Table 3D-4 Gradal Number of Farm Size

Farm Size (ha)	Farmers	%	Area (ha)	ha/Farmer
Under 1.0	13,711	44.9	6,139.8	0.46
1.0 - 3.0	14.477	47.2	19,030.9	1.31
3.0 - 5.0	2,072	6.8	5,056.3	2.44
5.0 - 10.0	259	0.8	747.0	-
10.0 - 25.0	77	0.3	169.9	-
25.0 - 50.0	4	0.0	20.1	-
50 over	13	0.0	41.4	-
Total	30,673	100.0	31.205.1	1.02

Total: 1971, Sensus of Agriculture (Ilocos Norte)

FIGURE 3D-1 RELATION OF ROTATIONAL AREA, FIA. RIG. AND RUG.

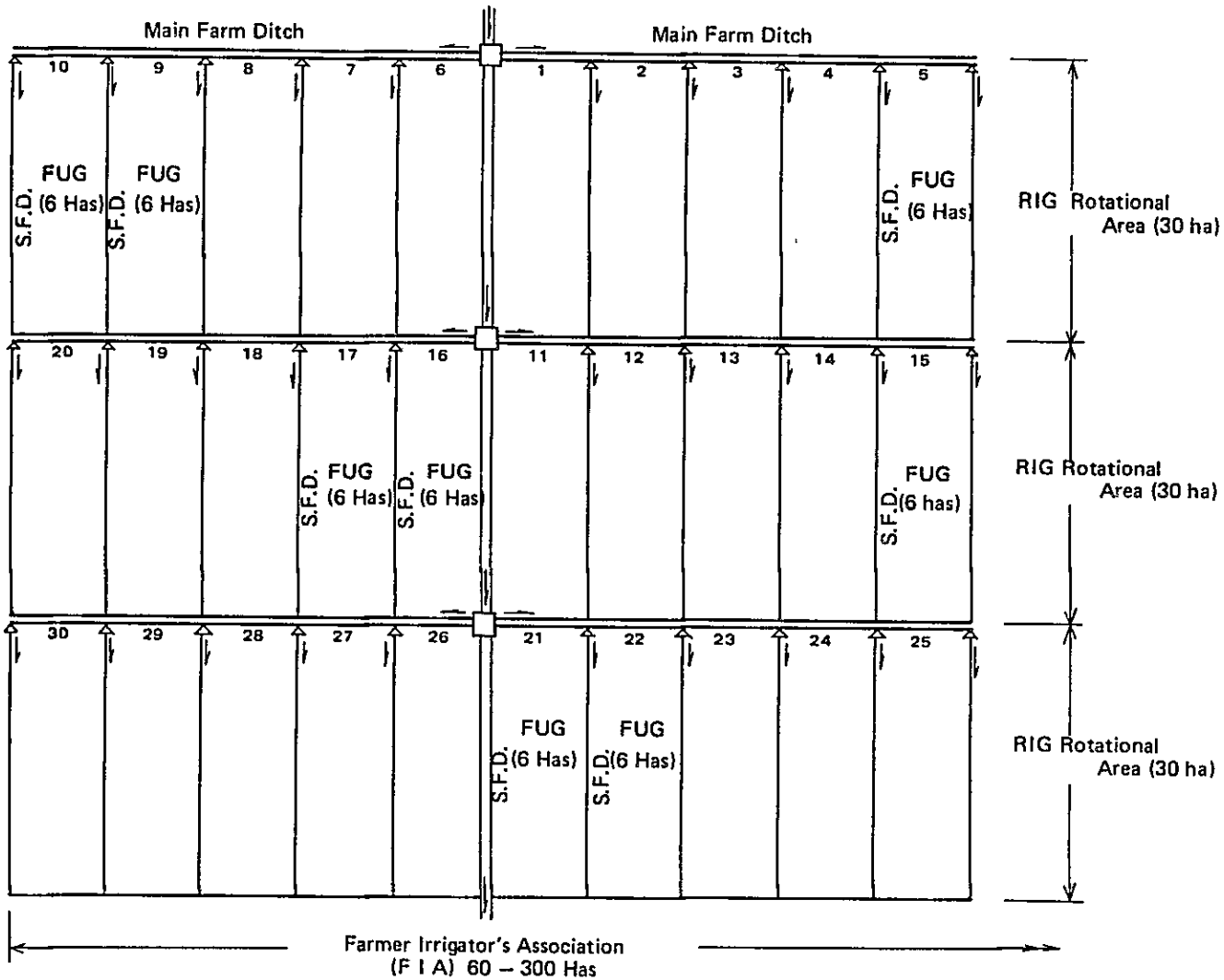


Table 3D-5 Relation of FIA and Barrio in the Project Area

Name of Barrio	Arable Area (1) (ha)	No. of Farmers (2)	(1)/(2) (ha)	No. of FIA	Average Area of FIA (ha)
A. Solsona					
1. Aquitap	82	116	0.71	1	82
2. Bagbags	199	67	2.97	1	199
3. Barcelona	115	127	0.91	1	115
4. Cataugrarn	414	145	2.86	2	207
5. Darasoas	96	164	0.59	1	176
6. Lanreta (Pof.)	80	19	4.21		
7. Lipay	376	81	464	2	188
8. Ma-anauteng	392	133	2.95	2	196
9. Manalpac	225	219	1.03	1	225
10. Nagpatpatan	94	123	0.76	1	94
11. Puttao	143	116	1.23	1	143
12. Santaana	137	142	0.96	1	137
13. Tolgtog	46	134	0.34	1	148
14. Santiago	102	176	0.58		
15. Juan (Pof.)	84	306	0.27	1	180
16. Maliquet	96	109	0.88		
17. Nalasin	188	96	1.95	1	188
Sub-total	2,869	2,273	1.26	17	169
No. of C.I.S	2,373	-	-	49	48
B. Gingras					
1. Baresbes	577	269	2.14	3	192
2. Borgong	386	274	1.41	2	195
3. Elithabes	390	219	1.78	2	196
4. Foz	147	119	1.24	1	147
5. Lumbad	285	76	3.75	1	285
6. San Marcelino	500	489	1.02	2	250
7. Surrate	366	243	1.51	2	189
8. Maglayaan	290	85	3.14	1	290
Sub-total	2,941	1,774	1.66	14	210
No. of C.I.S	2,476	-	-	47	53
C. Marcos					
1. Aquinit	516	195	2.65	2	258
2. Culao	304	143	2.13	1	304
3. Eacodo	291	214	1.36	1	291
4. Fredinand	232	126	1.84	1	232
5. Ragos	519	228	2 78	2	259
6. Santiago	322	223	1.44	2	161
Sub-total	2,184	1,129	1.93	9	243
No. of C.I.S	1,791	-	-	22	81
D. Espilitu					
1. Balioeg	557	217	2.57	2	278
2. Bagasi	183	115	1.59	1	183
3. Calstebanan	210	107	1.96	1	210
4. Macayepyep	117	137	0.85	1	117
5. Sinamar	184	208	0.88	1	184
6. Taltalagan	251	163	1.54	1	251
7. Valdez	127	145	0.88	1	127
Sub-total	1,630	1,092	1.49	8	204
No. of C.I.S	1,407	-	-	16	88
E. Nueva Era					
1. Poblacion	55	106	0.52		
2. Basikire	52	89	0.58	1	144
3. Caray	37	62	0.60		
4. Cabittaran	193	95	2.03	1	193
5. Stonino	121	69	1.75	1	239
6. Acnana	118	85	1.39		
Sub-total	576	506	1.14	3	192
No. of C.I.S	50	-	-	4	12
Total	10,200	6,774	1.50	51	200
No. of C.I.S	8,097	-	-	138	58.7

