintained with the following number of farm;

Number of Farm			Farm Area		
Total	Existing	Newly Settling	Land Category	Total Farm Area (ha)	Average Farm Size (ha)
			Total	7,730	2.7
2,860	2,280	580	Rice Field	5,300	1.9
			Upland Field	1,200	0.4
			Coconut	1,230	0.4

Note: The number of existing farm is shown in TABLE G2-5.

b) Cropping System

Double cropping of rice will be practiced continuously in the existing rice field and also in the depressed land of the newly developed rice field. On the other hand, the cropping pattern of the wet season rice + the upland crop in the dry season will be introduced in the remaining area located in the higher elevation area without any drainage problem. Naturally, it is recommended to rotate the diversified crops in the rice fields for the maintenance of soil fertility.

c) Mechanization and Labor Balance

1) Mechanization

The farming operation combined with man power and agricultural machines will be required after completion of the project in order to carry out the land preparation of rice field with a short period to meet the paddy growing season, to carry out the farming operation with small labour force and to increase yield by means of deep plowing.

Taking into account the land and labour force conditions in the project area, the partial mechanization at the minimum level as shown in the Annex G is proposed. The machinery to be used and degree of farm mechanization are planned as follows;

Degree of Farm Mechanization by Operation

Operation	Selected Machinery		Degree of Mechanization (%)
	Machinery	Attachment	
(1) Land preparation	4-wheel tractor (40-50HP Diesel)	Rotary (1.6 m)	20
(2) Land preparation	Power tiller (7-8HP Diesel)	Plow (0.25 m), Harrow (1.5 m)	45
(3) Threshing	Power thresher (Axial flow, 7-8HP)	-	75
(4) Threshing	Pedal thresher	-	25
(5) Drying	Dryer (2-ton Flat bin, 5 HP)	-	60 (Supplemental drying)

The above machinery will be planned to be used to supplement animal power and man power. Owing to the humid climate in the project area, special attention has to be paid on paddy drying after harvesting. The solar drying in the paddy yards is most economical

in comparison with any mechanical drying. As the existing paddy drying yards located in some villages have insufficient spaces, the construction and rehabilitation of paddy drying yards are proposed. Some mechanical drying will be needed for the supplementary drying on the drying yards. For this purpose, the flat typed dryer is planned to be introduced for the final drying (from 18 percent moisture content to 14 percent), covering 60 percent of rice harvested area.

The estimated machinery cost per hectare (the fixed and variable cost) is estimated at 893 Pesos (see Annex G).

2) Farm Labor Balance

The labor requirements for the cultivation per hectare for both cases of "Without Mechanization, by animal power" and "With Mechanization" were estimated as shown in Annex G, TABLE G3-28.

Supposing that two men of the converted labor force per farm will be available per farm on the average in the project area, the farm labor balance between supply and requirement was estimated for the year of 2000, as shown in Annex G, FIGURE G3-4. The existing low employment opportunities will be improved to a considerable extent through the increase of labor requirement and more equitable distribution of monthly labor requirement. As seen in the above figure, the monthly distribution of labor requirement will balance the available labor force in the project area. The month with maximum total requirement is October at 90 percent of the estimated total available farm labor force, while the average monthly total requirement is 57 percent. The monthly draft animal requirement is 23 percent of the available draft animal force on the average and the maximum is 91 percent.

The labor requirements per hectare with the project are estimated at 107 man-days (transplanted) to 72 man-days (direct

seed) without mechanization or by animal power only and at 88 man-day (transplanted) to 53 man-days (direct seed) with mechanization.

Total labor requirement calculated based on the cropping pattern with the project is estimated at about 980,000 days in 2000 years. Available labor force estimated based on 2,860 farms with two labor per farmer is 1,716,000 days. Hence farm labor balance per year is positive. The most busiest season is July and October. Farm labor balance in these months is also positive.

4.6.4. Supporting Services

a) Extension Services

It is essential to strengthen agricultural extension activities for the achievement of the irrigated agricultural development in the project service area and to increase the agricultural activity. The following items of strengthening are planned;

- At least one field technologist and one livestock inspector have to be staffed in every three barangays to provide farmers with adequate and systematic extension services, which is planned in the Regional Five-Year Plan (1987 - 1987);

- Training of extension personnel especially in the following items, i) proper soil management and fertilization for the less fertile soils with nutrient deficiency, ii) on-farm irrigation technique, iii) proper quality control of agricultural product;

- Provision of adequate transportation facilities and audio-visual equipments;

- Demonstration of the modernized irrigation farming methods.

During the initial stage of the project implementation, the pilot scheme will be established and operated for the extension activities in the project area under the project. The success of pilot scheme will be indispensable to attain the full target within the planned period.

b) Cooperative

As mentioned previously, the paddy production in the project area would be expanded from about 3,300 tons without the project to about 35,000 tons with the project. Upland crops would be expected at about 20,400 tons with the project. In order to attain the target for production, about 400 tons of paddy seeds, about 4,500 tons of fertilizer and about 500 tons of pesticides and herbicides should be purchased by the beneficiaries.

The marketing of incremental outputs and inputs mentioned above and the credit for purchasing of inputs shall be handled on time.

Since the marketable volume and the credit flow at present are not so much, the greater parts of goods are handled by dealers and farmers themselves. The cooperative's activity to be expected after completion of the project should be functional, global and enterprising. Considering these conditions, activities of Farm Marketing Cooperative established in San Miguel shall indicate the directions of cooperative movement to be recommended in future.

The farm marketing cooperative with large size is recommended to be established in Trinidad and Ubay. The existing farm marketing cooperative in San Miguel shall need an expansion of facilities. The outlines are as follows.

- Main functions are marketing contract, crop insurance, credit and education of Samahang Nayong members.
- Rice mill, storage, truck, store shop and work shop of farm machines should be invested.
- Cooperative shall be organized by stockholders as members of Samahang Nayon.
- Crop insurance is an imperative matter to give an incentive to the commercialized farmers. Hence crop insurance system would be pretty developed.
- The updated Philippine Development Plan, 1984-1987 adopts the group farming scheme to foster strong linkages among production, processing and marketing. This farming arrangement will be built on the existing elements of the agricultural cooperative movement. Activities of farm marketing cooperative should be promoted through the coordinating with this group farming scheme.

NIA has coordinated for the irrigators' association to cover various tasks such as procurement of farming materials, credit, marketing etc. It is actual situation that when the members of the irrigators' association purchase fertilizer or chemicals, NIA shall pay funds instead of purchaser, because farmers are in shortage of cash. The payment contracts between NIA and the irrigators' association member make this activity possible.

Hence, in an initial stage after completion of the project, the irrigators' association would have function as pre-cooperative.

c) Plan of Pilot Project

1) *Objectives*

The pilot project should be quickly introduced in the project area with the following objectives; The farmer masters the water management for irrigation practice and modern farming practice instead of traditional farming practice and can get a high agricultural productivity in the early stage.

At least within the second year of the project implementation, one pilot farm should be developed to conduct the trial and demonstration activities in the farmers' fields, which has same infrastructure to that of the project.

There is another problem to supply seed with good quality to the project service area. In the full development year of the project, about 100 tons of rice quality seeds for renewal will be required. Most of the right varieties seeds should be supplied timely from the pilot farm where seed production technology will be applied. The seeds of other crops also should be supplied in the same way as rice seeds.

2) Location of Pilot Farm

The selection criteria of the pilot farm are as follows;

i) Strategic location along the major highways and near a community;

ii) Availability of irrigation water source prior to project completion;

iii) Farmer' willingness to take part in the Pilot Project.

According to the above said criteria, the proposed site of the pilot farm is one of the command areas of proposed turn-out in the lateral CA of Capayas Irrigation System, where the pilot farm is faced on the highway from Carmen to Ubay. Irrigation water will be supplied by pumps from the Bayang river.

3) Project Facilities and Operation

The management staff in the proposed organization of the pilot scheme will be headed by a project manager who is a rice agronomist with good background on seed production and soil management. The manager will be supported by four staffs, namely a upland crops

agronomist, irrigation engineer for water management, mechanical engineer for land development and farm mechanization inclusive of post harvest technology, and agro-economist to manage the farm. These staff members should be sufficiently qualified and experienced with the necessary training prior to the assignment in the pilot scheme. The pilot farm should be operated on the basis of the farmers' decision making in their farm management under the sole responsibility of the pilot scheme staff for extension and training services.

Following shows the outline of pilot farm.

Location	:	Ubay Municipality, served by Lateral CA.
Facilities		
- Farm Area	:	25 ha
- Building		
Operation Office	:	300 sq.m
Equipment Shed	:	100 sq.m
Store House	:	50 sq.m

d) Farmer Irrigators' Association

It is proposed that four levels of irrigators' organization are established for operation and maintenance of the irrigation systems as follows;

i) Rotational Unit Group on supplemental farm ditch level (averagely 5 to 10 ha),

ii) Farmer Irrigators' Group on turnout level (averagely 25 to 50 ha),

iii) Farmer Irrigators Association on Operation Division level (about 1,000), and

iv) Federation of Farmer Irrigators' Association. (Project level)

Prior to the construction of the project, and as early as possible, the first two levels shall be organized with bottom-up approach from Rotational Unit Group to Farmer Irrigators' Group. Through enabling the beneficial farmers to participate in the project even at initial stage, the farmers have to acquire participative and problem-solving oriented behavior and to develop values of collective action as they confront irrigation-related issues ranging from review/revision of tentatively planned canal alignment to construction of on-farm facilities. The latter two levels organizations should be formally established in the phase of operation and maintenance of the irrigation facilities. The project is to be responsible for supplying adequate supporting services in organizing four levels Farmer Irrigators' Associations, and also for designing of on-farm facilities which will be necessary for on-farm development.

For the on-farm development of irrigation facilities, it is recommendable that the concerned farmers with the said Irrigators' Group will be hired by NIA for the construction works. The funds of the on-farm development should be born by the land owners through specific loan.

Ultimately, the Irrigators' Associations will carry out by themselves operation and maintenance works on the lateral canal level irrigation systems, that is, planning and implementation of water distribution, collection of amortized project cost and irrigation fee.

The proposed irrigation area includes new development area to rice fields from grass land. Generally, landowner will bear the development cost of new rice fields. However, new settlers to new rice fields have to purchase the grass lands or the developed rice fields. Therefore, it is required that the Irrigators' Association should have the function to provide the fund to purchase lands and develop the rice field.

In addition, the irrigator's association will carry out the following role;

i) Government authority will purchase the grass land in the said estate farms and develop the lands to rice fields. The developed rice fields will be purchased by the settlers to the lands.

ii) The other reclaimable grass lands owned by the smaller land holders will be purchased directly by the new settlers. Otherwise the developed rice field by the holders will be sold to new settlers.

iii) The new settlers organize the Farmer Irrigators Group to borrow funds for purchasing cost and reclamation cost.

It is proposed that new funds for land purchasing and land reclamation should be established through two step loan system of international bank and domestic bank.

e) Agricultural Development Coordinating Committee

In order to support farmers in the project area, the Agricultural Development Coordinating Committee should be organized at an initial stage of project implementation.

The Committee will be composed of representatives from the different government agencies involved in agricultural activities such as NIA, MAF, MAR, NFA and MLGCD, including credit institutions such as Rural Bank (RB), Philippine National Bank (PNB), Agricultural Credit Administration (ACA) and Development Bank of Philippines (DBP) and the representatives from the private agricultural sector like the Seed Growers Association (SGA), private suppliers of inputs and private rice processors.

The coordinating committee will be headed by the NIA Project Manager and the Provincial Governor as Honorary Chairman, having the following objectives and functions:

- To institute the implementation of integrated agricultural development programs in the project area to achieve the high agricultural productivity and the increase of farmer's income.

- To provide well-coordinated and effective services for the supply of irrigation water, fertilizer, pesticides, farm machine, credit and financing.

- To solve the problems of the coordinating agencies in the project implementation such as overlapping of responsibility and confusion in providing the supporting or assistance to the farmers.

- To assist the implementation of irrigated agricultural development so as to be completed successfully.

4.6.5. Processing and Marketing

a) Paddy Processing and Facilities

Total present capacity of 27 rice mills in the three municipalities was estimated at 3,305 bags or 165 tons per day. If about 20 percent of palay produced in the wet season (1,400 tons) is marketed, the capacity of 27 mills will be enough to operate within 10 to 15 days.

According to the crop production plan, palay volume of 18,500 tons with the project would be harvested from the period 20th September to 10th November. If new palay grains have to be milled by the end of November in the full development stage, present capacity of the mill and storage will not be enough.

The following three alternative plans for additional mill and storage facilities are considered.

Projection of Additional Mill and Storage

Study Case	Mill		Storage	
	Present Capacity (ton/day)	Additional Capacity (ton/day)	Present Capacity (ton)	Additional Capacity (ton)
A	165	165	2,157	7,200
B	165	200	2,157	2,157
C	165	250	2,157	-

This case study shows the following results; In case that additional milling facility having the capacity of 165 ton/day as same as present one (Case A), required storage capacity to be provided is estimated at 7,200 tons, equivalent to about three times of present capacity of about 2,160 tons. On the other hand, in case that storage facilities will not be increased because of enough capacities to handle an incremental volume of paddy (Case C), milling facilities having the capacity of 250 ton/day will be need additionally. Case B shows that if additional storage capacity of about 2,160 tons will be provided, 200 ton/day of milling facilities will be needed.

b) Marketing Facilities for Input Materials

Input quantities in full development stage are planned at about 90 tons of paddy seeds, about 4,500 tons of fertilizer, about 350 tons of pesticides, about 260 tons of herbicides and about 3,150 tons of lime.

Paddy seeds shall be renewed at the interval of once in four years. 100 tons per year of the certified seeds have to be supplied in the Project. As the seed volume multiplicated in the experiment station, BPI, Gabi is not enough to fill the requirement, new seed farm is recommended to be established in the project area.

Fertilizer requirements amount to about 3,200 tons in the Phase I and about 4,500 tons in the phase II project, that is totalized at 7,700 tons. These fertilizers have to be shipped from Cebu port. In 1982, about 4,000 tons of fertilizer were unloaded at Tagbilaran port. Maximum monthly volume was shipped at about 1,400 tons in October. After completion of the Bohol Irrigation Project Phase I and Phase II projects, the marketed volume of fertilizer would be increased three times of the present one. The expansion plan for the number of vessel, the controlled distribution system and the new warehouse should be made to meet the demand of fartilizer consumption in Bohol province.

c) Livestock Development Facilities

Trinidad and San Miguel established the following comprehensive development plan for livestock in 1984 to encourage the farmers to engage in livestock and poultry production, development of pastures.

Livestock Development Plan

Project	Locations	Cost (₱ 1,000)	Schedule Implement	Implementing Agency
(San Miguel)				
Feedmill	Bayongan	1,000	1985-88	MOAF, MHS
- do -	Poblacion	750	- do -	Bank
Slaughterhouses houses	Mahayag Poblacion	60,000	1985-86	Provincial Government
(Trinidad)				
Feedgrains Marketing Program	All balangays	-	1980-90	NGA, BAEx
Slaughterhouse	Poblacion	30,000	1981	MPWH/ Municipality

Source: Comprehensive Development Plan in 1984

According to the Provincial Development Council's Development Plan, 1983-87, establishment of the animal breeding centers of 12

places is scheduled in Bohol province. These centers will contribute to encourage farmers to use pure bull-artificial (artificial insemination) services.

Agriculture Promotion Center in Tagbilaran is carrying out a test for the new feeds program on ipil-ipil leafmeal. Ipil-ipil branch with leaf and cassava roots are processed like pellet by special machine. This program will be useful for promotion of livestock development in the project area.

d) Manufacture of Lime

The Provincial Development Council's Development Plan includes the project of manufacture of industrial and agricultural lime in Ubay and Trinidad.

