TABLE G3-16 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

TABLE G3-17 PROJECTED POPULATION AND NUMBER OF FARM IN THE PROJECT AREA (2000)

Item	Total	San Miguel	Trinidad	Ubay
1. No. of Barangay	22	5	6	11
2. 1980 Population	10,870	2,878	3,215	5,777
3. 1980 No. of Household	2,117	540	496	1,081
4. 1980 No. of farm	1,826	511	410	905
5. 1987 Population (1.6%/year)	12,086	3,200	2,463	6,423
6. 2000 Population (0.9%/year)	13,573	3,594	2,766	7,213
7. 2000 No. of farm	2,280	638	512	1,130

Note: (1) The 1987 and 2000 population were projected on the base of population growth rates indicated in the parenthesis.

(2) The number of farm households in 2000 was projected on the base of population increase rate from 1980 to 2000.

TABLE G3-18 FARM OPERATION METHOD OF RICE CULTIVATION

Plowing	Harrowing & Leveling	Trans-planting	Spraying	Weeding	Harvesting	Threshing	Drying	Hauling
1. 4-wheel Tractor + Draft Animal								
4-wheel Tractor (Rotary) —	Draft Animal (Harrow & Leveler) —	Manpower —	Manpower (Hand Sprayer) —	Manpower (Rotary Weeder) —	Manpower (Sickle) —	Power Thresher —	Sunshine & Dryer —	Draft Animal (Cart)
2. Power Tiller								
Power Tiller (Plow) —	Power Tiller (Harrow & Leveler) —	Manpower —	Manpower (Hand Sprayer) —	Manpower (Rotary Weeder) —	Manpower (Sickle) —	Power Thresher —	Sunshine & Dryer —	Power Tiller (Trailer)
3. Animal Power								
Draft Animal (Plow) —	Draft Animal (Harrow & Leveler) —	Manpower —	Manpower (Hand Sprayer) —	Manpower (Rotary Weeder) —	Manpower (Sickle) —	Pedal Thresher —	Sunshine —	Draft Animal (Cart)

Note: (1) The farm operation method of the direct seeded rice is the same as the above method except for the operation of seeding
(2) No. of passing of plowing, first harrowing and final harrowing are indicated in Table 1.

TABLE G3-19 CAPACITY AND EFFICIENCY OF MACHINERIES/ANIMAL BY OPERATION

Operation/Machinery & Animal	Ope. Width (1) (m)	Ope. Speed (2) (km/hr)	Theoretic Ope. Capacity (3) (ha/hr)	Field Efficiency 1/ (4) (%)	Field Ope. Capacity (5)=(3)x(4) (ha/hr)	Ope. Efficiency (6) (%)	Actual Ope. Capacity (7)=(5)x(6) (ha/hr)	Hours per ha (8) (ha/hr)	Ope. Times (9) (Time)	Hours per ha (10)=(9)x(8) (ha/hr)	Ope. Hours per day (11) (hr/day)	Days per ha (12)=(9)/(11) (day/ha)
1. Plowing, Carabao W/Plow	0.12	2.2	0.026	84	0.022	70	0.015	66.7	1	66.7	8	8.4
2. Plowing, Power Tiller W/Plow	0.24	4.3	0.103	84	0.087	80	0.070	14.3	1	14.3	8	1.8
3. Plowing, 4-wheel Tractor W/Rotary	1.58	2.6	0.411	78	0.321	85	0.273	3.7	1	3.7	8	0.5
4. First Harrowing, Carabao W/Harrow	0.7	2.4	0.168	80	0.134	70	0.094	10.6	2	21.2	8	2.7
5. First Harrowing, Power Tiller W/Harrow	1.0	2.9	0.290	82	0.238	80	0.190	5.3	2	10.6	8	1.3
6. Final Harrowing, Carabao W/Harrow/Leveler	1.0	2.4	0.240	80	0.192	70	0.134	7.5	4	30.0	8	3.8
7. Final Harrowing, Power Tiller W/Harrow/Leveler	1.4	3.2	0.448	82	0.367	80	0.294	3.4	2	6.8	8	0.9
8. Threshing, Power Thresher	-	-	0.244 (1.0 ton)	82	0.200 (0.8 ton)	75	0.150 (0.6 ton)	6.7	1	6.7	7	1.0
9. Threshing, Pedal Thresher	-	-	0.058 (0.24 ton)	80	0.046 (0.19 ton)	75	0.034 (0.14 ton)	43.5	1	29.4	7	4.2
10. Drying, Drier	-	-	0.111 (0.50 ton)	80	0.089 (0.40 ton)	80	0.071 (0.32 ton)	14.0	1	14.0	16	0.9
11. Hauling, Carabao with Cart	-	2.5	0.2 ton	80	0.16 ton	70	0.11 ton					

Note: 1/... Such losses in the fields as turning of machineries, adjustment of machineries, etc. are deducted from theoretical capacity.

2/... Such losses happening outside the fields as transportation of machineries between garage and fields, inspection of machineries just before operation (min. 10 minutes), fixing and removal of machineries with putting lubricant oils (min. 30 minutes) etc. from the field operation capacity.

TABLE G3-20 FARM MACHINERY COST

Machinery	(1) Aquisition (₱)	(2) Life Span (year)	(3) Depreciation Cost 1/ (₱/year)	(4) Repair Cost (₱/year)	(5) Other Fixed Cost 2/ (₱/year)	(6) Total Cost (₱/year)	(7) Coverage per Unit (ha)	(8) Total Cost per ha (₱)	(9) Area Coverage (%)	(10) Fixed Cost per ha (₱)
4-wheel tractor	215,000	10	19,350	17,200 (8%)	2,150	38,700	1,200 hr/year	32/hr	20	24
Power tiller	32,060	5	5,771	2,565 (8%)	321	8,657	9.0x1.6 4/	601	45	270
Power thresher	23,125 3/	8	2,602	694 (3%)	231	3,527	30x1.6 4/	24	75	184
Pedal thresher	650	6	98	-	7	105	5.0x1.6 4/	7	25	2
Dryer	16,000	8	1,800	800 (5%)	160	2,760	30.0x1.6 4/	58	60	35
Total										515

Note: 1/ ... Computed as (1) x 0.9/(2)

2/ ... Computed as (1) x 0.01

3/ ... Price without engine because the engine of hand tractor can be used for thresher

4/ ... Cropping intensity of rice

TABLE G3-20 FARM MACHINERY COST

Operation/Machinery	(1) Ope. hours per ha (hr/ha)	(2) Fuel Consumption (lit./hr)	(3) Fuel (lit.)	(4) Unit Cost (₱/lit.)	(5) Cost of Fuel (₱)	(6)=(5)x1.3 Cost Inclusive of Oil (₱)	(7) Area Coverage (%)	(8) Variable Cost per ha (₱)
1. Plowing, 4-wheel tractor	3.7	D. 4.0	14.8	6.1	90.3	117.4	20	24
2. Plowing, Power tiller + Plow	14.3	D. 1.5	21.5	6.1	131.1	170.7	45	77
3. 1st harrowing, power tiller + harrow	10.6	D. 0.8	8.5	6.1	51.9	67.5	45	30
4. Final harrowing, power tiller + harrow	6.8	D. 0.8	5.4	6.1	32.9	42.8	45	19
5. Threshing, power thresher	6.7	D. 1.0	6.7	6.1	40.9	53.2	75	40
6. Drying, Drier	14.0	G+0.75 K 1.5	G+0 10.5 K 21.0	8.5 7.5	89.3 57.5	116.1 204.8	60	193
Total								383

Note: D ..... Diesel
G ..... Gasoline
K ..... Kerosene

TABLE G3-21 ANIMAL COST

Operation	Requirement (day/ha)	Rate (₱/day)	Amount (₱/ha)	Area Coverage (%)	Amount (₱)
1. Plowing	7.0	15	105	35	37
2. First harrowing	2.4	15	36	55	20
3. Final harrowing	4.8	15	72	55	40
4. Hauling	4.5	15	68	100	68
Total	18.7				165

Note: Commodity and distance for hauling work;

Commodity	Quantity (ton)	Distance (km)
Seedling	2.0	2 km
Fertilizer & Chemicals	0.5	4 km = 2 km x 2
Palay with straw	8.5	1 km
Palay	4.1	4 km = 2 km x 2
Palay	2.0	1 km = 1 km x 2

TABLE G3-22 LABOR REQUIREMENT, RICE, TRANSPLANTED

(Unit: man-day/ha)

Operation	W/O Project, Present		W/Project, Future 1/		W/Project, Future 2/	
	Man-day	Animal-day	Man-day	Animal-day	Man-day	Machinery
1. Seed-bedding						
a. Land Preparation/Sowing			1.2	1.0	0.5	0.3
b. Care of Seedings			1.5	-	1.5	-
Sub-total			2.7	1.0	2.0	0.3
2. Land Preparation						
a. Cleaning/dike Mending			3.0	-	3.0	-
b. Plowing			(1x)8.4	8.4	(1x)1.8	1.8
c. Breaking/Harrowing			(2x)2.7	2.7	(2x)1.3	1.3
d. Final Harrowing/Leveling			(4x)3.8	3.8	(2x)0.9	0.9
Sub-total			17.9	14.9	7.0	4.0
3. Planting						
a. Pulling/Deliver of Seedlings			7.5	0.5	7.2	0.2
b. Furrowing/Planting/Thinning			20.0	-	20.0	-
Sub-total			27.5	0.5	27.2	0.2
4. Fertilizing						
a. Basal Fertilizers			1.5	0.4	1.2	0.1
b. Top-dressing			1.5	0.4	1.2	0.1
Sub-total			3.0	0.8	2.4	0.2
5. Pest Control			3.5	2.0	3.5	2.0
6. Cultivation/Weeding			12.0	-	12.0	-
7. Irrigation/Drainage			5.0	-	5.0	-
8. Harvesting						
a. Reaping/Plucking/Bundling			16.0	-	16.0	-
b. Hauling/Piling			3.4	1.7	3.0	1.0
c. Threshing/Winnowing			12.6	4.2	6.9	0.5
Sub-total			32.0	5.9	25.9	1.5
9. Post Harvesting						
a. Drying			-	-	-	-
b. Saching/Piling/Delivery			3.5	1.3	2.7	0.5
Sub-total			3.5	1.3	2.7	0.5
10. Total 3/			107.1	26.4	87.7	8.7

Remarks: 1/... Draft animal, 2/... Mechanization, 3/The figures in the parenthesis ... Draft animal

TABLE G3-23 LABOR REQUIREMENT, RICE DIRECT SEEDED

(Unit: man-day/ha)

Operation	W/O Project, Present Man-day	W/O Project, Present Animal-day	W/Project, Future 1/ Man-day	W/Project, Future 1/ Animal-day	W/Project, Future 2/ Man-day	W/Project, Future 2/ Machinery
1. Seed-bedding						
a. Land Preparation/Sowing			-	-	-	-
b. Care of Seedings			-	-	-	-
Sub-total			-	-	-	-
2. Land Preparation						
a. Cleaning/Bund Mending			3.0	-	3.0	-
b. Plowing			(1x)8.4	8.4	(1x)1.8	1.8
c. Breaking/Harrowing			(2x)2.7	2.7	(2x)1.3	1.3
d. Final Harrowing/Leveling			(4x)3.8	3.8	(2x)0.9	0.9
Sub-total			17.9	14.9	7.0	4.0
3. Planting						
a. Pulling/Deliver of Seedlings			-	-	-	-
b. Furrowing/Planting/Thinning			3.0	0.5	2.7	0.2
Sub-total			3.0	0.5	2.7	0.2
4. Fertilizing						
a. Basal Fertilizers			1.5	0.4	1.2	0.1
b. Top-dressing			1.5	0.4	1.2	0.1
Sub-total			3.0	0.8	2.4	0.2
5. Pest Control			3.5	2.0	3.5	2.0
6. Cultivation/Weeding			2.0	-	2.0	-
7. Irrigation/Drainage			7.0	-	7.0	-
8. Harvesting						
a. Reaping/Plucking/Bundling			16.0	-	16.0	-
b. Hauling/Piling			3.4	1.7	3.0	1.0
c. Threshing/Winnowing			12.6	4.2	6.9	0.5
Sub-total			32.0	5.9	25.9	1.5
9. Post Harvesting						
a. Drying			-	-	-	-
b. Saching/Piling/Delivery			3.5	1.3	2.7	0.5
Sub-total			3.5	1.3	2.7	0.5
10. Total 3/			71.9	25.4(23.4)	53.2	8.4(6.4)

Remarks: 1/... Draft animal, 2/... Mechanization, 3/ The figures in the parenthesis ... Draft animal

TABLE G3-24 LABOR REQUIREMENT, MUNGBEAN

(Unit: man-day/ha)

Operation	W/Project, Future 1/ Man-day	W/Project, Future 1/ Animal-day	W/Project, Future 2/ Man-day	W/Project, Future 2/ Machinery
1. Seed-bedding				
a. Land Preparation/Sowing	-	-	-	-
b. Care of Seedings	-	-	-	-
Sub-total	-	-	-	-
2. Land Preparation				
a. Cleaning/Bund Mending	3.0	-	3.0	-
b. Plowing	(1x)8.4	8.4	-	-
c. Breaking/Harrowing	(2x)5.9	5.9	(2x)1.0	1.0 3/
d. Final Harrowing/Leveling	(4x)4.6	4.6	(4x)4.6	4.6
Sub-total	21.9	18.9	8.6	5.6
3. Planting				
a. Pulling/Deliver of Seedlings	-	-	-	-
b. Furrowing/Planting/Thinning	6.0	2.0	6.0	2.0
Sub-total	6.0	2.0	6.0	2.0
4. Fertilizing				
a. Basal Fertilizers	1.5	0.5	1.5	0.5
b. Top-dressing	-	-	-	-
Sub-total	1.5	0.5	1.5	0.5
5. Pest Control	(2x)3.0	3.0	3.0	3.0
6. Cultivation/Weeding	10.0	2.0	10.0	2.0
7. Irrigation/Drainage	(2x)3.0	-	3.0	-
8. Harvesting				
a. Reaping/Plucking/Bundling	12.5	-	12.5	-
b. Hauling/Piling	2.0	1.5	2.0	1.5
c. Threshing/Winnowing 4/	12.0	1.0	12.0	1.0
Sub-total	24.5	2.5	24.5	2.5
9. Post Harvesting				
a. Drying	-	-	-	-
b. Saching/Piling/Delivery	-	-	-	-
Sub-total	-	-	-	-
10. Total 5/	69.9	28.9(25.9)	56.6	15.6(12.6)

Remarks

1/: With animal power

2/: Only plowing is mechanized by tractor with rotary

3/: Two passings of tractor with rotary

4/: Including the labor requirement of powt-harvesting work

5/: The figures in the parenthesis show draft animal requirment

TABLE G3-25 LABOR REQUIREMENT, PEANUT

(Unit: man-day/ha)

Operation	W/Project, Future 1/ Man-day	W/Project, Future 1/ Animal-day	W/Project, Future 2/ Man-day	W/Project, Future 2/ Machinery
1. Seed-bedding				
a. Land Preparation/Sowing	-	-	-	-
b. Care of Seedings	-	-	-	-
Sub-total	-	-	-	-
2. Land Preparation				
a. Cleaning/Bund Mending	3.0	-	3.0	-
b. Plowing	(1x)8.4	8.4	-	-
c. Breaking/Harrowing	(2x)5.9	5.9	(2x)1.0	1.0 3/
d. Final Harrowing/Leveling	(2x)4.6	4.6	(2x)4.6	4.6
Sub-total	21.9	18.9	8.6	5.6
3. Planting				
a. Pulling/Deliver of Seedlings	-	-	-	-
b. Furrowing/Planting/Thinning	6.0	2.0	6.0	2.0
Sub-total	6.0	2.0	6.0	2.0
4. Fertilizing				
a. Basal Fertilizers	1.5	0.5	1.2	0.5
b. Top-dressing	1.0	-	1.0	-
Sub-total	2.5	0.5	2.5	0.5
5. Pest Control	(2x)3.0	3.0	3.0	3.0
6. Cultivation/Weeding	10.0	2.0	10.0	2.0
7. Irrigation/Drainage	(2x)3.0	-	(2x)3.0	-
8. Harvesting				
a. Reaping/Plucking/Bundling	19.0	-	19.0	-
b. Hauling/Piling	6.2	3.1	6.2	3.1
c. Threshing/Winnowing 4/	30.3	-	30.2	-
Sub-total	55.5	3.1	55.5	3.1
9. Post Harvesting				
a. Drying	-	-	-	-
b. Saching/Piling/Delivery	-	-	-	-
Sub-total	-	-	-	-
10. Total 5/	101.9	29.5(26.5)	88.6	16.2(13.2)

Remarks:

1/: With animal power

2/: Only plowing is mechanized by tractor with rotary

3/: Two passings of tractor with rotary

4/: Including the labor requirement of post harvesting work

5/: The figures in the parenthesis show draft animal requirement

TABLE G3-26 LABOR REQUIREMENT, CORN

(Unit: man-day/ha)

Operation	W/Project, Future 1/ Man-day	W/Project, Future 1/ Animal-day	W/Project, Future 2/ Man-day	W/Project, Future 2/ Machinery	Remarks
1. Seed-bedding					
a. Land Preparation/Sowing	-	-	-	-	
b. Care of Seedings	-	-	-	-	1/: With animal power
Sub-total	-	-	-	-	
2. Land Preparation					
a. Cleaning/Bund Mending	3.0	-	3.0	-	2/: Only plowing is mechanized by tractor
b. Plowing	(1x)8.4	8.4	-	-	
c. Breaking/Harrowing	(2x)5.9	5.9	(2x)1.0	1.0 3/	
d. Final Harrowing/Leveling	(4x)4.6	4.6	(4x)4.6	4.6	
Sub-total	21.9	18.9	8.6	5.6	3/: Two passings of tractor with rotary
3. Planting					
a. Pulling/Deliver of Seedlings	-	-	-	-	
b. Furrowing/Planting/Thinning	6.0	2.0	6.0	2.0	
Sub-total	6.0	2.0	6.0	2.0	4/: Including the labor requirement of any harvesting and post-harvesting works
4. Fertilizing					
a. Basal Fertilizers	1.5	0.5	1.5	0.5	
b. Top-dressing	1.0	-	1.0	-	
Sub-total	2.5	0.5	2.5	0.5	
5. Pest Control	(2x)3.0	3.0	(2x)3.0	3.0	
6. Cultivation/Weeding	10.0	2.0	10.0	2.0	5/: The figures in the parenthesis show draft animal requirement
7. Irrigation/Drainage	(3x)4.5	-	(3x)4.5	-	
8. Harvesting					
a. Reaping/Plucking/Bundling 4/	45.0	3.0	45.0	3.0	
b. Hauling/Piling	-	-	-	-	
c. Threshing/Winnowing	-	-	-	-	
Sub-total	45.0	3.0	45.0	3.0	
9. Post Harvesting					
a. Drying	-	-	-	-	
b. Saching/Piling/Delivery	-	-	-	-	
Sub-total	-	-	-	-	
10. Total 5/	92.9	29.4(26.4)	79.6	16.6(12.6)	

TABLE G3-27 LABOR REQUIREMENT, VEGETABLES (WATER MELON)

(Unit: man-day/ha)

Operation	W/Project, Future 1/ Man-day	W/Project, Future 1/ Animal-day	W/Project, Future 2/ Man-day	W/Project, Future 2/ Machinery	Remarks
1. See-bedding					
a. Land Preparation/Sowing	-	-	-	-	
b. Care of Seedings	-	-	-	-	1/: With animal power
Sub-total	-	-	-	-	
2. Land Preparation					
a. Claaning/Bund Mending	3.0	-	3.0	-	2/: Only plowing is mechanized by tractor
b. Plowing	(1x)8.4	8.4	(1x) -	-	
c. Breaking/Harrowing	(2x)5.9	5.9	(2x)1.0	1.0 3/	
d. Final Harrowing/Leveling	(4x)4.6	4.6	(2x)4.6	4.6	
Sub-total	21.9	18.9	8.6	5.6	3/: Two passings of tractor with rotary
3. Planting					
a. Pulling/Deliver of Seedlings	-	-	-	-	
b. Furrowing/Planting/Thinning	16.0	-	16.0	-	
Sub-total	16.0	-	16.0	-	4/: Including the labor requirement of post harvesting work
4. Fertilizing					
a. Basal Fertilizers	1.5	0.5	1.5	0.5	
b. Top-dressing	1.5	0.5	1.5	0.5	
Sub-total	3.0	1.0	3.0	1.0	
5. Pest Control	(8x)12.0	12.0	(8x)12.0	12.0	5/: The figures in the parenthesis show draft animal requirement
6. Cultivation/Weeding	30.0	3.0	30.0	3.0	
7. Irrigation/Drainage	(6x)9.0	-	(6x)9.0	-	
8. Harvesting					
a. Reaping/Plucking/Bundling					
b. Hauling/Piling	28.0	3.0	28.0	3.0	
c. Threshing/Winnowing 4/					
Sub-total	28.0	3.0	28.0	3.0	
9. Post Harvesting					
a. Drying	-	-	-	-	
b. Saching/Piling/Delivery	12.0	3.0	12.0	3.0	
Sub-total	12.0	3.0	12.0	3.0	
10. Total 5/	131.9	42.9(30.9)	118.6	27.6(15.6)	

TABLE G3-28 MONTHLY FARM LABOR BALANCE, WITH PROJECT (2000)

(unit: thousand man-day)

Item	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	Total
A. Labor Requirement													
1. Irrigated area	13.0	82.2	113.7	23.2	35.5	111.9	62.7	75.6	32.0	38.3	84.0	67.3	739.4
(1) Rice, Wet season	11.0	82.2	113.7	23.2	35.5	103.5	9.1						378.2
- Transplanted, W/O 1/	6.4	45.6	61.5	11.1	19.6	49.3	1.3						194.8
- Transplanted, W/ 2/	2.4	28.9	43.3	8.9	13.3	32.9	0.7						130.4
- Direct-seeded, W/O	1.6	5.3	5.8	1.8	1.5	12.8	4.3						33.1
- Direct-seeded, W/	0.6	2.4	3.1	1.4	1.1	8.5	2.8						19.9
(2) Rice, Dry season						8.4	53.6	68.5	14.1	16.5	68.9	14.6	244.6
- Transplanted, W/O						4.3	27.8	35.1	6.1	8.4	29.2	3.5	114.4
- Transplanted, W/						1.8	17.8	24.7	4.8	5.9	19.7	2.2	76.9
- Direct-seeded, W/O						1.7	5.5	5.6	1.8	1.2	12.0	5.6	33.4
- Direct-seeded, W/						0.6	2.5	3.1	1.4	1.0	8.0	3.3	19.9
(3) Diversified Crops	2.0							7.1	17.9	21.8	15.1	52.7	116.6
- Mungbean									3.3	4.7	4.8	6.5	19.3
- Peanut								3.5	4.5	2.7	1.2	18.0	29.9
- Corn								3.6	4.7	3.0	1.2	14.6	27.1
- Vegetables	2.0								5.4	11.4	7.9	13.6	40.3
2. Rainfed Upland	18.9	14.4	11.7	20.9	5.1	3.9	4.9	1.8				3.7	85.3
- Cassava	8.1	6.9	5.4	9.6	1.2	1.0	2.3					2.1	36.6
- Sweet potato	5.4	3.0	2.7	4.7	3.3	2.4	1.0	1.8					24.3
- Coconut	5.4	4.5	3.6	6.6	0.6	0.5	1.6					1.6	24.4
3. Total (1 + 2)	31.9	96.6	125.4	44.1	40.6	115.8	67.6	77.4	32.0	38.3	84.0	71.0	824.7
4. Animal Husbandry	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9	154.8
5. Grand Total	44.8	109.5	138.3	57.0	53.5	128.7	80.5	90.3	44.9	51.2	96.9	83.9	979.5
B. Available Labor Force	(3/ 143 thousand man-day)												1,716.0
C. Balance	98.2	33.5	4.7	86.0	89.5	14.3	62.5	52.7	98.1	91.8	46.1	59.1	736.5

Note: 1/ Without mechanization

2/ With mechanization

3/ Estimated at 2,860 farms x 2.0 men x 30 days/month x 25 days/30 days

TABLE G3-29 LIVESTOCK PRODUCTION IN THE PROJECT AREA

	Type	Composition of animals		No. of Farm	Annual Production		
					Kind	per farm	Total
1.	Cow-calf, cattle fattening	Cow for breeding offspring for fattening	: 1	540	Fat animals (two years old)	0.7	378
2.	Carabao-calf	Female carabao for breeding	: 1	360	Carabao calf (three years old)	0.7	252
3.	Swine fattening	Swine for fattening	: 10	360	Fat swine (6-12 months old)	9	3,240
4.	Piggeries production	Sow offsprings	: 2	360	Piggeries (6 months old)	24	8,640
5.	Goat breeding	Buck Does	: 1 : 10	180	Lumb (6 months old)	22	3,960

TABLE G3-30 LABOR REQUIREMENT OF ANIMAL HUSBANDRY

Type	No. of participating farms	Labor requirement/Farm		Labor requirement (Total)	
		Per year	Per month	Per year	Per month
	(no.)	(man-day)	(man-day)	(1,000 man-day)	(1,000 man-day)
1. Cow-calf, cattle fattening	(30) 540	93.0	7.8	50.2	4.2
2. Carabao-calf	(20) 360	61.6	5.1	22.2	1.8
3. Swine fattening	(20) 360	70.0	5.8	25.2	2.1
4. Piggeries production	(20) 360	117.0	9.8	42.1	3.5
5. Goat breeding	(10) 180	88.6	7.4	15.9	1.3
Total	1,800			155.6	12.9