Table 3D-6 Present Paddy Production

Present Production

Year	Philippines			Ilocos Reageon[1]			Ilocos Norte			Five Municipalities Concerned[2]		
	Area (ha)	Yield (ton/ha)	Production (ton)	Area (ha)	Yield (ton/ha)	Production (ton)	Area (ha)	Yield (ton/ha)	Production (ton)	Area (ha)	Yield (ton/ah)	Production (ton)
1968	3,303,660	1.37	4,560,697	297,080	1.60	476,032						
1969	3,332,150	1.33	4,444,656	281,350	1.68	471,583						
1970	3,113,440	1.68	5,233,408	343,360	1.88	644,213						
1971	3,112,630	1.71	5,342,916	321,310	2.03	653,347	31,527	1.50	47,323	8,459	1.64	13,852
1972	3,246,380	1.57	5,100,084	421,470	1.55	651,961						
1973	3,111,800	1.42	4,414,630	322,140	1.34	430,188						
1974	3,436,800	1.63	5.594,134	351,370	1.54	540,201						
1975	3,538,840	1.78	5,660,046	338,500	1.25	422,000						
1976	3,579,320	1.72	6,159,472	342,590	1.69	577,460						
1977	3,547,500	1.82	6,456,076	310,860	1.64	511,042						
Average	3,332,225	1.59	5,296,612	333,003	1.62	537,803						

Note: 1/ Ilocos Reageon: Ilocos Norte, Ilocos Sur, Abra, Benguet, Pangasinan

2/ Five Municipalities Concerned: Solsona, Dingras, Marcos, Espiritu, Nueva Era.

Source: Philippines: BAE con

Ilocos Reageon: BAE con

Ilocos Norte: National Census and Statistics Office, 1971 Census of Agriculture, Bohol

Five Municipalities Concerned: - do -

Table 3D-7 Estimated Area Harvested, Yield and Production of Major Crops in Five Municipalities Concerned

Year	Paddy Rice, Irrigated, Wet						Paddy Rice, Irrigated, Dry						Paddy Rice, Rainfed, Wet					
	5 MCPTs.			Whole Province			5 MCPTs.			Whole Province			5 MCPTs.			Whole Province		
	Area (ha)	Yield (ton/ha)	Production (ton)	Area (ha)	Yield (ton/ha)	Production (ton)	Area (ha)	Yield (ton/ha)	Production (ton)	Area (ha)	Yield (ton/ha)	Production (ton)	Area (ha)	Yield (ton/ha)	Production (ton)	Area (ha)	Yield (ton/ha)	Production (ton)
1972	6,023	2.32	14,030	17,762	2.71	48,060	796	2.15	1,713	1,985	2.11	4,193	3,775	1.43	5,411	14,238	1.39	19,783
1973	6,029	2.74	16,542	17,752	2.64	47,379	776	1.98	1,537	1,933	1.80	3,491	3,725	1.33	4,972	14,053	1.28	18,461
1974	5,931	2.51	14,881	17,462	2.45	42,783	883	2.40	2,115	2,204	2.45	5,400	3,912	2.56	9,300	14,756	2.34	34,541
1975	5,336	1.79	9,557	15,831	1.54	24,324	844	0.62	524	2,105	2.65	5,575	3,771	1.73	6,513	14,559	1.39	20,262
1976	5,892	2.35	13,846	17,483	2.00	35,434	1,603	2.15	3,446	3,997	2.20	5,880	3,699	2,37	8,764	14,284	1.90	27,452
1977	6,011	2.81	16,902	17,837	2.42	43,057	2,253	1.82	4,093	5,630	1.89	10,554	3,500	2.67	9,332	13,516	2.17	29,236
1978	6,606	2.69	17,780	19,601	2.31	45,277	2,299	1.65	3,801	5 733	1.71	9,794	3,299	2.66	8,771	12,745	2.16	27,475
Average	5,975	2.47	14,791	17,675	2.31	40,902	1,350	1.82	2,461	3,370	1.90	6,412	3,669	2.07	7,580	14,021	1.81	25,315

Year	Virginia Tobacco						Corn					
	5 MCPTs.			Whole Province			5 MCPTs.			Whole Province		
	Area (ha)	Yield (ton/ha)	Production (ton)	Area (ha)	Yield (ton/ha)	Production (ton)	Area (ha)	Yield (ton/ha)	Production (ton)	Area (ha)	Yield (ton/ha)	Production (ton)
1972	770	0.39	303	3,200	0.40	1,280	851	0.55	472	2,450	0.47	1,147
1973	772	0.39	284	3,000	0.40	1,200	890	0.44	393	2,550	0.43	1,088
1974	314	0.75	235	1,304	0.78	1,012	1,205	0.43	515	3,440	0.43	1,420
1975	409	0.57	234	1,698	0.59	1,000	1,280	0.43	548	3,657	0.41	1,512
1976	615	0.71	435	2,556	0.72	1,840	1,244	0.46	571	3,552	0.51	1,795
1977	309	0.64	197	2,940	0.75	2,208	1,260	0.50	632	3,596	0.44	1,574
1978	388	0.65	251	3,690	0.76	2 804	1,341	0.61	822	3,830	0.59	2,255
Average	504	0.55	277	2,627	0.62	1,621	1,153	0.49	565	3,296	0.47	1,542