4.7. On-Farm Development

4.7.1. Land Development in Hilly Area

a) Concept of Land Development

The land development works aiming at paddy reclamation is an essential project component. Available water resources developed by the project implementation will be by no means effectively applied for irrigated agriculture without the reclamation practice.

The land development works will be carried out by means of heavy equipment in parallel with construction of lateral canals together with on-farm development work. When all development works are implemented in the same phase, the big part of the project area will be available for irrigated paddy cultivation until the end of the project implementation.

As the cost requirement for paddy reclamation work in hilly area varies dependent on the degree of land slope and dimension of terrace, the size of paddy plot to be developed was discussed in connection with the development cost and optimum size for better farm management.

The land leveling cost which is accounted for major part of paddy reclamation cost is escalated in accordance with the increase in land slope. FIGURE 4-15 shows a schematic plan of land terracing in different scheme of ground slope and terrace dimension.

The standard dimension of a paddy plot for the reclamation scheme was finally determined as follows in connection with optimum size for farm management and cost requirement:

- The maximum length of a paddy plot along the contour line will be 100 m;
- The standard width of a paddy plot across the contour line will be 20 m, the allowable width to be 10 m to 30 m;
- The maximum rise between paddy terraces will be 60 cm.

b) Land Parcelling

The project area commanded by lateral/sub-lateral canals is parcelled into rotation areas as the terminal units of water management and irrigated farm management. The land parcelling was made on the areal topographic maps of 1:10,000 in scale, based on the result of field work, topography, drainage conditions, present land use and location of present paddy fields.

In order to materialize land parcelling satisfactorily to meet the irrigation and drainage requirements together with the farm management plan, following criteria were applied at the parcelling works.

- Scale of rotation area is planned as 50 ha to 25 ha depending on the location of proposed service area and topographic characteristics of the objective area.

- Administrative boundary and property line are not reflected particularly at the parcelling works, in fact it is quite difficult to accommodate such an artificial line with irrigation boundary.

- As for layout of ditches, a main farm ditch is to extend along contour line in order to get the maximum service area.

- The maximum length of a main farm ditch and a supplementary farm ditch is 1,000 m.

As a result of land parcelling works, 145 units of rotation area are identified in the project area, which is divided into 112 units and 33 units for Bayongan area and Capayas area respectively.

c) Water Requirements of On-Farm Level

Practical water requirements on on-farm level are expressed by the sum of water balance between supplied water and consumed water on on-farm level. In order to increase irrigation efficiency, appropriate water management structure to review actual field water requirement and to revise the water supply schedule should be planned.

At the land soaking and preparation period, the irrigation water requirements are decided from the water content of the soil, soil depth for cultivation, and application period for a rotation area.

Irrigation water requirements for diversified upland crops depend on the available water content in the soil and consumptive use in accordance with its growing stage as well as interval of the irrigation application.

d) Farm Ditches and Roads

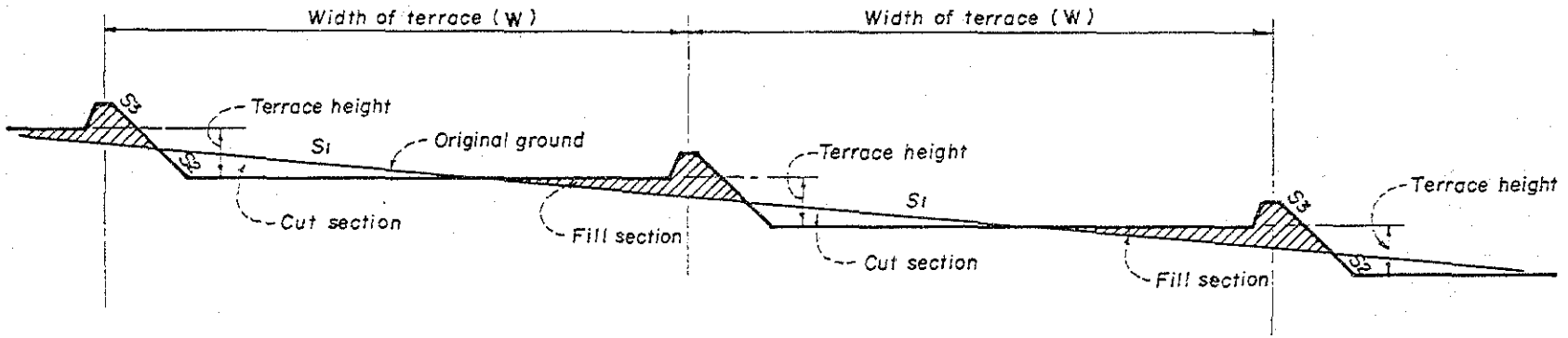
Farm ditches are classified into main farm ditch, supplementary farm ditch and farm drain. Farm ditches are designed at each rotation area to meet the irrigation requirements of terminal farm lot. Proper design of the ditches is made to provide efficient water distribution and to control irrigated farm management.

The design capacity of farm ditches is determined at the maximum water requirement of 2,183 lit/sec/ha, which will be required during land soaking and preparation period for 1st irrigation.

Main farm ditch is designed to convey required water to supplementary farm ditches through division box provided at the head of the supplementary farm ditches. No direct turnout for a farm is provided at the main farm ditch.

Supplementary farm ditch is designed in a rotation unit to distribute water to farms, which is provided with farm turnouts at selected points to be convenient for distribution water to each farm lot.

Farm drains are planned in the rotation area as required so as to remove excess water from farms, which is mostly planned along present paddy field. The drainage modulus is assumed at 5.61 lit/sec/ha. The terminal end of a main farm ditch and a supplementary farm ditch is connected with a farm drain or other natural creeks. The farm drain being connected with other water supply systems will be increased in the design capacity so as to accommodate with its surplus discharge.



REMARKS:

S1 : Ground slope,(%)

S2 : Cut slope, 1:1

S3 : Raise slope, 1:1

TERRACE DIMENSION AND EARTH WORK VOLUME IN EACH GROUND SLOPE

ITEM	UNIT	GROUND SLOPE IN PERCENT (%)									
		1.0		2.0		3.0		4.0		5.0	
WIDTH OF TERRACE	m	20	30	20	30	10	20	10	20	5	10
HEIGHT OF TERRACE	cm	20	30	40	60	30	60	40	80	5	100
LEVELING WORKS	m^3	250	375	500	750	375	750	500	1,000	625	1,250

FIGURE 4–15 SKETCH AND DIMENSION OF LAND TERRACING

Farm road is planned in consideration of its utility in the area for better farm management as well as operation and maintenance works. In this connection, farm road is planned to be connected with public road or farm road of adjacent rotation area.

The total width of farm road is assumed to be three meters in view of future requirement for mechanized farming practice as well as for the materials supply and other works for operation and maintenance stage.

4.7.2. Land Development in Existing Paddy Field

Existing paddy fields in the project area have been developed between hills and placed under the conditions to receive the runoff and seepaged water. As the paddy fields have generally small size of drainage area, drainage systems have been poorly developed in the existing area. Plot to plot drainage systems are commonly developed.

With regard to irrigation development plan for present paddy fields, existing plot to plot drainage system could be utilized for irrigation network as it is by connecting a supplementary farm ditch at the elevated section of the paddy field.

On the other hand, drainage facilities of the present paddy are required, due to the increased return flow from elevated paddy field on the hill developed by the project.

As a practical irrigation and drainage development plan for present paddy field, it is proposed to make use of the farm drain for dual purposes of irrigation and drainage. The paddy field in a rotation area is to parcel into irrigation units within the drainage area. The farm turnout from a drainage ditch will be installed at the upstream plot of the irrigation unit, and a drain inlet will be installed at the lowest plot. Plot to plot irrigation method is carried out within the irrigation unit.

4.7.3. Water Management System

a) Irrigation Hour on On-Farm Level

Water distribution on on-farm level is practiced by following three types of methods as required: Rotational method is practiced during land soaking and insufficient water supply period; simultaneous method is applied for normal irrigation; and intermittent method is for diversified upland crops.

The simultaneous irrigation method has no need to manage water by hourly schedule. On the contrary, the rotational and intermittent irrigation methods are required to distribute water by hourly schedule to farms on supplementary farm ditch level due to irregular size of each farm lot and different water requirements of diversified crop.

In order to practice the rotational irrigation satisfactorily, a mutual cooperation among irrigators in a rotation unit based on the precise concept for size of a farm lot and water requirements for each crop will be required. The necessary knowledge for water distribution will be acquired through day-to-day water allocation practice by themselves.

With regard to water supply for diversified crop during dry season, the intermittent irrigation method is applied as required period. The irrigation requirements for diversified crop will vary considerably depending on the kind of crops as well as rainfall conditions. Accordingly water for diversified crop irrigation will be supplied in gross included with paddy water, and it will be allocated time to time from the gross water.

b) Water Distribution Control

Supplied water from lateral/sub-lateral canal to rotation area is conveyed through a main farm ditch and distributed to each

supplementary farm ditch. The water from the main farm ditch to the supplementary farm ditches are controlled by division boxes provided with the main farm ditch at the head of each supplementary farm ditch.

When supplied water from the lateral/sub-lateral canal is diverted in the two or three flows at the turnout point, the outlet box of the turnout will be provided with division facilities at the same function as division box.

The division box has the function to divert water to each rotation unit equally by the fixed rate of discharge in proportion to the size of each service area by means of overflow weir system.

A temporary revision regarding diversion rate among rotation units will be carried out by the temporary adjustment of weir level, while permanent correction for the diversion rate will be done by replacing of weir edges at corresponding diversion system.

Farm turnouts are finished along the supplementary farm ditch at the convenient point for receiving water to the farms. The farm turnout is provided with no control structure nor measurement device. Accordingly, the water distribution is carried out in cooperation with farmers themselves.

4.8. Rural development

4.8.1. Social Infrastructure

Present road networks in the project area are insufficient for inter communication between barangays and farm-to-market. Therefore, operation and maintenance of roads appurtenant to the canal systems are to be used for public communication.

The road networks provided by the project are as follows:

Item	Effective Width (m)	Length Bayongan System (km)	Length Capayas System (km)	Total (km)
Main Road	4.5	9.9	2.4	12.3
Lateral Road	3.0	52.0	16.0	68.0
Total		61.9	18.4	80.3
Road Density, (m/ha)		15.0	15.9	15.2

In addition, farm road networks will be spreaded over the project area. Although it is originally developed by the irrigation community for themselves, it could be utilized for inter communication between communities. The total length of the farm road is assumed to be 266 km.

4.8.2. Integrated Community Center

Five-Year Development Plan (1983-1987) has adopted a "New Line" of approach to the national development efforts to solve the current socio-economic problems which is different from the past plans, and mainly stresses "Economic Growth With National Harmony" and "Human Development" with eight major national development goals. Of the eight goals, the seven are to promote rural development in order to alleviate the poverty in backward and depressed areas such as upland and non-irrigated area.

Under these national strategies and policies, Bohol Irrigation Development Project Phase I and Phase II will contribute to the regional development with the increase of an agricultural production under stable irrigation water supply. Furthermore, in accordance with the project implementation, additional consideration was incorporated into rural development under the Fifth Development Plan guideline for rural development, aiming at rural community on barangay level, such as;

i) Village fisheries in which all the villagers would enjoy fishing activities in the pond to be constructed in order to help increase their protein consumption and to get additional cash income,

ii) Domestic water supply by means of canal systems,

iii) Agricultural cooperative works equipped with drying yard, and

iv) Promotion of sports such as basketball using the drying yard.

In the direction of rural development mentioned above, integrated rural community centers on barangay level were planned at 22 sites in the project area, and their typical layout and general plan are presented in FIGURE 4-16 to FIGURE 4-17.

The village community facilities consist of an open space provided with a shallow well, a comfort room, a drying yard paved by concrete and sunshade space, afforestation area and a village pond. The sort of public facilities will be the core of community on barangay level.

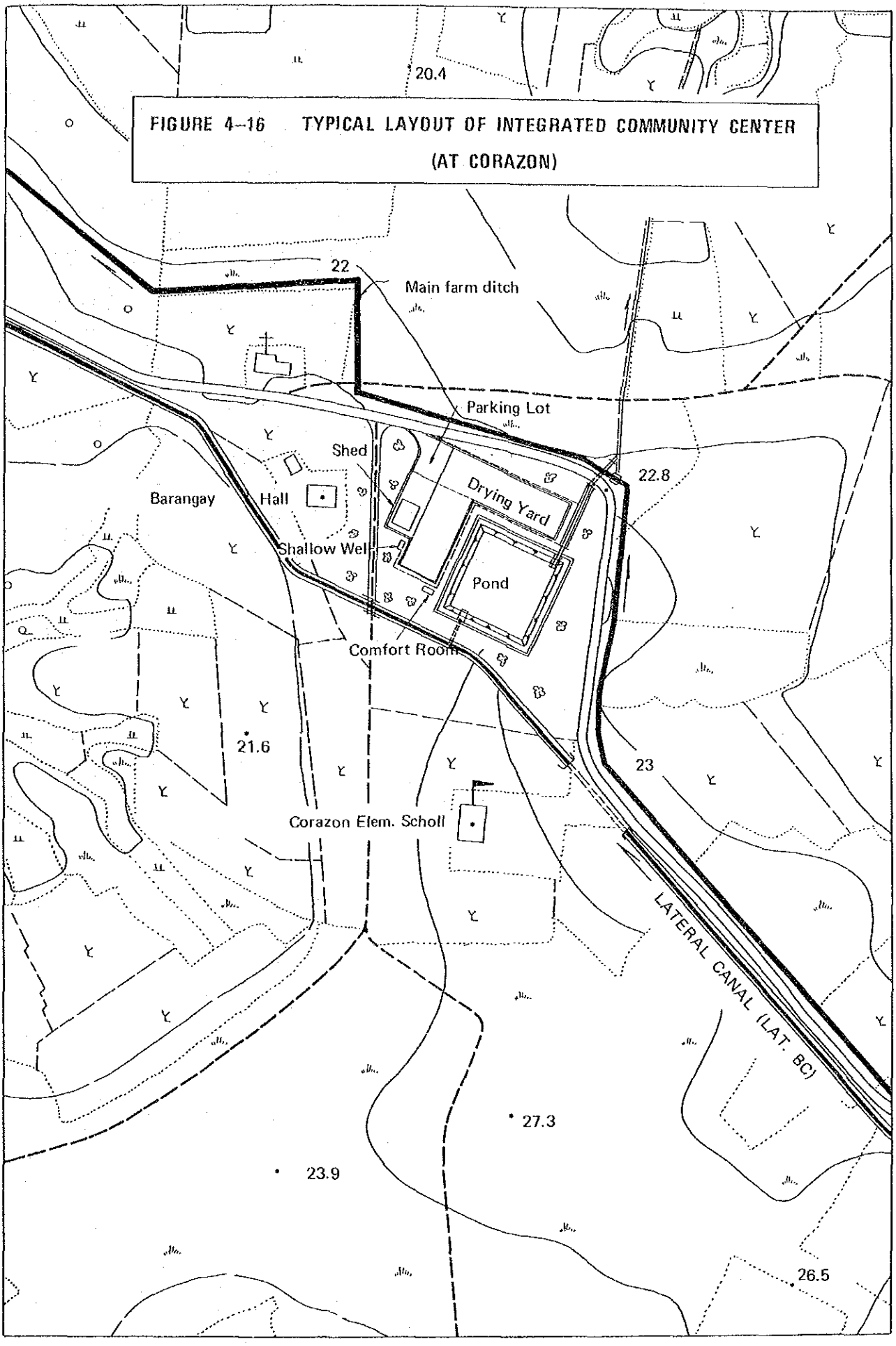
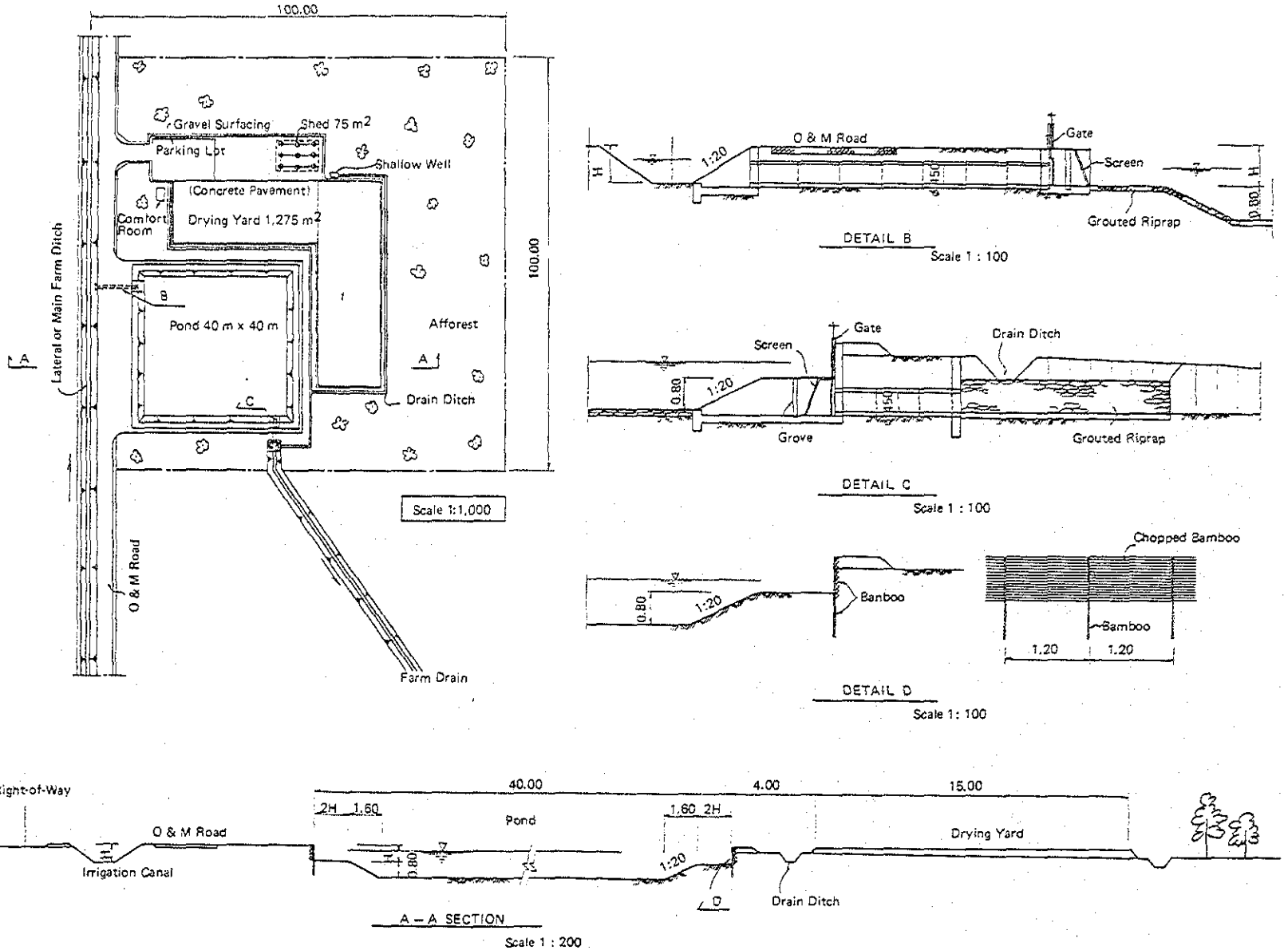