TABLE G3-31 MAN POWER AND FACILITIES OF PILOT SCHEME

Item	Capacity	Number
1. Man-power requirement		
1-1 Project manager		1
1-2 Agronomist		1
1-3 Agricultural engineer		1
1-4 Farm management specialist		1
1-5 Seed technicians		2
1-6 Administrative assistant		1
1-7 Clerk/typist		1
1-8 pump operator		1
1-9 Laborers		20
1-10 Mechanics		1
2. Farm Machinery requirement		
2-1 Four-wheel tractor & accessaries	40-50 HP	1
2-2 Power tiller	3HP, 5HP, 7-8 HP x 2	4
2-3 Sprayer (Knapsack-type)	18 l	2
2-4 Powered thresher (IRRI type)	1 ton/hr	2
2-5 Dryer (Flat bed type)	2.0 ton bin	2
2-6 Pump & Accessaries (Low-Lift)	600 gallon/min.	2
2-7 Service truck	2 ton	1
2-8 Motor Cycle		5
2-9 Seed cleaner		1
2-10 Sorter and packing machine		1
2-11 Balance (Flat form)	1000 kg	1
2-12 Micellouneous tools & equipment		1
3. Building		
3-1 Office & Training room	60 m^2	1
3-2 Warehouse & Machinery Shade	60 m^2	1

FIGURE G3-1 PROPOSED CROPPING CALENDAR

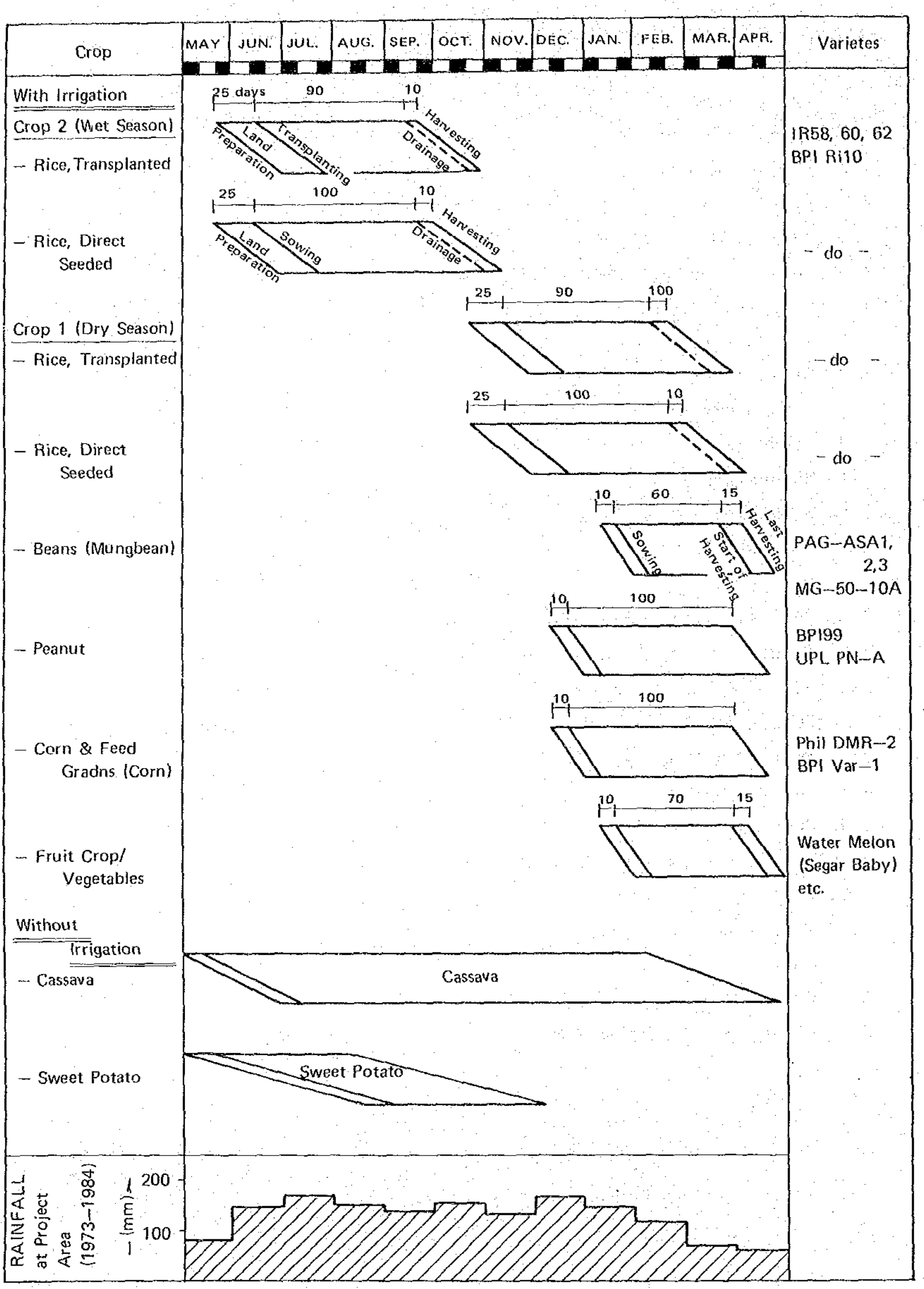


FIGURE G3-2 PROPOSED CROPPING PATTERN

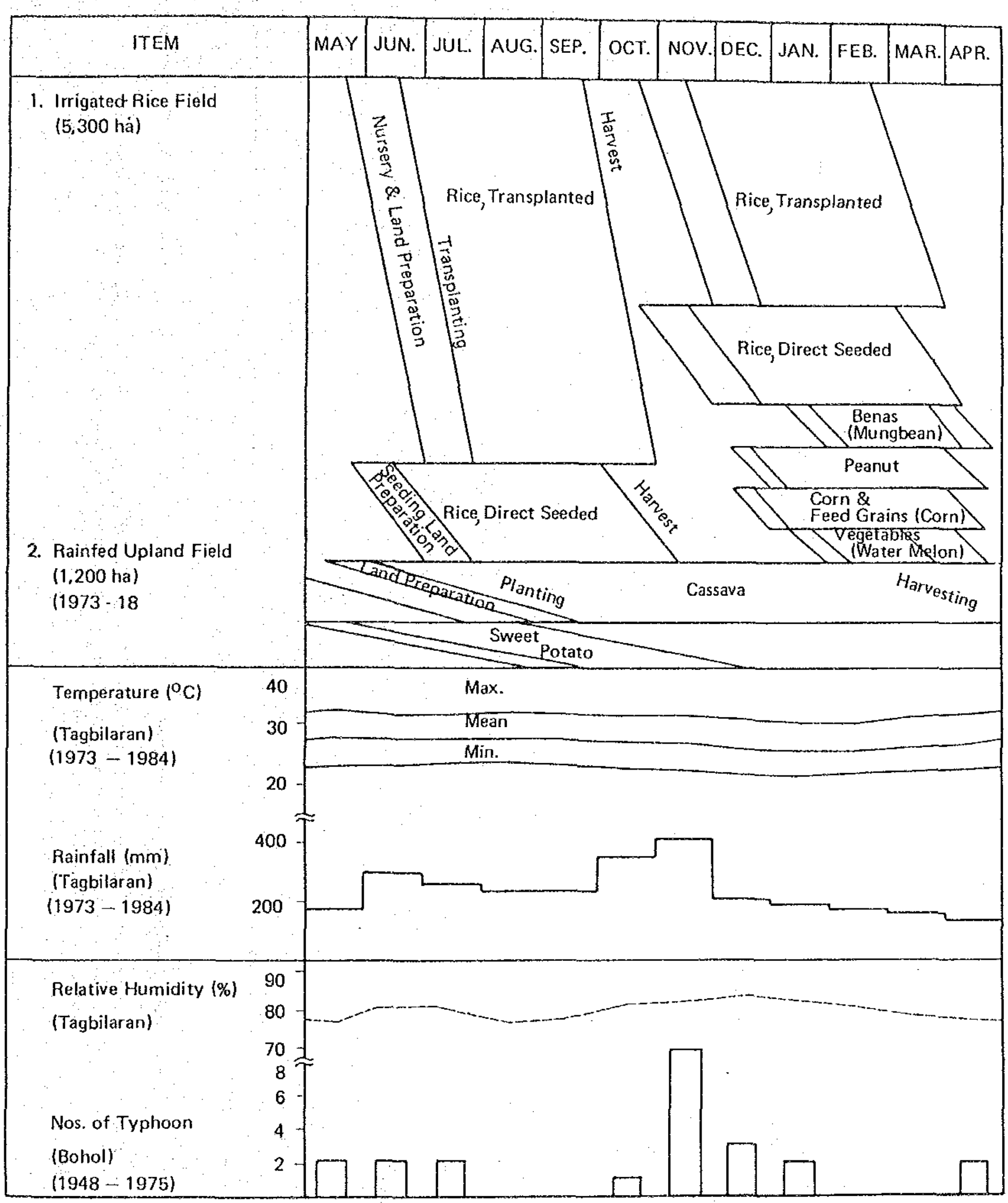
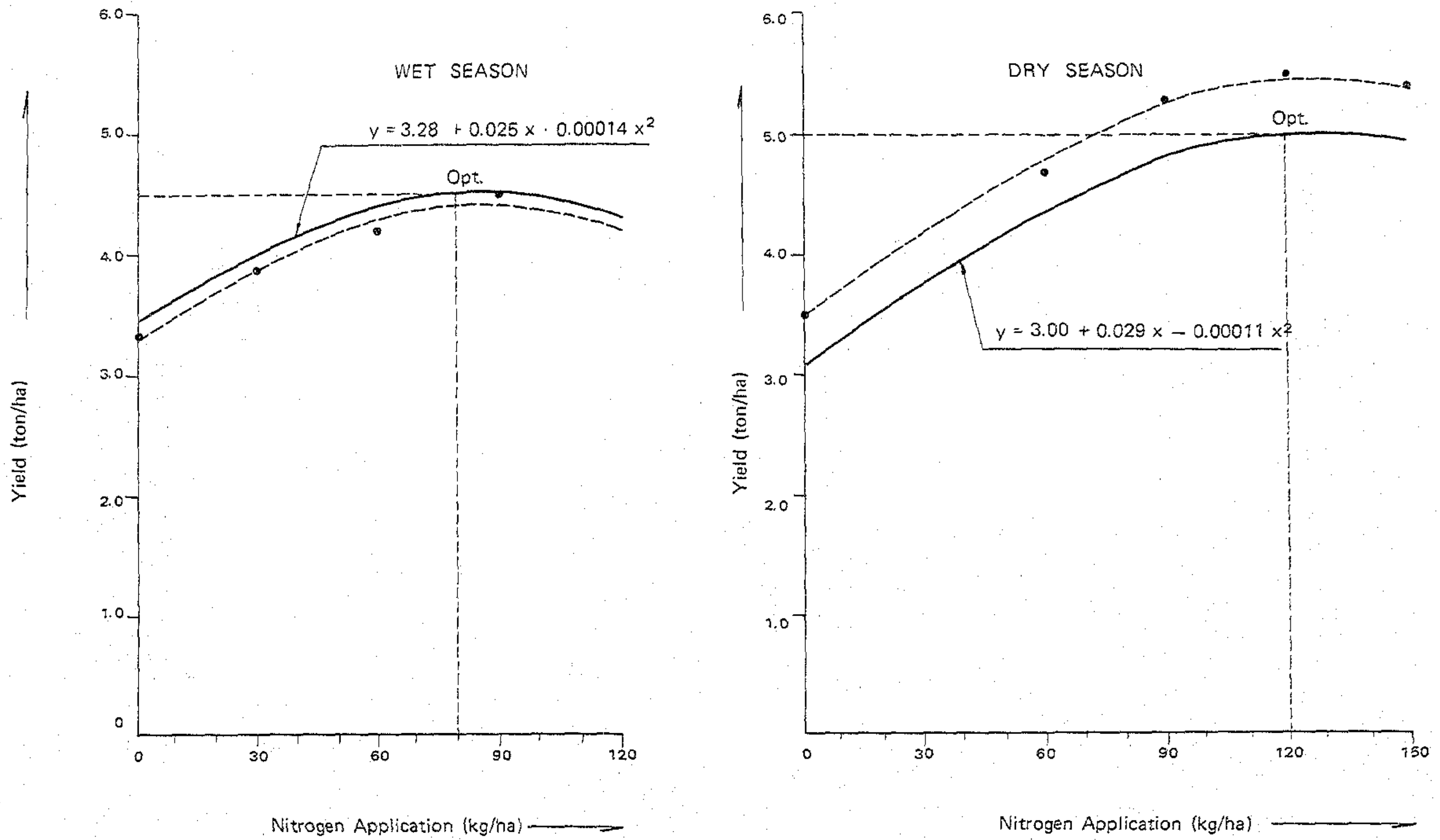


FIGURE G3-3 EXPERIMENTAL AND PREDICTED YIELDS FOR PROJECT AREA



Remarks: -------- Experimental yield: Effect of levels of nitrogen on yield of rice varieties (IR26, 28, 30, 32, 34, 36) at three national experiment stations (Maligaya Rice Research and Training Center, Bicol Rice and Corn Experiment Station and Visayas Rice Experiment Station), 1975

——— Predicted yield for the Project area

FIGURE G 3-4 FARM LABOR BALANCE WITH PROJECT

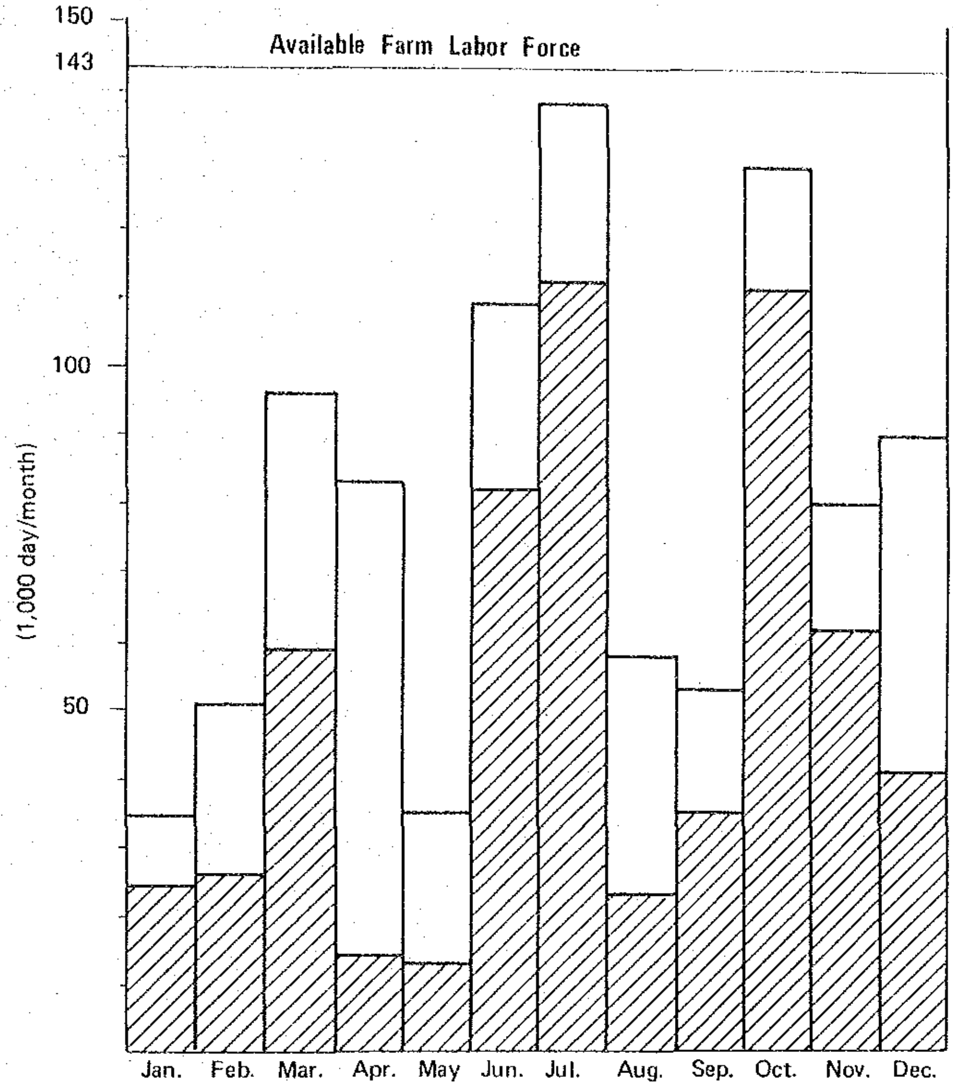
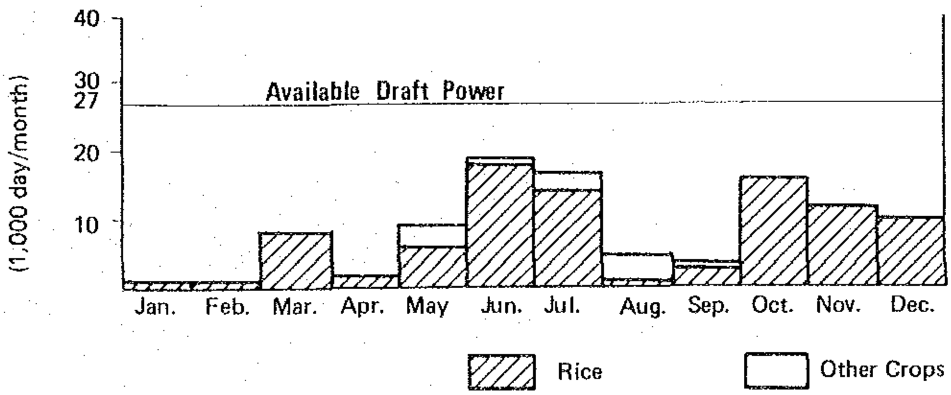


FIGURE G.3-5 ANIMAL POWER BALANCE WITH PROJECT



CHAPTER VI DATA BASE

For the analysis of present agriculture and also for the formulation of agricultural development plan, extensive data are collected mostly at the provincial and regional offices of the National Census and Statistics Office (NCSO) of the National Economic Authority (NEDA), the Bureau of Agricultural Economics of the Ministry of Agricultural (MA) and the National Food Authority (NFA) of , as well as at the MA Offices at the municipal to regional levels and Provincial Development Staff Office in Bohol.

Because of the limited time for the data collection, the analysis and planning methods have to be based on the existing data as much as possible. However it was observed that the existing data base have the following weakness in general;

(i) There is in-consistency among various data sources in such basic data as the present land use, population, number of households and crop production, especially at the Barangay and municipal levels.

(ii) Few-time-series data are available for the above-said basic data.

One of the reasons for the weakness may be attributed to the unavailability of accurate boundaries among the Barangays and municipalities and also the inadequate data collection systems.

ANNEX H. DAM AND CANALS

ANNEX H DAMS AND CANALS

LIST OF TABLES

LIST OF FIGURES

CHAPTER I DAMS

1.1 Seismic Analysis

The seismic force must be considered as one of these external forces on dam design. Since there is no standard value of seismic force in the Philippines, it will be determined based on the following analysis.

Analysis of seismic force at the dam site is made by adopting Dr. Okamoto's theory (refer to Earthquake Proof Engineering by Shunzo Okamoto) based on the data of earthquake occured within a radius of about 300 km from the dam site as shown in FIGURE H1-1 (source: Catalogue of Significant Earthquakes (1907~1982) - PAGASA).

According to Okamoto's formula, the maximum seismic acceleration, which is predicted the occurence in the proposed dam site, is given by the following equation.

$$\log_{10} \frac{\alpha}{640} = \frac{D + 40}{100} (-0.1036M^2 + 1.7244M - 7.604)$$

Where, α: Predicted maximum seismic acceleration (gal-cm/sq.sec)

D: Distance between the seismic center occured about proposed dam site (km)

M: Magnitude of seismic center

Also, distance between the seismic center and proposed dam site is estimated as follows:

$$D = \sqrt{A^2 + B^2}$$

Where, A: Distance in the latitude between them

$A = (Pn - 9.96°) \times 111$ km/°

Pn; the latitude of seismic center (°)

9.96°; the latitude of proposed dam site (Bayongan dam)

111; length of latitude per one degree (km/°)

B; Distance in the longitude between them (km)

$$B = (Pe - 124.35°) \times 111 \times \cos\left(\frac{9.96 + Pn}{2}\right)$$

Pe; the longitude of seismic center (°)

124.35°; the longitude of proposed dam site

As the result of analysis, seismic acceleration at the dam site is estimated to be about 191 Gal in the maximum, while there were earthquakes recorded 83 times with the maximum acceleration of more than one Gal, as shown in TABLE H1-1.

On the other hand for making examination of occurance frequency of earthquake, the estimated seismic accelerations are ploted in the x coordinate with No./year in the y coordinate, as shown in FIGURE H1-2.

Then, for making the earthquake-proof design of the fill dam, the analysis method subjected to the seismic intensity against an earthquake of 100 year probability will be adopted.

Taking into account location of the proposed dam site which belongs to the seismic intensity V in the Philippines (See 3.2.4 b). in the Main Report) and seismicity coefficient in the design of other dams, the coefficient of K = 0.20 will be justified. Therefore, for the design of the Bayongan dam and Capayas dam K = 0.20 is applied as design seismicity coefficient.

1.2 Flood Analysis

a) Design Flood Discharge

For estimation of design flood discharge in the Philippines, there are useful formulas by B.P.W. These are ranked into four grades of frequency ie. "Extreme", "Rare", "Occasional", and "Frequent". These formulas could substantially correspond to Dr. Creager's formula which is internationally prevailing. (See Annex B.4)

In this study, Design floods of the Bayongan dan Capayas dams will be estimated by B.P.W's formulas as the prime, then verified by other methods such as Creager's formula, Rational Method, survey of historical floods, and meteorological approach through Probable Maximum Precipitation.

Summaries of above studies are shown in TABLE H1-2 (Bayongan)

TABLE H. 1.-1

SEISMIC ANALYSIS BY DR. OKAMOTO'S FORMULA

PROJECT NAME ; BOHOL IRRIGATION PROJECT II F/S

LOCATION ; BAYONGAN,SAN-MIGUEL,BOHOL

DAMSITE'S LATITUDE ; 9.96(DEGREES)

DITTO LONGITUDE ; 124.35(DEGREES)

NUMBER OF DATA ; 83 RECORDS ; 1907 TO 1982 = 76 YRS

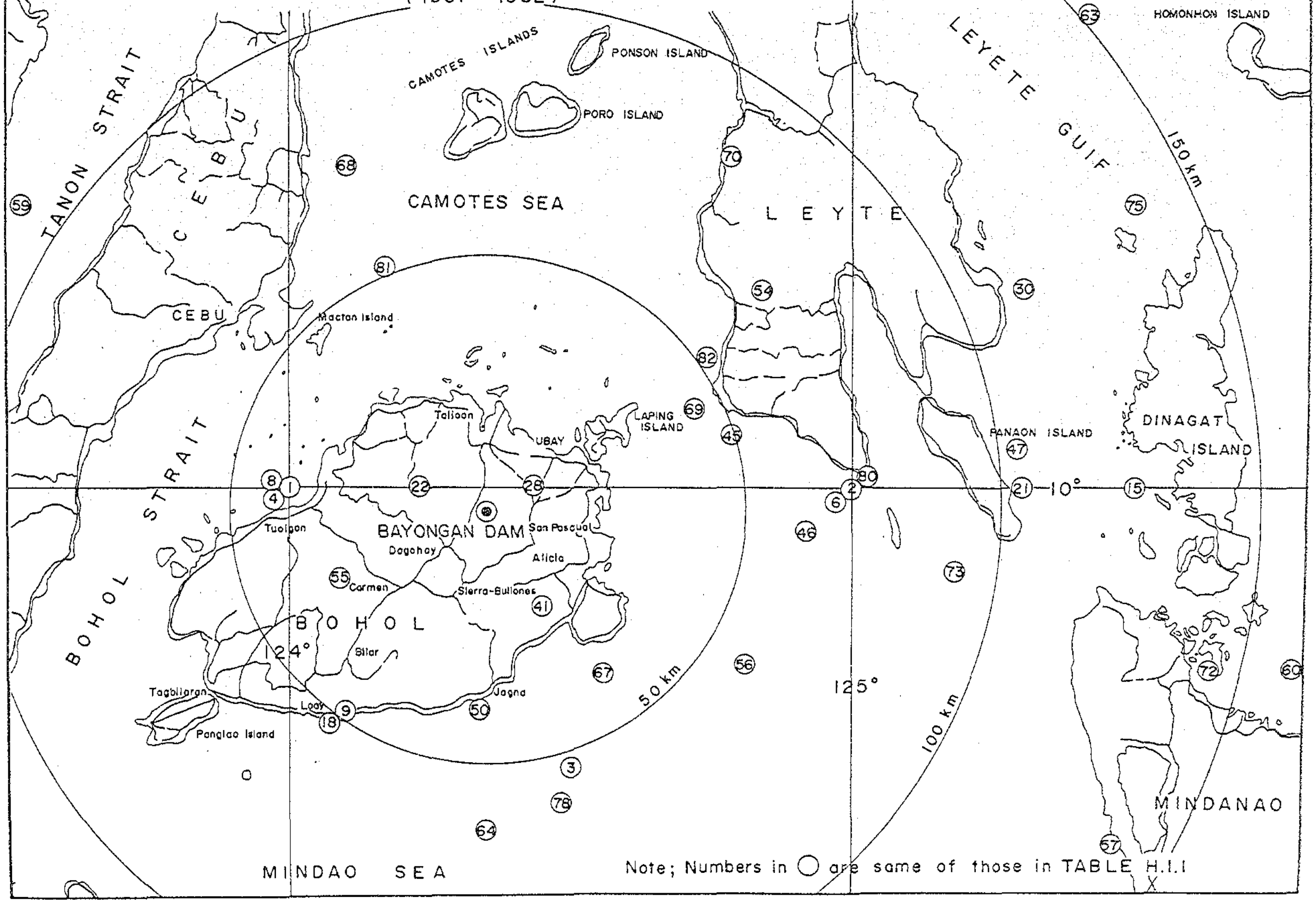
NO.	DATE (M-D-Y)	LAT. (DEG)	LON. (DEG)	MG.	DIST. (KM)	ACC. (GAL)	NO./Y
1	03.07.50	10.00	124.00	6.8	38.52	191.1	0.0132
2	09.02.48	10.00	125.00	7.0	71.20	134.4	0.0263
3	10.30.26	9.50	124.50	6.3	53.63	101.9	0.0395
4	07.19.41	10.00	124.00	5.8	38.52	89.6	0.0526
5	02.04.41	9.00	124.00	6.9	113.24	67.4	0.0658
6	09.21.29	10.00	125.00	6.0	71.20	51.1	0.0789
7	07.12.11	9.00	126.00	7.8	209.73	46.3	0.0921
8	01.26.56	10.00	124.00	5.0	38.52	37.3	0.1053
9	03.10.75	9.60	124.10	5.2	48.42	34.2	0.1184
10	03.19.52	9.50	126.50	7.8	240.69	33.4	0.1316
11	01.24.48	10.50	122.00	8.2	263.61	31.7	0.1447
12	05.05.25	9.50	123.00	6.8	156.27	31.2	0.1579
13	01.24.48	11.00	122.00	8.2	281.28	26.6	0.1711
14	03.31.55	8.00	124.00	7.3	220.92	25.5	0.1842
15	05.24.31	10.00	125.50	6.3	125.80	24.7	0.1974
16	07.25.42	11.50	124.50	6.8	171.72	24.6	0.2105
17	06.07.47	11.50	125.00	6.9	185.06	23.5	0.2237
18	05.06.65	9.60	124.10	4.9	48.42	22.6	0.2368
19	02.10.57	10.25	126.00	6.8	183.16	20.6	0.2500
20	02.10.57	10.00	126.00	6.7	180.43	18.2	0.2632
21	12.14.77	10.00	125.30	5.8	103.95	17.4	0.2763
22	01.14.82	9.99	124.23	3.4	13.54	17.1	0.2895
23	10.20.42	8.50	122.50	7.3	259.51	15.8	0.3026
24	02.10.57	10.00	126.00	6.6	180.43	15.3	0.3158
25	03.12.15	12.00	124.00	7.0	229.63	14.5	0.3289
26	01.01.19	8.00	126.00	7.4	282.95	13.7	0.3421
27	02.11.57	10.00	126.00	6.5	180.43	12.7	0.3553
28	05.03.82	10.03	124.44	3.1	12.54	12.5	0.3684
29	02.10.57	10.25	126.00	6.5	183.16	12.1	0.3816
30	09.23.73	10.35	125.30	5.7	112.46	11.7	0.3947
31	09.22.40	8.00	124.00	6.8	220.92	11.5	0.4079
32	08.30.24	8.50	126.50	7.3	285.92	11.4	0.4211
33	05.03.43	12.50	125.50	7.4	308.49	10.1	0.4342
34	03.07.50	11.00	122.50	6.8	232.59	9.6	0.4474
35	04.27.19	11.00	123.00	6.4	187.19	9.2	0.4605
36	03.07.50	10.50	122.25	6.8	237.10	9.0	0.4737
37	01.24.31	10.00	126.00	6.3	180.43	8.5	0.4868
38	02.11.57	10.00	126.00	6.3	180.43	8.5	0.5000