Source: BAEcon, Ilocos Norte

Note : 5 MCPTs Concerned: Solsona, Dingras, Marcos, Espitiru and Nueva Era

Table 3D-8 Crop Yield, in the Project Area without Project, at Present

Crop	No. of Sample Farmers	Area Planted (ha)	Total Production (cavan)	Ave. Yield (cavan/ha)	Ave. Yield (ton/ha)
1. Paddy Rice[1/]					
(a) Irrigated, Wet					
- Madongan Area	62	85.48	2,667.80	31.21	1.56
- Except Madongan Area	65	68.85	2,449.00	35.57	1.77
Total	127	154.33	5,116.80	33.15	1.65
(b) Irrigated, Dry					
- Madongan Area	24	13.13	323.54	24.64	1.23
- Except Madongan Area	29	13.78	443.87	32.21	1.61
Total	53	26.91	767.41	28.52	1.43
(c) Rainfed, Wet					
- Madongan Area	2	5.0	110.00	22.00	1.10
- Except Madongan Area	36	41.85	1,105.22	26.41	1.32
Total	38	46.85	1,215.22	25.94	1.30
2. Tobacco[1/]	68	29.76	29,108 kg	1,007 kg	1.01
3. Corn[2/]	-	-	-	-	0.49

Source: 1/ Farm Management Survey in the Project Area by LRED, NIA (1978), but the yield of tobacco is surveied in the Phase II Area of Overall Plan.

2/ BAEcon, Ilocos Norte, Average of estimated yield in the five municipalities concerned.

Table 3D-9 Paddy Production under Masagana 99 Program by Municipality

Municipality	Solsona					Dingras					Marcos				
Phase	VI	VII	VIII	IX	X	VI	VII	VIII	IX	X	VI	VII	VIII	IX	X
No. of Farmers W/O Credit	730	1,598	1,198	1,990	1,365	1,403	3,018	1,927	1,690	1,617	920	1,218	1,076	1,200	1,171
W Credit	214	69	-	6	17	250	231	-	50	-	50	177	-	-	-
Total	944	1,667	1,198	1,996	1,382	1,653	3,249	1,927	1,740	1,617	970	1,395	1,076	1,200	1,171
Area Harvested (ha)	738	1,619	775	1,900	979	1,413	2,600	1,535	1,393	1,444	800	1,120	834	1,030	909
Ave. Yield (cav./ha)	78	80	85	80	75	76	75	73	81	66	64	70	72	70	65
Production ('000 cav.)	58	130	66	152	73	107	105	112	113	95	51	78	60	72	59

Municipality	Espiritu					Nueva Era					Total				
Phase	VI	VII	VIII	IX	X	VI	VII	VIII	IX	X	VI	VII	VIII	IX	X
No. of Farmers W/O Credit	304	1,625	417	1,086	394	289	855	396	1,095	785	3,646	8,314	5,014	7,061	5,332
W Credit	-	72	-	120	-	-	90	-	10	-	514	639	-	186	17
Total	304	1,697	417	1,206	394	289	945	396	1,105	785	4,160	8,953	5,014	7,247	5,349
Area Harvested (ha)	271	941	279	1,017	276	244	906	289	960	206	3,466	7,486	3,712	6,300	3,814
Ave. Yield (cav./ha)	50	67	72	70	60	76	69	67	68	53	72	71	75	75	67
Production ('000 cav.)	14	63	20	71	17	19	63	19	65	11	249	529	277	473	255

Source: BPI, Ilocos Norte

Note: (1)' VI Nov., 1975 - Apr., 1976 (Dry season)
VII May, 1976 - Oct., 1976 (Wet season)
VIII Nov., 1976 - Apr., 1977 (Dry season)
IX May, 1977 - Oct., 1977 (Wet season)
X Nov., 1977 - Apr., 1978 (Dry season)

(2) cav. = 50 kg

Table 3D-10 Input Materials used in the Project Area, at Present

Input	Unit	Paddy Rice[1/] Irrigated, Wet (8,041 ha) Per ha	Amount	Irrigated, Dry (3,411 ha) Per ha	Amount	Rainfed, Wet (2,601 ha) Per ha	Amount	Tobacco[2/] (23 ha) Per ha	Amount	Corn & Others[3/] (584 ha) Per ha	Amount	Total Amount (14,660 ha)
1. Seed	cavan	1.11	8,926	1.30	4,434	1.08	2,809	-	-	0.3	175	Paddy 16,169 Corn,etc. 175
2. Fertilizer												
- 45-0-0	bag	0.49	3,940	1.05	3,582	0.17	442	1.40	32	-	-	7,996
- 21-0-0	bag	0.05	402	0.17	580	0.12	312	1.83	3	-	-	1,297
- 16-20-0	bag	0.02	161	0.07	239	0.12	312	1.67	2	0.9	526	1,240
- 12-12-12	bag	0.14	1,126	0.60	2,047	0.15	390	0.14	-	-	-	3,563
- 14-14-14	bag	0.12	965	0.28	955	-	-	0.24	-	-	-	1,920
- 15-15-15	bag	0.03	241	0.09	307	0.04	104	0.03	-	-	-	652
Total			6,835		7,710		1,560		37		526	16,668
3. Pesticides												
- Liquid	quart	0.16	1,287	0.28	955	0.07	182	1.82	3	0.3	175	2,602
- Granular	Kg	0.30	2,412	0.11	375	0.21	546	-	-	-	-	3,333
4. Herbicides												
- Liquid	quart	-	-	0.01	34	-	-	-	-	-	-	34
- Granular	Kg	0.01	80	-	-	-	-	-	-	-	-	80

Source: 1/ Farm Management Survey in the Project, NIA, LRED, 1978

2/ Surveied in Phase II Area of Overall Plan by above survey

3/ BAEcon "Costs and Returns of Paddy, Corn and Other Selected Commodities", The input materials for yellow corn, second semester (crop year 1974)