FIGURE 4-16 TYPICAL LAYOUT OF INTEGRATED COMMUNITY CENTER (AT CORAZON)

FIGURE 4–17 GENERAL PLAN OF INTEGRATED COMMUNITY CENTER



CHAPTER V. PROJECT FACILITIES

CHAPTER V. PROJECT FACILITIES

5.1. Reservoir and Dam Plan

5.1.1. Basic Condition for Dam Plan

a) Basic Data

The Bayongan and Capayas storage dams, the distribution canal and the on-farm facilities are the major facilities in this project. The project facility plans have been made based on the conditions of topography and geology, available construction materials near the site, functions of the project facilities, construction methods etc. The data relevant to draw up the project facility plans are collected, and analyzed in accordance with the following surveys and investigations:

- Topographical Maps

Reservoir Area	Scale	1:4,000
Damsite	Scale	1:4,000
Irrigation Service Area	Scale	1:4,000
On-Farm Development	Scale	1:2,000

- Geological Investigation in Damsite

Description	Capayas	Bayongan	Total
No. of Bore Hole	3	28	31
Drilling Length	63 meters	635	698
Water Pressure Test	17 times	85	102
Standard Penet. Test	0 time	90	90

- Construction Material Survey in Damsites

Description	Capayas	Bayongan	Total
No. of Test Pit	6	25	31
No. of Sampling	7	15	22
No. of Grain Size Test	9	14	23
No. of Spec. G. Test	12	17	29
No. of Soundness Test	3	3	6
No. of N. Moisture Test	6	11	17
No. of A. Limit Test	4	8	12
No. of Standard C. Test	3	9	12
No. of Permeability Test	1	3	4
No. of U.U. Triaxial Test	1	3	4
No. of C.U. Triaxial Test	1	3	4
No. of Consolidation Test	1	3	4

b) Seismic Intensity at Damsite

In reference to the data "Catalogue of Significant Philippine Earthquakes" (1907 - 1982) by PAGASA and by application of Dr. Okamoto's theory, a seismic acceleration of 200 Gal with a return period of 100 years is considered to take place. (See Annex H, Paragraph 1.1)

Therefore, 200 Gal or an equivalent seismic force of K = 0.20 is adopted in the design of the dam.

c) Flood Discharge for Spillway Design

The design flood capacities of the Bayongan and Capayas dams has been estimated based on the formula prepared by Ministry of Public Works and Highway, Philippines which was also checked by Creager's formula and others. The flood routing studies, considering the surcharge effect in the reservoir areas, have been made by using assumed hydrograph for various sizes of spillways (See Annex H, Paragraph 1.2).

Summary of above studies is as follows:

	Unit	Bayongan	Capayas
Design Flood Inflow	cu.m/s	443	417
Design Flood Outflow	cu.m/s	20	226
Spillway Size	m	20	60

5.1.2. Bayongan Dam

a) Reservoir Plan

The Bayongan damsite is selected at Barangay Bayongan so as to get the maximum storage capacity with the shortest dam crest length and the lowest dam height.

The damsite is covered with thin overburden with a thickness of two to three meters and consisting of consolidated and impervious rock formation of siltstone, sandstone and conglomerate. It has no problem for seepage through dam foundation and as well as the bearing capacity to support the dam body.

The reservoir area and capacity of the dam are calculated on the basis of map with a scale 1:4,000 and shown in FIGURE 4-6.

There are some land acquisition problems to resettle about 30 farm families and about 200 ha cultivation land in the Bayongan reservoir area.

In accordance with the reservoir capacity of 27.5 MCM in Bayongan, the reservoir dimensions such as dam height, dam length, reservoir area etc. are shown in TABLE 5-2.

b) Topography and Engineering Geology

1) Topography

The proposed Bayongan damsite is located at about six kilometers east of San Miguel. The damsite lies on the upstream of the Trinidad river called the Bayongan river, which originates at Governor Boyles in the flat plane with about EL 130 m and traverses the damsite toward northwest. The river changes its flow direction at about three kilometers downstream from the damsite and joins the San Miguel river, a tributary of the Trinidad river. And then the river changes the name as the Trinidad which empties into the Camotes Sea in the vicinity of Talibon. The river bed elevation at the damsite is about 25 m and its slope is about 1/350.

The catchment area of 11.2 sq.km is surrounded by hills with the elevation of top hills of about 100 m to 70 m. The damsite presents low and gentle hills which are 30 to 50 m in height from the river bed and can provide a large reservoir capacity.

2) Engineering Geology

The damsite belongs to Ilihan formation, (N2), whose age is Middle Miocene. 28 boreholes have been drilled along the dam axis and ridges, and some water pressure tests and penetration tests have been also carried out in boreholes. In addition, 25 pits have been provided for the construction material survey.

In accordance with the result of geological investigation works, the rock formation of the dam site consists mainly of siltstone with the alternating beds of siltstone, mudstone, sandstone and conglomerate. The formation rock is overlain by thin overburden layer such as terrace deposits and talus deposits. The thickness of the overburden layer is less than two to three meters only, and the thickness of weathered rock layer is also two to three meters.

The base rock at the dam site has a good quality which shows 80 to 100 percent core-recovery colored gray and 50 to 100 percent Rock Quality Designation (RQD), even though its unconfined compression strength might be assumed less than 100 kg/sq.cm. In fact that is massive, in uniform, and fresh bed rock. According to quality classification of bedrock (by Dr. Tanaka), weathered rock corresponds to D to CL class and fresh rock to CM class. As to N value overburden layer shows less than 20 of N value, extremely weathered rock and moderately weathered rock is less than 50 and sometimes less than 20, and slightly weathered and fresh rock indicates more than 50. The overburden and weathered rocks which are not suitable for dam foundation shall be stripped.

The permeability of base rock is less than 10 lugeon value, and mainly less than five. Since the base rock is impervious and has enough bearing capacity, the foundation treatment by grouting works is not necessary in the Bayongan dam.

The impervious blanket, however, is placed at the upstream foundation and connected to the core zone to prolong seepage length instead of grouting works.

Therefore, the dam foundation has no interruption in the construction of fill type dam, and it has a good bearing capacity and water tightness for about 30 m dam in height from an engineering and geological point of view.

The geological profile along the dam axis is shown in FIGURE 5-1.

c) Construction Material

The borrow areas of earth, sand and gravel material and the quarry sites have been surveyed by the Study Team and selected at the places as shown in FIGURE 5-2.

All borrow areas and the quarry sites are located near the damsite and can supply the material with a sufficient quantity for the dam embankment volume.

The laboratory tests for material samples taken from the borrow areas and the quarry sites have been carried out and their physical and mechanical properties are shown in TABLE 5-1.

The Bayongan dam is planned with the zone type earth fill dam taking into account the dam height of 31 m and available embankment material around the damsite.

1) Earth Material

The earth material (the impervious core material) will be taken from the borrow area in the upstream left bank of the damsite. The

borrow area presents the flat topography with a gentle slope, which easily provides the drainage trench to decrease the moisture content of earth material and also easily collects material by bulldozer pushing.

The material in this borrow area consists of a fine clay and silt belonging to MH and CH without weathered rock fragment or gravel and presents the high field moisture content of 30 to 40 percent against the optimum moisture content of 23 to 28 percent, so that the field moisture should be controlled during the dam embankment works so as to decrease the moisture content in the borrow area.

This impervious material should be used for the core zone but for the upstream shell zone in the dam.

2) Sand and Gravel Material

Embankment Material

The semi-pervious materials consisting of weathered rock and gravel are found in the borrow area located at the right upstream hilly area in the reservoir area. The specific gravity of this material is usually more than 2.6 and also the void ratio indicates generally ranging 0.2 to 0.4 when the recent heavy equipments such as the vibrating roller have been used during the compaction works. This material is suitable for the embankment of the upstream of shell zone in the dam, because of a high value of shearing strength around 40 degrees.

Filter and/Concrete Aggregate Material

The pervious material consisting of sand and gravel will be collected from the Hinlayagan river and the Kinanoan river about 12 km and 16 km far from the damsite respectively.

The material in both borrow areas has a good gradiation distribution curve suitable for the filter and is available without any problem.

3) Rock Material

The Dagohoy quarry site, the Cansudiao quarry site and Barangay Estaka quarry site will be proposed for the rock material. Dagohoy quarry site[1/] proposed in Phase I project will be most suitable. This rock shall be used for rip-rap material and toe rock of the dam.

The laboratory test for rock material in the Dagohoy quarry site was made in Phase I project and its result is as follows;

- Specific Gravity (Gr) : 2.70
- Absorption (W) : 0.2%
- Unconfined Strength (QU): 710 kg/sq.cm
- Elastic Strength (E) : 13,700 kg/sq.cm

d) Preliminary Design of Dam

1) Dam Foundation

The base rock in the Bayongan damsite consists of the consolidated and impervious siltstone, which is sufficient to prevent the seepage through dam foundation and support the dam body. The over-burden with a thickness less than two to three meters covers the base rock.

The stripping of one meter depth is planned in the entire area of dam base to remove the top soil and loose materials covered with vegetation. Core trench excavation is up to three to four meters from the original ground surface to remove the weathered rock layer so as to place the core material on a firm rock foundation.

Note; 1/ Hauling distance from the Bayongan Damsite is 12.5 km.

Foundation treatment such as grouting would be not necessary, because of the consolidated and impervious foundation. An impervious blanket in a small scale, however, is placed at the upstream foundation and connected to the core zone to prolong the seepage length instead of grouting works.

2) Dam Type and Standard Section

The dam of Bayongan is planned as a zone type fill dam with center core taking into consideration available material around the damsite with a short transportation distance and sufficient quantity for a dam height of 31 m.

Gravel hills are located in the proposed reservoir area and their materials consist of conglomerate which is the best suitable material for the shell zone of the dam.

The standard section of the Bayongan dam is shown in DRAWING NO.DA-3.

3) Spillway

The designed flood capacity of spillway has been estimated by the BPW's Formula with the "Extreme Line" (see Annex H).

Since the Bayongan dam has a large reservoir area of about 2.8 sq.km corresponding to one fourth of the catchment area, the big surcharge effect in the reservoir area for flood could be expected.

The flood routing analysis considering the surcharge effect in the reservoir area has been made as shown in Annex H, FIGURE H1-3.

As a result of the flood routing analysis, the spillway design capacity becomes considerably small as 20 cu.m/sec.

There are two possible locations for spillway, one is on the lowest saddle at the left abutment of the damsite and the other is on the right bank.

The spillway route on the left bank, however, has a disadvantage with a long distance tail race through the existing paddy field to release the spillwater smoothly to the Bayongan river. The spillway route on the right bank can easily connect to the Bayongan river and is more advantageous than that of the left bank.

The spillway is designed with the gateless weir with tapering chute, flip bucket and tail race. The layout of spillway is shown in DRAWINGS No. DA-4.

4) Intake Facilities

There are two alternatives for intake route, one is through intake facilities consisting of an intake tower and a conduit pipe embedded in the dam foundation, and the other is the facilities of a tunnel through the right abutment and an inclined intake placed on the mountain slope in the abutment.

Comparing the two alternatives, an intake constructed by a tunnel has the following advantages and can be made with cheap construction cost;

- In case of intake without tunnel, a conduit pipe with a diameter of 2.2 m has to be embedded at elevation 37.0 m on the right abutment of a steep slope. The excavation along the conduit pipe route requires a huge quantity due to the steepness of the slope. In addition, the intake tower connected to the conduit pipe and a bridge between tower and the right abutment are also required.

- An irrigation canal with a capacity of 9.74 cu.m/sec connected to the intake conduit pipe runs through the hilly foot of the right bank of the dam. This irrigation canal alignment requires a huge quantity of excavation and filling works, as well as crossing structures or syphons, since the alignment of the canal will pass through the hilly foot of a steep slope and cross two to three streams.

- In case of tunnel outlet, the spillway route is selected at the right bank and connected easily to the Bayongan river.

  In case of intake without tunnel, the spillway route should be placed on the left bank, because the spillway should cross the irrigation canal alignment and require the syphon structure with a high construction cost. The construction cost of spillway on the left bank, of course is higher than that on the right bank.

- The alternative plans and comparison of construction cost are shown in FIGURE 5-3.

The maximum intake capacity is designed with 9.74 cu.m/sec, which is taken by the inclined intake facility placed on the slope at the right abutment.