CONTINUED

CONTINUED

NO.	DATE (M-D-Y)	LAT. (DEG)	LON. (DEG)	MG.	DIST. (KM)	ACC. (GAL)	NO./Y
39	02.10.57	10.50	126.50	6.8	242.38	8.3	0.5132
40	08.13.36	9.00	126.50	6.8	258.39	6.5	0.5263
41	03.15.80	9.79	124.45	3.1	21.81	6.2	0.5395
42	08.18.57	12.00	124.50	6.5	227.03	5.5	0.5526
43	04.10.55	8.00	125.00	6.5	228.93	5.4	0.5658
44	07.08.51	9.90	122.20	6.5	235.17	4.8	0.5789
45	09.16.82	10.09	124.79	4.0	50.21	4.7	0.5921
46	05.27.79	9.92	124.91	4.3	61.39	4.7	0.6053
47	11.14.81	10.07	125.29	5.1	103.47	4.4	0.6184
48	03.31.55	8.10	123.20	6.5	241.91	4.3	0.6316
49	03.31.55	8.10	123.20	6.5	241.91	4.3	0.6447
50	09.23.82	9.60	124.34	3.6	39.97	4.1	0.6579
51	11.15.57	8.00	124.50	6.3	218.18	4.0	0.6711
52	11.05.41	12.50	123.00	6.9	317.95	3.3	0.6842
53	02.17.70	9.80	125.90	5.8	170.42	3.3	0.6974
54	07.04.81	10.35	124.84	4.3	68.85	3.3	0.7105
55	02.05.81	9.84	124.09	3.1	31.40	3.0	0.7237
56	01.16.78	9.68	124.81	4.0	59.14	2.9	0.7368
57	05.01.79	9.36	125.46	5.4	138.52	2.9	0.7500
58	07.13.62	10.00	123.00	5.5	147.65	2.8	0.7632
59	09.10.52	10.50	123.50	5.0	110.52	2.8	0.7763
60	12.12.68	9.67	125.78	5.6	159.68	2.6	0.7895
61	07.13.62	10.00	122.50	6.0	202.29	2.6	0.8026
62	07.12.31	12.00	123.00	6.5	270.03	2.6	0.8158
63	07.12.70	10.84	125.41	5.5	151.44	2.5	0.8289
64	11.25.81	9.39	124.35	4.0	63.27	2.3	0.8421
65	11.25.62	11.20	124.80	5.4	146.14	2.3	0.8553
66	07.08.51	11.00	122.00	6.5	281.28	2.1	0.8684
67	03.20.81	9.67	124.56	3.2	39.54	2.0	0.8816
68	11.10.75	10.57	124.10	4.1	73.01	1.7	0.8947
69	09.16.82	10.14	124.72	3.3	45.11	1.7	0.9079
70	10.10.80	10.59	124.78	4.3	84.24	1.6	0.9211
71	06.15.28	11.50	121.50	6.8	354.72	1.5	0.9342
72	12.07.69	9.67	125.63	5.2	143.65	1.5	0.9474
73	12.28.79	9.85	125.18	4.4	91.57	1.4	0.9605
74	04.01.65	9.93	125.85	5.4	164.03	1.3	0.9737
75	01.21.64	10.50	125.50	5.1	139.19	1.3	0.9868
76	03.17.62	9.50	123.00	5.3	156.27	1.3	1.0000
77	09.13.73	9.20	126.10	5.8	209.30	1.2	1.0132
78	05.03.81	9.44	124.48	3.6	59.45	1.2	1.0263
79	06.12.64	11.25	124.75	5.2	149.69	1.2	1.0395
80	03.06.82	10.01	125.06	4.0	77.81	1.0	1.0526
81	09.22.77	10.39	124.17	3.3	51.62	1.0	1.0658
82	11.16.82	10.23	124.74	3.3	52.10	1.0	1.0789
83	04.08.77	9.04	121.82	4.4	295.20	0.0	1.0921

FIGURE H.I.I SIGNIFICANT EPICENTERS AROUND THE PROJECT AREA
(1907 - 1982)



Note; Numbers in ◯ are same of those in TABLE H.I.I

FIGURE H. 1. 2 SEISMIC ANALYSIS ON BAYONGAN DAM

DAM LOCATION ; 9.96° in LATITUDE, 124.35° in LONGITUDE

DATA SOURCE ; CATALOGUE OF PHILIPPINE EARTHQUAKES, 1907～82

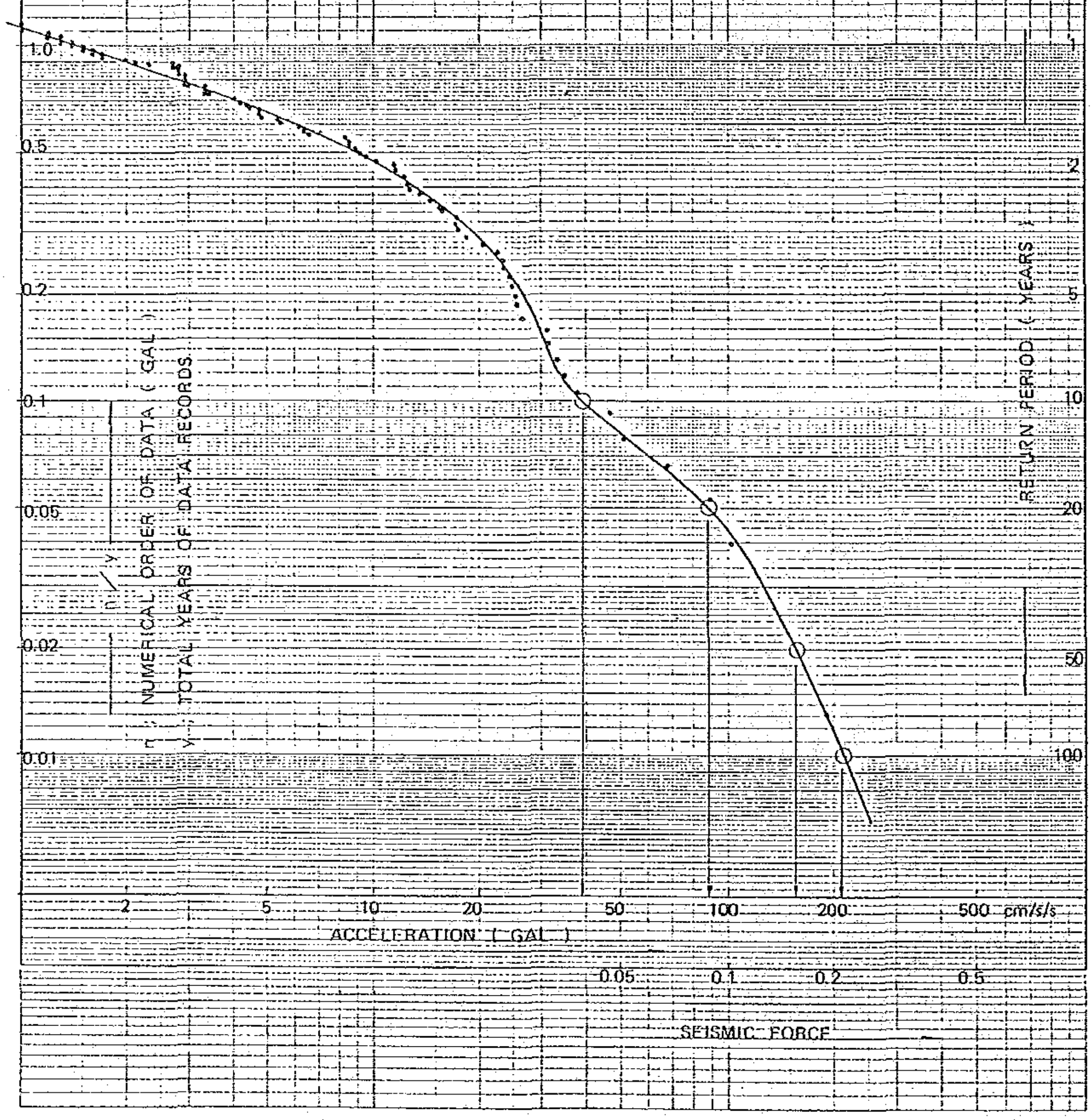
DATA CONVERSION ; BY DR. OKAMOTO'S FORMULA

$$\mathrm{Log}\frac{\mathrm{Gal\ Max.}}{640} = \frac{D + 100}{100}(-7.604 + 1.7244 \cdot M - 0.1036 \cdot M^2)$$

Where ; Gal ; Acceleration at the damsite (cm/s/s)

D ; Distance between the damsite and epicenter (Km)

M; Magnitude at epicenter



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and TABLE H1-3 (Capayas).

b) Flood Routing

For optimizations of spillway sizes, studies of flood routing are necessary for these spillways which are uncontrolled (gateless). These studies have been made by using assumed hydrograph and through various sizes of spillways.

Assumption of hydrograph is made by the following empirical equations;

$$\frac{t_u}{t_p} = \left(\frac{Q_u}{Q_p}\right)^{0.6} \quad \text{and} \quad \frac{t_d}{t_p} = p \cdot \frac{1 - (Q_d/Q_p)}{(Q_d/Q_p)^{0.4}} \qquad \underline{1/}$$

where t_u; Time (hours) during rising-up the discharge

t_p; Travel time (hours) of peak discharge (see the next equation)

Q_u; Discharge (cu.m/s) at the time of t_u

Q_p; Peak discharge (cu.m/s)

t_d; Time (hours) during drop-down the discharge

$t_d = 0$ at Q_p

Q_d; Discharge at the time of t_d

p; Constant   p = 1 in normal case

$t_p = C \cdot A^{0.22} r_e^{-0.35}$ 2/

where C; Constant according to topo-condition

c ≒ 290 for well forested area

c ≒ 200 for medium forsted or grassland

c ≒ 140 for poorly forested or golf links

c ≒ 100 for de-forested area

c ≒ 65 for plantless city area

c = 150 for Bayongan area

c = 200 for Capayas area

A; Catchment area (sq.km)

r_e; Area mean rainfall intensity (mm/hr)

r_e = 130 mm/hr for Bayongan area

r_e = 101 mm/hr for Capayas area

Note: 1/: by H. Sugiyama (Kyoto University, not published yet)

2/: by Dr. Kadoya and Fukushima (Kyoto University, 1976)

TABLE H1-2

COMPARATIVE ESTIMATION OF DESIGN FLOOD (BAYONGAN)

Step	Method	Description	Max. Discharge	Equivalent Creager's C	Remarks
The Prime	B.P.W's Formula (Extreme)	$Q_{max} = \frac{210 \cdot A}{\sqrt{A + 17}}$	443 cu.m/sec or 39.6 cu.m/sec/sq.km	100.5	A; Catchment Area 11.2 sq.km
Verif. 1	Creager's Formula (C = 100)1/	$Q_{max} = 46CA^{(0.894A^{-0.048})}$	441 cu.m/sec or 39.4 cu.m/sec/sq.km	100	Q; in cu.ft/sec A; in sq. mile
Veif. 2	Rational Method (R.P = 1,000 yrs)	$Q_{max} = \frac{1}{3.6} \cdot f \cdot r_t \cdot A$ With the Rainfall data at Dagohoy 1957 - 84	364 cu.m/sec or 32.5 cu.m/sec/sq.km	82.6	$f = 0.9$ $r_t = \frac{R24}{24}\left(\frac{24}{T}\right)^{0.6}$ $= \frac{403.5}{24}\left(\frac{24}{0.8}\right)^{0.6}$ $\fallingdotseq 130$ mm/hr $T = 150A^{0.22}r_t^{-0.35}$ $= 0.8$ hr2/
Verif. 3	From Traces of Historic Floods in Bohol	Typhoon "DELILAH: at Nov. 22, 1964	2,219 3/ cu.m/sec or 3.80 cu.m/sec/sq.km	40.7	
		Typhoon "NITANG" at Sept. 2, 1984	1.410 3/ cu.m/sec 2.41 cu.m/sec/sq.km	25.9	
Verif. 4	From the Probable Maximum Precipitation	-	-	-	Meteorological P.N.P may be only about 200 mm/day 403.5 ≫ 200

Note:
1. C = 100 is Dr. Creager's recommendation as the Probable Maximum Flood.
2. Fukushima & Kadoya's Formula
3. These data were obtained by the survey of Flood Traces at Loboc Hydropower Station (Mar. 1985)

TABLE H1-3 COMPARATIVE ESTIMATION OF DESIGN FLOOD (CAPAYAS)

Step	Method	Description	Max. Discharge	Equivalent Creager's	Remarks
The Prime	B.P.W's Formula (Rare)	$Q_{max} = \frac{150 \cdot A}{\sqrt{A + 13}}$	417 cu.m/sec or 28.6 cu.m/sec/sq.km	77	A; Catchment Area 14.6 sq.km
Verif. 1	Creager's Formula (C = 75)[2]	$Q_{max} = 46CA^{(0.894A^{-0.048})}$	405 cu.m/ sec or 27.7 cu.m/sec/sq.km	75	Q; in cu.ft/sec A; in sq. mile
Verif. 2	Rational Method (R.P = 1,000 yrs)	$Q_{max} = \frac{1}{3.6} \cdot f \cdot r_t \cdot A$ With the Rainfall data at Dagohoy 1957 - 84	369 cu.m/sec or 25.3 cu.m/sec/sq.km	68	$f = 0.9$ $r_t = \frac{R24}{24}\left(\frac{24}{T}\right)^{0.6}$ $= \frac{403.5}{24}\left(\frac{24}{1.2}\right)^{0.6}$ $\fallingdotseq 101$ mm/hr $T \fallingdotseq 200A^{0.22} r_t^{-0.35}$ $= 1.2$ hr[2]
Verif. 3	From Traces of Historic Floods in Bohol	Typhoon "DELILAH: at Nov. 22, 1964	2,219[3] cu.m/sec or 3.80 cum./sec/sq.km	40.7	
		Typhoon "NITANG" at Sept. 2, 1984	1,410[3] cu.m/sec 2.41 cu.m/sec/sq.km	25.9	
Verif. 4	From the Probably Maximum Precipitation	-	-	-	Meteorological P.N.P may be only about 200 mm/day 403.5 $\gg$ 200

Note: 1. C = 75 is particularly applied because of small scale of Capayas dam.
2. Fukushima & Kadoya's Formula
3. These data were obtained by the survey of Flood Traces at Loboc Hydropower Station (Mar. 1985)

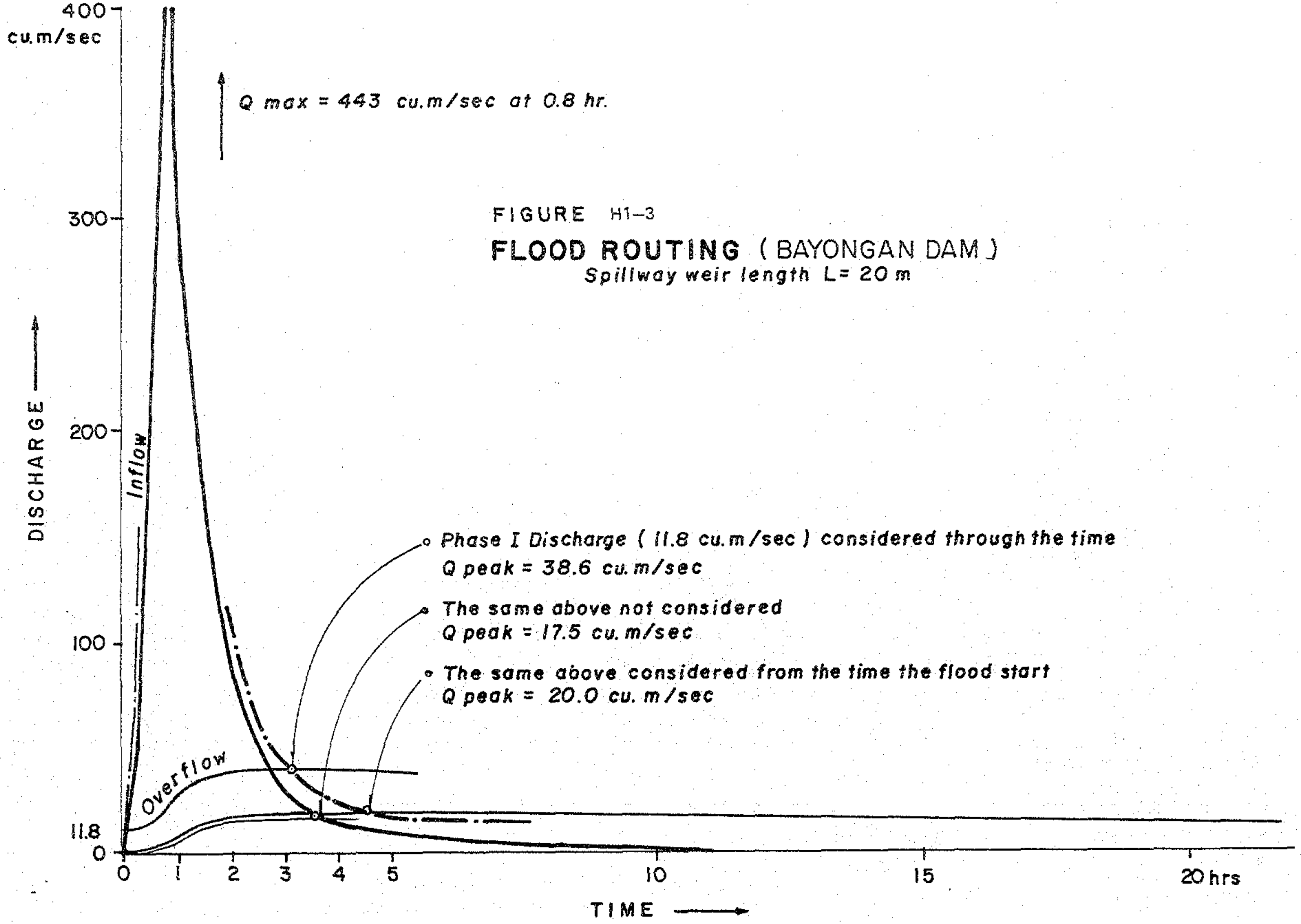


FIGURE H1-3

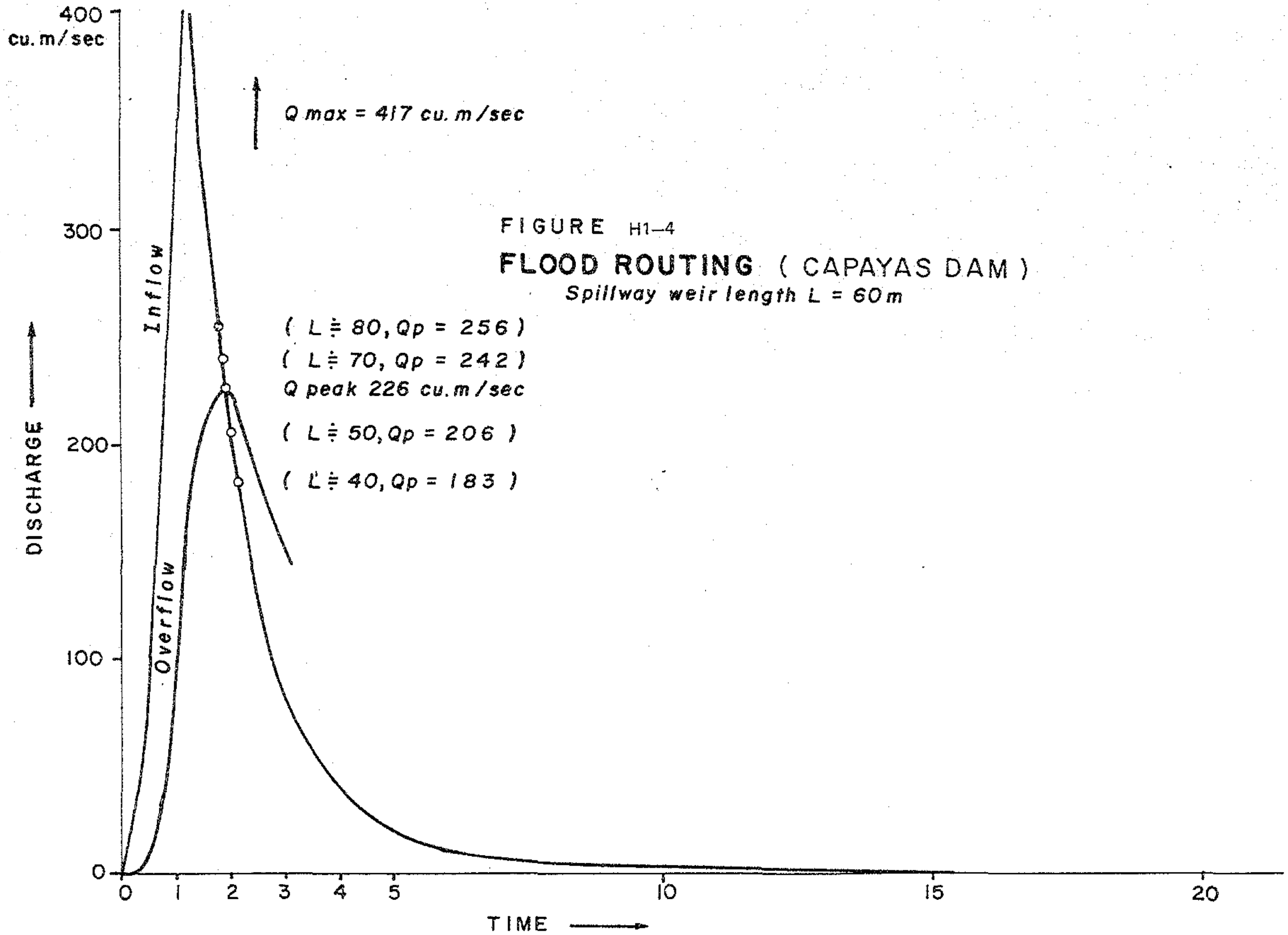
FLOOD ROUTING (BAYONGAN DAM)

Spillway weir length L= 20 m

FIGURE H1-4

FLOOD ROUTING (CAPAYAS DAM)

Spillway weir length L = 60m



Results of flood routings are shown in FIGURE H1-3 (Bayongan) and FIGURE H1-4 (Capayas).

1.3 Hydromechanical Analysis

a) Bayongan Dam

Flow condition of the Bayongan dam spillway at the peak discharge (20 cu.m/s) is summarized in TABLE H1-4.

Discharge capacity of the Bayongan dam intake in various water-head is shown in FIGURE H1-5. Diversion capacity of the intake tunnel during dam construction is also described in this figure.

b) Capayas Dam

Flow condition of the Capayas dam spillway at the peak discharge (226 cu.m/s) is summarized in TABLE H1-5.

Discharge capacity of the Capayas dam intake in various water-head is shown in FIGURE H1-6. Diversion capacity of the intake conduit during the dam construction is also described in the figure.