Table 3D-11 Input Materials per Hectare at Present

Items	Unit	Paddy Rice[1/]			Tobacco[2/]
		Irrigated, Wet	Irrigated, Dry	Rainfed, Wet	
1. Input Materials/ha (Planted Area Base)					
- Fertilizer, N-P_2O_5-K_2O	Kg	13.5-2.0-1.8	32.3-7.0-6.3	7.5-2.4-1.2	66.8-19.4-2.7
- Pesticides, Liquid	quart	0.16	0.28	0.07	1.82
- Pesticides, Granular	Kg	0.30	0.11	0.21	-
- Herbicides, Liquid	quart	-	0.01	-	-
- Herbicides, Granular	Kg	0.01	-	-	-
2. Applied Area of Input Materials					
- Fertilizer	%	50.7	65.5	44.8	92.5
- Pesticides	%	47.0	44.8	33.2	87.0
- Herbicides	%	0.8	10.0	0.3	-
3. Input Materials/ha (Applied Area Base)					
- Fertilizer, N-P_2O_5-K_2O	Kg	26.6-3.9-3.6	49.3-10.7-9.6	16.7-5.4-2.7	72.2-21.0-2.9
- Pesticides, Liquid	quart	0.3	0.6	0.2	2.1
- Pesticides, Granular	Kg	0.6	0.2	0.6	-
- Herbicides, Liquid	quart	-	10.1	-	-
- Herbicides, Granular	Kg	1.3	-	-	-

Source: 1/ Farm Management Survey in the Project Area, NIA, LRED, 1978

2/ Surveied in the Phase II Area of Overall Plan by above survey.

Table 3D-12 No. of Farm Machinery in the Project at Present

Municipality	Paddy Field Area (ha)	Hand Tractor	4 Wheel Tractor	Portable Thresher	Big Rice Thresher
Solsona	2,650	2	4	109	-
Dingras	3,311	-	-	5	-
Marcos	1,585	-	-	-	-
Espiritu	1,280	1	-	1	-
Nueva Era	359	-	-	6	-
Total	9,185	3	4	121	-
Assumed Area Coverage per Unit (ha)		8	24	5	20
Assumed Mechanization Area in the Project (ha)		24	96	605	-
Area Coverage of Mechanization in the Project (%)		1.3		6.6	-

Source: Barangay Screening Survey, BAEcon, 1976

Table 3D-13 Farm Labor Balance, without Project, at Present

(unit: man-day)

Items	Area (ha)	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1. Labor Requirement per ha														
(a) Paddy Rice[1/]														
- Irrigated, Wet	1	-	-	-	0.1	4.8	24.4	9.9	4.6	4.7	12.9	10.6	1.8	73.8
- Irrigated, Dry	- do -	7.2	11.4	9.3	2.0	3.2	-	-	-	0.2	13.3	27.4	8.0	82.0
- Rainfed, Wet	- do -	0.1	-	-	0.2	2.9	14.2	18.5	7.7	3.4	7.1	15.7	3.4	73.2
(b) Tobacco[1/]	- do -	12.1	26.7	34.7	27.4	8.4	-	-	-	5.3	11.1	26.0	19.7	171.4
(c) Corn[2/] & Others	- do -	1.0	10.0	-	-	-	-	-	-	-	24.2	12.2	-	47.4
2. Total Labor Requirement ('000 man-day)														
(a) Paddy Rice														
- Irrigated, Wet	8,041	-	-	-	0.8	38.6	196.2	79.6	37.0	37.8	103.7	85.2	14.5	593.4
- Irrigated, Dry	3,411	24.6	38.9	31.7	6.8	10.9	-	-	-	0.7	45.4	93.5	27.3	279.8
- Rainfed, Wet	2,601	0.3	-	-	0.5	7.5	36.9	48.1	20.0	8.8	18.5	40.8	8.8	190.2
(b) Tobacco	23	0.3	0.6	0.8	0.6	0.2	-	-	-	0.1	0.3	0.6	0.5	4.0
(c) Corn & Others	584	0.6	5.8	-	-	-	-	-	-	-	14.1	7.1	-	27.6
Total	14,660	25.8	45.3	32.5	8.7	57.2	233.1	127.7	57.0	47.4	182.0	227.2	51.1	1,095.0
3. Available Farm Labor Force ('000 man-day)		231.0	231.0	231.0	231.0	231.0	289.0	289.0	231.0	231.0	289.0	289.0	231.0	3,004.0
4. Balance (3-2)		+205.2	+185.7	+198.5	+222.3	+173.8	+55.9	+161.3	+174.0	+183.6	+107.0	+61.8	+179.9	+1,909.0

Source: 1/ "Farm Management Survey, NIA, LRED, 1978

2/ Based on the data of labor requirement in "Cost and Returns of Palay and Other Selected Commodities, BAEcon Research Report No. 7, 1975"

Note: Available farm labor force per month = 289,000 man-day (peak labor months) or 231,000 man-day (other months)
(See Appendix , Economic labor Analysis)

Table 3D-14 Livestock and Poultry Population (1978)

Municipality	Carabao	Cattle	Horse	Hogs	Goats	Sheeps	Chiken	Ducks
Solsona	1,539	5,691	110	2,560	112	-	4,903	-
Dingras	1,643	3,282	31	3,948	210	20	19,503	-
Marcos	882	1,741	95	2,250	127	-	1,709	-
Espiritu	2,546	2,291	84	3,319	610	-	4,720	132
Nueva Era	849	948	67	1,021	552	115	4,589	29
Total	7,459	13,953	387	13,098	1,611	135	35,424	161

Source: Bureau of Animal Industry, Ilocos Norte,

Table 3D-15 Number of Carabao by Municipality

Municipality	No. of Farms Reporting	Nos. by Age Group					Proportion to All Age Carabao (%)			
		All Ageas	Under 3 years	3 years and Over	Work Carabao	Female 3 years and Over	Under 3 years	3 years and Over	Work Carabao	Females 3 years And Over
Solsona	911	1,244	250	994	874	232	20	80	70	19
Dingras	1,754	2,352	203	2,149	1,930	265	9	91	82	11
Marcos	856	1,326	215	1,111	937	236	16	84	71	18
Espiritu	1,313	2,534	500	2,034	1,742	274	20	80	69	11
Nueva Era	364	666	167	499	410	50	25	75	62	8
Total	5,198	8,123	1,335	6,787	5,893	1,057	16	84	73	13