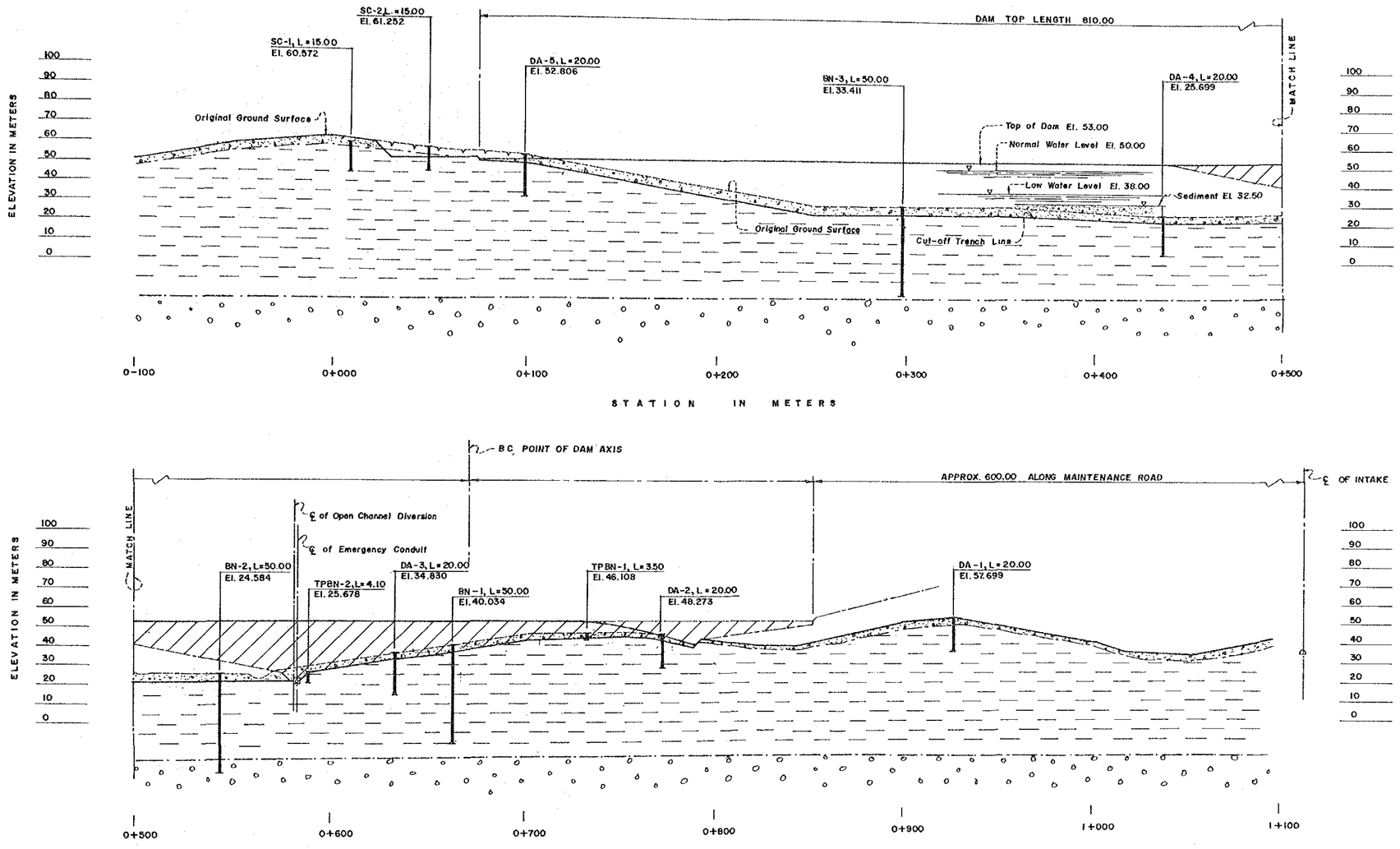
Since the maximum capacity of 9.74 cu.m/sec is required mostly on reservoir water level of 45 m, in accordance with the result of reservoir operation studies, two gates with a size of 900 x 900 mm are to be installed at the intake near the low water level.

The required water is taken under pressure flow through the gate openings and introduced into the tunnel. The tunnel is designed with a "Wagon hood type" having a height of 2.4 m and the

TABLE 5-1 SUMMARY OF TESTS RESULTS OF CONSTRUCTION MATERIALS

Material Name and Use of Resources	Capayas Dam: Impervious Material for Core, Damsite	Capayas Dam: Pervious M. for Filter, Ilaya River	Capayas Dam: Pervious M. for Riprap, Dagohoy	Capayas Dam: Gravel & Sand for Concrete, Ilay River	Bayongan Dam: Impervious M. for Core, Left Hillside of Dam	Bayongan Dam: Semi-pervious M. for Shell, Hills Upstm. Dam	Bayongan Dam: Pervious M. for Riprap, Dagohoy	Bayongan Dam: Gravel & Sand for Filter and Concrete, Hinlayagan
Physical Properties								
Classification	SC,CH,MH	GW, GP	Rock	GW, GP	CH, MH	GM, GC	Rock	GW, GP
Specific Gravity	2.54-2.76	2.60-2.64	2.70	2.60-2.64	2.46-2.75	(2.60)	2.70	2.61-2.69
N. Moisture Content	23-33%	-	-	-	27-42	N.A	-	-
Clay Content	15-32%	Negligible	-	Negligible	25-60	"	-	Negligible
Gravel Content	0-34%	87	-	87	0-6	"	-	77
Plastic Index	32-46	N.P	-	N.P	34-59	"	-	N.P
Loss by S. Sulfate	-	27.5%	N.A	27.5	-	-	N.A	8.2
Mechanical Properties	gr./cu.cm							
Max. Dry Density	1.50-1.61	(1.86)	(2.04)	-	1.36-1.49	(1.86)	(2.04)	(1.86)
Optimum M.C	20-23%	(10)	-	-	23-29	N.W.C. (10)	-	N.W.C. (10)
C by UU. Test	7.8 t/sq.m	(0)	(0)	-	9-11	(0)	(0)	(0)
Ø by "	7.5 deg.	(43)	(45)	-	12.5-20.5	(43)	(45)	(43)
C by CU. Test	-	-	-	-	1.2-2.1	-	-	-
Ø by "	-	-	-	-	18.0-27.0	-	-	-
Permeability	7×10^{-6} cm/sec	-	-	-		-	-	-
CC by Con. Test	0.15	-	-	-	0.28-0.29	-	-	-
UC. Comp. Strength	-	-	710 kg/sq.cm	-	-	-	710 kg/sq.cm	-

Note: Figures in parenthesis are temporarily assumed by the Study Team.



LEGEND

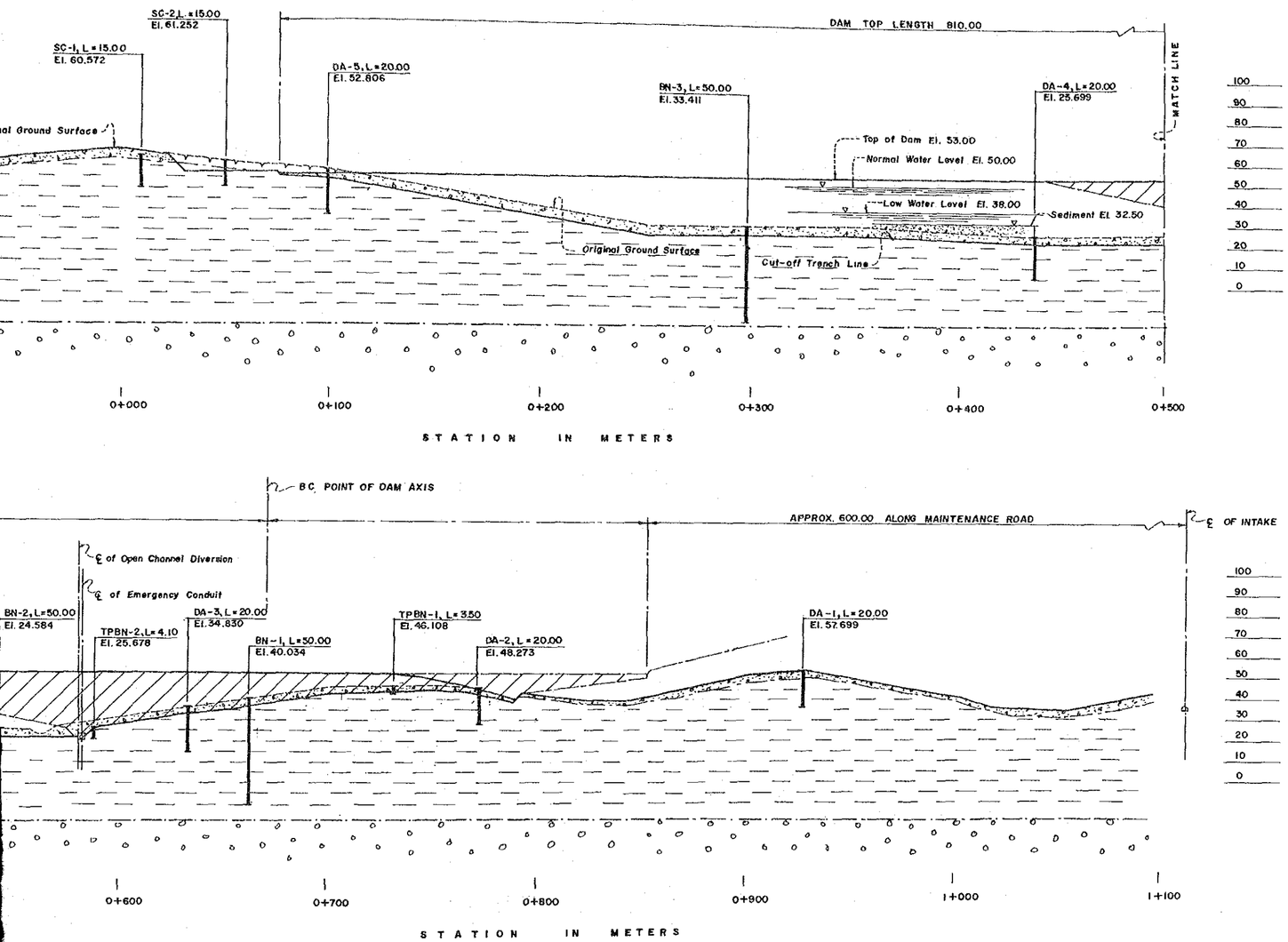
- Soil and weathered rock
- Alternation of siltstone and sand stone
- Conglomerate
- Geological contact line
- Drill holes

0 20 40 60 80 100 m

SCALE 1:1000

BAYONGAN DAM

FIGURE 5-1 GEOLOGICAL PROFILE ALONG DAM



LEGEND

- Soil and weathered rock
- Alternation of siltstone and sand stone
- Conglomerate
- Geological contact line
- Drill holes

0 20 40 60 80 100 m

SCALE 1:1000

BAYONGAN DAM

FIGURE 5-1 GEOLOGICAL PROFILE ALONG DAM AXIS

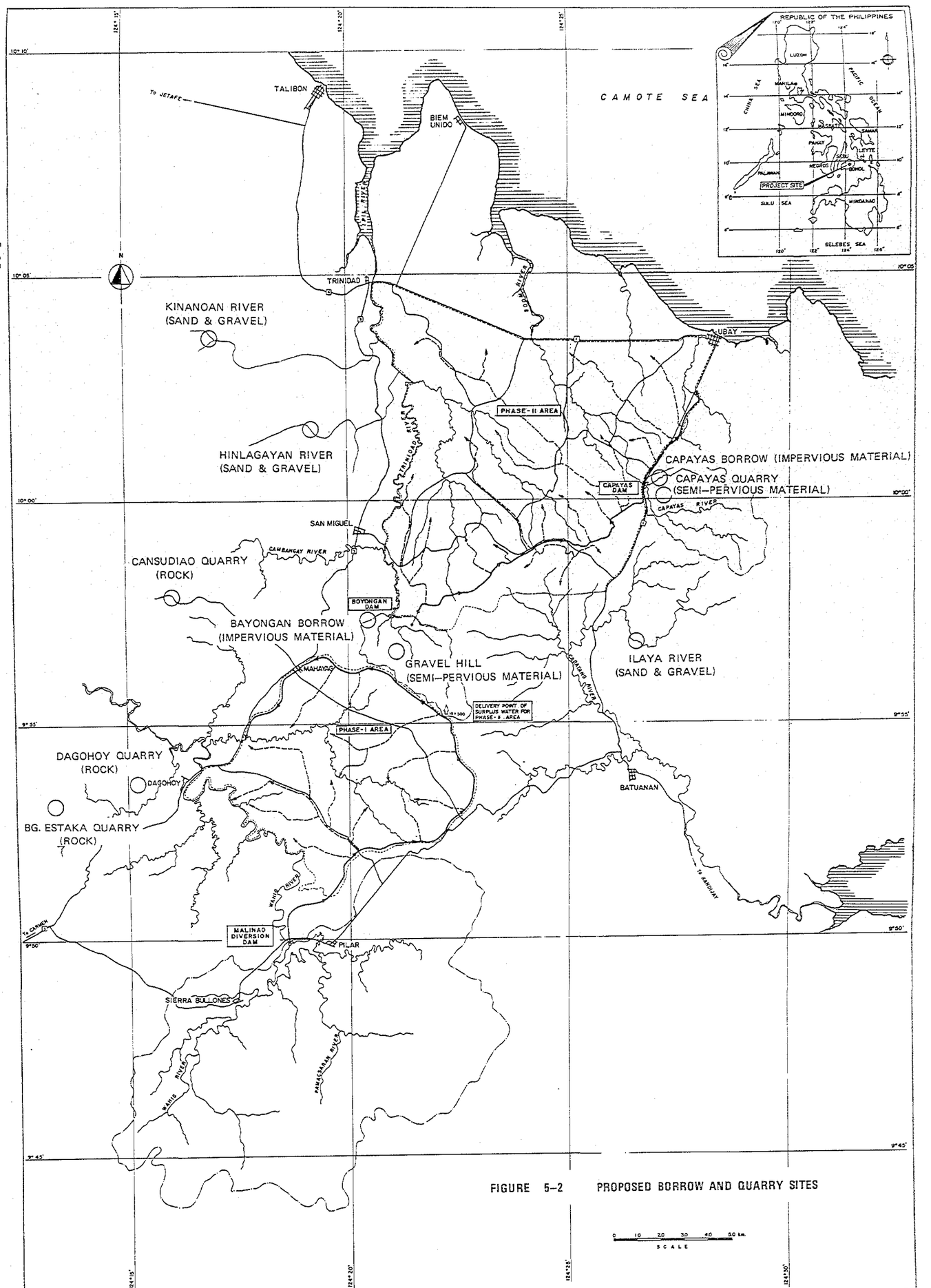
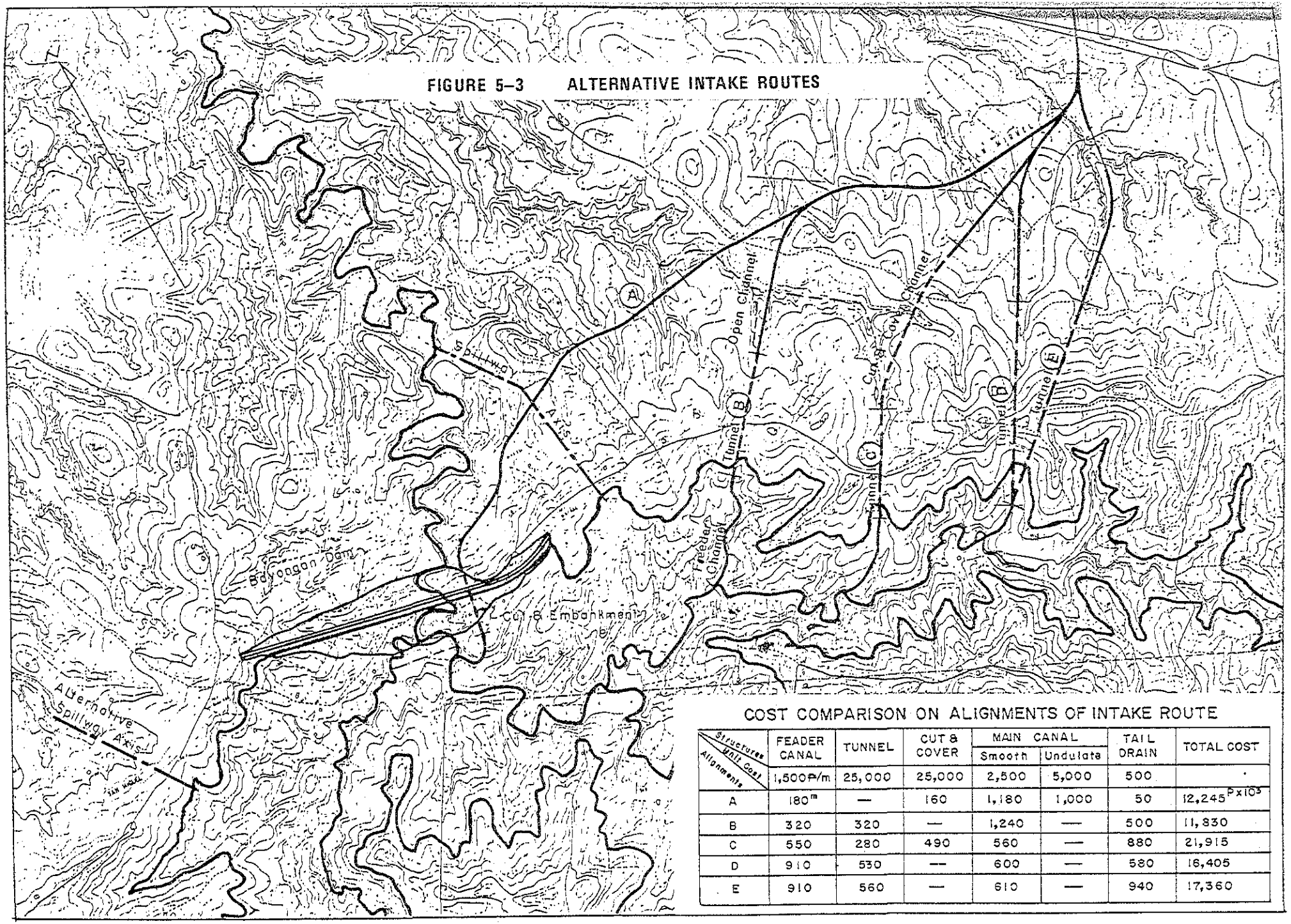