1.4 Stability Analysis

In order to estimate a degree of safety against assumed failure of slope of earth dam, the standard method of slip circle which applies the following equations are generally used.

$$Fs = \frac{\Sigma(C \cdot l + (N - Ne)\tan\phi)}{\Sigma(T + Te)} \qquad \text{or}$$

$$Fs = \frac{\Sigma(C' \cdot l + (N - u - Ne) \cdot \tan\phi')}{\Sigma(T + Te)}$$

where Fs; Factor of safety

C; Cohesion, on the basis of total stress, of materials on the slip circle (t/sq.m)

C'; Ditto on the basis of effective stress

l; Base length of slice (m)

N; Normal force of slice (t)

Ne; Normal force of seismic load (t)

u; Pore pressure acting on slip circle (t)

ϕ; Internal friction angle, on the basis of total stress, of materials on the slip circle (degree)

ϕ'; Ditto on the basis of effective stress

T; Tangential force of slice (t)

Te; Tangential force of seismic load (t)

The factor of safety shall be more than 1.2 in normal case, but in particular case such as rapid drawdown, it could be acceptable if it is more than 1.1.

According to the above equations, a computer program has been originated by the joint effort of the consultant and counterpart so that the office computer system (TRS-80) of PDD, NIA has functioned effectively.

Soil mechanical data applied to these analyses are described in TABLE H1-6 (Bayongan dam) and TABLE H1-7 (Capayas dam).

Results of computations prove that these proposed dam layouts are reasonable, as shown in TABLE H1-8 (Bayongan) and TABLE H1-9 (Capayas).

TABLE H1-4 FLOW CONDITION OF SPILLWAY

(Bayongan Dam)

Station (m)	Bottom (m)	Width (m)	Flow Depth (m)	Velocity (m/s)	Froude Number	Remarks
0 + 0.00	EL 50.00	20	0.47	2.14	1.00	Crest
0 + 1.11	49.43	20	0.22	4.51	3.06	Contraction
0 + 50.00	48.45	10	0.49	4.04	1.84	Contraction
0 + 100.00	47.45	5	0.93	4.28	1.41	Contraction
0 + 117.56	45.11	5	0.49	8.13	3.70	
0 + 130.00	42.00	5	0.38	10.5	5.45	
0 + 149.38	39.32	5	0.37	10.9	5.76	
0 + 240.00	39.60	5	0.53	7.54	3.31	
0 + 257.93	34.85	5	0.46	8.69	4.10	
0 + 350.00	(19.50)	5	0.34	11.9	6.56	Flip Bucket

TABLE H1-5 FLOW CONDITION OF SPILLWAY

(Capayas Dam)

Station (m)	Bottom (m)	Width (m)	Flow Depth (m)	Velocity (m/s)	Froude Number	Remarks
CHUTE						
0 + 0.00	EL 34.00	60	1.13	3.33	1.00	Crest
0 + 3.79	31.33	60	0.43	8.68	4.21	
0 + 13.00	31.23	60	0.46	8.25	3.90	
SIDE CHANNEL						
0 - 60.00	30.00	6.5	-	-	-	Chute Entered
0 + 0.00	27.50	8	4.33	6.52	1.00	Chute Entered
0 + 125.00	26.25	8	3.33	8.48	1.48	
0 + 200.00	(22.50)	8	2.35	12.0	2.51	Flip Bucket

FIGURE H. 1. — 5 DISCHARGE CAPACITY OF INTAKE TUNNEL (BAYONGAN)

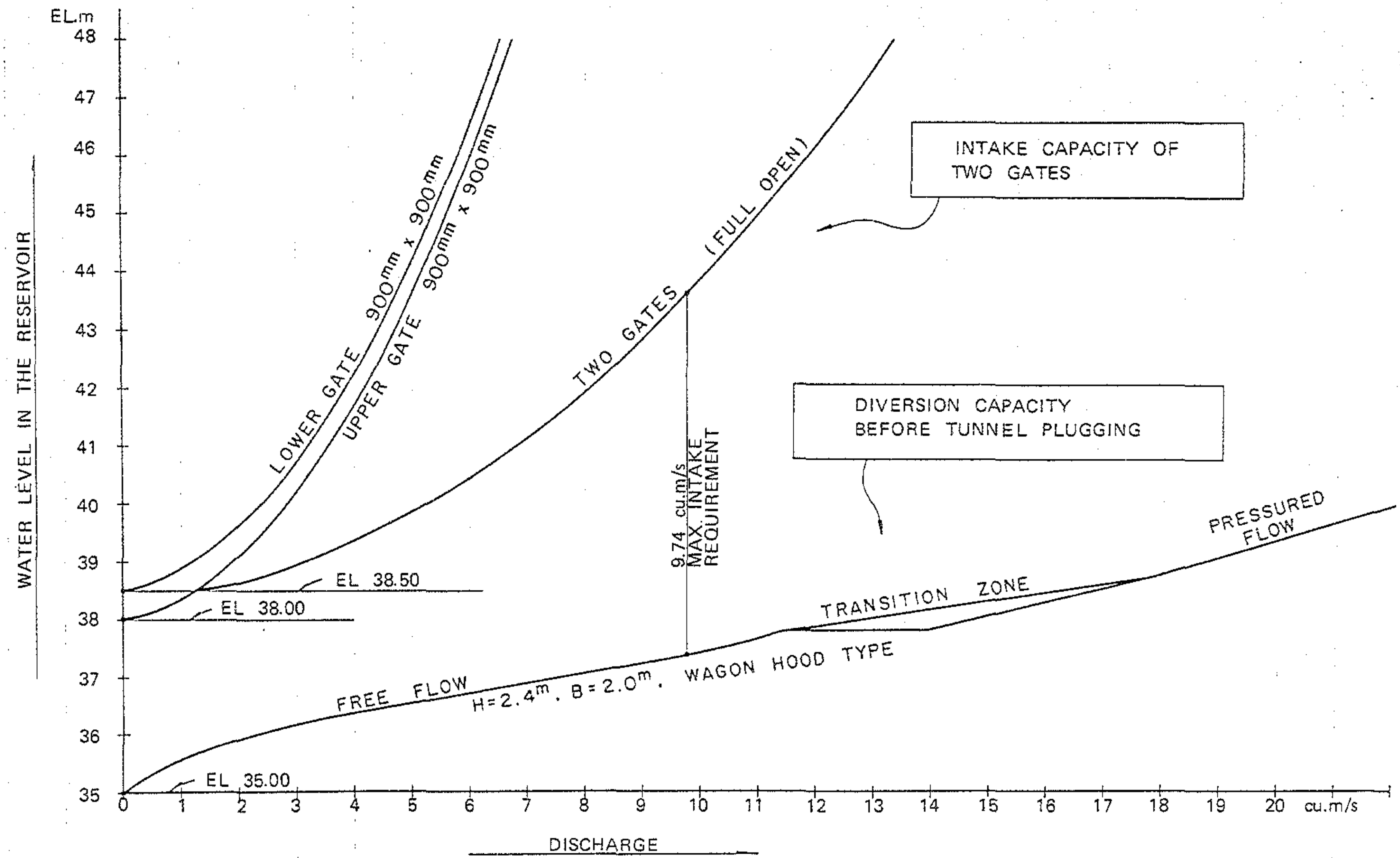


FIGURE H. 1. — 6 DISCHARGE CAPACITY OF INTAKE CONDUIT (CAPAYAS)

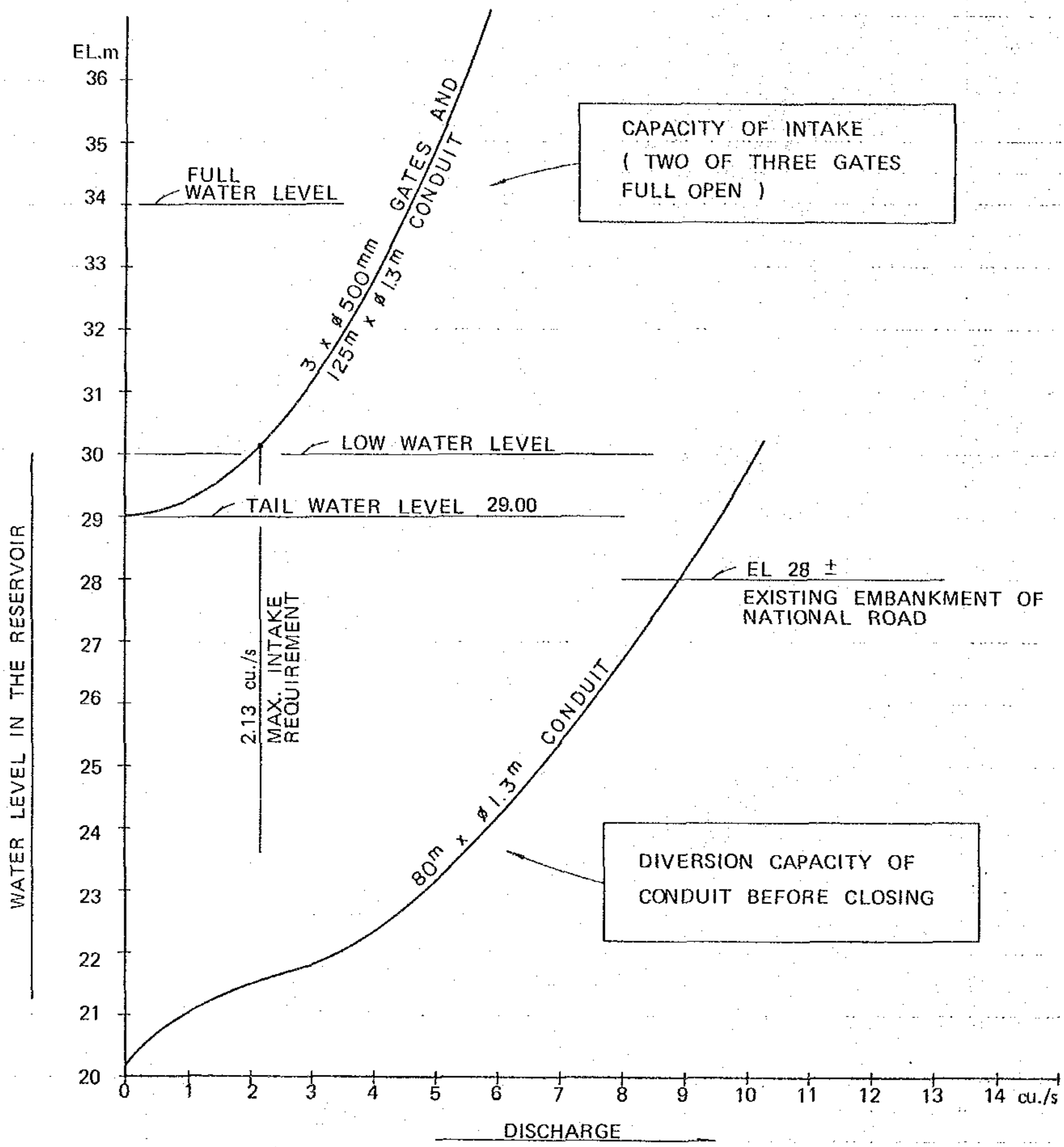


TABLE H1-6

SOIL MECHANICAL DATA OF DAM BODY (BAYONGAN)

Material (Zone)	Specific Gravity G_s	Void Ratio e	Dry Density γ_d (t/cu.m)	Moisture Content w (%)	Wet Density γ_t (t/cu.m)	Saturated Density γ_{sat} (t/cu.m)	Total Stress Base: Cohesion c (t/sq.m)	Total Stress Base: I.F.A ϕ (Degree)	Effective Stress Base: Cohesion c' (t/sq.m)	Effective Stress Base: I.F.A ϕ' (Degree)	Effective Stress Base: Ratio of Pore Pressure u (%)
Hilly gravel	2.6	0.4	1.86	10	2.05	2.14	0	43	-	-	-
Filter	2.6	0.4	1.86	10	2.05	2.14	0	43	-	-	-
Core material	2.5	0.85	1.35	30	1.76	1.81	-	-	10	15	10
Random fill	2.55	0.5	1.70	15	1.96	2.03	5	40	-	-	-
Dagohoy rock	2.65	0.3	2.04	0	2.04	2.27	0	45	-	-	-
Foundation	2.6	0.25	2.08	10	2.29	2.28	0	45	-	-	-

Note: G_s; Based on the soil tests and or on the general informations (see Annex C)
e, w, c, ϕ, c', ϕ', and u; ditto
$\gamma_d = G_s/(1 + e)$, $\gamma_t = \gamma_d \cdot (1 + w/100)$, $\gamma_{sat} = (G_s + e)/(1 + e)$

TABLE H1-7 SOIL MECHANICAL DATA OF DAM BODY (CAPAYAS)

Material (Zone)	Specific Gravity G_s	Void Ratio e	Dry Density γ_d (t/cu.m)	Moisture Content w (%)	Wet Density γ_t (t/cu.m)	Saturated Density γ_{sat} (t/cu.m)	Total Stress Base: Cohesion c (t/sq.m)	Total Stress Base: I.F.A ϕ (Degree)	Effective Stress Base: Cohesion c' (t/sq.m)	Effective Stress Base: I.F.A ϕ' (Degree)	Effective Stress Base: Ratio of Pore Pressure u (%)
Homogeneous fill	2.55	0.70	1.50	25	1.88	1.91	-	-	5	10	10
Toe drain	2.60	0.40	1.86	10	2.05	2.14	0	43	-	-	-

Note: G_s; Based on the soil tests and or on the general informations (see Annex C)
e, w, c, ϕ, c', ϕ', and u; ditto
$\gamma_d = G_s (1 + e)$, $\gamma_t = \gamma_d (1 + w/100)$, $\gamma_{sat} = (G_s + e)/(1 + e)$

TABLE H.1.-8 (Sheet No.1/8)

SLOPE STABILITY ANALYSIS

(STANDARD METHOD OF SLICES)

BAYONGAN DAM

UPSTREAM SLOPE : 3.25:1

DOWNSTREAM SLOPE: 2.25:1

** MINIMUM FACTOR OF SAFETY **

CASE NO.	CIRCLE NO.	COORDINATES OF CENTER - X - (M)	COORDINATES OF CENTER - Y - (M)	RADIUS (M)	FACTOR OF SAFETY
		** UPSTREAM FACE **			
1	41	70	80	40	1.21
2	41	70	80	40	2.21
3	41	70	80	40	1.21
4	41	70	80	40	1.15
		** DOWNSTREAM FACE **			
1	75	180	80	65	1.50
2	86	180	110	90	2.25

Note: With Earthquake (Seismic Force Coefficient, K = .20)

Number of Slip Circles Analyzed for Each Case:
Upstream Face - 88 Downstream Face - 87

** EXPLANATION **

Case 1 - Reservoir is at Normal Water Level and Seepage is Steady.

Case 2 - End of Construction (there is residual construction pore pressure).

Case 3 - Reservoir is at Intermediate Water Level and Seepage is Steady.

Case 4 - Rapid Drawdown (from normal water level to low water level - there is residual pore pressure).

TABLE H.1.-8 (Sheet No.2/8)

INPUT DATA

COORDINATES OF CENTER OF SLIP CIRCLE (X,Y):

	Upstream	Downstream
Minimum X - Meters	50	150
Maximum X - Meters	80	180
Increment of X - Meters	10	10
Minimum Y - Meters	80	80
Maximum Y - Meters	110	110
Increment of Y - Meters	10	10

INCREMENT OF RADIUS - Meters	5
SLICE THICKNESS - Meters	2
SEISMIC FORCE COEFFICIENT, K	.20

** SOIL MECHANICAL DATA OF EACH ZONE **

ZONE NO.	MOIST DENSITY (T/cu.m.)	SATURATED DENSITY (T/cu.m.)	COHESION (T/sq.m.)	ANGLE OF INT. FRIC. (Degrees)	CONST. PORE PRESSURE (Per cent)
1	2.05	2.14	0.00	43.0	0
2	2.05	2.14	0.00	43.0	0
3	1.76	1.81	10.00	15.0	10
4	2.05	2.14	0.00	43.0	0
5	1.96	2.03	5.00	40.0	0
6	2.04	2.27	0.00	45.0	0
7	2.29	2.28	0.00	45.0	0

Note: Zone No. 7 is the foundation.

TABLE H.1.-8 (Sheet No.3/8)

** SLOPE STABILITY ANALYSIS **

Name of Dam: BAYONGAN
Location : BOHOL PROVINCE

Type of Dam: EARTHFILL
Face of Dam: UPSTREAM
Slope : 3.25:1

*** WITH EARTHQUAKE ***

CIRCLE NO.	COORDINATES OF CENTER - X - (M)	- Y - (M)	RADIUS (M)	FACTOR OF SAFETY CASE 1	CASE 2	CASE 3	CASE 4
1	50	80	45	1.28	2.41	1.28	2.24
2	50	80	50	1.35	2.61	1.35	1.66
3	50	80	55	1.36	2.61	1.35	1.56
4	50	80	60	1.47	2.81	1.45	1.66
5	50	80	65	1.52	2.92	1.49	1.67
				1.28*	2.41*	1.28*	1.56*
6	50	90	55	1.37	2.66	1.37	2.07
7	50	90	60	1.34	2.58	1.34	1.60
8	50	90	65	1.34	2.56	1.33	1.53
9	50	90	70	1.44	2.75	1.42	1.61
10	50	90	75	1.49	2.85	1.46	1.63
				1.34*	2.56*	1.33*	1.53*
11	50	100	65	1.43	2.82	1.43	2.01
12	50	100	70	1.33	2.55	1.33	1.54
13	50	100	75	1.33	2.53	1.32	1.47
14	50	100	80	1.42	2.71	1.40	1.58
15	50	100	85	1.56	2.85	1.53	1.69
				1.33*	2.53*	1.32*	1.47*
16	50	110	75	1.41	2.77	1.41	1.79
17	50	110	80	1.32	2.51	1.33	1.49
18	50	110	85	1.31	2.50	1.31	1.45
19	50	110	90	1.47	2.74	1.46	1.62
20	50	110	95	1.57	2.83	1.53	1.70
				1.31*	2.50*	1.31*	1.45*
21	60	80	45	1.40	2.75	1.40	1.55
22	60	80	50	1.36	2.62	1.35	1.48
23	60	80	55	1.36	2.63	1.34	1.47
24	60	80	60	1.46	2.83	1.43	1.59
25	60	80	65	1.58	2.93	1.54	1.70
				1.36*	2.62*	1.34*	1.47*
26	60	90	55	1.37	2.64	1.37	1.46
27	60	90	60	1.34	2.56	1.33	1.42
28	60	90	65	1.34	2.57	1.32	1.44
29	60	90	70	1.51	2.82	1.48	1.64
30	60	90	75	1.60	2.93	1.55	1.76
				1.34*	2.56*	1.32*	1.42*
31	60	100	65	1.34	2.56	1.35	1.39
32	60	100	70	1.32	2.52	1.33	1.40
33	60	100	75	1.37	2.59	1.37	1.47
34	60	100	80	1.53	2.80	1.50	1.66
35	60	100	85	1.61	2.94	1.56	1.77

TABLE H.1.-8 (Sheet No.4/8)

UPSTREAM..........

*** WITH EARTHQUAKE ***

CIRCLE NO.	COORDINATES OF CENTER - X - (M)	- Y - (M)	RADIUS (M)	FACTOR OF SAFETY CASE 1	CASE 2	CASE 3	CASE 4
				1.32*	2.52*	1.33*	1.39*
36	60	110	75	1.32	2.50	1.36	1.35
37	60	110	80	1.31	2.48	1.33	1.37
38	60	110	85	1.48	2.68	1.47	1.58
39	60	110	90	1.55	2.79	1.52	1.71
40	60	110	95	1.62	2.98	1.57	1.81
				1.31*	2.48*	1.33*	1.35*
41	70	80	40	1.21	2.21	1.21	1.15
42	70	80	45	1.33	2.55	1.34	1.34
43	70	80	50	1.35	2.59	1.33	1.39
44	70	80	55	1.35	2.64	1.34	1.44
45	70	80	60	1.63	2.89	1.57	1.74
46	70	80	65	1.69	3.14	1.63	1.86
				1.21*	2.21*	1.21*	1.15*
47	70	90	50	1.21	2.22	1.29	1.15
48	70	90	55	1.31	2.48	1.34	1.30
49	70	90	60	1.32	2.54	1.33	1.37
50	70	90	65	1.55	2.82	1.52	1.65
51	70	90	70	1.58	2.81	1.53	1.71
52	70	90	75	1.67	3.10	1.61	1.89
				1.21*	2.22*	1.29*	1.15*
53	70	100	60	1.21	2.22	1.38	1.15
54	70	100	65	1.29	2.44	1.35	1.30
55	70	100	70	1.50	2.71	1.51	1.56
56	70	100	75	1.50	2.77	1.48	1.63
57	70	100	80	1.59	2.86	1.55	1.78
58	70	100	85	1.68	3.20	1.64	1.96
				1.21*	2.22*	1.35*	1.15*
59	70	110	70	1.21	2.23	1.44	1.15
60	70	110	75	1.40	2.54	1.48	1.43
61	70	110	80	1.51	2.73	1.52	1.60
62	70	110	85	1.53	2.83	1.51	1.69
63	70	110	90	1.60	2.91	1.57	1.83
64	70	110	95	1.69	3.29	1.67	2.04
				1.21*	2.23*	1.44*	1.15*
65	80	80	40	1.23	2.27	1.37	1.18
66	80	80	45	1.29	2.45	1.34	1.30
67	80	80	50	1.60	2.87	1.57	1.67
68	80	80	55	1.61	2.98	1.56	1.74
69	80	80	60	1.66	3.04	1.60	1.87
70	80	80	65	1.76	3.54	1.73	2.11
				1.23*	2.27*	1.34*	1.18*
71	80	90	50	1.23	2.26	1.42	1.20
72	80	90	55	1.49	2.66	1.55	1.53

TABLE H.1.-8 (Sheet No.5/8)

UPSTREAM.......... Page 3

*** WITH EARTHQUAKE ***

CIRCLE NO.	COORDINATES OF CENTER - X - (M)	- Y - (M)	RADIUS (M)	FACTOR OF SAFETY CASE 1	CASE 2	CASE 3	CASE 4
73	80	90	60	1.57	2.86	1.57	1.68
74	80	90	65	1.61	2.99	1.58	1.80
75	80	90	70	1.64	3.04	1.59	1.92
76	80	90	75	1.77	3.68	1.76	2.20
				1.23*	2.26*	1.42*	1.20*
77	80	100	60	1.24	2.27	1.46	1.26
78	80	100	65	1.58	2.75	1.63	1.65
79	80	100	70	1.60	2.93	1.60	1.75
80	80	100	75	1.62	3.06	1.60	1.87
81	80	100	80	1.65	3.12	1.61	1.99
82	80	100	85	1.79	3.81	1.80	2.28
				1.24*	2.27*	1.46*	1.26*
83	80	110	70	1.64	2.69	1.83	1.69
84	80	110	75	1.57	2.79	1.63	1.68
85	80	110	80	1.63	2.99	1.64	1.83
86	80	110	85	1.65	3.18	1.65	1.96
87	80	110	90	1.67	3.20	1.64	2.07
88	80	110	95	1.83	3.96	1.84	2.36
				1.57*	2.69*	1.63*	1.68*

Note: * - Minimum factor of safety in every center of slip circle.

TABLE H.1.-8 (Sheet No.6/8)

** SLOPE STABILITY ANALYSIS **

Name of Dam: BAYONGAN
Location : BOHOL PROVINCE

Type of Dam: EARTHFILL
Face of Dam: DOWNSTREAM
Slope : 2.25:1

*** WITH EARTHQUAKE ***

CIRCLE NO.	COORDINATES OF CENTER - X - (M)	- Y - (M)	RADIUS (M)	FACTOR OF SAFETY CASE 1	CASE 2
1	150	80	40	2.75	3.37
2	150	80	45	2.34	2.83
3	150	80	50	2.24	2.59
4	150	80	55	2.24	2.50
5	150	80	60	2.11	2.53
6	150	80	65	2.20	3.06
				2.11*	2.50*
7	150	90	45	17.32	20.57
8	150	90	50	2.85	3.51
9	150	90	55	2.36	2.80
10	150	90	60	2.27	2.63
11	150	90	65	2.25	2.57
12	150	90	70	2.15	2.67
13	150	90	75	2.21	3.21
				2.15*	2.57*
14	150	100	55	6.31	7.61
15	150	100	60	2.69	3.34
16	150	100	65	2.36	2.83
17	150	100	70	2.27	2.69
18	150	100	75	2.24	2.65
19	150	100	80	2.14	2.75
20	150	100	85	2.22	3.33
				2.14*	2.65*
21	150	110	65	4.70	5.78
22	150	110	70	2.71	3.33
23	150	110	75	2.38	2.89
24	150	110	80	2.33	2.82
25	150	110	85	2.29	2.77
26	150	110	90	2.17	2.88
27	150	110	95	2.24	3.46
				2.17*	2.77*
28	160	80	40	14.52	17.27
29	160	80	45	2.54	3.12
30	160	80	50	2.14	2.65
31	160	80	55	2.03	2.40
32	160	80	60	1.91	2.37
33	160	80	65	1.87	2.52
				1.87*	2.37*
34	160	90	50	6.51	7.81
35	160	90	55	2.41	2.97
36	160	90	60	2.13	2.57
37	160	90	65	2.07	2.40

TABLE II.1.-8 (Sheet No.7/8)

DOWNSTREAM..........