Source: Agricultural Census, 1971

Table 3D-16 Distribution of Farm and Area by Tenure and Size of Farm

Size of Farm	Full Owner		Pertial Owner and Lease		Share Tenant and Lease		Lease		Pertial Owner and Share Tenant		Share Tenant		Total	
	Farm	Area	Farm	Area	Farm	Area	Farm	Area	Farm	Area	Farm	Area	Farm	Area
less 1.0 ha	165	70.03	7	4.0	-	-	9	5.0	159	87.10	742	328.77	1,082	494.9
1.0 to 1.99	95	103.75	10	10.5	-	-	5	5.0	369	439.67	682	780.70	1,160	1,339.62
2.0 to 2.99	18	38.0	4	8.0	1	2.0	-	-	122	253.06	108	231.30	253	532.36
3.0 to 3.99	2	6.0	-	-	-	-	-	-	10	30.73	20	61.93	32	98.66
4.0 to 4.99	-	-	-	-	-	-	-	-	7	28.89	4	16.21	11	45.10
5.0 ha & Over	2	10.25	-	-	-	-	-	-	1	5.0	2	13.75	5	29.00
Total	281	228.03	21	22.5	1	2.0	14	10.0	668	844.45	1,558	1,432.66	2,543	2,539.64
(%)	11.0	9.0	0.8	0.9	0.0	0.0	0.6	0.4	26.3	33.3	61.3	56.4	100.0	100.0

Note: Above figures indicate the data obtained from selected farmers of 348 households as sample in 33 Barangays

Table 3D-17 Present Cropping Pattern

Annual Crops	Phase I		Phase II		Overall	
Number of Farms	162		133		295	
	Area	%	Area	%	Area	%
Palay						
1st crop irrigated	123.93	(62.2)	48.77	(18.5)	172.70	(37.3)
2nd crop irrigated	26.91	(13.5)	-	-	26.91	(5.8)
Rainfed	46.85	(24.5)	130.97	(49.7)	177.82	(38.4)
Sub-total	(197.69)	(99.2)	(179.74)	(68.2)	(377.43)	(81.6
Tobacco	-	-	29.76	(11.7)	29.76	(6.6)
Garlic	-	-	47.09	(17.9)	47.09	(10.2)
Mongo	-	-	1.24	(0.5)	1.24	(0.3)
Corn	-	-	0.59	(0.1)	0.59	(0.1)
Sub-total	-	-	(79.68)	(30.2)	(79.68)	(17.2)
Idle land	1.5	(0.8)	4.09	(1.6)	5.59	(1.2)
Total Area	199.19	(100.0)	262.51	(100.0)	461.70	(100.0)
Cropping intensity	116 %		146 %		130 %	
Average size of farm 1/	1.05 ha		1.35 ha		1.19 ha	

Note: 1/: $\frac{\text{1st crop area + Rainfed area}}{\text{Number of Farms}}$

Table 3D-18 Average Yield of Palay

Item	No. of Farms	Total Production (Cav.)	Total Area Planted (ha)	Average Yield Planted (Cav.)	Total Area Harvested (ha)	Average Yield Harvested (Cav.)
1. Irrigated Wet						
Phase I	127	5,117	154.33	33.2	151.88	33.7
Phase II	20	874	18.37	47.6	17.92	48.8
Overall	147	5,991	172.70	34.7	169.80	35.3
2. Irrigated Dry						
Phase I	53	767	26.91	28.5	25.52	30.1
Phase II	-	-	-	-	-	-
Overall	53	767	26.91	28.5	25.52	30.1
3. Rainfed						
Phase I	38 1/	1,215	46.85	25.9	44.65	27.2
Phase II	120 2/	3,697	130.97	28.2	121.39	30.5
Overall	158	4,912	177.82	27.6	166.04	29.6
4. Average						
Phase I	218	7,099	228.09	31.1	222.05	32.0
Phase II	140	4,571	149.34	30.6	139.31	32.8
Overall	358	11,670	377.43	30.9	361.36	32.3

Note: 1/ 3 farms included in irrigated farms.
2/ 7 farms included in irrigated farms.

Table 3D-19 Disposition of Palay Production

(Unit: Cavan.)

Item	No. of Farms	Area Planted (ha)	Total Production	Disposition of Production								
				Rent to Landlord		Harvester/ Thresher	Thresher	Sold/To be Sold	Home use	Seeds	Feeds	Creditor
				Share	Lease							
1. Irrigated Wet												
Phase I	127	154.33	5,117	1,797	-	712	-	84	2,290	175	25	34
Phase II	20	18.37	874	175	-	105	1	10	547	29	7	-
Overall	147	172.70	5,991	1,972	-	817	1	94	2,837	204	32	34
2. Irrigated Dry												
Phase I	53	26.91	767	233	-	102	-	9	377	37	7	2
Phase II	-	-	-	-	-	-	-	-	-	-	-	-
Overall	53	26.91	767	233	-	102	-	9	377	37	7	2
3. Rainfed												
Phase I	38	46.85	1,215	412	8	153	-	62	503	50	14	13
Phase II	120	130.97	3,697	967	-	104	7	44	2,379	170	24	2
Overall	158	177.82	4,912	1,379	8	257	7	106	2,882	220	38	15
4. Total												
Phase I	218	228.09	7,099 (100.0)	2,442 (34.4)	-	967 (13.6)	-	155 (2.3)	3,170 (44.7)	262 (3.7)	46 (0.6)	49 (0.7)
Phase II	140	149.34	4,571 (100.0)	1,142 (24.6)	8 (0.2)	209 (4.6)	8 (0.2)	54 (1.3)	2,926 (64.0)	199 (4.4)	31 (0.7)	2 (0.0)
Overall	358	377.43	11,670 (100.0)	3,584 (30.7)	8 (0.0)	1,176 (10.0)	8 (0.0)	209 (1.9)	6,096 (52.3)	461 (4.0)	77 (0.7)	51 (0.4)

Table 3D-20 Farm Population and Labor Force
- Person per one farm-household -

Area	Total Population	Active population engaged in farming		Engaged in other occupation	Monors and Others
		Full time	Part time		
Phae I	5.81	1.28	1.35	0.32	2.86
Phae II	5.68	1.23	0.83	0.27	3.35
Average	5.76	1.26	1.12	0.30	3.08

Table 3D-21 Inventory Ending and Capital Investment
- Pesos per one farm-household -

Investment	Phase I	Phase II	Average
Farm House	33	43	38
Shed for Animal	13	7	10
Irrigation Pump Set	-	611	283
Storage Warehouse	40	39	39
Machiners	2	70	33
Pugon	-	51	23
Native Plow	44	54	48
Native Harrow	22	18	20
Sprayer	19	18	18
Rotary Weeders	-	0.2	0
Threshing Device	4	6	5
Potable Thresher	-	49	23
Bull Cart	77	12	47
Shovel	8	5	7
Hoe	1	1	1
Rake	1	1	1
Harvest Tools	4	5	5
Other Equipments	18	27	22
Total	286	1,107	623