FIGURE 5-2 PROPOSED BORROW AND QUARRY SITES

FIGURE 5-3 ALTERNATIVE INTAKE ROUTES



COST COMPARISON ON ALIGNMENTS OF INTAKE ROUTE

Structures / Alignments / Unit Cost	FEADER CANAL	TUNNEL	CUT & COVER	MAIN CANAL		TAIL DRAIN	TOTAL COST
				Smooth	Undulate		
	1,500₱/m	25,000	25,000	2,500	5,000	500	
A	180m	—	160	1,180	1,000	50	12,245 P×10³
B	320	320	—	1,240	—	500	11,830
C	550	280	490	560	—	880	21,915
D	910	530	—	600	—	580	16,405
E	910	560	—	610	—	940	17,360

width of 2.0 m to release the maximum discharge capacity of 9.74 cu.m/sec under the free flow condition.

The layout of intake facility is shown in DRAWING No.DA-3.

5.1.3. Capayas Dam

a) Reservoir Plan

The Capayas damsite is located near the bridge, where the existing highway crosses the Bayang river. This site will have possibility for storage of the maximum capacity of 2.34 MCM and can utilize 60 to 70 percent of the Bayang river runoff although a long dike of about 1,150 m is required to keep the full water level of EL 34.0 m.

The damsite is covered with thin overburden with a thickness of two to five meters and consists of consolidated and impervious rock formation of siltstone, sandstone and conglomerate. It has no problem for seepage through dam foundation and as well as the bearing capacity to support the dam body.

The reservoir area and capacity of the dam is calculated on the basis of map with a scale 1:4,000 and shown in FIGURE 4-5.

In accordance with the reservoir capacity of 2.34 MCM in Capayas, the reservoir dimensions such as dam height, dam length, reservoir area etc. are shown in TABLE 5-2.

b) Topography and Engineering Geology

1) Topography

The proposed Capayas damsite is located at about six kilometers southwest of Ubay. The damsite is situated at the upstream of the Bayang river, a tributary of the Soom river.

The river traverses the damsite toward northwest and joins the Soom river at about 5.5 km downstream from the damsite in the vicinity of Tubog.

The river bed elevation is about 21 m at the damsite and its gradient is about 1/150.

The Capayas reservoir is surrounded by hills with the elevation of top hills of about less than 100 m, but the catchment area of 13.1 sq.km is surrounded by mountain area with elevation between 100 m and 425 m.

The topography of the damsite is formed with the river section having a narrow width of about 20 m at the elevation of 21 m and with both banks having a long distance of about 600 m respectively.

2) Engineering Geology

The foundation at the Capayas damsite is composed of sedimentary rock of Ilihan formation and the reservoir area consists of Ilihan formation, Malibalibod Volcanics Andesite and Aglomerate in the geological stratigraphy. The volcanic rock of Malibalibod volcanics unconformally overlies the Ilihan formation, and predominates in the topographically high land. The sedimentary rock forms hills less than about EL 40 m, but on the other hand the volcanic rock makes hills more than about EL 60 m. The contact of this rock is located at about 600 m on the upstream of the damsite, where the dip and strike of the sedimentary rock shows almost N10°E, 20°NW.

Three boreholes have been drilled along the dam axis and some water pressure tests have been also carried out. And six test pits have been excavated.

According to the result of investigation on the three boreholes drilled along the dam axis, the dam foundation is mainly composed of soft sedimentary rocks consisting of alternation of silt stone, mudstone, sandstone and conglomerate.

The foundation at the damsite is formed with a consolidated rock formation which presents 80 to 100 percent core recovery and 30 to 90 percent RQD. The overburden or weathered layer to be removed in dam construction is lying with thin layer of three to five meters below ground surface. Weathered rock layer corresponds with D to CL class but fresh rock belongs to CM class.

The permeability of base rock is less than 5 Lugeon value, so that the foundation treatment such as grouting work is not required in the Capayas dam with a low height of 17.0 m. The spoiled blanket, however, shall be settled up the river bank at the upstream of dam body instead of grouting works to prolong the seepage length.

The geological profile along dam axis is shown in FIGURE 5-4.

c) Construction Material

The borrow areas of earth, sand and gravel and the quarry sites surveyed by the Study Team and selected at the places as shown in FIGURE 5-2.

All borrow areas and quarry sites near the damsite can supply the material with a sufficient quantity for the dam embankment volume.

The laboratory tests for material samples taken from the borrow areas and quarry sites have been carried out and their physical and mechanical properties are shown in TABLE 5-1.

1) Earth Material

Impervious and semi-pervious materials are easily found at the borrow areas located on the both abutments of the damsite and the upstream area in the reservoir. The excavated materials at the intake and spillway structural site are also available as embankment material.

Earth material mainly consists of sandy clay and silty clay containing moderate weathered rock fragment and gravel, which are the most suitable materials for the earth fill dam.

As clear in TABLE 5-1, the earth material in the borrow areas presents rather high field moisture content, which should be controlled in the dam embankment.

The material itself belongs to class CH and MH consisting of fine particle size of clay and silt, so that the dam embankment should be made by using the earth material mixed with weathered rock and gravel as much as possible in order to obtain good compaction effort. The Capayas dam will be designed with homogenous earth fill type taking into account the plenty of earth material mixed with weathered rock and gravel and the dam height of 17 m at the maximum.

2) Sand and Gravel Material

The filter and concrete aggregate material was collected at the Ilaya river and its gradation presents a good distribution curve suitable for the filter material.

3) Rock Material

The riprap material is taken from the Dagohoy quarry site[1/]. The semi-pervious material is available at the existing quarry located on the upstream of the damsite and used presently for the paving material of road.

Note; 1/ Hauling distance from the Capayas damsite is 35 km.

d) Preliminary Design of Capayas Dam

1) Dam Foundation

The base rock at the damsite consisting of consolidated siltstone and conglomerate appears in the river bed but covered with overburden layer with a thickness of two to five meters in both abutment.

The dam base except core trench would be stripped with a depth of 0.5 to one meter to remove top soil with vegetation and loose surface layer.

The excavation of core trench should be extended up to the firm rock formation and its depth is approximately one meter at the river bed and five meters at maximum in both abutments of the dam.

With a maximum dam height of 17 m, no grouting works to improve the dam foundation are necessary due to the consolidated and impervious rock foundation.

2) Dam Type and Standard Section

The Capayas dam consists of a short section of about 20 m length having a height of 17.0 m reckoned from the river bed and a long section of about 1,150 m length of an earth dike with a height of five to ten meters.

Homogeneous dam type is adopted for the Capayas dam taking into consideration the low height dam and the availability of embankment materials. However, the downstream embankment zone at the river bed section is planned to be filled with rock material. The existing national highway bridge in the downstream toe of the dam could be used without replacement or any improvement.

The standard section of the Capayas dam is shown in DRAWING No.DA-7.

3) Spillway

The design flood capacity of the Capayas spillway has been estimated based on the formula prepared by Bureau of Public Works, the Philippines which was also checked by Creager formula and others.

The specific unit discharge has a high value of 28.6 cu.m/sec/sq.km corresponding to Creage's C value of 77. It is due to its small catchment area of only 14.6 sq.km. Hence the design flood capacity reaches 417 cu.m/sec.

The flood routing study, considering the surcharge effect in the reservoir area, has been made by using assumed hydrograph for various sizes of spillway. The flood routing study result is shown in Annex H, FIGURE H1-4 and the spillway design capacity is found to be 226 cu.m/sec.

The optimum spillway size is planned as the weir length of 60 m and the overflow depth of 1.5 m under the conditions of the design capacity of 226 cu.m/sec and non controlled overflow type is adopted.

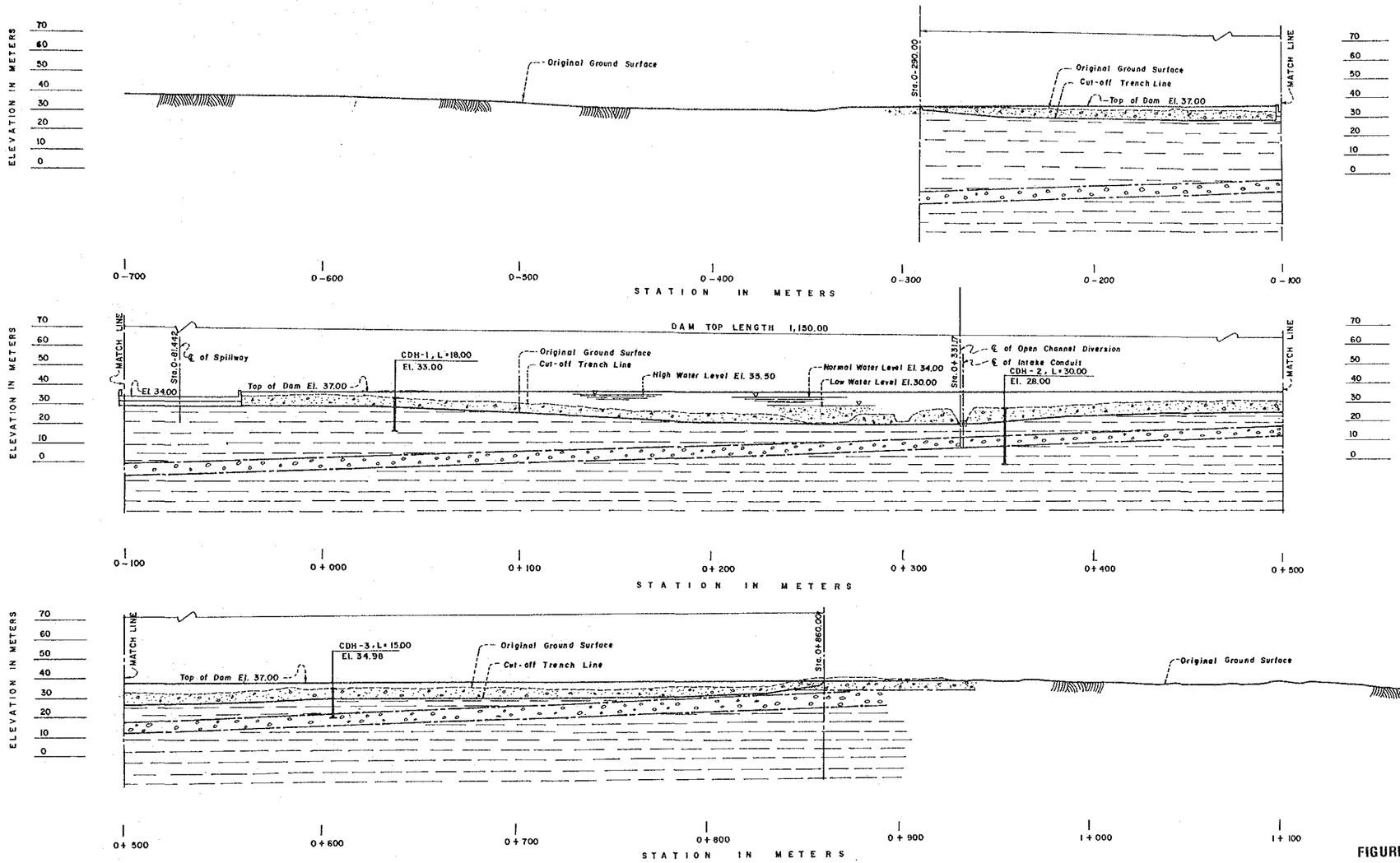
The spillway site has to be located at the left bank of the damsite, since the intake facility has to be installed in the right bank of the damsite in order to supply irrigation water to the Capayas system extending over the right side bank of the damsite.

The side channel chute is planned at the downstream portion of the overflow weir, since the flood discharge spilled from the weir should flow smoothly to the Bayang river.

The layout of spillway is shown in DRAWING No. DA-8.