*** WITH EARTHQUAKE ***

CIRCLE NO.	COORDINATES OF CENTER - X - (M)	- Y - (M)	RADIUS (M)	FACTOR OF SAFETY CASE 1	CASE 2
38	160	90	70	1.90	2.37
39	160	90	75	1.90	2.61
				1.90*	2.37*
40	160	100	60	3.93	4.74
41	160	100	65	2.33	2.88
42	160	100	70	2.12	2.54
43	160	100	75	2.07	2.42
44	160	100	80	1.93	2.42
45	160	100	85	1.93	2.72
				1.93*	2.42*
46	160	110	70	3.47	4.23
47	160	110	75	2.31	2.82
48	160	110	80	2.16	2.57
49	160	110	85	2.10	2.47
50	160	110	90	1.96	2.53
51	160	110	95	1.94	2.84
				1.94*	2.47*
52	170	80	45	5.07	6.18
53	170	80	50	2.38	2.93
54	170	80	55	1.88	2.35
55	170	80	60	1.77	2.37
56	170	80	65	1.66	2.41
				1.66*	2.35*
57	170	90	55	4.03	4.92
58	170	90	60	2.16	2.66
59	170	90	65	1.98	2.44
60	170	90	70	1.76	2.29
61	170	90	75	1.66	2.40
				1.66*	2.29*
62	170	100	65	3.39	4.13
63	170	100	70	2.17	2.68
64	170	100	75	1.95	2.35
65	170	100	80	1.77	2.27
66	170	100	85	1.69	2.45
				1.69*	2.27*
67	170	110	75	2.79	3.41
68	170	110	80	2.13	2.62
69	170	110	85	1.98	2.36
70	170	110	90	1.77	2.29
71	170	110	95	1.67	2.47
				1.67*	2.29*
72	180	80	50	3.42	4.16
73	180	80	55	2.16	2.68
74	180	80	60	1.63	2.35

TABLE H.1.-8 (Sheet No.8/8)

DOWNSTREAM..........

*** WITH EARTHQUAKE ***

CIRCLE NO.	COORDINATES OF CENTER - X - (M)	- Y - (M)	RADIUS (M)	FACTOR OF SAFETY CASE 1	CASE 2
75	180	80	65	1.50	2.48
				1.50*	2.35*
76	180	90	60	3.11	3.80
77	180	90	65	2.08	2.58
78	180	90	70	1.59	2.29
79	180	90	75	1.53	2.46
				1.53*	2.29*
80	180	100	70	2.83	3.46
81	180	100	75	1.97	2.44
82	180	100	80	1.60	2.27
83	180	100	85	1.56	2.45
				1.56*	2.27*
84	180	110	80	2.50	3.06
85	180	110	85	1.98	2.46
86	180	110	90	1.61	2.25
87	180	110	95	1.56	2.44
				1.56*	2.25*

Note: * - Minimum factor of safety in every center of slip circle.

TABLE H.1.-9 (Sheet No.1/7)

SLOPE STABILITY ANALYSIS

(STANDARD METHOD OF SLICES)

CAPAYAS DAM

UPSTREAM SLOPE : 3:1

DOWNSTREAM SLOPE: 2:1

** MINIMUM FACTOR OF SAFETY **

CASE NO.	CIRCLE NO.	COORDINATES OF CENTER - X - (M)	COORDINATES OF CENTER - Y - (M)	RADIUS (M)	FACTOR OF SAFETY
		** UPSTREAM FACE **			
1	45	35	50	24.75	1.65
2	34	30	55	29.75	2.06
3	45	35	50	24.75	1.56
4	45	35	50	24.75	1.92
		** DOWNSTREAM FACE **			
1	29	65	55	29.75	1.50
2	25	65	50	24.75	1.71

Note: With Earthquake (Seismic Force Coefficient, K = .20)

Number of Slip Circles Analyzed for Each Case:
Upstream Face - 65 Downstream Face - 49

** EXPLANATION **

Case 1 - Reservoir is at Normal Water Level and Seepage is Steady.

Case 2 - End of Construction (there is residual construction pore pressure).

Case 3 - Reservoir is at Intermediate Water Level and Seepage is Steady.

Case 4 - Rapid Drawdown (from normal water level to low water level - there is residual pore pressure).

TABLE H.1.-9 (Sheet No.2/7)

INPUT DATA

COORDINATES OF CENTER OF SLIP CIRCLE (X,Y):

	Upstream	Downstream
Minimum X - Meters	15	60
Maximum X - Meters	40	80
Increment of X - Meters	5	5
Minimum Y - Meters	40	40
Maximum Y - Meters	55	55
Increment of Y - Meters	5	5

INCREMENT OF RADIUS - Meters	2.50
SLICE THICKNESS - Meter/s	1.00
SEISMIC FORCE COEFFICIENT, K	.20

** SOIL MECHANICAL DATA OF EACH ZONE **

ZONE NO.	MOIST DENSITY (T/cu.m.)	SATURATED DENSITY (T/cu.m.)	COHESION (T/sq.m.)	ANGLE OF INT. FRIC. (Degrees)	CONST. PORE PRESSURE (Per cent)
0	1.00	1.00	0.00	0.0	0
1	1.88	1.91	5.00	10.0	10
2	2.05	2.14	0.00	43.0	0
3	0.00	0.00	0.00	0.0	0

TABLE H.1.-9 (Sheet No.3/7)

** SLOPE STABILITY ANALYSIS **

Name of Dam: CAPAYAS
Location : BOHOL PROVINCE

Type of Dam: EARTHFILL
Face of Dam: UPSTREAM
Slope : 3:1

*** WITH EARTHQUAKE ***

CIRCLE NO.	COORDINATES OF CENTER - X - (M)	- Y - (M)	RADIUS (M)	FACTOR OF SAFETY CASE 1	CASE 2	CASE 3	CASE 4
1	15	40	14.75	6.97	6.15	6.97	9.77
				6.97*	6.15*	6.97*	9.77*
2	15	45	19.75	6.34	5.60	6.34	8.43
				6.34*	5.60*	6.34*	8.43*
3	15	50	24.75	5.56	4.93	5.56	6.79
				5.56*	4.93*	5.56*	6.79*
4	15	55	29.75	4.97	4.42	4.86	5.67
				4.97*	4.42*	4.86*	5.67*
5	20	40	12.25	14.66	12.61	14.66	18.80
6	20	40	14.75	4.18	3.83	4.18	4.95
				4.18*	3.83*	4.18*	4.95*
7	20	45	17.25	11.19	9.67	11.19	12.37
8	20	45	19.75	3.82	3.49	3.67	4.20
				3.82*	3.49*	3.67*	4.20*
9	20	50	22.25	9.07	7.88	8.87	9.20
10	20	50	24.75	3.43	3.15	3.16	3.59
				3.43*	3.15*	3.16*	3.59*
11	20	55	27.25	7.64	6.66	7.01	7.35
12	20	55	29.75	3.17	2.99	2.89	3.29
				3.17*	2.99*	2.89*	3.29*
13	25	40	12.25	5.53	4.99	5.23	5.32
14	25	40	14.75	3.09	2.94	2.80	3.14
				3.09*	2.94*	2.80*	3.14*
15	25	45	17.25	4.99	4.48	4.40	4.63
16	25	45	19.75	2.69	2.63	2.41	2.73
				2.69*	2.63*	2.41*	2.73*
17	25	50	19.75	25.30	21.53	21.88	21.03
18	25	50	22.25	4.26	3.97	3.71	4.02
19	25	50	24.75	2.41	2.45	2.18	2.50
				2.41*	2.45*	2.18*	2.50*
20	25	55	24.75	16.22	13.88	12.82	13.49
21	25	55	27.25	3.68	3.61	3.25	3.60
22	25	55	29.75	2.21	2.32	2.03	2.35
				2.21*	2.32*	2.03*	2.35*
23	30	40	9.75	8.49	7.49	6.72	7.21

TABLE H.1.-9 (Sheet No.4/7)

UPSTREAM..........

*** WITH EARTHQUAKE ***

CIRCLE NO.	COORDINATES OF CENTER - X - (M)	- Y - (M)	RADIUS (M)	FACTOR OF SAFETY CASE 1	CASE 2	CASE 3	CASE 4
24	30	40	12.25	3.50	3.45	2.98	3.27
25	30	40	14.75	2.34	2.49	2.08	2.39
				2.34*	2.49*	2.08*	2.39*
26	30	45	14.75	6.62	6.15	5.29	5.90
27	30	45	17.25	3.06	3.16	2.68	3.02
28	30	45	19.75	2.03	2.24	1.85	2.15
				2.03*	2.24*	1.85*	2.15*
29	30	50	19.75	5.58	5.60	4.72	5.40
30	30	50	22.25	2.61	2.81	2.35	2.69
31	30	50	24.75	1.87	2.12	1.73	2.04
				1.87*	2.12*	1.73*	2.04*
32	30	55	24.75	4.66	4.93	4.10	4.77
33	30	55	27.25	2.41	2.68	2.21	2.56
34	30	55	29.75	1.78	2.06	1.66	1.98
				1.78*	2.06*	1.66*	1.98*
35	35	40	9.75	4.10	4.47	3.51	4.28
36	35	40	12.25	2.54	2.94	2.28	2.76
37	35	40	14.75	1.90	2.30	1.74	2.12
				1.90*	2.30*	1.74*	2.12*
38	35	45	12.25	11.42	12.61	10.24	12.45
39	35	45	14.75	3.36	3.82	3.04	3.67
40	35	45	17.25	2.17	2.58	2.00	2.41
41	35	45	19.75	1.74	2.15	1.63	1.98
				1.74*	2.15*	1.63*	1.98*
42	35	50	17.25	8.33	9.67	7.86	9.59
43	35	50	19.75	3.01	3.53	2.80	3.40
44	35	50	22.25	2.03	2.46	1.90	2.30
45	35	50	24.75	1.65	2.08	1.56	1.92
				1.65*	2.08*	1.56*	1.92*
46	35	55	22.25	6.39	7.61	6.17	7.57
47	35	55	24.75	2.83	3.40	2.66	3.27
48	35	55	27.25	2.01	2.49	1.90	2.33
49	35	55	29.75	1.66	2.14	1.58	1.98
				1.66*	2.14*	1.58*	1.98*
50	40	40	9.75	2.74	3.56	2.73	3.43
51	40	40	12.25	2.09	2.80	2.02	2.63
52	40	40	14.75	1.75	2.43	1.68	2.22
				1.75*	2.43*	1.68*	2.22*
53	40	45	12.25	3.97	5.05	4.02	5.02
54	40	45	14.75	2.54	3.31	2.51	3.19
55	40	45	17.25	1.93	2.61	1.87	2.44
56	40	45	19.75	1.66	2.35	1.60	2.14

TABLE H.1.-9 (Sheet No.5/7)

UPSTREAM..........

*** WITH EARTHQUAKE ***

CIRCLE NO.	COORDINATES OF CENTER - X - (M)	- Y - (M)	RADIUS (M)	FACTOR OF SAFETY CASE 1	CASE 2	CASE 3	CASE 4
				1.66*	2.35*	1.60*	2.14*
57	40	50	17.25	4.00	5.16	4.04	5.14
58	40	50	19.75	2.40	3.19	2.38	3.07
59	40	50	22.25	1.94	2.68	1.88	2.50
60	40	50	24.75	1.68	2.42	1.62	2.18
				1.68*	2.42*	1.62*	2.18*
61	40	55	19.75	18.27	22.96	18.27	23.01
62	40	55	22.25	3.80	4.97	3.83	4.95
63	40	55	24.75	2.45	3.31	2.42	3.18
64	40	55	27.25	1.97	2.79	1.92	2.59
65	40	55	29.75	1.74	2.56	1.68	2.30
				1.74*	2.56*	1.68*	2.30*

Note: * - Minimum factor of safety in every center of slip circle.

TABLE H.1.-9 (Sheet No.6/7)

** SLOPE STABILITY ANALYSIS **

Name of Dam: CAPAYAS
Location : BOHOL PROVINCE

Type of Dam: EARTHFILL
Face of Dam: DOWNSTREAM
Slope : 2:1

*** WITH EARTHQUAKE ***

CIRCLE NO.	COORDINATES OF CENTER - X - (M)	- Y - (M)	RADIUS (M)	FACTOR OF SAFETY CASE 1	CASE 2
1	60	40	9.75	2.57	2.97
2	60	40	12.25	1.98	2.25
3	60	40	14.75	1.58	1.82
				1.58*	1.82*
4	60	45	12.25	4.10	4.89
5	60	45	14.75	2.34	2.75
6	60	45	17.25	1.88	2.18
7	60	45	19.75	1.53	1.80
				1.53*	1.80*
8	60	50	17.25	3.82	4.67
9	60	50	19.75	2.36	2.82
10	60	50	22.25	1.85	2.19
11	60	50	24.75	1.55	1.86
				1.55*	1.86*
12	60	55	22.25	3.60	4.49
13	60	55	24.75	2.33	2.84
14	60	55	27.25	1.89	2.28
15	60	55	29.75	1.59	1.95
				1.59*	1.95*
16	65	40	9.75	4.63	5.29
17	65	40	12.25	2.33	2.44
18	65	40	14.75	1.70	1.85
				1.70*	1.85*
19	65	45	14.75	3.50	3.98
20	65	45	17.25	1.95	2.10
21	65	45	19.75	1.57	1.76
				1.57*	1.76*
22	65	50	17.25	23.80	27.75
23	65	50	19.75	2.85	3.27
24	65	50	22.25	1.86	2.05
25	65	50	24.75	1.51	1.71
				1.51*	1.71*
26	65	55	22.25	8.51	10.02
27	65	55	24.75	2.65	3.09
28	65	55	27.25	1.81	2.03
29	65	55	29.75	1.50	1.74
				1.50*	1.74*
30	70	40	12.25	3.30	3.67
31	70	40	14.75	2.15	2.26

TABLE H.1.-9 (Sheet No.7/7)

DOWNSTREAM..........

*** WITH EARTHQUAKE ***

CIRCLE NO.	COORDINATES OF CENTER - X - (M)	- Y - (M)	RADIUS (M)	FACTOR OF SAFETY CASE 1	CASE 2
				2.15*	2.26*
32	70	45	17.25	2.89	3.09
33	70	45	19.75	1.84	1.96
				1.84*	1.96*
34	70	50	19.75	12.54	14.63
35	70	50	22.25	2.43	2.62
36	70	50	24.75	1.67	1.81
				1.67*	1.81*
37	70	55	24.75	6.59	7.68
38	70	55	27.25	2.14	2.33
39	70	55	29.75	1.59	1.76
				1.59*	1.76*
40	75	40	14.75	2.41	2.80
				2.41*	2.80*
41	75	45	17.25	19.33	22.56
42	75	45	19.75	2.41	2.62
				2.41*	2.62*
43	75	50	22.25	7.52	8.77
44	75	50	24.75	2.20	2.35
				2.20*	2.35*
45	75	55	27.25	4.70	5.48
46	75	55	29.75	1.93	2.08
				1.93*	2.08*
47	80	45	19.75	2.78	3.32
				2.78*	3.32*
48	80	50	24.75	3.49	4.12
				3.49*	4.12*
49	80	55	29.75	3.05	3.57
				3.05*	3.57*

Note: * - Minimum factor of safety in every center of slip circle.

CHAPTER II CANALS

2.1 General

The project area is located in an undulated hilly area with eleve-tion of 40 m to 5 m and is incised by narrow valleys developed along the streams flowing down from south to north. The soils in the project area are composed of Ubay soil series which characterized by slightly coarse-textured surface soil underlaid by loamy or clayey but gravelly subsoils.

Irrigation canal systems are planned to take water directly from the proposed reservoirs and to distribute the irrigation water to existing paddy field expanded along the streams and hilly area to be reclaimed. In connection with irrigation canal system, drainage system is also provided using the existing streams. The Bayongan and Capayas dams are proposed as a water source of the project and main irrigation canals start these dam outlets to make up its distribution networks in the project area. Based on the topography and location of water sources, the project area is divided by the Soom -Bayan river into two irrigation systems, namely, Bayongan and Capayas.

Under these concepts, the Bayongan and Capayas systems are planned to cover an area of 4,140 ha with 112 service units and of 1,160 ha with 33 service units, respectively. Service unit of each irriga-tion system is demarcated by an area of 25 ha in minimum, 50 ha in maximum and about 36 ha on the average.

2.2 Irrigation Canal System

2.2.1 Function and Requirement of Canal

The proposed irrigation canal systems consist of main, lateral and sub-lateral canals. The layout of these canals is planned with understanding their respective functions and requirements.

Two main canals of Bayongan and Capayas are planned to secure the proper water distribution in the project area. The functions of main canal are to convey irrigation water most economically and effectively from each dam to the proposed lateral canals.

The functions of lateral and sub-lateral canals are to deliver irrigation water from main canal and/or lateral canal to the head portions of service units. To facilitate an efficient water management, service units should preferably be supplied only from lateral or sub-lateral canals.

2.2.2 Canal Alignment

Prior to the field survey of irrigation canal route, preliminary canal alignment is made on a scale of 1/4,000 topographic maps. Modification of preliminary canal alignment was conducted on the said maps in accordance with the proposed land use, allowing service by gravity system and result of field survey.

The main irrigation canal to cover the Bayongan system area is placed between the Bayongan dam outlet and the Capayas reservoir and runs through a flat hilly area with the elevation of 40 m to 35 m. The water level of main canal is 37 m at 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 design discharge of 7.54 cu·m/sec. in crop maintenance period and of 9.74 cu·m/sec. in land soaking period.

The main irrigation canal to cover the Capayas system starts from the Capayas dam outlet and reaches near Ubay.
The canal alignment is placed at the moderately undulated area having the elevation of 30 m to 25 m. The Capayas main canal is planned at the total length of 3.27 km with maximum design discharge at 1.65 cu·m/sec. for crop maintenance period and 2.13 cu·m/sec. for land soaking period.

Both of the main canals run mostly along the ridge area of hill and cross only a few streams. Canals are constructed with cut and fill portion and excavated materials can be used for filling materials.

The alignment of lateral and sub-lateral irrigation canals are selected to run at the higher place of hilly area in order to cover service units as much as possible by the gravity system. 30 lines of lateral and sub-lateral canal with total length of 87.73 km are planned with a design discharge of 3.15 cu.m/sec. in maximum. The lateral and sub-lateral alignments can run also the flat hilly area with structures crossing a few streams.

The size of service area commanded by a lateral canal is designed from 160 ha to 1,700 ha consisting of 5 to 46 service units.

The diagram of irrigation networks is formed in accordance with the irrigation water requirement, demarcation of each service unit, proposed lateral canal alignment and irrigation systems.

Proposed irrigation canal alignment, irrigation system in lateral canalwise and proposed irrigation canal features are shown in FIGURE H2-1, FIGURE H2-2 and TABLE H2-1, respectively.

2.2.3 Design of Irrigation Canal

Trapezoidal cross section are designed for all the proposed canals. Design criteria prevailing in NIA are mainly adopted for the design of canal and related structures.

1) Design discharge

   Design discharge for all the irrigation canals and related structures are obtained in compliance with the peak irrigation water requirement of 1.422 l/sec/ha in crop maintenance period. During the land soaking period, the peak irrigation water requirement is estimated at 1.837 l/sec/ha and excessive irrigation water compared with the crop maintenance period will be delivered using the canal freeboard.

2) Velocity

   The maximum and the minimum permissible velocity are determined so as not to give the erosion and deterioration and not to allow the sedimentation and the growth of aquaplant and moss in canals. Considering the above basic requirements, the canal velocities are determined as follows;

	Max.	Min.
Concrete Lined Canal	1.0 m/sec.	0.5 m/sec.
Earth Canal	0.8 "	0.3 "

3) Roughness Coefficient

The Manning's Formula is used for determination of hydraulic properties of canals. Following roughness coefficient, "n" is applied;

	Roughness Coefficient
Concrete Lined Canal	0.015
Earth Canal	0.025

4) Freeboard

The freeboard in canals is determined as 40 percent of the water depth with the minimum of 0.30 m whichever is bigger.

5) Canal base width/water depth (B/h) ratio

The ratio of canal base width and water depth is used at 1 for concrete lined canal of which discharge is less than 4 cu·m/sec. and 2 for earth canal and concrete lined canal with discharge more than 4 cu·m/sec.

6) Side Slope

The inside slope of 1:1 is adopted for concrete lined canal with discharge less than 4 cu·m/sec. and 1:1.5 for other size of canals. The outside slopes of 1:1.5 for embankment portion and 1:1 for cutting portion are used taking into account the soil conditions.

7) Berm Width

Berm width is taken with same length as canal height.

8) Lining of Canal

All the main canals with the total length of 15.72 km are lined with 10 cm thickness of plain concrete to check seepage from the canal banks and bottom and to protect the canal section against erosion.

Twenty three types of canal section are proposed for the irrigation canal system. Hydraulic properties of each type are shown in attached drawing in main report.

2.2.4 Related Structures

A number of related structures are essential for full functions of canal. These structures are classified into measurement, distribution, regulation, conveyance and protection purpose.

1) Distributing and Measuring Structure

Head Regulator and Turnout are provided as a distributing structures of canals.

Head Regulator is installed to divert irrigation water from main canal to lateral canal. Neyrpic Orifice Module (so called "Distributor") is provided as a measuring divice of Head Regulator. The distributor is so designed as to be capable of constantly delivering a predetermined rate of flow regardless variations in the upstream water level.

Turnout is constructed for the diversion of irrigation water from lateral canal to sub-lateral canal or lateral canal and/or sub-lateral canal to service unit. As a measuring divice, constant head orifice is furnished at the inlet portion of turnout.

Following distributing structures are designed for canal systems;

	Head Regulator (places)	Turnout (places)
Bayongan System		
Main canal	6	-
Lateral/Sub-lateral	-	126
Capayas System		
Main canal	3	-
Lateral/Sub-lateral	-	36
Total	9	162

2) Regulating Structure

Check and drops are provided for regulating of water level in the canal. A check is provided at the just downstream of distributing structure to maintain the required water level during the period of partial flow in the canal. There are three types of check; (1) check cum duckbill weir, (2) check cum drop and (3) check gate only. Type (1) of check cum duckbill weir is furnished in main canal in order to secure the function of distributor. Type (2) and (3) are installed in lateral and/or sub-lateral canal according to the site conditions.

To dissipate the excess energy in canals, vertical drops of 1.5 m or 1.0 m in water surface are provided for the canal design. Regulating structures required for the project are tabulated below;

	Check			Drop
	(1)	(2)	(3)	(places)
Bayongan System				
Main	5	-	-	-
Lateral/Sub-lateral	-	44	13	84
Capayas System				
Main	2	-	-	1
Lateral/Sub-lateral	-	4	8	28
Total	7	48	21	113

3) Conveyance Structure

Crossing structures such as bridge, pipe crossing and syphon are installed to convey the irrigation water over or under road, river and stream. Pre-cast concrete pipe is used for crossing structures with a canal discharge of less than 1.0 cu·m/sec. and the concrete bridges for a discharge of more than 1.0 cu·m/sec. due to decrease the head losses of irrigation canals.

For the syphon barrel, pre-cast concrete pipe is also used because of the design discharge estimated less than 1.0 cu·m/sec.

Following conveyance structures are designed for the project;

	Bridge (places)	Pipe Crossing (places)	Syphon (places)
Bayongan System			
Main	11	-	-
Lateral/Sub-lateral	18	105	-
Capayas System			
Main	4	-	-
Lateral/Sub-lateral	-	35	2
Total	33	140	2

4) Protecting Structures

Spillway of the side channel overflow type will be provided in the canal to spill the excess water in the canal.

Cross drains are constructed across the irrigation canals at the places where the canals run across depressed place or natural streams. Protecting structures required for the project are tabulated below;

	Spillway (places)	Cross Drain (places)
Bayongan System		
Main	3	18
Lateral/Sub-lateral	1	57
Capayas System		
Main	1	10
Lateral/Sub-lateral	2	40
Total	7	125

2.3 Drainage Canal Systems

2.3.1 Function and Requirement of Canal

The functions of drainage canals are to drain out water in fields and to lead the water to drain outlets. The layout of the irrigation system and the topography of the related area are the main factors for determining the location of the drainage canal. Existing natural streams or depressed places are used for the drainage canal as much as possible.

2.3.2 Canal Alignment

Many natural streams flowing down from the south to the north direction will be available for the main drainage canal. These streams 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 rain water comes down to 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 river course 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 canals is proposed at 49.0 km with 49 lines in the project area. Design discharge and canal gradient vary from 0.87 cu.m/sec. to 0.09 cu.m/sec. and from 1/3,000 to 1/750, respectively.

Drainage diagram is planned in compliance with location of existing stream, demarcation of drainage area, drainage unit requirement and irrigation canal alignment.

2.3.3 Design of Drainage Canal

The design discharge of drainage canals is estimated at 5.61 l/sec/ha based on the rainfall record with a frequency of 5 years. Manning's Formura is used for hydrauric calculation with a roughness coefficient of 0.04. Drainage canals are designed trapezoidal in shape with inside slopes of 1:1 and base width to water depth ratio of 1.0. To prevent erosion and sedimentation in the canals, permissible velocity is taken at 0.3 m/sec. in minimum and 0.8 m/sec. in maximum.

2.3.4 Related Structure

Regulating and conveyance structures are provided in the canals as related structure of the drainage canal.