Table 3D-22 Livestock and Poultry Inventory (Ending)
- per one farm household -

Livestock	Phase I No. of Population	Phase I Value (₱)	Phase II No. of Population	Phase II Value (₱)	Average No. of Population	Average Value (₱)
Carabao	1.04	1,258	0.92	1,813	0.99	1,508
Cattle	1.26	1,324	0.57	790	0.95	1,083
Horse	0.55	96	0.00	6	0.31	53
Goat	0.37	33	1.14	110	0.72	68
Pig	5.84	333	1.21	288	3.75	313
Chicken	6.50	57	10.11	102	8.13	77
Ducks	0.22	0.2	0.09	0.1	0.16	0.1
Geese	-	-	0.02	0.8	0.00	0.3
Sheep	-	-	0.13	6	0.06	3
Others	0.13	6	0.41	25	0.25	14
Total		3,107.2		3,140.9		3,119.4

Table 3D-23 Labor Days and Hired Labor Cost

	Irrigated Wet Palay			Irrigated Dry Palay			Rainfed		
	Labor Per Ha. (days)	Hired Labor (days)	Hired Labor Cost (₱)	Labor Per Ha. (days)	Hired Labor (days)	Hired Labor Cost (₱)	Labor Per Ha. (days)	Hired Labor (days)	Hired Labor Cost (₱)
Seedbeding	2.73	0.06	0.49	3.88	-	-	2.23	0.01	0.09
Land preparation	15.45	4.47	40.54	16.70	5.91	54.73	15.20	2.13	19.66
Repair of dikes	2.26	0.11	1.07	2.44	-	-	2.60	0.04	0.33
Pulling/transplanting	16.41	8.32	71.55	18.07	8.46	74.45	18.20	6.41	57.05
Handweeding	4.33	0.07	0.62	5.27	-	-	5.11	0.26	1.90
Weedicides	0.33	-	-	0.4	-	-	0.54	-	-
Rotary weeding	0.65	-	-	-	-	-	-	-	-
Fertilizing	1.01	0.01	0.09	1.37	-	-	1.96	0.04	0.29
Spraying	0.81	0.02	0.18	0.73	-	-	1.04	-	-
Water management	3.67	-	-	7.9	-	-	-	-	-
Harvesting	16.00	9.0	90	16.67	7.82	78.2	13.64	7.67	67.50
Threshing	9.98	4.97	49.7	19.34	9.61	96.1	9.65	4.79	46.94
Hauling	1.57	0.13	1.11	1.73	0.04	0.4	1.50	0.06	0.53
Drying	1.18	0.06	0.51	1.47	-	-	1.97	-	-
Total	76.38	27.22	255.86	81.96	31.84	303.88	73.25	21.41	194.29
	(100%)	(35.6%)		(100%)	(38.8%)		(100%)	(29.2%)	

Table 3D-24 Other Source of Income

Area	No. of Farms	Farms Reported	Salarie & Wages	Income from Business	Rent of Farmland	Rent of Machine	Rent of Work Animal	Interest Income	Work on Other Farm	Other Income	Total Income
	%	%									
Phase I	162(100)	95(59)	(221) 130	(103) 60	(11) 6	(43) 25	(3) 2	(0.5) 0.3	(135) 79	(117) 68	(633) 371
Phase II	133(100)	85(64)	(474) 303	(75) 48	(51) 33	(8) 5	(5) 3	(7) 5	(224) 143	(385) 246	(1,229) 785
Total or Average	295(100)	180(61)	(341) 203	(90) 53	(30) 18	(27) 16	(4) 2	(4) 2	(177) 108	(243) 148	(916) 550

Note: Figures in parenthesis are estimated by divided by number of farms reported.

Table 3D-25 Total Annual Cost of Family Living Allowance
- Pesos per one farm household -

Item	Phase I	Phase II	Average
Rice & other cereals	218	397	299
Fish meat & beverage	389	649	506
Soft drink	70	96	82
Food ingredients	147	148	147
Housing	177	335	248
Tobacco & Cigarettes	87	124	104
Clothing	238	372	298
Fuel, light & water	98	137	115
Household equipments	60	126	90
Household operation	53	91	70
Personal medicare	107	226	161
Transportation & communi.	107	142	123
Recreation	16	33	24
Education	390	989	660
Others	3	7	5
Total	2,160	3,572	2,932