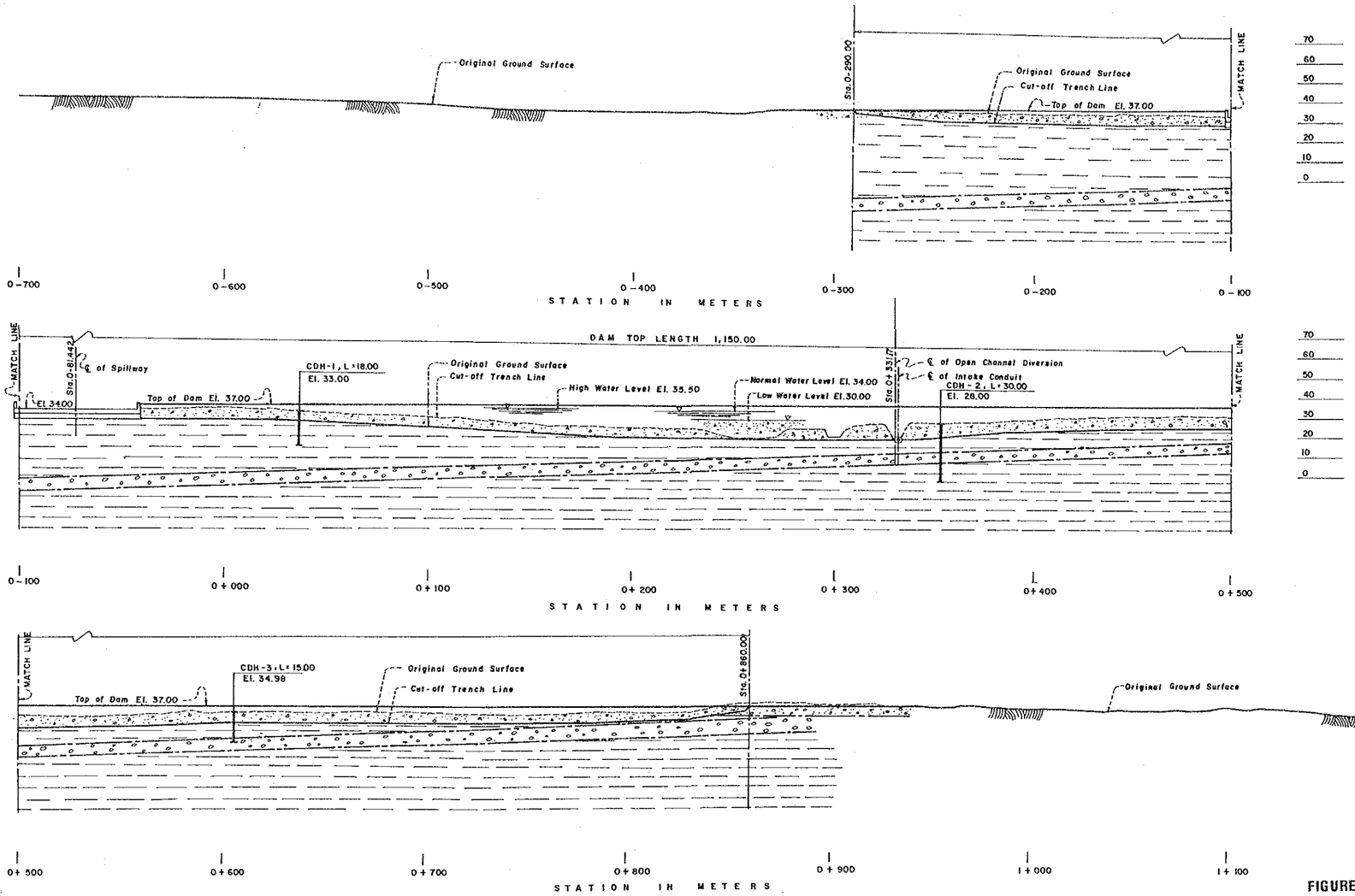
TABLE 5-2 OUTLINE OF RESERVOIR AND DAM

Description	Unit	Bayongan	Capayas
1. General			
Name of Basin		Bayongan	Capayas
Name of River		Bayongan Creek	Bayang
Base Rock Formation		Siltstone, Mudstone & Sandstone	Siltstone, Mudstone, Sandstone & Conglomerate
Catchment Area	sq.Km	11.2	14.6
Annual Mean Rainfall	mm	2,050	2,050
Annual Mean Runoff	MCM	10.29	10.99
2. Reservoir			
Reservoir Area	sq.Km	2.77	0.56
Total Reservoir Capacity	MCM	27.54	2.34
Effective Reservoir Capacity	MCM	22.48	1.63
Dead Water Capacity	MCM	5.06	0.71
High Water Level	m		35.50
Full Water Level	m	50.00	34.00
Low Water Level	m	38.00	30.00
Effective Water Depth	m	12.00	4.00
3. Dam			
Dam Type		Zone	Homogeneous
Dam Height	m	31.00	17.00
Dam Length	m	810.00	1,150.00
Dam Crest Width	m	7.00	6.00
Dam Crest Elevation	m	53.00	37.00
Embankment Volume	1,000 cu.m	1,126	233
4. Spillway			
Type		Chute	Side Channel
Design Flood Discharge	cu.m/sec	454.8	419.1
Design Flood Capacity for Spillway	cu.m/sec	20.0	226.0
Overflow Depth	m	0.60	1.50
Overflow Length	m	20.0	60.0
5. Intake Facilities			
Type		Tunnel	Conduit
Maximum Intake Capacity	cu.m/sec	9.74	2.13
Size of Intake	mm	2,400	1,300



CAPAYAS DAM

FIGURE 5–4 GEOLOGICAL PROFILE ALONG DAM AXIS



CAPAYAS DAM

FIGURE 5-4 GEOLOGICAL PROFILE ALONG DAM AXIS

4) Intake Facility

The intake facility is located at the right bank of the Bayang river and could be used as the river diversion during construction period.

The river diversion is planned as open channel at elevation 20 m to divert the river water smoothly. The intake facility is designed with the intake elevation of 30 m and the outlet elevation of 29 m, so that the conduit pipe should be installed in the bottom of diversion channel to take the reservoir water by syphon system.

The intake is designed with chimney type concrete structure.

The design discharge capacity of intake facility is 2.13 cu.m/sec at the maximum to cover the proposed Capayas irrigation system area of 1,160 ha.

The layout of intake facilities is shown in DRAWING No.DA-7.

5.1.4. Major Features of Reservoir and Dam

In accordance with the reservoir plan and preliminary design of dam, the reservoir and dam dimension are summarized in TABLE 5-2.

5.2. Irrigation and Drainage Networks

5.2.1. Main Canal

a) Topography and Engineering Geology

The project area is located in moderately undulated hilly area with elevation of 40 m to 5 m and is incised by narrow valleys developed along the streams flowing down from south to north.

Existing paddy field is extended over the lower area along the natural streams. In addition to these paddy fields, upland fields are existing in the hilly area. All the existing paddy and upland fields have no irrigation systems and relied mainly upon rainfall. As the other water resources, groundwater using the shallow well and stored water in the small scale ponds are used for irrigation and domestic uses. These facilities are constructed by the farmers themselves.

The soils in the project area belong to Ubay soil series and consist of slightly coarse-textured surface soil underlaid by loamy or clayey but contain a little amount of gravel in sub-soils.

b) Alignment of Main Canal

The project area is divided by the Soom-Bayang river into two irrigation systems, namely, Bayongan and Capayas systems. As a water source of each irrigation system, the Bayongan and Capayas reservoirs are provided at the upstream of the Trinidad and Bayang rivers, respectively.

The main irrigation canal to cover the Bayongan system area of 4,140 ha is placed between the Bayongan dam outlet and the Capayas reservoir, and runs in the southern border of the project area through a flat hilly area with the elevation of 40 m to 35 m. The water level of main canal is planned to be 37 m at the starting point of the Bayongan dam outlet and the 34 m at the terminal point of main canal in the Capayas reservoir. Total length of the Bayongan main canal is designed at 12.45 km with maximum discharge capacity of 9.74 cu.m/sec.

The main irrigation canal of the Capayas system area starts from the Capayas dam outlet and reaches near Ubay. The canal alignment is placed at the west border of the project area through

the moderately undulated hilly area having the elevation of 30 m to 25 m. The water level is 29 m at the Capayas dam outlet and 26 m at terminal point which is the head of lateral canal near Ubay. the Capayas main canal is planned at the total length of 3.27 km with maximum discharge capacity at 2.13 cu.m/sec and covers an area of 1,160 ha.

Both of main canals run mostly along the ridge area of hill and cross only a few streams. Canals are designed considering the balance of cut and fill volume portion, and excavated materials can be used for embankment portion of canals.

c) Design of Main Canals

On the basis of the most effective use of water and economical layout of irrigation facilities, the following concepts are adopted for the design of canals in accordance with the criteria prevailing in NIA.

Based on the peak irrigation water requirement of 1.422 lit/sec/ha in rice growing period, the design discharge for all the canals and the related structures are calculated. Excessive water during land soaking period will be delivered using the freeboard of canals. Canals are designed trapezoidal in shape with inside slopes 1:1 or 1:1.5, bottom width to water depth ratio (B/h) of 1 or 2 and berm width of same length as canal height. The inside slope and B/h ratio is determined by the canal design discharge.

All the main canals are lined with ten centimeters thiçkness of plain concrete to check seepage from the canal banks and bottom and to protect the canal section against erosion. Manning's Formula is used for calculation of the canal section with roughness coefficient of 0.015. Allowable velocity ranges from 0.5 m/sec to 1.0 m/sec and freeboard is determined 0.4 times of designed water depth.

d) Related Structures

Related structures to main canals include those structures of measurement and distribution, regulation, conveyance and protection purpose.

Distributing and Measuring Structure

Nine head regulators are provided to divert proper irrigation water amount from main canal to lateral canal. Neyrpit Orifice Module is installed as a measuring device of head regulator.

Regulating Structure

Seven checks are provided at the just downstream of each head regulator to maintain the required water level during the period of partial flow in the main canal. Sluice gates with a duckbill weir type of check is proposed for the main canal in order to secure the function of Neyrpit Orifice Module. A vertical drop of 1.5 m in terms of water surface, especially for the Capayas main canal, is designed to dissipate the excess energy in canal.

Related Structure

15 concrete bridges are installed to cross over the irrigation canal.

Protecting Structure

Four spillways of the side channel overflow type are installed to spill the excess water in the main canal. 28 cross drains are also provided at the places where canal runs across depressed area or natural small streams.

Operation & Maintenance Road

O & M road is provided along the canal except portions where existing road runs in parallel. O & M road of 6.0 m wide with gravel pavement of 4.5 m wide and 20 cm thick will be constructed on either side of canal bank.

5.2.2. Lateral and Sub-lateral Canals

a) Alignment of Lateral and Sub-lateral Canal

The alignment of lateral and sub-lateral irrigation canals are selected to flow at the higher place of hilly area in order to cover service units as much as possible by the gravity system.

The lateral canals run along the ridge area of peninsular shape formed by narrow valleys incised in the project area. When service units are located convexly apart from the lateral canal, sub-lateral canal will be branched off from the lateral canal.

Nine lines of laterals and 21 lines of sub-lateral canals with total length of 87.73 km are planned with a design discharge ranging from 3.15 cu.m/sec to 0.04 cu.m/sec.

The size of units commanded by a lateral canal varies from 160 ha to 1,700 ha consisting of 5 to 56 service units.

Irrigation diagram for the Bayongan and Capayas systems are shown in FIGURE 4-9 to FIGURE 4-10.

b) Design of Lateral and Sub-lateral Canals

All the lateral and sub-lateral irrigation canals are designed as trapezoidal shape of earth canal with inside slopes of 1:1.5, B/h ratio of two and berm of the same width as canal height. Manning's

Formula is used for calculation of the canal section with roughness coefficient of 0.025. Allowable velocity ranges from 0.3 m/sec to 0.8 m/sec and freeboard is determined at 0.4 times of design water depth with a minimum of 0.30 m whichever is bigger.

c) Related Structures

The lateral and sub-lateral canal system is planned with following structures;

Turnout

Turnouts are furnished to divert irrigation water from lateral to sub-lateral canal or lateral and/or sub-lateral canal to service unit. Constant head orifice is installed as a measuring device of turnout. Required number of turnout is aggregated at 162 places.

Check and Drop

Checks are provided at the just downstream of turnout. Two types of check; i) check cum drop and ii) sliding gate only are planned according to the site conditions. Vertical drops of 1.5 m or 1.0 m in terms of water surface are designed to dissipate the excess energy in canals. Required number of check and drop is 69 and 112 places, respectively.

Bridge, Pipe Crossing and Syphon

18 bridges, 140 places of pipe crossing and two syphons are installed to cross the irrigation canal over or under road, river and stream.

Spillway and cross Drain

Spillway of the side channel overflow type and cross drain are provided as a protecting structures of canal. Required

number is three for spillway and 97 for cross drain.

Operation & Maintenance Road

O & M road is provided along the canals except the section where the existing road runs in parallel. The road has 4.0 m wide road way having 3.0 m wide gravel surfacing of 20 cm in thickness.

DRAWING NO. CA-1 to NO. CA-10 present the canal alignment, profile of main and lateral canals and typical design of structures.

5.2.3. Drainage Canal

a) Drainage Networks

Drainage networks are planned taking into consideration location of natural streams, demarcation of drainage areas, unit drainage modulus and irrigation canal alignment.

Many natural streams and creeks flowing down from south to north direction will be available for the main drainage canal. These streams and creeks are situated at the lowest place in the project area and will have a sufficient drainage capacity.

The lateral drainage system will not be required generally, because the irrigation water or runoff water comes down the paddy field formed along the slope of hill by the plot to plot irrigation method and reach the streams. The lateral drainage canal will be planned at the lower area, where natural stream is indistinct and/or drain water from the proposed service units has to lead to existing stream due to set up a new irrigation system.

Total length of drainage canal is proposed at 49.0 km with 49 lines varying a designed discharge from 0.87 cu.m/sec to 0.09 cu.m/sec.

Drainage diagram is shown in FIGURE 4-13.

b) Design of Drainage Canals

The design discharge of drainage canals is obtained in compliance with the unit drainage modulus of 5.61 lit/sec/ha. Drainage canals are designed trapezoidal unlined section in shape with inside slopes of 1:1 and B/h ratio of 1. Manning's Formula is also used for hydraulic calculation with a roughness coefficient of 0.04. Allowable velocity varies from 0.3 m/sec to 0.8 m/sec.

As the related structures, drop is installed in canals which have steeper slopes than those needed to reach allowable velocities. Crossing structures for the road and drain outlet at the terminal point of canals will also be provided.

5.2.4. Major Features of Canals

The preliminary design of the canal systems is shown in the attached Drawings, and the major features of the canal systems are summarized in TABLE 5-3 for irrigation canal and in TABLE 5-4 for drainage canal.

5.3. On-farm Development Works

5.3.1. Typical Design of On-Farm Facilities

In order to materialize the concept of on-farm facilities in the plan, land parcelling and layout of on-farm facilities were planned in the two sample areas, based on the topographic map of

TABLE 5-3 OUTLINES OF IRRIGATION CANALS

Description	Unit	Bayongan System	Capayas System	Total
Irrigation Area	ha	4,140	1,160	5,300
No. of Service Unit	unit	112	33	145
Total Length of Canal	km	81.32	22.13	103.45
Main Canal	km	12.45	3.27	15.72
Lateral Canal*	km	68.87	18.86	87.73
Canal Density, Total	m/ha	19.60	19.00	19.50
Main Canal	m/ha	3.00	2.80	3.00
Lateral Canal*	m/ha	16.60	16.20	16.50
No. of Lateral	line	6	3	9
No. of Sub-Lateral	line	18	3	21
Maximum Design Discharge				
Main Canal	cu.m/sec.	9.74	2.13	-
Lateral Canal	cu.m/sec.	3.15	1.10	-
Canal Gradient				
Main Canal		1/7,000	1/3,000	-
Lateral Canal*		1/5,000-1/1,000	1/3,000-1/1,000	-
Length of Lining Section				
Main Canal	km	12.45	3.27	15.72
Related Structure				
No. of Head Regulator	place	6	3	9
No. of Turnout	place	126	36	162
No. of Check	place	62	14	76
No. of Drop	place	84	29	113
No. of Spillway	place	4	3	7
No. of Crossing	place	105	35	140
No. of Bridge	place	29	4	33
No. of Syphon	place	-	2	2
No. of Cross Drain	place	75	50	125
Length of O&M Road				
Main Canal	km	9.9	2.6	12.5
Lateral Canal*	km	52.0	16.0	68.0

* including sub-lateral canal

TABLE 5-4 OUTLINES OF DRAINAGE CANALS

Description	Unit	Bayongan System	Capayas System	Total
Irrigation Area	ha	4,140	1,160	5,300
Total Length of Canal	km	39.9	9.1	49
Canal Density	m/ha	9.6	7.8	9.2
No. of Canal	Line	43	6	49
Maximum Design Discharge	cu.m/sec.	0.81	0.87	-
Canal Gradient		1/3,000-1/500	1/2,000-1/750	-
Rerated Structure				
No. of Crossing	Place	63	16	79
No. of Drop	place	178	28	206
No. of Drain Outlet	place	43	6	49

1:2,000 in scale prepared by NIA and the results of field survey.

One sample area "A" is located on the northern part of the project area in the Capayas canal system, and the other "B" is on the eastern part in the Bayongan canal system. Each sample area is provided with an average topographic characters pervading over the project area.