Drop is installed to regulate the water surface in the canals that have steeper slopes than those needed to reach permissible velocities. Road crossing with pipe barrel is furnished at the place where existing road crosses the drainage canal. Drain outlets at the terminal point of canals will also be provided. Required regulating and conveyance structures are tabulated below;

Structures	Bayongan system (places)	Capayas system (places)	Total (places)
Road Crossing	63	16	79
Drop	178	28	206
Drain Cutlet	43	6	49

2.4 Operation & Maintenance Road

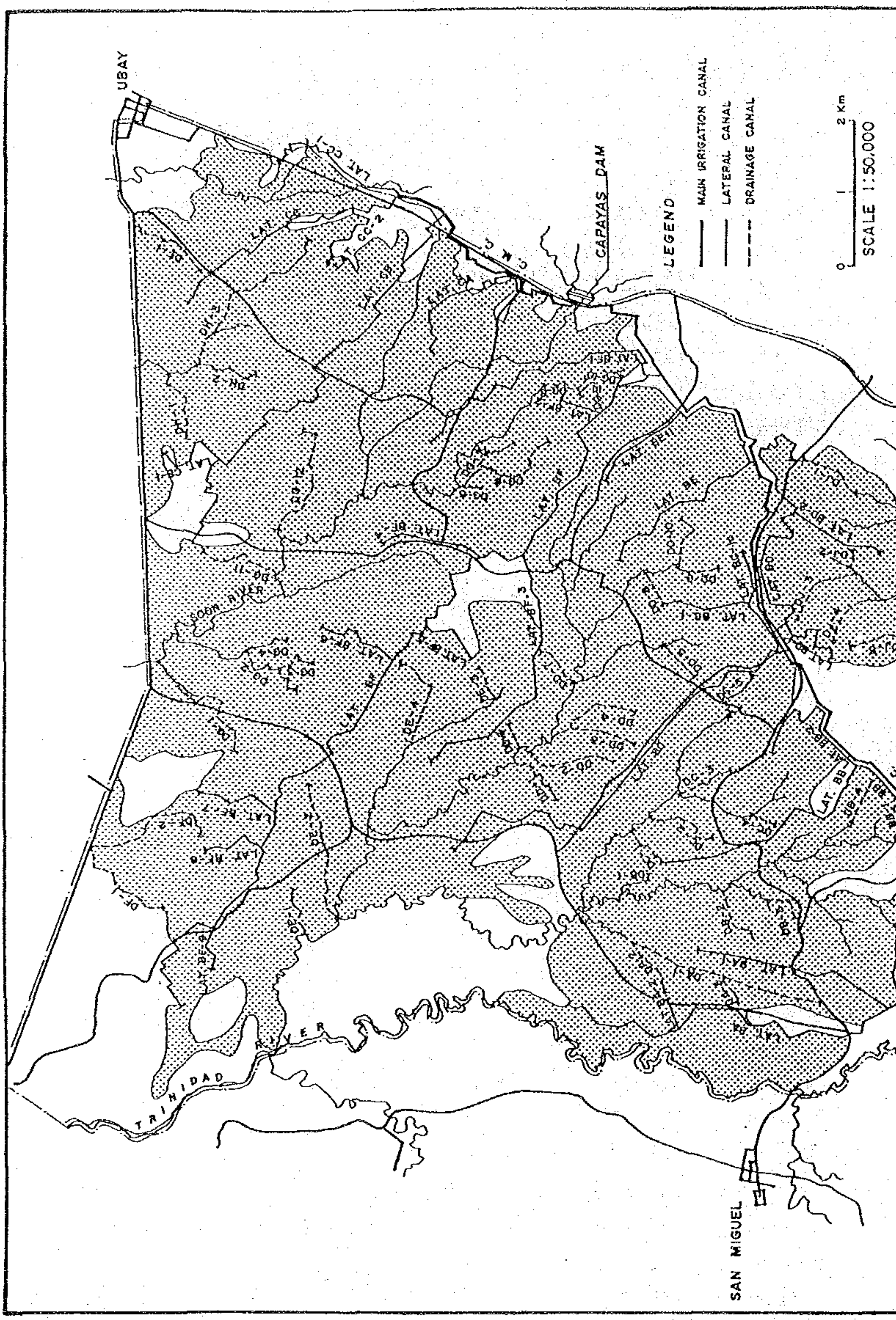
Operation and maintenance road is planned along the irrigation canals except sections where existing road runs in parallel. O & M road will be constructed on one bank 6.0 m wide roadway having 4.5 m wide gravel surfacing of 20 cm thickness for main canal and 4.0 m wide roadway having 3.0 m wide gravel surfacing of 20 cm thickness for lateral and sub-rateral canals.

Required O & M road in each system is shown below;

	Along Main Canal	Along Lateral/ Sub-lateral Canal
Bayongan System	9.90 km	52.0 km
Capayas System	2.60	16.0

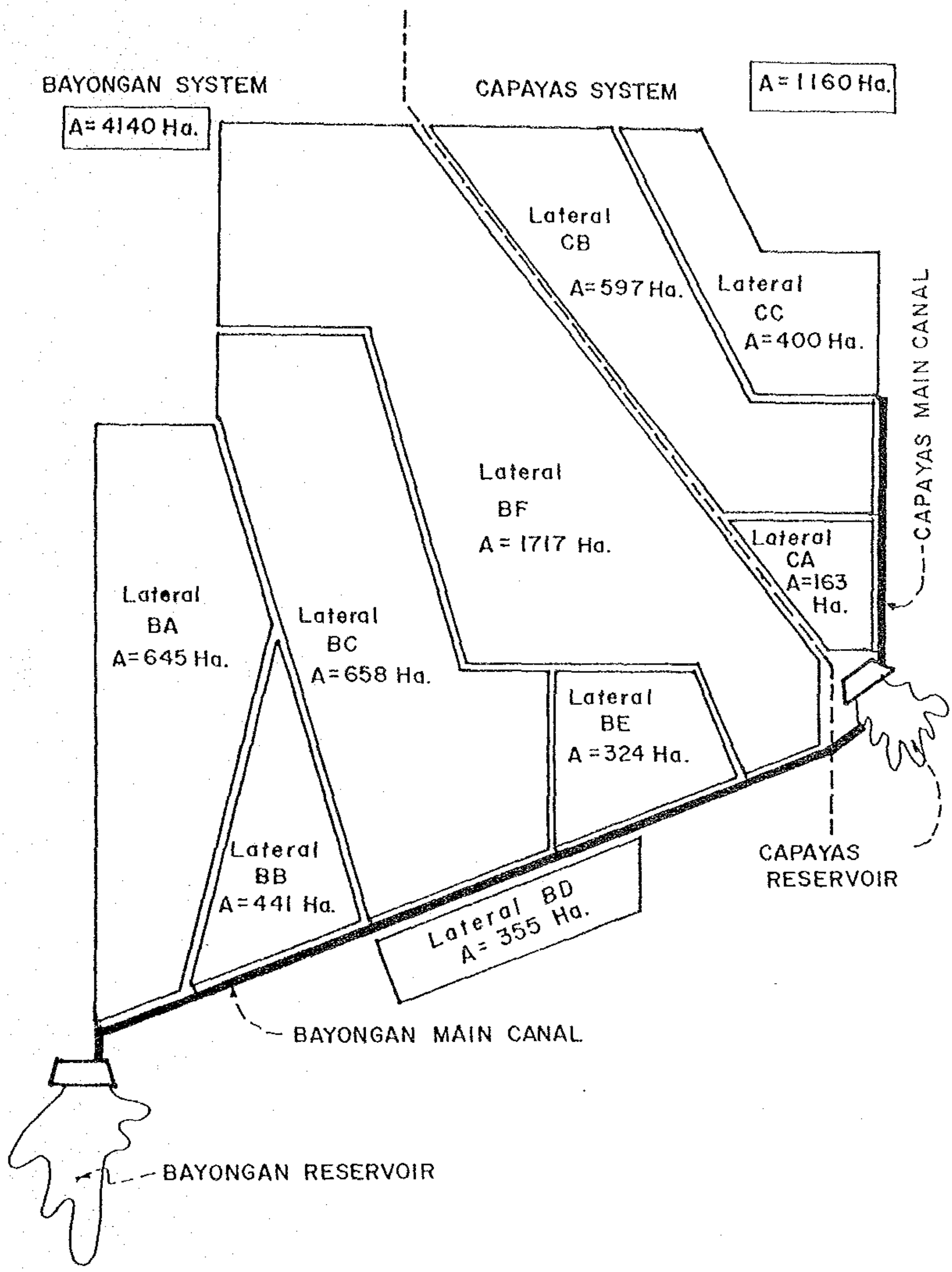
TABLE H2-1 PROPOSED IRRIGATION CANAL FEATURES

System	Canal	Canal Name	Commanding Area	Length	Remarks
Bayongan	Main	B.M.C.	4,140 ha	12.45 km	
	Lateral	LAT.BA	645	6.42	
	S-Lateral	LAT.BA-1	284	3.10	
	ditto	LAT.BA-2	41	0.55	
	Lateral	LAT.BB	441	5.37	
	S-Lateral	LAT.BB-1	37	0.80	
	ditto	LAT.BB-2	153	2.53	
	Lateral	LAT.BC	658	6.20	
	S-Lateral	LAT.BC-1	151	1.85	
	ditto	LAT.BC-1a	60	0.69	
	Lateral	LAT.BD	355	4.96	
	S-Lateral	LAT.BD-1	100	1.47	
	ditto	LAT.BD-2	75	1.24	
	Lateral	LAT.BE	324	2.60	
	S-Lateral	LAT.BE-1	189	3.30	
	Lateral	LAT.BF	1,717	13.18	
	S-Lateral	LAT.BF-1	198	4.57	
	ditto	LAT.BF-2	68	0.55	
	ditto	LAT.BF-3	222	3.47	
	ditto	LAT.BF-4	149	1.35	
	ditto	LAT.BF-5	76	0.80	Total Length
	ditto	LAT.BF-6	73	1.00	Main 12.45 km
	ditto	LAT.BF-7	126	1.12	Lateral 38.73 km
	ditto	LAT.BF-8	39	0.95	Sub-Lat 30.14 km
	ditto	LAT.BF-9	34	0.80	Total 81.32 km
Capayas	Main	C.M.C	1,160	3.27	
	Lateral	LAT.CA	163	2.53	
	ditto	LAT.CB	597	7.35	Total Length
	S-Lateral	LAT.CB-1	63	1.20	Main 3.27 km
	Lateral	LAT.CC	400	3.98	Lateral 13.86 km
	S-Lateral	LAT.CC-1	66	2.60	Sub-Lat 5.00 km
	ditto	LAT.CC-2	71	1.20	Total 22.13 km



PROPOSED IRRIGATION AND DRAINAGE CANAL ALIGNMENT
FIGURE H2-1

FIGURE H2-2 IRRIGATION SYSTEM IN LATERAL CANAL



ANNEX I. ON–FARM DEVELOPMENT AND WATER MANAGEMENT

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CHAPTER I ON-FARM DEVELOPMENT

1.1 Land Development

a) General

Land development in hilly area is an essential component of the project. Total 3,600 hectares of Class-I land with land slope less than three percent is proposed to be developed to paddy field by the project component, while 1,200 hectares of Class-II land with land slope three to five percent is assumed to be developed to upland farm.

As to the farm development of the Class II land after the project, beneficical farmers would desire to reclaime paddy as following background. In this connection, necessary countermeasures to cope with this possibitity should be taken before the project, as it will cause an additional water demand.

- Under the poor land resources and population pressure, farmers in Bohol Island have reclaimed a great number of paddy terraces even on the steep slope so much as irrigation water is avairable.

- Paddy terrace development on the sloped land will be quite attrective for farmers at the standpoint of erosion control of soil and better farm management expected.

- Class-I land of rotation area is not evenly distributed in size to each property lot.

- In case of communal irrigation project, farmers have expanded their paddy terraces by themselves very soon after the water is avairable.

- Voluntary reclamation of land by farmers themselves is never prohibited by NIA.

Demand for additional water supply by farmers to reclamated paddy after the project will be an important subject of Farmers Irrigatars' Associations to be dissolved by themselves. Because, the concern with NIA regarding water seepply will be how to answer irrigation requirement of the system area in exchange for collectible irrigation fee.

b) Proposed Criteria of Land Development

Paddy reclamation in hilly area will be planned by contour terracing method which is most commonly carried out in such undulated hills as in the project area. The dimension of paddy to be developed by the project is proposed as follows:

- Standard width of terrace will be 20 meters.
- The minimum and maximum widths of terrace will be 10 meters and 30 meters respectively.
- The Maximum length of one plot of paddy will be 100 meters.
- The maximum hight of terrace will be 60 centimeters.
- Side slope of terrace on cut and fill sections will be 1 : 1.

In order to obtain adequate soil depth availrable for crop production, deep plowing by means of heavy equipment will be planned as required.

Proposed paddy land with a large size will be divided into irrigation units with one to one and a half hectares in size in order to make a terminal irrigation unit for rotational irrigation practice. Plot to plot irrigation will be planned within each irrigation unit. Farm turnouts and internal ditches are constructed as required at the expense of beneficial farmers.

As layout of on-farm facilities is influential in figuring the land reclamation plan, the layout of on-farm facilities should be planned in connection with the land development plan. As a rule, a land development plan is more adjustable in the layout of terracing than the routing of on-farm facilities.

Right of way of on-farm facilities should be established prior to the commencement of land development works. The line of right of way shoul be protected so as not to be destroyed by the development works.

1.2 On-Farm Development

a) Design Criteria of On-Farm Facilities

Standard design and design criteria of on-farm facilities are shown in FIGURE OF-3, OF-4 attached to MAIN REPORT and as follows:

Unit discharge:

For irrigation requirement 2.183 l/sec/ha
For drainage requirement 5.61 l/sec/ha

Flow formular :

Mannings' open channel formular is used to determine the ditch elements

Coefficent of roughness :

n = 0.03 for main farm ditch
n = 0.04 for supplementary farm ditch and farm drain

Allowable maximum velocity :

1.0 m/s for farm ditches
0.7 m/s for farm drain

Inside and outside slopes :

1 : 1 for cut section and fill section

Profile slope of ditches :

0.001 for main farm ditch at the minimum

Elements of ditches : unit: cm

Item	MFD	SFD	Farm Draiw
Berm width	40	35	30
Bottom width	40	30	30 min
Free board	15		20

Note: Total depth of supplementary farm ditch is determined to be 30 cm.

b) On-Farm Facilities

On-farm facilities are planned based on NIA criteria with regard to on-farm facilities adding some proposed modifications aiming at better water management by farmers' group. The on-farm facilities are outlined as follows:

1) Turnout

The turnout point will be selected along lateral/sub-lateral canals based on the physical condition of rotation area to be convenient to supply water for all rotation units.

When the rotation area extends along lateral canal or a ridge line with long span, the turnout point will be selected around the middle section of rotation area so as to covey water evenly to each rotation units.

2) Main Farm Ditch

The main farm ditch is planned to convey water from the turnout to each supplementary farm ditch through division box. No direct turnout from the main farm ditch to farm lots is designed.

The division box is composed of two wing type checks; one is provided at the head of the supplementary farm ditch and the other is just at the downstream across the main farm ditch.

Two checks are designed to provide a fixed proportional division of flow in accordance with respective size of service area commanded by each check. The standard trapezoidal (Cipolletti) weirs are installed in checks at each overflow section as shown in FIGURE OF-4 attached at MAIN REPORT.
The dimension of two weirs is determined in accordance with the size of each service area. A temporary alternation in diversion rate of flow can be accommodated by means of stop logs, while the permanent correction of diveision flow due to change of service area is accomplised by replacing of corresponding weirs.

3) Supplementary Farm Ditch

The supplementary farm ditches are planned in each rotation area with the purpose of distributing water to farm lots in each rotation area. The route of supplementary farm ditch is selected along ridge line or across the terraces depending on the local conditions.

As much as possible, supplementary farm ditch should not be constructed on fill section, but on cut section considering probable erosion problem after the project.

The supplementary farm ditch planned along hilly area will be designed for irrigation only in view of protecting the subgrade from scouring by drainage water.

4) Farm Drains

Farm drains are planned along the present paddy field as required so as to remove excess water from the paddy field. The farm drain can be used for the irrigation purpose of the present paddy field.

5) Farm Road

Farm road is planned for better farm management of the community, and operation and maintainance of on-farm facilities. In this connection, farm road is connected with public road or farm road adjacent to rotation area.

The total width of farm road is assumed to be three meters in view of future requirement for public transportation, machanized farm management and operation and maintainance work of on-farm facilities.

1.3 Typical Layout for On-Farm Development

a) General Description of Sample Areas

Layout of on-farm development was planned at selected two sample areas in the project area based on the topographic maps of 1: 2,000 in scale. One sample area (area "A") commanded by the Capayas system is located at Barangay Tuburan, and the other sample area (area "B") commanded by the Bayongan system is located at Barangay Hambabawran.

1) Sample area "A"

The sample area "A" is extended on the sloped area in which hilly areas and paddy fields are alternated. As the paddy field is branched into four tributaries within the area, the hills in the area is separated into three blocks.

The drainage water through the sample area is concentrated to the paddy fields, and the size of drainage area amounts to 87 hectares at the lowest end of the sample area. However as the drainage system of the area branches into four major tributaries, the drainage water causes less problems in the area.

The route of lateral canal C-B transits across the drainage area about one and a half kilometers in span along the rotation area. The average ground slope of proposed reclamation area is estimated to be two percent.

Although no avairable cadastal map of the rotation area authorized by the Government, the property lines in the rotation area were followed by the field survey. The number of farms in the sample area was 12.

2) Sample Area "B"

The sample area is shaped a head land. Several ridge lines are branched off from the main ridge in the middle to both ways. The area is located at the tail end of lateral canal B-E.

Proposed reclamation area is extended on the hills which have average ground slope of two percent. Paddy fields have been developed on the depressed areas and along narrow depressions which have relatively steep profile slopes.

As the sample area had been bought by the Government and sold to farmers after divided into lots, each farm lot is shaped of regular size with 200 by 150 meters length apurtenanted an additional right of way for farm road along one side line of each lot.

Although no available cadastal map was obtained in the field survey, the property lines were followed in the field survey. The number of the property lots related to proposed land development amounts to 27.

b) Layout of On-Farm Facilities

As a result of home works based on the topographic maps, proposed routes of irrigation and drainage ditches are not followed along the property line except only limited sections. On the contrary, proposed farm roads are able to confirm property lines.

Farm lots with relatively large size were divided into irrigation units to have one to one and a half hectares in size. Internal ditches between supplementary farm ditch and the irrigation units were planned as required.

The layouts of on-farm development in two sample area are shown in FIGURE OF-1 and OF-2 attached to MAIN REPORT. And the quantities of on-farm facilities are shown in TABLE I-1 and I-2.

TABLE I1-1 SUMMARY OF ON-FARM FACILITIES IN SAMPLE AREA "A"

Item	Unit	Rotation Unit 1	2	3	4	Total
Gross area	ha					50.6
Irrigated area	ha	7.0	8.8	7.9	5.9	29.6
No. of irrigation unit	unit	6	8	6	6	26
Main farm ditch	m	-	-	-	-	510
Supplementary farm ditch	m	840	330	280	480	1,930
Farm drain	m	1,040	270	650	660	2,620
Farm road	m					2,280
Division box	unit	1		1		2
Check and drop	unit	4	1	2	3	10
Road crossing	unit	2	1	2	3	8

TABLE I1-2 SUMMARY OF ON-FARM FACILITIES IN SAMPLE AREA "B"

Item	Unit	Rotation Unit 1	2	3	4	5	Total
Gross area	ha						64.4
Irrigated area	ha	6.9	10.6	9.5	8.4	10.7	46.1
No. of irrigation unit	unit	6	8	7	8	9	38
Main farm ditch	m	-	-	-	-	-	720
Supplementary farm ditch	m	210	700	310	450	390	2,060
Farm drain	m	50	100	620	440	350	1,560
Farm road	m						1,520
Division box	unit	1		1	1		3
Check and drop	unit		2	2	3		7
Road crossing	unit	1	3	3	2	5	14

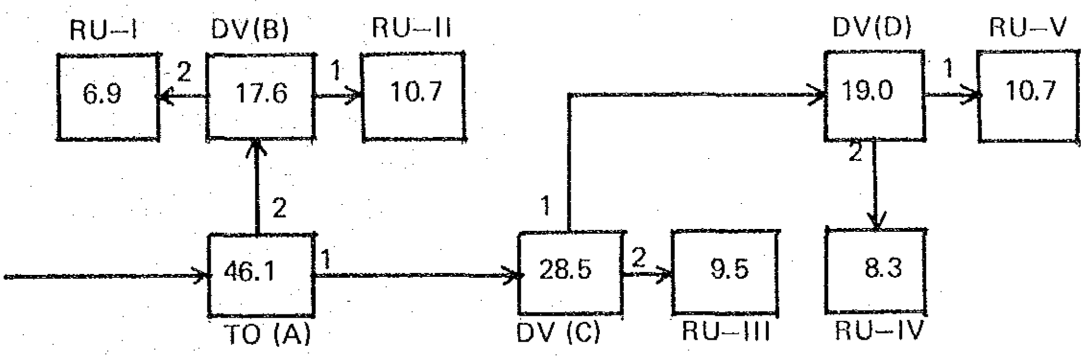
c) Typical Design of Division Box

In order to materialize the design process of water distribution structure of on-farm facilities, the typical design was carried out at sample area "B". The schimatic chart of the water diversion structure is shown in FIGURE I1-3.

TABLE I1-3 shows the dimension of devision weirs at sample area "B" corresponding to the schimatic chart as shown in FIGURE I1-3.

FIGURE I1-3 SCHIMATIC CHART FOR DIVERSION SYSTEM OF SAMPLE AREA "B"

(Unit: ha)



Where:

TO = Turnout
DV = Division Box
RU–= Rotation Unit – Number

TABLE I1-3 DIMENSION OF DIVERSION WEIR FOR DIVERSION SYSTEM OF SAMPLE AREA "B"

Division box	Item	Unit	Number of Weir 1	Number of Weir 2
A	Service area	ha	28.5	17.6
	Length of weir	cm	40.0	24.7
B	Service area	ha	10.7	6.9
	Length of weir	cm	40.0	24.7
C	Service area	ha	19.0	9.5
	Length of weir	cm	40.0	20.0
D	Service area	ha	10.7	8.3
	Length of weir	cm	40.0	31.0

CHAPTER II WATER MANAGEMENT

2.1 Water Management Structure

a) General

The Phase II irrigation system will be integrated by the Bohol irrigation system after the Phase II project in accordance with rules and regulations of NIA. Two zone offices will be founded for operation and maintainance of two irrigation systems; one is Zone I for Phase I system, and the other is Zone II for Phase II system.
The responsibility for the Bohol irrigation system and Zone I office concerned with Zone II system are as follows:

- Bohol irrigation System:
  The irrigation superintendent of Bohol Irrigation System is responsible for operation and management of entire irrigation systems, who will supervise two irrigation systems of Phase I and Phase II through each zone engineer.

- Zone I Office:
  Zone I engineer is responsible for operation and management of Phase I system as well as necessary water management works to deliver surplus water to Phase II system through the Phase I main canal.

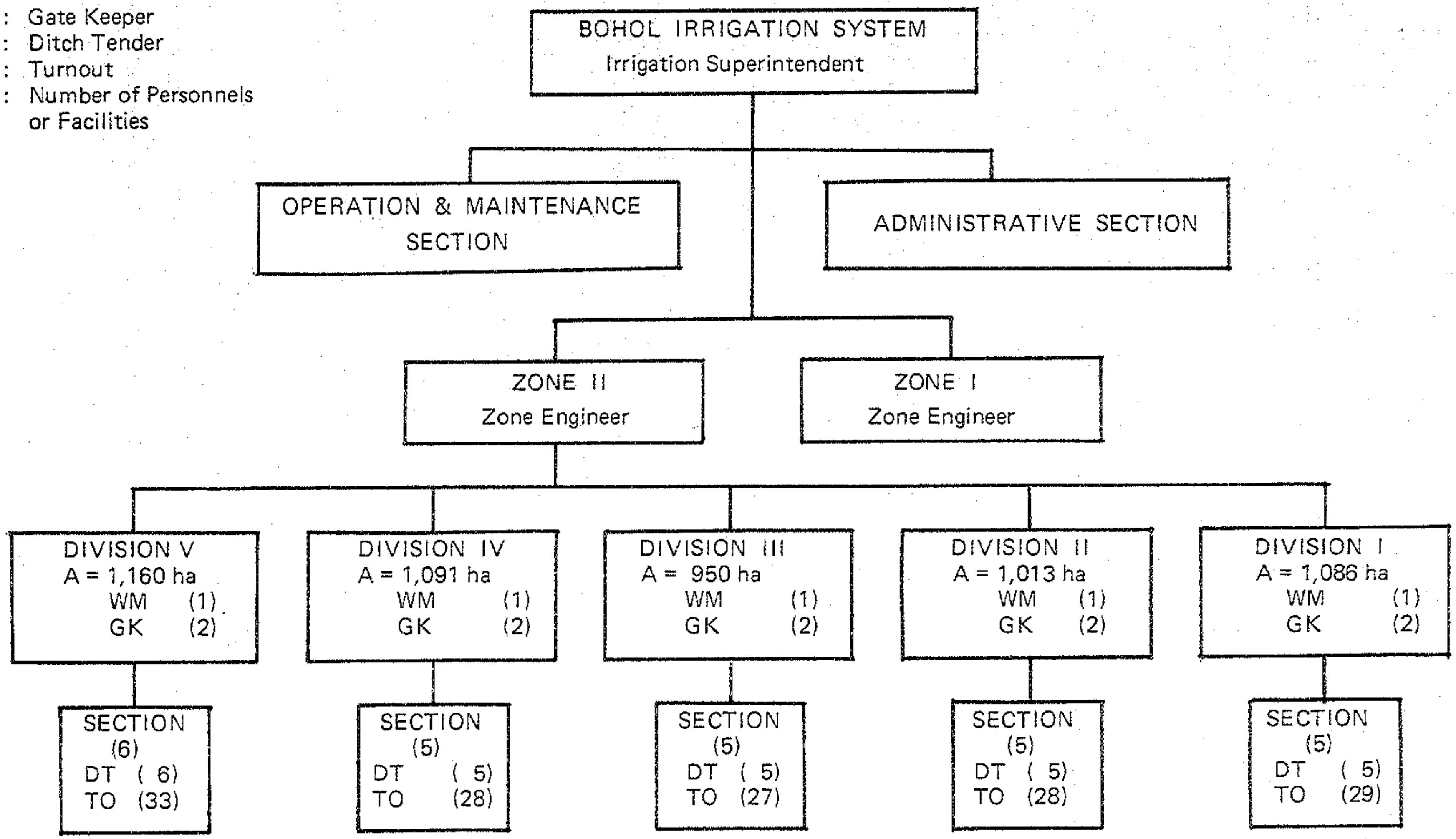
b) Structure and Activities of Zone II Office

Zone engineer is responsible for operation and management of Phase II system, who Prepares operation plan, carries out day-to-day water management of major irrigation facilities and supervises water management of lateral/sub-lateral canals through water masters in their operation divisions.