CHAPTER IV. THE PROJECT

FIGURE 4B-1 ALTERNATIVE PLANS OF OVERALL DEVELOPMENT FOR ILOCOS NORTE IRRIGATION PROJECT

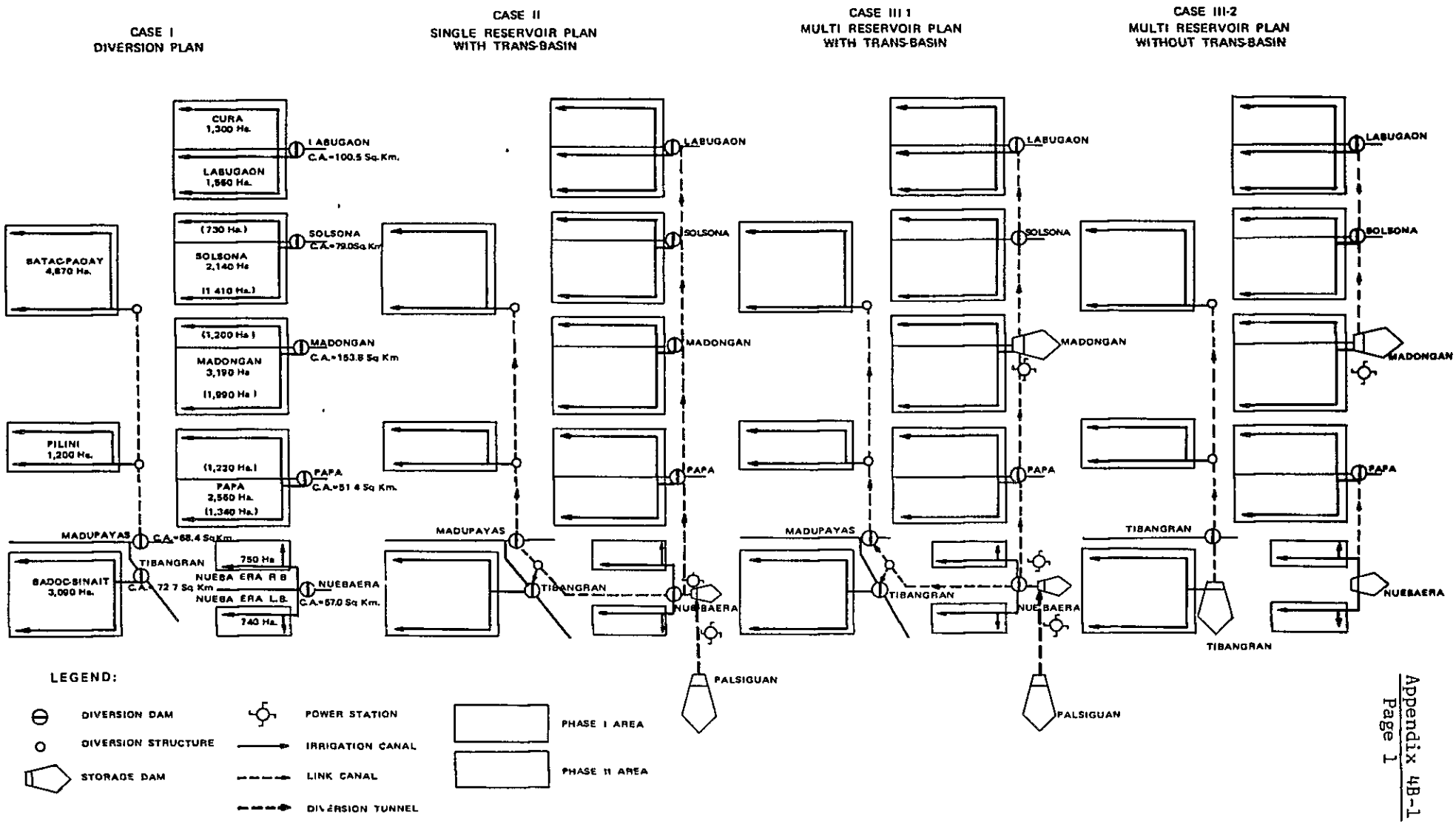


Table 4B-1 Summary of Alternative Studies

	Non-Phasing Development				Phasing Development			
	Case I	Case II	Case III-1	Case III-2	Case II		Case III-1	
	Overall	Overall	Overall	Overall	Overall	Phase I	Overall	Phase I
1. Proposed Area (ha)	21,400	21,400	21,400	21,400	21,400	10,200	21,400	10,200
2. Irrigable Area (ha)								
1st Crop (Wet season)	13,150	21,400	21,400	18,600	21,400	8,080	21,400	8,980
2nd Crop (Dry season)	4,630	21,400	21,400	11,270	21,400	2,960	21,400	7,740
3. Power Capacity (MW)	-	42	51	11	42	-	51	-
4. Project Cost (Million Pesos)								
Irrigation	475	1,151	1,233	1,080	1,151	215	1,233	452
Power	-	280	330	60	280	-	330	60
Total	475	1,431	1,563	1,140	1,431	215	1,563	512
(1,000 US$)	64,190	193,380	211,220	154,050	193,380	29,050	211,220	69,190
5. Irrigation Project Cost								
Cost per ha (US$/ha)	3,000	7,270	7,790	6,820	7,270	2,850	7,790	5,990
Allocated Joint Cost (US$/ha)	-	6,580	6,780	6,470	6,580	-	6,780	5,260
6. Annual Full Benefits (Million Pesos)								
Irrigation	47	173	176	135	172	32	172	66
Power	-	37	45	11	37	-	45	11
Total	47	210	221	146	209	32	217	77
7. IRR (%)	8.7	13.1	12.7	10.5	12.2	12.3	12.1	12.3
8. Construction Period (Year)	7	7	7	7	8	4.5	8	5.5

Table 4B-2 Percolation Test in the Project Area

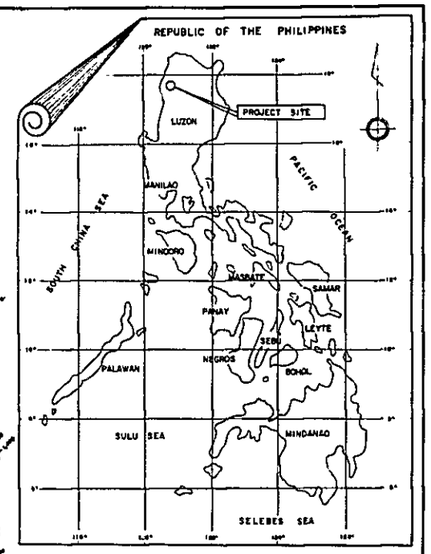
Test Site No.	Location	Land Capability Classification	Series	Surface Soil Texture	Percolation Rate (mm/day)	Remarks
Phase I Area						
1	Mariket, Solsona	Rice land (2R)	Solsona	CL	7.4	measured by LDED[1/], PDD in Feb. 1978
2	Solsona, Solsona	Rice land (2R)	Sn. Manuel	CL	6.3	- do -
3	Santiago, Solsona	Rice land (1R)	Tagulad	SC	1.9	- do -
4	Barong, Dingras	Rice land (2R)	Umingan	CL	2.3	- do -
5	Baresbes, Dingras	Rice land (3R)	Umingan	CL	2.0	- do -
6	Tabtabagan, Banna	Rice land (2R)	Sn. Manuel	CL	2.1	- do -
7	Talogtog, Solsona	Dual class land	Solsona	SL	5.2	- do -
8	Barikir, Nueva Era	Dual class land	Tagulod	SiCL	2.4	
9	Puttao, Solsona	Rice land (1R)	Solsona	FSL	1.2	
10	Bagbogo, Solsona	Rice land (1R)	Umingan	SL	1.8	
11	Padungan, Dingras	Dual class land	Umingan	SL	1.9	
12	Ragas, Marcos	Dual class land	Solsona	FSL	1.8	
	Sub-Mean				3.0	
Phase II Area						
13	Barangay 3, Paoay	Rice land (1R)	San Fernando	C	1.0	
14	San Roque, Paoay	Rice land (1R)	San Manuel	SL	3.4	
15	Neintan, Batac	Rice land (1R)	San Manuel	CL	0.5	
16	Barangay 1, Batac	Rice land (1R)	Bantog	CL	1.5	
17	Nagurayan, Batac	Dual class land	San Manuel	SCL	0.5	
18	Hordan, Sinait	Rice land (1R)	Badoc	C	1.3	
19	Sta. Cruz, Sinait	Rice land (2R)	Bantay	CL	0.2	
20	Tamaneyan, Badoc	Rice land (1R)	San Manuel	SiL	1.0	
21	Badio, Pinili	Rice land (1R)	San Fernando	CL	0.5	
	Sub-Mean				1.0	
	Mean				2.2 ≒ 2.0 mm/day	