The sample area "A" is located in Barangay Tuburan, in Ubay. The objective area is extended along the side slope which composed consisted of the part of a drainage area. The lateral canal will traverse along the objective area about two kilometers in length. Because of this topographic nature, the rotation area requires relatively high density of supplementary farm ditch and farm drain as well as farm road in the typical design as shown in DRAWING NO. OF-1.

The sample area "B" is located in Barangay Hambabaurau, in Ubay. The rotation area is located on the hills surrounded by creeks at three directions. The topographic condition gives a different feature in the layout of on-farm facilities resulting lower density of on-farm facilities than "A" sample area. The typical design of the rotation area is shown in DRAWING NO. OF-2.

The summary of on-farm facilities in the two sample areas is shown in following table:

Summary of On-farm Facilities in Two Sample Areas

Item	"A" Area	"B" Area	Total	Density (m/ha)
1. Location	Barangay Tuburan	Barangay Hambabauran		
2. Area (ha)				
Gross Area	50.6	64.4	115.0	
Irrigated Area	29.6	46.1	75.7	
3. Major On-farm Facilities				
Main Farm Ditch (m)	510	720	1,230	16.2
Supplementary Farm Ditch (m)	1,930	2,060	3,990	52.7
Farm Drain (m)	2,620	1,560	4,180	55.3
Farm Road (m)	2,280	1,520	3,800	50.2
Appurtenant Structure				
Turnout	1	1	2	
Division Box	2	3	5	
Drops	10	7	17	
Road Crossing	8	14	21	
4. Number of Rotation unit	4	5	9	
Average Area per Unit	7.4	9.2	8.4	

5.3.2. On-Farm Facilities

On-farm facilities and the functions are outlined as follows:

Turnout : Intake facilities of a rotation area provided with water control and measurement functions,

Main farm ditch : A water supply system which conveys water from the turnout to supplementary farm ditch,

Supplementary farm ditch: The terminal water distribution system to supply water to farm lots,

Division box : Check structure provided at the head of the supplementary farm ditch to divert water into two flows in proportion to each size of service area,

Farm drain	:	Drainage system mostly planned to remove excess water from present paddy field,
Cross culvert	:	Road crossing structure of ditches,
Check and drop	:	Drop structure to alleviate the slope of ditches,
Farm road	:	Road network provided for the convenience of farm management and operation and maintain of the facilities.

DRAWING NO. OF-3 and NO. OF-4 show the standard design of on-farm facilities.

5.4. Cost Estimation

5.4.1. Condition of Cost Estimation

The project cost is estimated under the following conditions.

i) The civil works are constructed on the contract basis. The construction machinery and equipment required for construction will be provided by the contractors. Therefore, only depreciation costs of machinery and equipment are included in the estimated construction cost.

ii) The project cost consists of construction cost and associated cost. Component of the project cost is shown in Annex J, FIGURE J2-1.

iii) The exchange rate between Philippine Pesos and U.S. Dollar is fixed as follows.
US$1.00 = 18.0 Philippine Pesos.

iv) The Physical contingency related to the construction and associated cost is set at 15 percent of the direct cost. The price contingency is predicted at 6.0 - 9.0 percent for foreign currency and 8.0 - 20.0 percent for local currency. Details are shown in Annex J.

5.4.2. Construction Cost

a) Basic Rate

The basic rate of labor, material and construction equipment is estimated considering the prevailing rate in the Philippines. Detailed basic rate is shown in Annex J, TABLE J2-1 to J2-7.

b) Unit Cost

Unit cost of construction work is calculated, according to the proposed items which are classified by construction method since the construction is executed on the contract basis with the overhead of 25 percent against the unit rate are considered. Estimated unit costs are summarized in Annex J, TABLE J2-8 and detailed data are shown in Data book of the report.

c) Construction Cost

The construction cost is divided into foreign and local currency portions. Local currency portion is estimated on the basis of the current prices in Manila in 1985 and foreign currency portion is estimated on the CIF prices in Manila. Construction cost is estimated based on unit cost for individual working items. The summary is shown in Annex J, TABLE J2-9 and the breakdown is shown in Annex J, TABLE J2-10 to J2-13.

5.4.3. Associated Cost

Associated cost is composed of five items, such as on-farm development cost, land acquisition & compensation cost, engineering including the consulting services & administration cost, O & M cost and pilot arm cost. The breakdown of each items is shown in Annex J, TABLE J2-14 to TABLE J2-18.

5.4.4. Project Cost

a) Project Cost

The project cost is estimated at ₱658 million of which ₱400 million is foreign currency and ₱258 million is local currency. The summary of the project cost is shown in TABLE 5-5.

b) Annual Disbursement Schedule

The annual disbursement schedule of the project cost is based on the project implementation schedule, and the summary is presented as follows;

Annual Disbursement Schedule

(Unit: ₱'000)

Year	Foreign Currency	Local Currency	Total
1987	18,600	7,900	26,500
1988	10,100	10,100	20,200
1989	88,900	59,500	148,400
1990	110,500	73,000	183,500
1991	128,000	80,800	208,800
1992	43,900	26,700	70,600
Total	400,000	258,000	658,000

TABLE 5-5 THE PROJECT COST

(Unit: ₱'000)

Description	Foreign Currency	Local Currency	Total
1. Construction Cost			
a) Preparatory Work	2,000	1,700	3,700
b) Capayas System			
° Dam Works	16,900	8,300	25,200
° Canal Works	8,700	4,600	13,300
° Land Leveling	3,000	1,300	4,300
° (Sub-Total)	28,600	14,200	42,800
c) Bayongan System			
° Dam Works	81,100	33,800	114,900
° Canal Works	42,700	23,700	66,400
° Land Leveling	12,700	5,400	18,100
(Sub-Total)	136,500	62,900	199,400
Total	167,100	78,800	245,900
2. On-farm Development Cost	14,300	7,300	21,600
3. Land Acquisition, Compensation and Resettlement Cost	0	4,500	4,500
4. Engineering & Administration	35,000	7,900	42,900
5. O & M Equipment	6,300	800	7,100
6. Pilot Farm	3,800	0	3,800
7. Total (1 - 6)	226,500	99,300	325,800
8. Physical Contingencies	34,500	14,700	49,200
9. Total (7 - 8)	261,000	114,000	375,000
10. Price Escalation	139,000	144,000	283,000
11. Grand Total	400,000	258,000	658,000

CHAPTER VI. PROJECT IMPLEMENTATION AND OPERATION

CHAPTER VI. PROJECT IMPLEMENTATION AND OPERATION

6.1. Project Implementation

6.1.1. Executing Agency of the Project

The executing agency of the project will be National Irrigation Administration (NIA), which has a sufficient capability and deep experience in carrying out the detailed design, construction of civil works and operation and maintenance of the completed facilities of the project.

NIA will execute the detail designed for major project facilities recruiting a consulting firm, the construction contracting with a competent contractor and the operation and maintenance guiding the irrigators' association.

The organization of NIA is shown in FIGURE 6-1. In this organization, the detailed design works are carried out by the Design and Specification Department, construction by the Construction Department and operation and maintenance by the System Management Department.

6.1.2. Financing

The foreign currency portion of the project will be financed by the international financing institute while the local currency portion will be provided by the Philippine Government.

6.1.3. Construction Mode

A qualified contractor to construct the civil works of the project will be also selected by the international competitive bidding. The on-farm works except land levelling works will be made by farmers association newly established in the service area under the technical guidance by NIA, Office of Operation.

Of course, some complicated works such as turnout, drop and crossing structures might be constructed by NIA administration to provide construction equipment and materials except labor forces.

The operation and maintenance works of the project facilities will be made directly by NIA, O/M staff together with farmer's association. NIA will provide necessary equipments of O/M prior to competition of construction works.

6.1.4. Preparatory Works

Preparatory works are composed of survey and investigation works for the detailed design stage and site facilities for administration of the project implementation.

Though the topographical map with a scale of 1:4,000 covering the whole project area and geological investigations at the proposed damsite which had been provided during the Feasibility Study will be useful.

Therefore, additional survey and investigation works necessary for the detailed design will be limited in the items shown in Annex L.

The site facilities for the project administration will be completed by NIA, before commencement of the project construction. The proposed facilities are shown in Annex J.

6.1.5. Administration Office

The organization of NIA project implementation office is proposed as shown in FIGURE 6-2, taking into consideration administrative and engineering works at the project site office during construction period. Machinery and equipment for the administration are shown in Annex J.

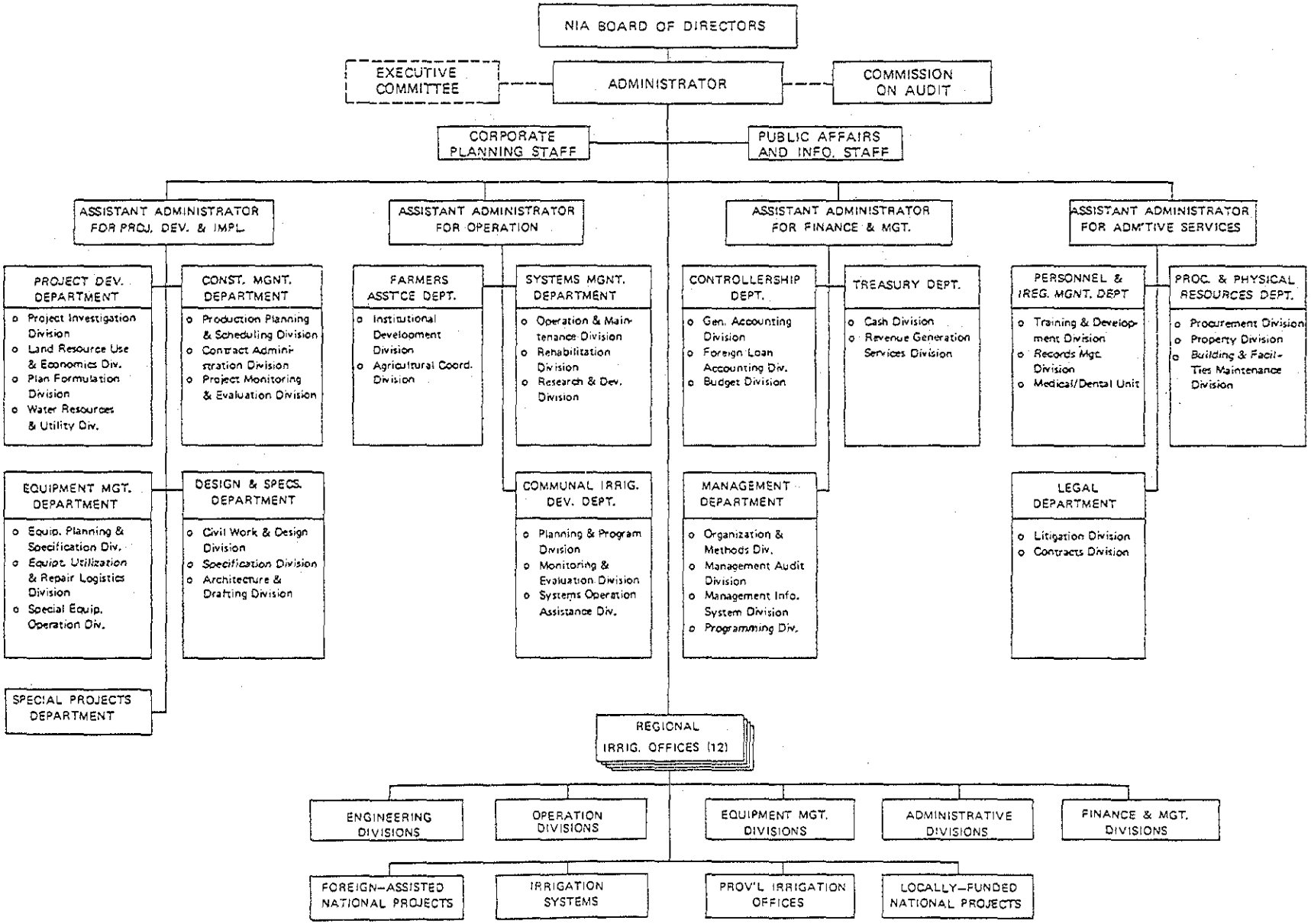
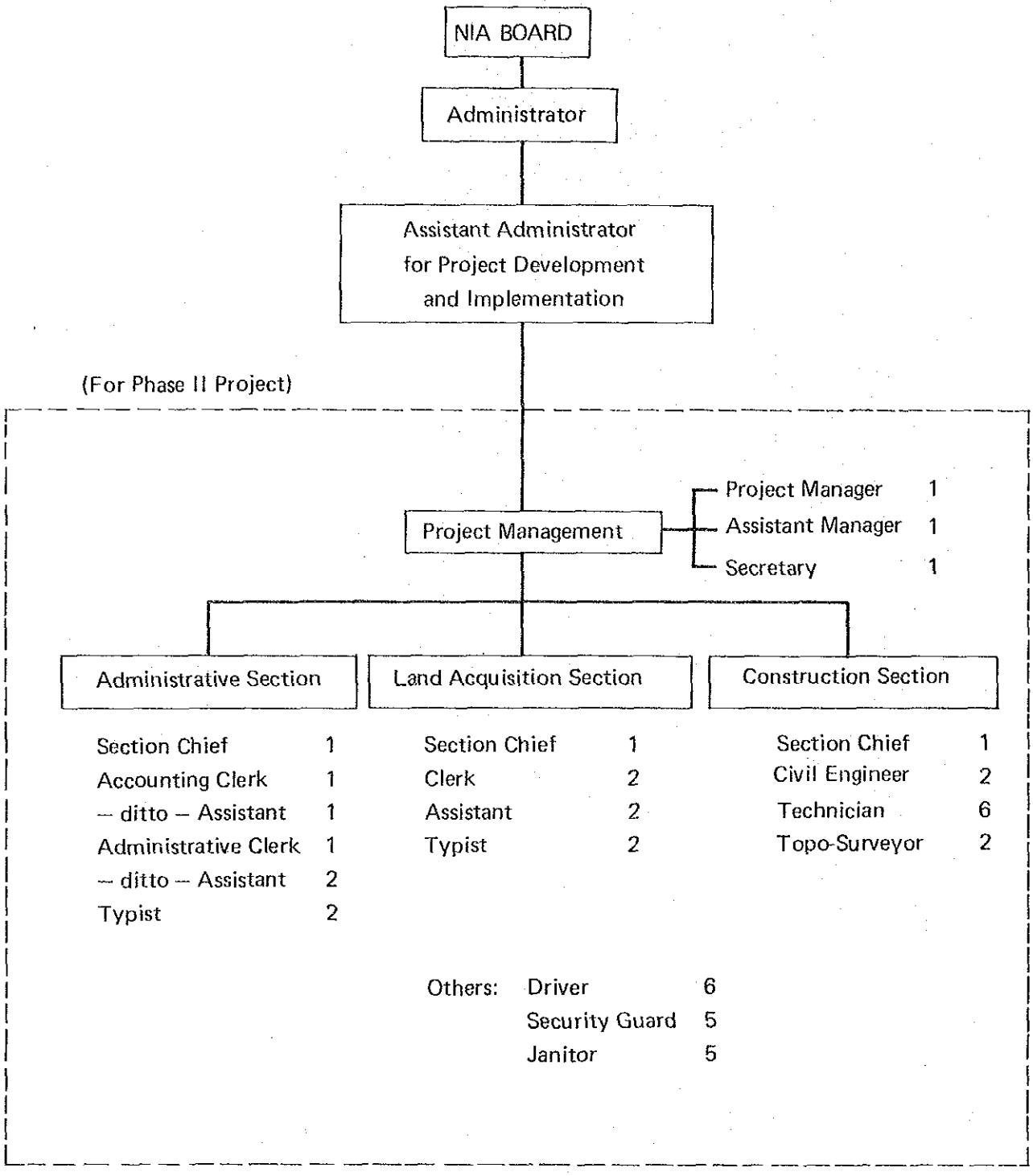


FIGURE 6–1 ORGANIZATION CHART OF NATIONAL IRRIGATION ADMINISTRATION

FIGURE 6-2 PROPOSED ORGANIZATION OF PROJECT IMPLEMENTATION



6.1.6. Consulting Services

NIA engineering staff could have an ability to carry out the detailed design and construction for the ordinary structure in the proposed project facilities. The Consulting Services will be required for the specific items to assist the NIA engineering staff.