Proposed organization of Zone II office is shown in FIGURE I2-1, and the activities of Zone II office with regard to water management of Phase II system are outlined as follows:

FIGURE J2–1 SCHIMATIC ORGANIZATION CHART FOR PROPOSED ZONE II OFFICE

WM : Water Master
GK : Gate Keeper
DT : Ditch Tender
TO : Turnout
(5) : Number of Personnels or Facilities



1) Zone II Office

The operation and maintainance group headed by a zone engineer is responsible for preparation of operation plan, water management of major irrigation facilities as well as reservoir operation. Two groups of gate keepers, one is for the Bayongan system and the other is for the Capayas system, are in charge of water control for two systems of Bayongan and Capayas.

The water management group headed by a supervising water management technologist (SWMT) is responsible for water management of lateral/sub-lateral canals, who supervises water masters in their operation divisions.

2) Operation Division

The system of Phase II is divided into five operation divisions; each operation division is to be under the direct supervision of water master. NIA will construct working stations of each water master in the middle of the division area in accordance with the regulations and rules of NIA. Average size of the operation division is 1,000 hectares.

Each water master is responsible for operation and management of lateral/sub-lateral canals commanded by his operation division, who directs two gate keepers and five to six ditch tenders. He prepares cropping calender, conducts water distribution works and renders technical advices to Farmer Irrigators' Group regarding water management on on-farm level.

The gate keepers carried out day-to-day water management for lateral canals under the direct supervision of water master in accordance with water distribution schedule.

The organization of the operation division is assumed to be turned over to corresponding Formers Irrigators' Association together with the responsibility for operation and maintainance of lateral/sub-lateral canal in accordance with the present strategy of NIA regarding operation and maintainance of National Irrigation Systems.

3) Operation Section

The service area of each operation division is divided into operation sections with an average service area of 200 hectares under the direct supervision of each ditch tender. The operation division will be one of the terminal units for irrigated farm management to cooperate with each other.

The operation section will control four to seven rotation areas. Ditch tender will supervise water distribution control for each rotation area through Farmer Irrigators' Groups and renders them necessary technical assistance.

2.2 Operation Plan

a) Cropping Calendar

Cropping calendar of rotation areas is prepared by each water master based on proposed planting area and cropping schedule collected from each Farmer Irrigators' Group. Annual planting date and order of each rotation area within operation section will be shifted intentionally according to timetable.

The cropping calendar of each operation division is formally determind by the Zone II office and transmitted to each Farmer Irrigators' Association through water masters in accordance with operation rule.

b) Operation Plan

Water masters prepare water distribution plan of each rotation area based on the cropping calendar and arrange it at each lateral canal in order to make use distribution guide for day-to-day water management.

Water supply plan from main canal to each lateral is determined by Zone II office in accordance with capacity of stored water in the Bayongan reservoir. The guide line with regard to water supply plan based on the capacity of stored water in the Bayongan reservoir is outlined in Main Report at 4.4.4 Reservoir Operation Rule.

Water supply plan based on the guide line is as follows:

- If the capacity of stored water in the Bayongan reservoir is exceeding the volume of guide line, the water supply plan will be fixed up in accordance with the proposed cropping calendar.

- On the contrary, when stored water in the reservoir is less than the guide line, the water supply plan will be determined by the discounted rate of water supply evenly to all lateral canal in accordance with the deficit capacity of water in the Bayongan reservoir.

Zone II office will prepare detailed plan for water supply of each lateral canal in accordance with available water. And each water master will arrange water distribution plan in his division to be conformed to the allocated discharge at each lateral canal.

Water supply schedule will be revised time to time by Zone II office based on water balance in the Bayongan reservoir, volume of effective rainfall and demand of irrigation water informed from water master.

2.3. Water Management Practice

a) General

Water resources once stored in the reservoir is delivered to a farm lot through following route of irrigation canals/ditches; main canal, lateral canal, sub-lateral, main farm ditch and supplementary farm ditch. Operation of these canal systems are carried out by NIA and Farmers Organizations.

According to proposed water management rule, structures concerned with operation of those irrigation canals/ditches are as follows:

- Zone II office is responsible for reservoirs and main canals.

- Operation divisions are responsible for lateral/sub-lateral canals, however it is to be turned over to respective Farmer Irrigators' Associations.

- Main farm ditches are responsible for Farmer Irrigators' Groups.

- Supplementary farm ditches are left to Terminal Unit Group.

b) Water Distribution Control

In order to distribute water satisfactorily to all farm lots, adequate water distribution management is required at each irrigation system. In this connection, water control and measurement facilities of each irrigation system are designed to be associated with relative importance of each system.

There are five to six in number of water distribution facilities between reservoir to farm lot. Discharge through these facilities except farm turnout is computed by hydraulic equations from dimension of flow such as sectional area of orifice, water depth, span of flow, differential of water head. Accordingly, flow through these facilities can be obtained by means of table or graph which is specially prepared for the convenience of operation personnel.

The water distribution facilities of respective canal system and dimensions of flow required of water measurement are as follows:

- Intake structure of reservoir is provided with sluice gate, discharge through it is obtained from water level of reservoir and sectional area of orifice.

- Diversion structure of main canal to lateral canal is provided with Neyrpic orifice module, the division flow is directly measured by total span of flow.

- Diversion structure of lateral canal to sub-lateral canal is provided with constant head orifice in accordance with NIA standard. Discharge through the orifice is obtained by sectional area of measuring orifice and differential of waterhead through the measuring orifice.

- Turnout of lateral/sub-lateral canal to rotation area is provided with constant head orifice in accordance with NIA standard.

- Division box is used for division of water from main farm ditch to supplementary farm ditch. The division box is provided with no control gate, but is designed to divert flow of main farm ditch into two flows in proportion to the size of each service area.

- Farm ternout is provided along supplementary farm ditch in order to divert water to a farm lot. No measurement facility nor permanent control facilities are provided for farm turnout. The distribution control within rotation unit is conducted by cooperation of beneficial farmers.

c) Water Management of Major Facilities

Water managements of the Bayongan system and the Capayas system are carried out independently so far as the Capayas system has enouth water in the reservoir or from the river. When the Capayas system has insufficient water in the system, necessary water is delivered from the Bayongan reservoir through the Bayongan main canal.

In case the Bayongan system waste water from main canal to the Capayas reservoir is mostly rufused for the Capayas system as far as the reservoir can afford empty capacity in the reservoir. However, as water resources of the Capayas system to be wasted through the Capayas reservoir amount to about 40 percent annually, the empty capacity in the Capayas reservoir should be managed as much as possilbe by operation of the Bayongan reservoir.

BY day to day operation, check water level should be kept during operation period and even temporally discontinuance period due to rainfall or other cause. The stored water in canal section is efficient not only to protect canal lining against uplift power, but also to shorten time lag caused at the beginning of operation as well as to decrease waste water due to time lag of operation.

d) Water Management of Lateral System

The most important requirement for water management of lateral canal/sub-lateral canal is to assure Farmers Irrigators' Groups of even water distribution of supplied water from main canal. In this connection systematic water distribution control will be conducted by full time gate operaters as proposed before.

As capacity of lateral canal is tapering from the head to terminal end, supplied water from main canal should be distributed correctly in accordance with operation schedule, any misoperation cause of surplus water in the canal span might endanger canal section in the lower rank of span or flooding of rotation area located at the terminal end.

In addition, water balance between operation sections should be maintained at the standpoint of even water distribution as well as canal safty. To this end, proposed water measurement section along canal is selected between two operation sections. The canal check or canal drop located just at the downstream of the terminal turnout of operation section is desirable for the purpose.

e) Water Management for On-Farm Level

Planting schedule of a rotation area is assumed to be carried out simultaneously in all rotation units during the period of five to ten days in accordance with the cropping calendar. Based on ths understanding, diversion rate of water at the head of each supplementary farm ditch is determined to be proportional to the size of each service area.

As no water control facilities is provided at each division point, complaint regarding water distribution will be diminished compared with manual control system.

In the course of water management, basic unbalance of water requirement between present paddy field and proposed paddy will be cleared. The excessive water for present paddy could be used of water source for paddy extension within rotation area after formally qualified by the Fermer Irrigators' Association concerned.

As stated above, farm lots will be divided into irrigation unit with one to one and a half hectare in size, more intensive irrigated farming is expected in each irrigation unit. Appropriate water management method of each irrigation unit should be aquired by each farmers themselves.

ANNEX J. PROJECT IMPLEMENTATION PROGRAM AND COST ESTIMATE

ANNEX J PROJECT IMPLEMENTATION PROGRAM AND COST ESTIMATE

LIST OF TABLE

LIST OF FIGURE

CHAPTER I PROJECT IMPLEMENTATION PROGRAM

1.1 Project Implementation

1.1.1. Executing Agency of the Project

The excuting agency of the project will be the 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 maintenace of the completed facilities of the project.

NIA will execute the detailed design for major project facilities recruiting a consulting firm, the construction contracting with a competent contractor and the operation and maintenance guiding the farmer's association.

The organization of NIA is shown in FIGURE 6-1 of Main Report. In this organization, the detailed design works are carried out by the design and speciffication division, construction by the construction division and operation and maintenance by the O/M division.

1.1.2 Financing

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

1.1.3 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 leveling works will be made by the farmers association newly established in service area under the technical guidance by the NIA O/M division.

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

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

1.1.4 Preperatory 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 scale of 1 : 4,000 covering the whole project area and geological investigations at the proposed dam site which had been provided during the Feasibility Study will be useful.

Therefore, additional survey and investigation works necessary for the detail design will be limited to the items as follows:

Item	Unit	Quantities
1. Topographical Survey		
Bayangan dam profile *	km	4.0
Capayas dam profile *	km	3.0
Canal alignment profile	km	160.0
2. Geological Investigation		
Core drilling at Bayongan dam	m	100.0
Core drilling at Capayas dam	m	100.0
Test pit at Bayongan dam	place	5
Test pit at Capayas dam	place	5
Laboratory test of dam material	L.S	1
Corn penetration test at canal	place	150
Sand & gravel test	L.S	1

Note: * Survey works of both dams including dam, spillway and intake axis profile.

The site facilities for the project administration will be completed by NIA before commencement of the project construction and consist of the following buildings.

Item	Unit	Quantities
Main office	sq·m	400
Staff residence	sq·m	800
Guest house	sq·m	200
Equipment warehouse	sq·m	200
Office supplies and furnitures	L.S	1

1.1.5 Administration Office

The organization of NIA office is proposed as shown in FIGURE 6-2 of Main Report, taking into consideration administrative and engineering works at the project site office during construction period. Machinery and equipments for the administration are as follows:

Item	Unit	Quantities
Jeep type of vehicles	Nos	6
Motorcycle	"	6
Theodrite	"	2
Level	"	2
Current meter	"	2
Radio set	"	1
Walkie-Tolie	"	10
Automatic rain gauge	"	1
Personal computer	"	1

1.1.6 Consulting services

Consulting services including local experts are required for the detailed design and construction supervision as well as bid evaluation. The total man-months for foreign and local experts are shown as follows:

Expert	Foreign Man-Month	Local Man-Month	Total Man-Month	NIA Staff Man-Month
1. Detailed design stage				
Project director	1	-	1	-
Project Manager	12	-	12	-
Dam engrs.	10	6	16	10
Irrigation engrs.	10	6	16	10
On farm development engrs.	-	4	4	20
Hydrologist	4	-	4	3
Hydraulic structure engrs.	10	6	16	10
Engineering geologist	3	-	3	5
Soil mechanist	3	-	3	5
Mechanical engr.	3	-	3	-
Topo-Surveyor	-	-	-	25
Cost estimator	3	-	3	3
Specification specialist	4	-	4	4
Specialist as required	5	3	8	-
Home support engr.	2	-	2	-
Total	70	25	95	95
2. Construction supervision stage				
Project director	2	-	2	
Resident engr.	36	-	36	
Design engr.	8	4	12	
Dam engr.	30	18	48	
Canal engr.	-	36	36	
Mechanical engr.	4	-	4	
Tender Evaluation Expert	3	-	3	
Specialist as required	4	2	6	
Home support engr.	3	-	3	
Total	90	60	150	

1.1.7 Land Acquisition and Compensation

Land aquisition in the reservoir and along the canal alignment will be undertaken by NIA before starting of construction works.

The detail is shown as follows:

Item	Unit	Quantities
1. Bayogan system		
(1) Bayogan reservoir		
Mountain area	ha	36
Waste area	"	145
Coconuts area	"	43
Paddy fields	"	34
Up-land	"	92
Residential house	houses	30
Housing site	ha	30
(2) Canal system		
Wast area	ha	10
Cultural area	"	85
(3) Resettlment	family	30
2. Capayas system		
(1) Capayas reservoir		
Mountain area	ha	20
Waste area	"	80
(2) Canal system		
Waste area	ha	3
Cultivated area	"	23

1.2 Construction Plan

1.2.1 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 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 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 dam axis and with a transporting distance less than 200 m and are selected from the excavated materials of dam foundation, spillway and intake structures.

ii) 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. This embankment materials are collected form the borrow area located at hilley area with elevation of 40 to 60 m in the left bank of dam site. The material is easily taken by bulldozer pushing along the slope and transported to the embankment site within a distance of about 300 m.
The material in borrow area has a high field moisture content due to high ground water level, so that trenches along the

slope of borrow area should be provided during construction period to make ground water level lower and get optimum field moisture content for core material.

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 damsited of Capayas and Bayongan, but at place along the Hinlayagan river 9 km far from both damsites.

The deposit of sand and gravel materials in the river is 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 combining 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 2 km 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 semi-pervious zone. This semi-pervious material is used for both shell zones on the upstream and the downstream.

The exacavated material 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 dam.

The rock material should be hard and solid to protect dams from errosion in the reservoir and to fullfil a function to release seepage water through dambody smoothly at the portion, so that the rock material should be collected from the Dagohoy quarry site.

Since the Capayas dam is of 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 material.

1.2.2 Construction Method of Bayongan Dam

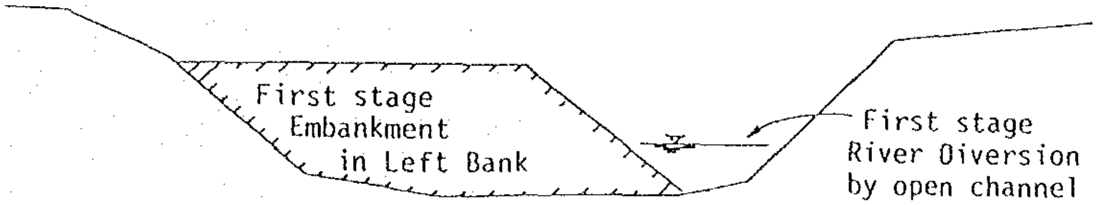
a) Work Volume

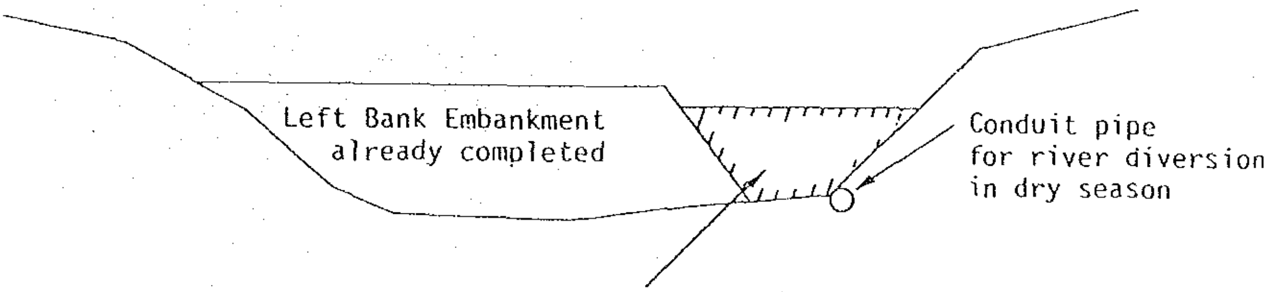
The work volume of the Bayongan dam construction is as follows.

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 at the right bank with an open channel and then the right bank embankment should be performed in the dry year diverting a small discharge into the conduit pipe installed in the foundation of right bank as shown in the following FIGURE.





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 are planned as follows ;

Zone	Distance from Borrow Area	Performonce Per Month
Core	500 m	70 cu.m/hrx7.0hr/dayx22 days = 10,000 cu.m
Filter	9,000 m	20 cu.m/hrx7.0hr/dayx25 days = 3,500 cu.m
Shell	2,000 m	90 cu.m/hrx7.0hr/dayx25 days x2 units = 30,000 cu.m

c) Spillway Works

The spillway works in the Bayongan dam is of 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 the 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 concrete conveying pipe of concrete pump is installed along the chute of spillway.

d) Intake Works

The intake works are consisting 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.

The following construction schedule is considered :

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

The intake works consisting of the inclined concrete base where spindles of gate are placed and intake structure where gates are installed 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 storaging water in the reservoir. The detailed construction schedule is shown in FIGURE 6-3 of Main Report.

1.2.3 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
Spilway Excavation	26,000 cu.m
Spilway 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 reservoir can be used.
After providing the river diversion with an open channel at 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 emban-

ked with only 5 to 10 m height 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 at the right bank should be made at the beginning stage of construction.

1.2.4 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
(1) Main Irrigation Canal			
Stripping (cu.m)	9,500	5,700	15,200
Excavation (cu.m)	271,300	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
(2) 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) & Division	179	47	226
(3) 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 such as dump truck. The concrete lining works are made by dividing into several working sections and placed by the mixer with small capacity for each section.

1.2.5 On-farm Development Works

a) Work Volume

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

Item	Bayogan 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 the bulldozer for the existing upland field and grass land having a slope of 2 % on the average.

c) On-farm Facilities

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

1.2.6 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 is delivered to the proposed Bayongan reservoir through the main canal constructed during phase I of the project.

The construction works of Phase II will be commenced one year before the completion of construction work in Phase I of the project.

The construction of the Capayas system will be finished with construction period of about one year, because the Capayas service area would be developed as model agriculture area in early stage of the Phase II project.

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

The summary of construction schedule is shown in FIGURE 6-3 of Main Report.

1.3 Implementation Schedule of the Project

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

The construction of major works will be completed within about one and a 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 the water immediately after completion of the major works.

The implementation program for the project is shown in FIGURE 6-4 of Main Report.

CHAPTER II COST ESTIMATION

2.1 Conditions of Cost Estimation

The project cost is estimated under the following conditions.

(1) 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 to the estimated project cost.

(2) The project cost is composed of construction cost and associated cost. Components of the project cost are shown in FIGURE J2-1.

(3) The exchange rate between Philippine Pesos and U.S.Dollar;

U.S. $ 1.00 = 18.0 Philippines Pesos

(4) The physical contigency related to the construction and associated cost is set at 15 % of the direct cost.The price contigency is assumed as follow.

(unit: %)

Year	Foreign Currency	Local Convency
1986	9.0	20.0
1987	9.0	20.0
1988	9.0	15.0
1989	7.5	10.0
1990	6.0	8.0
1991	6.0	8.0
1992	6.0	8.0

2.2 Construction Cost

2.2.1 Basic Rate

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

2.2.2 Unit Cost

Unit cost of construction work is calculated, according to the proporsed work items which are designed by construction method since the construction is made on the contract basis, the overhead of 25 % against the unit rate is considered. Summerized unit cost is shown in TABLE J2-8 and detailed data are shown in Data book of the Report.

2.2.3 Construction Cost

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

2.3 Associated Cost

Associated cost is composed of five items, such as on-farm development cost, land acquisition & compensation cost, engineering & administration cost, O & M equipment cost and pilot farm cost.

Breakdown of each item is shown in TABLE J2-14 to J2-18.

2.4 Project Cost

2.4.1 Project Cost

The project cost is estimated at ₱ 659 million of which ₱ 401 millon is foreign currency and ₱ 258 million is local currency. The summary of the project cost is shown in Main Report TABLE 5-5.

2.4.2 Annual Disbursement Schedule

The annual disbursement schedule is estimated on the basis of the project inplementation schedule, and the summary is as follows:

Annual Disbursement Program

(unit:1000 ₱)

Year	F/C	L/C	Total
1987	25,300	7,800	33,100
1988	10,100	10,100	20,200
1989	83,200	59,600	142,800
1990	110,500	73,000	183,500
1991	128,000	80,800	208,800
1992	43,900	26,700	70,600
Total	401,000	258,000	659,000

Details are shown in TABLE J2-19.

2.5 Operation and Maintenance Cost

The operation and maintenace cost annualy required for the project is composed of the salaries of O & M organization staff and the cost of operation and maintenance of O & M equipment and facilities. The operation and maintenance cost is estimated at ₱ 592 per ha. Breakdown of O & M cost is shown in TABLE J2-20.

2.6 Replacement Cost

Some of the facilities, especially mechanical works have shorter useful life than the project life and require replacement within the project useful life. The following table shows the useful life and replacement costs of the mechanical works.

(unit: 1000 ₱)

Item	Useful Life	Replacement Cost
Gate	25 years	3,854
O & M equipment	10 years	7,100

2.7 Pilot Farm Cost

Cost of pilot farm constructed in the Capayas service area is estimated at ₱ 3,800,000. Detailed breakdown is shown in TABLE J2-21.

FIGURE J2-1 PROJECT COST COMPONENT

(Construction Cost)

- Project Cost
  - [1] Construction Cost
    - (1) Preparatory work
    - (2) Capayas System Construction
      - (a) Dam work
      - (b) Canal work
      - (c) Land leveling
    - (3) Bayangan System Construction
      - (a) Dam work
      - (b) Canal work
      - (c) Land leveling

  (Associated Cost)

  - [2] On-farm Development Cost
    - (1) Farm ditch
    - (2) Supplementary farm ditch
    - (3) Farm drain
    - (4) On-farm road
    - (5) On-farm structure
  - [3] Land Acquisition & Compensation Cost
    - (1) Reservoir
    - (2) Irrigation Facilities (Canal, Structure, etc.)
  - [4] Engineering & Administration Cost
    - (1) Administration Cost
      - (a) Salary & wage
      - (b) Repair & Maintenance cost
      - (c) Equipment cost
      - (d) Trainning cost
    - (2) Consulting Service
      - (a) Detail design
      - (b) Construction supervision
    - (3) Investigation for detail design
      - (a) Topo-Survey
      - (b) Geology Survey
  - [5] O & M Equipment Cost
  - [6] Pilot Farm Cost
  - [7] Phisical Contingencies & [8] Price Contingencies

TABLE J2-1 LABOUR RATES (as of 1985)

Unit : ₱

	Rates/Day
Laborer	50.00
Skilled-Laborer	58.00
General Foreman	84.00
Carpenter	65.00
SR Carpenter	74.00
Head, Carpenter	79.00
SR Mason	69.00
Head, Mason	74.00
Steelman	65.00
Head, Steelman	74.00
Welder	65.00
C.E. AIDE	65.00
Driver, (Light Equipment)	65.00
Driver, (Heavy Equipment)	74.00
Driver, (General)	69.00
Mechanic	65.00
Master Mechanic	74.00
Electrician	65.00
Driller	74.00
Blaster	178.00
Plumber	61.00
Batch plant	65.00
Watchman	58.00
Janitor	50.00
Surveyor	97.00

TABLE J2-2 UNIT COST OF CONSTRUCTION MATERIAL (1)

Unit: ₱

Description	Unit	Total Unit Cost	Component F.C	Component L.C	Unit Cost F.C	Unit Cost L.C
Reinforced Bar	kg	10.5	80	20	8.5	2.0
Nail, Bolt and Nut	kg	18.0	80	20	14.5	3.5
Special Gasoline	ℓ	9.0	80	20	7.5	1.5
Gasolin	ℓ	8.5	80	20	7.0	1.5
Diesel	ℓ	6.5	80	20	5.5	1.0
Lubricating Oil	ℓ	30.0	80	20	24.0	6.0
Cement (1 Bag 0.40 kg)	Bag	50.0	60	40	30.0	20.0
Reinforced Concrete Pipe (1")						
∅450 (18")	p.c.	360.0	60	40	215.0	145.0
∅600 (24")	p.c.	400.0	60	40	240.0	160.0
∅750 (30")	p.c.	500.0	60	40	300.0	200.0
∅900 (36")	0.c.	650.0	60	40	390.0	260.0
∅1000	p.c.		60	40		
∅1300	p.c.	900.0	60	40	540.0	360.0
Concrete Hollow Block						
4' x 8' x 16'	p.c.	3.0	60	40	2.0	1.0
6' x 8' x 16'	p.c.	4.0	60	40	2.5	1.5
Blasting Material: Dynamite	kg	32.0	80	20	26.0	6.0
Blasting Material: A.N.F.O	kg	30.0	80	20	24.0	6.0
Blasting Material: Detanator	p.c.	21.0	80	20	17.0	4.0
Blasting Material: Fuse	m	10.5	80	20	8.5	2.0
Lumber	bd.ft*	8.0	0	100	0	8.0
Plywood 1/4 x 4 x 8	p.c.	68.0	0	100	0	68.0
Plywood 1/2 x 4 x 8	p.c.	145.0	0	100	0	145.0
Sod	m^2	1.2	0	100	0	1.2

* 1 bd.ft x 1.0 feet x 1.0 feet x 10 inch x 0.0023 cu.m

TABLE J2-3 UNIT COST OF CONSTRUCTION MATERIAL (2)

Unit; ₱

Description		Unit	Total Unit Cost	Compornent F.C.	Compornent L.C.	Unit Cost F.C.	Unit Cost L.C.
Drilling	Rod	p.c.	1,103.00	80	20	883.0	220.0
	Bid	p.c.	1,545.00	80	20	1,236.0	309.0
	Sleaves	p.c.	625.00	80	20	500.0	125.0
Small Gate							
	600 x 600mm	p.c.	3,800.00	80	20	3,040.0	760.0
	800 x 800mm	p.c.	4,400.00	80	20	3,520.0	880.0
	1200 x 1200mm	p.c.	12,000.00	80	20	9,600.0	2,400.0
	1600 x 1400mm	p.c.	16,000.00	80	20	12,800.0	3,200.0
	1600 x 1600mm	p.c.	17,000.00	80	20	13,600.0	3,400.0
H-Beam		kg	18.00	80	20	15.0	3.0
L-Beam		kg	13.00	80	20	11.0	2.0

LAND ACQUISITION AND COMPENSATION COST

Unit; ₱

Description	Unit	Total Unit Cost	Compornent F.C.	Compornent L.C.	Unit Cost F.C.	Unit Cost L.C.
Mauntain Area	ha	4,000	0	100	0	4,000.0
Waste Area	ha	6,000	0	100	0	6,000.0
Cultivated Area	ha	10,000	0	100	0	10,000.0
Housing	1 house	20,000	0	100	0	20,000.0
Housing Site	1 house	2,400	0	100	0	2,400.0
Resettlement Cost (Hauling charge and allowance)	1 family	6,000	0	100	0	6,000.0

TABLE J2-4 ADOPTED PROPORTION OF FOREIGN AND LOCAL COMPORNENT

	Description	Foreign Compornent	Local Compornent
1.	Cement	60 (%)	40 (%)
2.	Reinforced Bar	80	20
3.	Fuel and Oil	80	20
4.	Equipment for Construction	80	20
5.	Equipment for Agriculture	70	30
6.	Truck & vehicle	70	30
7.	Blasting Materials	80	20
8.	Steel Gate & Steel Structure	80	20
9.	Lumber	0	100
10.	Labour	0	100
11.	Land Acquisition and Compensation	0	100
12.	Taxes and Bonding Charges	0	100
13.	Contractors Profit	50	50

The source: Tariff and Customs Code 1982 Vol 1

TABLE J2-5 HIRING RATE AND FUEL CONSUMPTION (Per Hr)

Unit: ₱

Equipment			Capital Cost	Hiring Rate	Equipment Rate		Fuel Con-sumption
					F/C	L/C	
			x1000	x0.001			(ℓ)
Bulldozer	21t	200 p.s.	1,997	0.345	550	140	21
Bulldozer (with Ripper)	21t	200 p.s.	2,220	0.353	630	160	21
Bulldozer	15t	150 p.s.	1,268	0.345	350	90	16
Bulldozer	11t	108 p.s.	977	0.345	270	70	11
Bulldozer	8t	86 p.s.	746	0.433	260	70	9
Backhoe shovel	1.0^{m^3}	175 p.s.	2,614	0.292	610	150	19
Backhoe shovel	0.6^{m^3}	108 p.s.	1,440	0.292	340	80	12
Backhoe shovel	0.35^{m^3}	78 p.s.	951	0.308	230	60	9
Wheel loader	1.70^{m^3}	105 p.s.	1,020	0.374	310	80	8
Wheel loader	1.20^{m^3}	75 p.s.	617	0.374	190	50	6
Tunnel muck loader	0.35^{m^3}		1,097	0.450	400	100	
Dump truck	11t	314 p.s.	690	0.303	170	40	11
Dump truck	4t	160 p.s.	243	0.385	80	20	6
Truck	6.5t	175 p.s.	294	0.361	90	20	6
Truck	4.5t	164 p.s.	229	0.385	70	20	6
Water Lorry	4t	155 p.s.	373	0.336	100	30	6
Truck crane	15t	230 p.s.	1,808	0.239	350	90	9
Truck crane	20t	230 p.s.	2,031	0.239	390	100	9
Road Roller	8 ~ 10t	90 p.s.	518	0.355	150	40	6
Vibrating Roller	8 ~ 10t	105 p.s.	1,123	0.479	430	110	11
Vibrating Roller	3 ~ 5t	23 p.s.	310	0.479	120	30	3
Tamping Roller	8 ~ 15t	-	523	0.321	130	30	
Tamping Roller	3 ~ 5t	-	223	0.321	60	10	
Motor Grader	L = 2.5H	76 p.s.	740	0.356	210	50	5
Motor Grader	L = 3.1H	110 p.s.	883	0.356	250	60	7

TABLE J2-6 HIRING RATE AND FUEL CONSUNPTION (Per hr or Day)

Unit: ¥

Equipment		Capital Cost	Hiring Rate	Equipment Rate F/C	Equipment Rate L/C	Fuel Con-sumption
Compressor 10.5m³/min	(per day) 105 p.s.	321 x1000	2.500 x0.001	640	160	26 ℓ/day
Compressor 7.0m³/min	(per day) 75 p.s.	243	2.500	490	120	19"
Compressor 9.5m³/min	(per day) 46 p.s.	124	2.500	250	60	12"
Compressor 20m³/min	(per day) 28 p.s.	103	2.500	206	52	7"
Generator 15 kw	(per day) 22 p.s.	75	2.231	130	30	6"
Generator 45 kw	(per day) 58 p.s.	222	1.987	350	90	15"
Generator 75 kw	(per day) 93 p.s.	250	1.987	400	100	23"
Generator 100 kw	(per day) 120 p.s.	351	1.987	560	140	30"
Drainage pump ø80m/m H-10M	(per day) 2.2 kw	12	3.194	30	10	
Drainage pump ø110m/m H-20M	(per day) 11 kw	35	3.194	90	20	
Turbin pump ø100m/m	(per day) 7.5 kw	37	3.194	90	20	
Water pump ø50m/m	(per day) 1.7 kw	14	3.750	42	11	
Water pump ø100m/m	(per day) 3.7 kw	15	3.750	50	10	
Water pump ø150m/m	(per day) 7.5 kw	22	3.750	66	17	
Grouting pump 15 ~ 30 ℓ/min	(per day) 2.2 kw	44	3.648	130	30	
Grouting mixer 200ℓ	(per day) 5.5 kw	37	3.648	110	30	
Concrete plant 0.5m³ 26m³/h	4.1 kw	817	0.463	300	80	
Concrete mixer 0.5m³	(per day) 3.5 kw	817	0.463	300	80	
Concrete pump car 20 m³/hr	80 p.s.	814	0.413	270	70	6
Truck mixer 3.0 m³	220 p.s.	529	0.360	150	40	8
Crawler Drill (10m class)		618	0.479	240	60	
Hand Rammer 20kg (per day)		15	4.808	60	10	
Drifter for tunnel 30kg (per day)		20	4.808	80	20	
Classifier 105cm x 750cm	3.7 kw	697	0.210	120	30	
Vibrating Screen 410 x 480	22 kw	599	0.225	110	30	
Belt conveyer 45cm x 15m	2.2 kw	114	0.230	20	10	
Vibrator 45 m/m	(per day) 5.0 p.s.	13	4.028	40	10	1
Water pipe 100m/m		0.3	2.713	0.7	0.2	
Aggregate Hopper		34	2.639	72	18	

TABLE J2-7 FUEL CONSUMPTION OF EQUIPMENT (Per Hr)

Equipment	Fuel Consumption	
Bulldozer	0.105	(ℓ/p.s./hr)
Backhoe	0.110	
Wheel Loader	0.080	
Dump Truck	0.035	
Truck	0.036	
Motor Grader	0.067	
Road Roller	0.065	
Vibrating Roller	0.109	
Concrete Pump Car	0.072	
Water Lorry	0.036	
Truck Crane	0.040	
Other Equipment	0.050	

TABLE J2-8 MAJOR UNIT RATE

(Unit : ₱)

Description of works	Unit	Copayas System			Bayangan System		
		B/C	L/C	Total	F/C	L/C	Total
1. Dam Construction							
. Stripping	cu.m	15	6	21	22	9	31
. Earth excavation in trench & intake	"	19	8	27	25	10	35
. Soft Rock Excavation in Trench & Intake	"	35	15	50	45	18	63
. Earth Excavation in Spillway	"	19	8	27	40	16	56
. Soft Rock Excavation in Spillway	"	35	15	50	64	25	89
. Core material transportation	"	-	-	-	25	10	35
. " compaction	"	-	-	-	17	7	24
. Shell material transportation	"	-	-	-	27	11	38
" compaction	"	-	-	-	11	4	15
. Filter material transportation	"	67	26	93	67	26	93
. " compaction	"	15	7	22	15	7	22
. Riprap material transportation	"	102	42	144	102	42	144
. " compaction	"	6	2	8	6	2	8
. Earth material transportation	"	17	7	24	-	-	-
. " compaction	"	12	5	17	-	-	-
. Toe Material excavation & transportation	"	19	7	26	-	-	-
. " Compaction	"	10	5	15	-	-	-
. Tunnel excavation of Intake	"	-	-	-	436	221	657
. Tunnel steel Support	set	-	-	-	3,694	1,358	5,052
. Tunnel Concrete canal	cu.m	-	-	-	1,172	783	1,955
. Tunnel Grout	cu.m	-	-	-	1,796	776	1,572
. Drilling of Grout Holes	hole	-	-	-	55	34	89
. Intake concrete (class A)	cu.m	741	696	1,437	735	677	1,412
. Spillway concrete (")	"	741	696	1,437	731	629	1,360
2. Canal Construction							
. Stripping	cu.m	6	2	8	6	2	8
. Canal Excavation	"	29	13	42	29	13	42
. Excavation at side borrow area	"	8	3	11	8	3	11
. Canal fill compaction	"	16	8	24	16	8	24
. Back fill at canal	"	13	7	20	13	7	20
. Lining concrete	"	834	576	1,410	834	576	1,410
. Structure concrete	"	924	1,174	2,098	924	1,174	2,098
3. On-farm Construction							
. Farm Ditch (16.2m/ha)	ha	421	218	639	421	218	639
. Supplementary Farm Ditch (50.9m/ha)	"	1,170	533	1,703	1,170	533	1,703
. Farm Drain (14.1m/ha)	"	127	62	189	127	62	189
. Farm Road (46.2m /ha)	"	369	180	549	369	180	549
. On-farm Structures	"	471	309	780	471	309	780
. Land leveling	"	2,820	1,097	3,917	2,820	1,097	3,917
. Deep plawing	"	581	195	776	581	195	776
. Ridge Preparation	"	760	476	1,226	760	476	1,226
4. Common Unite Rate							
. Rainforced Bar	t	11,119	4,337	15,456	11,119	4,337	15,456
. Back Fill	cu.m	22	9	31	22	9	31

TABLE J2-9 CONSTRUCTION COST

(Unit : P'000)

Description	Capayas System F/C	Capayas System L/C	Capayas System Total	Bayongan System F/C	Bayongan System L/C	Bayongan System Total	Total F/C	Total L/C	Total Total
1. Preparatory Work	500	400	900	1,500	1,300	2,800	2,000	1,700	3,700
2. Dam									
- Temporary work	861	487	1,348	10,600	4,460	15,060	11,461	4,947	16,408
- Dam	8,963	3,695	12,658	57,431	23,052	80,483	66,394	26,747	93,141
- Spillway	5,250	3,095	8,345	7,239	3,508	10,747	12,489	6,603	19,092
- Intake	1,826	1,023	2,849	5,830	2,780	8,610	7,656	5,803	11,459
Sub Total	16,900	8,300	25,200	81,100	33,800	114,900	98,000	42,100	140,100
3. Canal Work									
- Temporary work	204	172	376	903	534	1,437	1,107	706	1,813
- Main Canal	2,871	1,386	4,257	24,007	12,724	36,731	26,878	14,110	40,988
- Lateral Canal	4,312	2,188	6,500	14,881	8,014	22,895	19,193	10,202	29,395
- Drainage Canal	1,313	854	2,167	2,909	2,428	5,337	4,222	3,282	7,504
Sub Total	8,700	4,600	13,300	42,700	23,700	66,400	51,400	28,300	79,700
4. On-Farm									
- Land Leveling	3,000	1,300	4,300	12,700	5,400	18,100	15,700	6,700	22,400
Total	29,100	14,600	43,700	138,000	64,200	202,200	167,100	78,800	245,900

TABLE J2-10 CONSTRUCTION COST ESTIMATION FOR PREPARATORY WORK

Description of Item	Unit	Quantity	Unit Rate			Amount (₱'000)			Remarks
			F/C	L/C	Total	F/C	L/C	Total	
1. Preparatory works									
(1) Facilities for Construction Supervision									
. Main Office	sq.m	400	1,200	800	2,000	480	320	800	
. Staff Residence	sq.m	800	1,200	800	2,000	960	640	1,600	
. Guest House	sq.m	200	1,800	1,200	3,000	360	240	600	
. Equipment warehouse	sq.m	200	600	400	1,000	120	80	200	
. Furniture	L.S	1	-	400	400	-	400	400	
Total						(1,920	1,680	3,600)	

TABLE J2-11(1) CONSTRUCTION COST ESTIMATION FOR CAPAYAS SYSTEM

Description of Item	Unit	Quantity	Unit Rate F/C	Unit Rate L/C	Unit Rate Total	Amount (₱'000) F/C	Amount (₱'000) L/C	Amount (₱'000) Total	Remarks
1. Capayas Dam									
(1) Temporary works	L.S.					861	487	1,348	(1 + 2 + 3)x0.05
Sub Total						861	487	1,348	
(2) Dam works									
Stripping	cu.m	36,000	15	6	21	540	216	756	
Earth Excavation	cu.m	10,000	19	8	27	190	80	270	
Soft Rock Excavation	"	6,000	35	15	50	210	90	300	
Earth Embankment	"	189,000	29	12	41	5,481	2,268	7,749	
Earth Embankment by Excavated Material	"	21,500	12	5	17	258	108	366	
Filter Embankment	"	900	82	33	115	74	30	104	
Riprap Embankment	"	16,300	108	44	152	1,760	717	2,477	
Toe Rock Embankment	"	800	29	12	41	23	10	33	
Miscellaneous (5%)						427	176	603	
Sub Total						(8,963	3,695	12,658)	
(3) Spillway									
Earth Excavation	cu.m	21,000	19	8	27	399	168	567	
Soft Rock Excavation	"	5,000	30	15	50	175	75	250	
Backfill	"	1,500	22	9	31	33	14	47	
Concrete Class A	"	2,600	741	696	1,437	1,927	1,810	3,737	
Rainforced Bar	Ton	170	11,119	4,337	15,456	1,890	737	2,627	
Bridge	sq.m	360	1,600	400	2,000	576	144	720	
Miscellaneous (5%)						250	147	397	
Sub Total						(5,250	3,095	8,345)	
(4) Intake									
Earth Excavation	cu.m	8,500	19	8	27	162	68	230	
Soft Rock Excavation	"	1,000	35	15	50	35	15	50	
Backfill	"	1,000	22	9	31	22	9	31	
Concrete pipe ø 1300mm	m	78	914	537	1,451	71	42	113	
Concrete Class A	cu.m	850	741	696	1,437	630	592	1,222	
Rainforced Bar	ton	55	11,119	4,337	15,456	612	239	851	
Intake Gate ø 500mm	set	3	46,455	975	47,430	139	3	142	
Foot Bridge	sq.m	48	400	100	500	19	5	24	

TABLE J2-11(2) CONSTRUCTION COST ESTIMATION FOR CAPAYAS SYSTEM

Description of Item	Unit	Quantity	Unit Rate			Amount (₱'000)			Remarks
			F/C	L/C	Total	F/C	L/C	Total	
Emergency Gate ø 500mm	set	1	49,040	777	49,817	49	1	50	
Miscellaneous 5%						87	49	136	
Sub Total						(1,826	1,023	2,849)	
Total						((16,900	8,300	25,200))	
2. Canal Works									
(1) Temporary works	L.S					204	172	376	(5 + 6 + 7)x2%
Sub Total						(204	172	376)	
(2) Main Canal									
Stripping	cu.m	5,700	6	2	8	34	11	45	
Earth Excavation	"	8,400	29	13	42	244	109	353	
Fill by Excavated Material	"	6,000	16	8	24	96	48	144	
Fill by Side Borrow	"	1,400	24	11	35	34	15	49	
Backfill	"	100	22	9	31	2	1	3	
Lining Concrete	"	1,540	834	576	1,410	1,284	887	2,171	
Structural Concrete	"	100	924	1,174	2,098	92	12	104	
Reinforced Bar	Ton	3	11,119	4,337	15,456	33	13	46	
Grauted Riprap	cu.m	100	651	437	1,088	65	44	109	
Gravel paiving	"	1,000	96	39	135	76	39	135	
Soading	sq.m	7,500	5	5	10	38	38	76	
RC-pipe ø 450	m	200	319	144	463	64	29	93	
ø 600	"	100	352	163	515	35	16	51	
ø 1000	"	100	616	274	890	62	27	89	
Distributor	set	3	-	-	-	542	28	570	
Gate 0.5x1.0	"	4	3,125	781	3,906	13	3	16	
Miscellaneous 5%						137	66	203	
Sub Total						(2,871	1,386	4,257)	5
(3) Lateral Canal									
Stripping	cu.m	27,000	6	2	8	162	54	216	
Earth Excavation	"	26,000	29	13	42	754	338	1,092	
Fill by Excavated Material	"	20,000	16	8	24	320	160	480	
Fill by Side Borrow	"	54,000	24	11	35	1,296	594	1,890	

TABLE J2-11(3) CONSTRUCTION COST ESTIMATION FOR CAPAYAS SYSTEM

Description of Item	Unit	Quantity	Unit Rate			Amount (₱'000)			Remarks
			F/C	L/C	Total	F/C	L/C	Total	
Backfill	cu.m	100	22	9	31	2	1	3	
Structural concrete	"	100	924	1,174	2,098	92	117	209	
Reinforced Bar	Ton	3	11,119	4,337	15,456	33	13	46	
Grouted Riprap	cu.m	300	651	437	1,088	195	131	326	
Gravel Paving	"	5,000	96	39	135	480	195	675	
Sodding	sq.m	58,500	5	5	10	293	293	586	
RC-pipe ø450	m	700	319	144	463	223	101	324	
" ø600	"	300	352	163	515	106	49	155	
Gate 0.5x1.0	set	34	3,125	781	3,906	106	27	133	
0.7x1.0	"	13	3,472	868	4,340	45	11	56	
Miscellaneous (5%)						205	104	309	
Sub Total						(4,312	2,188	6,500)	6
(4) Drainage Canal									
Earth Excavation	cu.m	22,100	29	13	42	641	287	928	
Backfill	"	300	22	9	31	7	3	10	
Structural concrete	"	300	924	1,174	2,098	277	352	629	
Reinforced Bar	ton	8	11,119	4,337	15,456	89	35	124	
Grouted Riprap	cu.m	200	651	437	1,088	130	87	217	
RC-pipe ø600mm	m	300	352	163	515	106	49	155	
Miscellaneous 5%						63	41	104	
Sub Total						(1,313	854	2,167)	7
Total						((8,700	4,600	13,300))	
3. Land Leveling									
Land Leveling	ha	690	2,820	1,097	3,917	1,946	757	2,703	
Deep plawing	ha	690	581	195	776	401	135	536	
Ridge preparation	ha	690	760	476	1,236	524	328	852	
Miscellaneous 5%						129	80	209	
Total						((3,000	1,300	4,300))	
Grand Total						(((28,500	14,200	42,800)))	

TABLE J2-12(1) CONSTRUCTION COST ESTIMATION FOR BAYONGAN SYSTEM

Description of Item	Unit	Quantity	Unit Rate			Amount (₱'000)			Remarks
			F/C	L/C	Total	F/C	L/C	Total	
1. Dam Works									
(1) Temporary Works						10,600	4,460	15,060	(1 + 2 + 3)x0.15
Sub Total						(10,600	4,460	15,060)	
(2) Dam Works									
Stripping	cu.m	72,000	22	9	31	1,584	648	2,232	
Earth Excavation	"	19,000	25	10	35	475	190	665	
Soft Rock Excavation	"	12,000	45	18	63	540	216	756	
Core Embankment	"	274,000	42	17	59	11,504	4,658	16,162	
Filter Embankment	"	98,000	82	33	115	8,036	3,234	11,270	
Up Stream Shell Embankment	"	432,000	38	15	53	16,416	6,480	22,896	
Down Stream Shell from Dam Borrow site	"	219,000	38	15	53	8,322	3,285	11,607	
Down Stream Shell by Excavated Material	"	56,000	11	4	15	616	224	840	
Riprap Embankment	"	40,000	108	44	152	4,320	1,760	6,080	
Toe Rock Embankment	"	2,000	29	12	41	232	96	328	
Sodding	sq.m	33,000	5	5	10	165	165	330	
Miscellaneous 10%						5,221	2,096	7,317	
Sub Total						(57,431	23,052	80,483)	1
(3) Spillway									
Earth Excavation	cu.m	56,000	40	16	56	2,240	896	3,136	
Soft Rock Excavation	"	24,000	64	25	89	1,536	600	2,136	
Backfill	"	2,000	22	9	31	44	18	62	
Structural Concrete, Class A	"	1,800	731	629	1,360	1,316	1,132	2,448	
Reinforced Bar	Ton	117	11,119	4,337	15,456	1,301	507	1,808	
Bridge	sq.m	90	1,600	400	2,000	144	36	180	
Miscellaneous 10%	L.S					658	319	977	
Sub Total						(7,239	3,508	10,747)	2
(4) Intake									
Earth Excavation	cu.m	16,000	25	10	35	400	160	560	
Soft Rock Excavation	"	11,000	45	18	63	495	198	693	
Backfill	"	1,000	22	9	31	22	9	31	
Tunnel Excavation	"	2,500	436	221	657	1,090	553	1,643	
Tunnel Support	set	267	3,694	1,358	5,052	986	363	1,349	
Structural Concrete Class A	cu.m	160	735	677	1,412	118	108	226	
Tunnel concrete	"	850	796	776	1,572	687	660	1,337	
Reinforced Bar	Ton	66	11,119	4,337	15,456	734	286	1,020	

TABLE J2-12(2) CONSTRUCTION COST ESTIMATION FOR BAYONGAN SYSTEM

Description of Item	Unit	Quantity	Unit Rate			Amount (P'000)			Remarks
			F/C	L/C	Total	F/C	L/C	Total	
Tunnel Grout Hole	Holes	430	55	34	89	24	15	39	
Tunnel Grouting	cu.m	85	1,172	783	1,955	100	67	167	
Clossure Gate 2.8x2.2m	set	1	49,020	1,960	50,980	49	2	51	
Intake Gate 0.9x0.9m	set	2	89,280	1,960	91,240	179	4	183	
Outlet Plag by Stop Log	L.S		25,832	2,085	27,917	26	2	28	
Control House	sq.m	50	8,000	2,000	10,000	400	100	500	
Miscellaneous 10%						530	253	391	
Sub Total						(5,830	2,780	8,610)	3
Total						((81,100	33,800	114,900))	
2. Canal Works									
(1) Temporary works						(903	534	1,437)	(4 + 5 + 6)x0.02
(2) Main Canal									
Stripping	cu.m	9,500	6	2	8	57	19	76	
Earth Excavation	"	289,000	29	13	42	8,381	3,757	12,138	
Fill by Excavated Material	"	11,500	16	8	24	184	92	276	
Backfill	"	500	22	9	31	11	5	16	
Lining Concrete	"	11,900	834	576	1,410	9,925	6,854	16,779	
Structural Concrete	"	403	924	1,174	2,098	370	470	840	
Reinforced Bar	Ton	11	11,119	4,337	15,456	122	48	170	
Grouted Riprap	cu.m	300	651	437	1,088	195	131	326	
Gravel Paving	"	4,000	96	39	135	384	156	540	
Sodding	sq.m	18,000	5	5	10	90	90	180	
R.C. Pipe ø250	m	500	319	144	463	160	72	232	
Gate 1.5x1.5	set	15	12,503	3,145	15,653	188	47	235	
Bridge	sq.m	924	1,280	320	1,600	1,183	296	1,479	
Distributor	L.S					1,614	81	1,695	
Miscellaneous 5%	L.S					1,143	606	1,749	
Sub Total						(24,007	12,724	36,731)	4
(3) Lateral Canal									
Stripping	cu.m	60,500	6	2	8	363	121	484	
Earth Excavation	"	172,100	29	13	42	4,991	2,237	7,228	
Fill by Excavated Material	"	131,000	16	8	24	2,096	1,048	3,144	

TABLE J2-12(3) CONSTRUCTION COST ESTIMATION FOR BAYONGAN SYSTEM

Description of Item	Unit	Quantity	Unit Rate			Amount (₱'000)			Remarks
			F/C	L/C	Total	F/C	L/C	Total	
Backfill	cu.m	1,500	22	9	31	33	14	47	
Structural Concrete	"	1,300	924	1,174	2,098	1,201	1,526	2,727	
Reinforced Bar	Ton	35	11,119	4,337	15,456	389	152	541	
Grouted Riprap	cu.m	900	651	437	1,088	586	393	979	
Gravel Paving	"	27,000	96	39	135	2,592	1,053	3,645	
Sodding	sq.m	122,000	5	5	10	610	610	1,220	
R.C. Pipe ø450	m	1,300	319	144	463	415	187	602	
" ø600	"	900	352	163	515	317	147	464	
Gate 0.5x1.0	set	122	3,125	781	3,906	381	95	476	
" 0.7x1.0	"	57	3,472	868	4,340	198	49	247	
Miscellaneous 5%						709	382	1,091	
Sub Total						(14,881	8,014	22,895)	5
(4) Drainage Canal									
Earth Excavation	cu.m	18,500	29	13	42	537	241	778	
Backfill	"	500	22	9	31	11	5	16	
Structural Concrete	"	1,300	924	1,174	2,098	1,201	1,526	2,727	
Reinforced Bar	Ton	35	11,119	4,337	15,456	389	152	541	
Grouted Riprap	cu.m	700	651	437	1,088	456	306	762	
R.C. Pipe ø600	m	500	352	163	515	176	82	258	
Miscellaneous 5%						139	116	255	
Sub Total						(2,909	2,428	5,337)	6
Total						((42,700	23,700	66,400))	
3. Land Leveling									
Land Leveling	ha	2,910	2,820	1,097	3,917	8,206	3,192	11,398	
Deep Plawing	"	2,910	581	195	776	1,691	567	2,258	
Ridge Preparation	"	2,910	760	476	1,226	2,212	1,385	3,597	
Miscellaneous 5%						591	256	847	
Total						((12,700	5,400	18,100))	
Grand Total						(((136,600	62,900	199,500)))	