The total man-months of consulting staff to be engaged in the detailed design and construction supervision are estimated on the assistant basis of NIA engineering staff as shown in Annex J and summerized as follows;

Man-Month of Engineer	Detailed Design Stage	Construction Supervision Stage
1. Consultant		
Foreign Expert	70	90
Local Expert	25	60
2. NIA Staff	95	396
Total	190	546

6.1.7. Land Acquisition and Compensation

Land acquisition in the reservoir area and along the canal alignment will be undertaken by NIA before starting of construction works.
The detail is shown in Annex J.

6.2. Construction Plan

6.2.1. General Construction Method

a) Temporary Works

The contractor's camp office, access road, tentative diversion of the river for dam construction, provision of borrow area,

drainage during construction etc., will be made as temporary works by the contractor.

b) Working Hours and Days

The construction works are planned to be carried out in one shift with net working hour of 6.5 hr/day and 25 working day/month, except the embankment and fill of earth works which will be carried out with 15 to 20 working days per month due to suspension by rainfall.

c) Available Construction Material at Site

i) Earth Material in Bayongan Dam

The Bayongan dam is planned with a center core type earth dam and requires the impervious core materials of about 274,000 cu.m. The embankment materials are collected from the borrow area located at hilly area with elevation of 40 to 60 m in the left bank of damsite. The materials are easily taken by bulldozer pushing along the slope and transported to the embankment site within a distance of about 300 m.

The materials in the borrow area have high field moisture content due to high ground water level, so that trenches along the slope of the borrow area should be provided during construction period to make ground water level lower and get optimum field moisture content for core material.

ii) Earth Material in Capayas Dam

The Capayas dam is planned with a homogeneous earth type dam and requires the embankment volume of about 230,000 cu.m. The embankment earth materials are mostly collected from the borrow area near damsite and with a transporting distance less than 200 m, and are selected from the excavated material of dam foundation, spillway and intake structures.

iii) Filter Material in Both Dams

Filter materials are consisting of sand and gravel with a designed grain size distribution. This material is not found near both damsites of Capayas and Bayongan, but at a place along the Hinlayagan river located at nine kilometers far from both damsites.

The deposit of sand and gravel materials in the river are extending over 3 km long and 30 m wide, and will be sufficient for the embankment of filter zones with total volume of about 99,000 cu.m for both dams.

iv) Shell Material in Bayongan Dam

The shell material in the Bayongan dam is found at the borrow area located at the upstream hilly area and two kilometers far from the damsite. This material consisting of weathered rock, sand and gravel including silt and clay materials and most suitable for the shell embankment material having a function of semipervious zone. This semi-pervious material is used for both shell zones on the upstream and the downstream.

The excavated materials from dam foundation, spillway and intake structures will be also available for the downstream shell zone mixing with semi-pervious material taken from the borrow area as mentioned in the above.

v) Rock Material

Rock material is used for the riprap on the upstream slope and also for the toe embankment at the downstream of dam. The rock material should be hard and solid to protect dams from erosion in the reservoir and to fulfill a function to release seepage water through dambody smoothly at top portion, so that the rock material should be collected from Dagohoy quarry site.

Since the Capayas dam is a small scale as compared with the Bayongan dam, the riprap material and the toe material are not required so hard and solid. The riprap material is expected to be taken from the quarry site near the damsite and the toe material from the borrow area having a coarse random material at the upstream.

vi) Concrete Aggregate

Concrete aggregate material such as sand and gravel is collected at the deposited area of the Hinlayagan river, where the filter material is also taken.

vii) Embankment Material of Canal

The excavated material in canal is sufficiently available for the embankment materials.

6.2.2. Construction Method of Bayongan Dam

a) Work Volume

The work volume of Bayongan dam construction is as follows:

Stripping	:	72,000 cu.m
Trench Excavation	:	31,000 cu.m
Dam Embankment	:	1,126,000 cu.m
Spillway Excavation	:	80,000 cu.m
Spillway Concrete	:	1,800 cu.m
Intake Tunnel	:	320 m
Intake Excavation	:	27,000 cu.m
Intake Concrete	:	1,000 cu.m
Gate & Valve Installation	:	L.S.

b) Dam Embankment Works

Dam embankment is made for core, filter and shell zone after stripping of all dam foundation and excavation of core trench.

The dam embankment is commenced at the left bank diverting river water on the right bank with an open channel, and then the right bank embankment should be performed in dry year diverting a small discharge into the conduit pipe installed in the foundation of right bank as shown in the following figures;

The embankment material is transported from each borrow area and compacted under the following criteria;

Zone	Spreading Thickness	Number of pass	Compaction Equipment
Core	20 cm	8	Tamping Roller 8-10 ton
Filter	30 cm	5	Vibrating Roller 3-5 ton
Shell	30 cm	5	-ditto- 8-10 ton

The embankment progress is planned as follows;

Zone	Embankment Volume	Performance per Month	Construction Period
Core	274,000 cu.m	8,000 cu.m/month	32 month
Filter	98,000 cu.m	3,500 cu.m/month	28 month
Shell	760,000 cu.m	30,000 cu.m/month	24 month

The performance of embankment works is planned as follows:

Zone	Distance from Borrow Area	Performance per Month
Core	500 m	70 cu.m/hr x 7.0 hr/day x 22 days = 10,000 cu.m
Filter	9,000 m	20 cu.m/hr x 7.0 hr/day x 25 days = 3,500 cu.m
Shell	2,000 m	90 cu.m/hr x 7.0 hr/day x 25 days x 2 units = 30,000 cu.m

c) Spillway Works

The spillway works in the Bayongan dam are a scale with excavation of 80,000 cu.m and concrete of 1,800 cu.m, and can be carried out at any time without any interruption of other works such as dam embankment and intake structure works.

The concrete works will be made at the section of chute and overflow weir separately and with the concrete mixing plant provided at the weir site and the concrete pump. The pipe to deliver the concrete by concrete pump is installed along the chute of spillway.

d) Intake Works

The intake works consist of tunnel with a section area of 9.5 sq.m and intake works placing the gate and valve at the right abutment slope. Construction period will be about one year as shown follows:

Works	1	2	3	4	5	6	7	8	9	10	11	12
Excavation, 320 m												
Invert Concrete, 320 m												
Area & Side Concrete, 320 m												

The intake works consist of the inclined concrete base to install spindles of gate and intake structure to facilitate the gate will be made in parallel with the tunnel works or a little later than tunnel works.

The gate itself will be installed at the end of dam construction stage before storing water in the reservoir.

The detailed construction schedule is shown in FIGURE 6-3.

6.2.3. Construction Method of Capayas Dam

a) Work Volume

The work volume of the Capayas dam construction is as follow:

Stripping	:	36,000 cu.m
Trench Excavation	:	16,000 cu.m
Dam Embankment Volume	:	233,000 cu.m
Spillway Excavation	:	26,000 cu.m
Spillway Concrete	:	2,600 cu.m
Intake Excavation	:	9,500 cu.m
Intake Concrete	:	850 cu.m
Outlet Gate	:	L.S.

b) Dam Embankment

A homogeneous earthfill type dam is designed so that any available material from the borrow area located in the upstream of the reservoir can be used. After providing the river diversion with an open channel on the right bank and completion of excavation, the embankment is commenced from the river bed section. The dam embankment criteria are the same as mentioned in the Bayongan dam. The section of both side banks except the river bed is embanked with only five to ten meters high as the dike, so that this section embankment can be made at any time.

c) Spillway and Intake Structures

The construction works of spillway and intake structures can be made in parallel with the embankment works. The only river diversion provided on the right bank should be made at the beginning stage of construction.

6.2.4. Irrigation and Drainage Canals

a) Work Volume

The work volume of irrigation and drainage canals is calculated as follows:

Item		Bayongan System	Capayas System	Total
Main Irrigation Canal				
Stripping	(cu.m)	9,500	5,700	15,200
Excavation	(cu.m)	217,300	8,400	279,700
Embankment	(cu.m)	12,000	7,400	19,400
Concrete Lining	(cu.m)	11,900	1,500	13,400
Struc. Concrete	(cu.m)	600	100	700
Gate	(place)	22	4	26
Lateral Irrigation Canal				
Stripping	(cu.m)	60,500	27,300	87,800
Excavation	(cu.m)	172,100	26,800	198,900
Embankment	(cu.m)	132,000	74,100	206,100
Struc. Concrete	(cu.m)	2,000	600	2,600
Turnout Gate	(place)	179	47	226

Item		Bayongau System	Capayas System	Total
Drainage Canal				
Excavation	(cu.m)	18,500	24,500	43,000
Embankment	(cu.m)	500	300	800
Reinforced Concrete	(cu.m)	2,000	500	2,500
Grouted Masonry	(cu.m)	700	200	900

b) Canal Works

The most of canal alignment is located at the top of hill with a flat area, so that excavation and fill of earth works are only made by bulldozer without any transportation. The concrete lining works are made by dividing into several working sections and placed by mixers with a small capacity provided in each section.

6.2.5. On-Farm Development Works

a) Work Volume

The model areas of about 200 ha in total were selected for the typical design of on-farm facilities in the project area. On the basis of the results of it design, the work volume of on-farm works is estimated. The on-farm works consist of land leveling, farm roads, farm ditches, drains and related structures. Required of on-farm works are tabulated below;

Item		Bayongan System	Capayas System	Total
1. Land Leveling Works	(ha)	2,910	690	3,600
2. On-farm Works	(ha)	4,140	1,160	5,300

b) Land Leveling

Land leveling including plowing of cutting portion is made using a bulldozer for the existing upland field and grass land having a slope two percent on average.

c) On-farm Facilities

These works will be carried out by farmer's association under administration of the NIA office.

6.2.6. Construction Schedule of Civil Works

The construction schedule of Phase II project will be determined taking into consideration construction schedule of Phase I, since irrigation water delivers to the proposed Bayongan reservoir through the main canal constructed during Phase I project.

The construction works of Phase II will be commenced one year before the completion of construction work in Phase I project. The construction of the Capayas system will be finished with construction period of about one and half years, because the Capayas service area would be developed as model agriculture area in early stage of Phase II project.

The Bayongan system will be completed within three years from the beginning of construction stage.

The summary of construction schedule of the project is shown in FIGURE 6-3.

6.3. Implementation Schedule of the Project

The construction of the major works will be commenced from about three years after the completion of the Feasibility Study taking into consideration the loan procedures, detailed design and bidding for contract.

The construction of major works will be completed within about one and half years for the Capayas system and about three years for the Bayongan system. The on-farm works will be commenced in parallel with the major works to supply water immediately after the completion of the major works. The implementation program for the project is shown in FIGURE 6-4.

FIGURE 6–3 CONSTRUCTION SCHEDULE

Description	Quantity
A. Capayas System	
1. Capayas Dam	
○ Temporary Work	
○ Dam Work	1/ 233,000 cu.m
○ Spillway Work	2/ 2,600 cu.m
○ Intake Work	3/ 850 cu.m
2. Irrigation & Drainage Canal	
○ Main Canal	3/ 8,400 cu.m
○ Lateral Canal	4/ 74,100 cu.m
○ Drainage Canal	3/ 24,500 cu.m
3. On–farm Work	
○ Land Leveling	690 ha
B. Bayongan System	
1. Bayongan Dam	
○ Temporary Work	
○ Dam Work	1/ 1,159,000 cu.m
○ Spillway Work	2/ 1,800 cu.m
○ Intake Work	5/ 27,000 cu.m
2. Irrigation & Drainage Canal	
○ Main Canal	3/ 271,300 cu.m
○ Lateral Canal	3/ 172,100 cu.m
○ Drainage Canal	3/ 18,500 cu.m
3. On–farm Work	
○ Land Leveling	2,910 ha

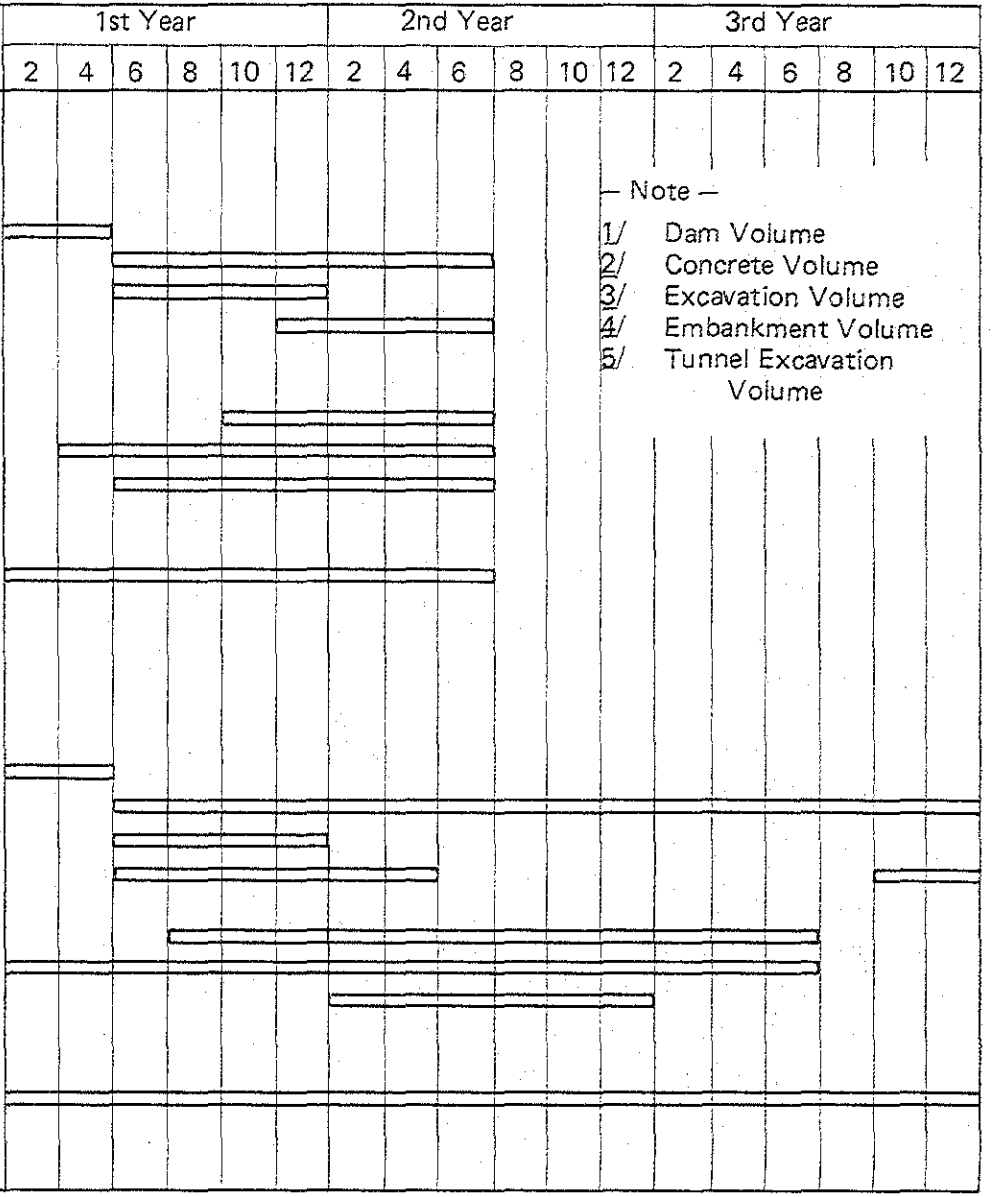


FIGURE 6-4 IMPLEMENTATION PROGRAM FOR THE PROJECT