1/ Land Resources and Economic Division, PDD-NIA

FIGURE 4B-2 MEASURING SITE OF PERCOLATION RATE

Beneficial Area

Measuring Site



SCALE

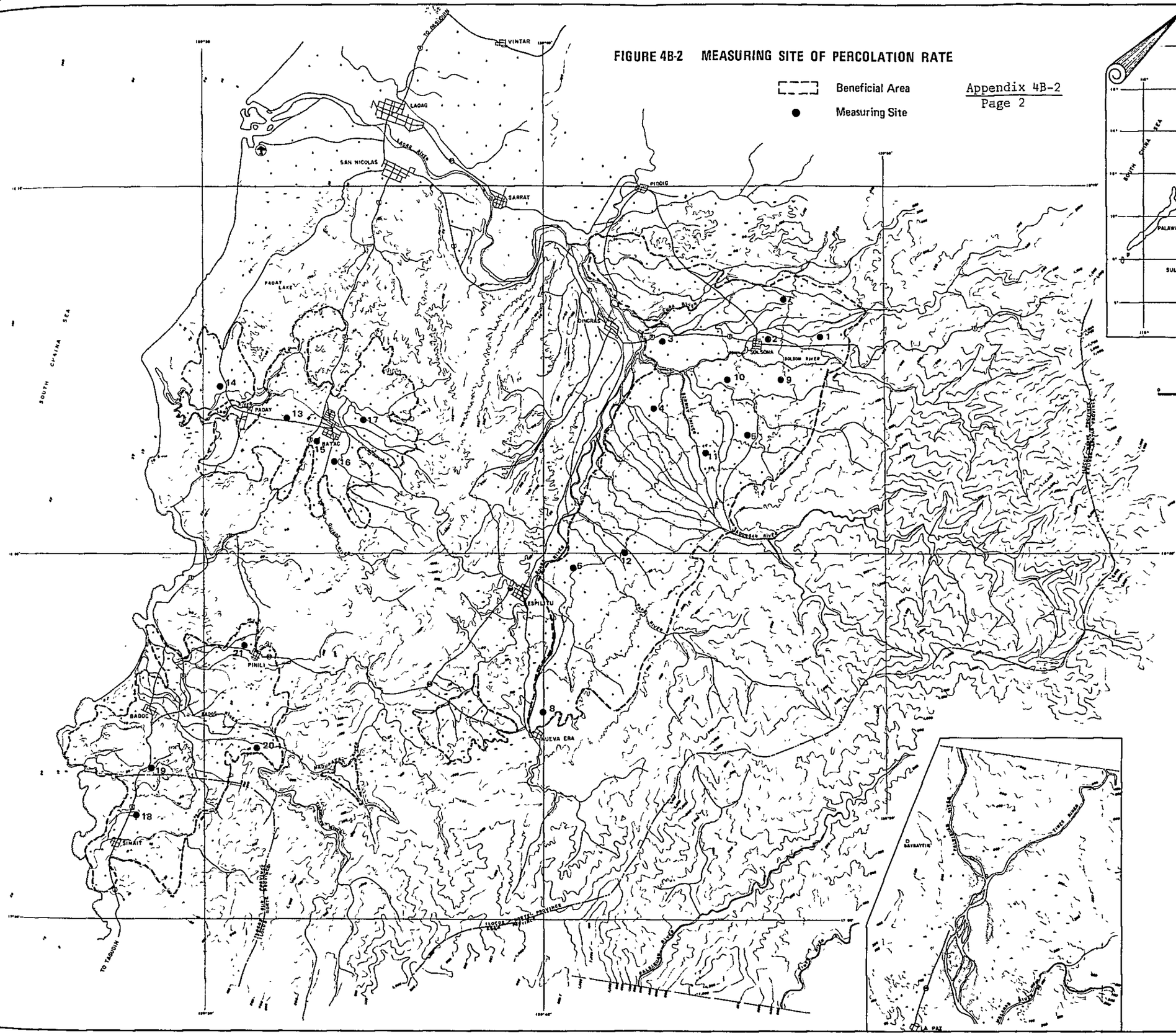


Table 4B-3 Water Requirement for Land Soaking and Land Preparation

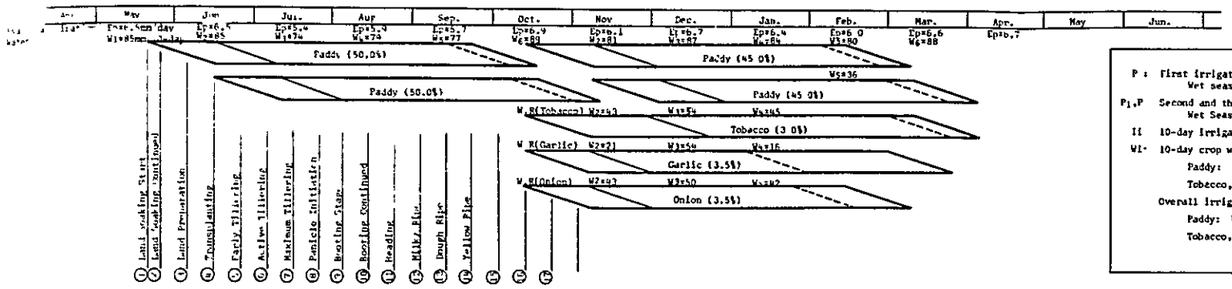
Land to be prepared in May, June and July

1.	First irrigation	:	175
	Top soil saturation 150 mm depth, 60% void, 70% dry	: 150 mm x 0.6 x 0.7	65
	Percolation (2 mm/day)	: 2 mm x 25 days	50
	Standing water	:	60
2.	Second and third irrigation	:	75
	Evaporation in 12 days	: 6.1 mm x 12 days	75
	Total		250

Land to be prepared in October, November and December

1.	First irrigation	:	150
	Top soil saturation 150 mm depth, 60% void, 40% dry	: 150 mm x 0.6 x 0.4	40
	Percolation (2 mm/day)	: 2 mm x 25 days	50
	Standing water		60
2.	Second and third irrigation	:	80
	Evaporation in 12 days	: 6.6 mm x 12 days	80
	Total		230

FIGURE 4B-3 CALCULATION OF WEIGHTED CROP WATER REQUIREMENT FOR PHASE I AREA



P : First irrigation for land soaking and preparation of paddy:
Wet season 175 mm, Dry season: 150 mm

P_1,P Second and third irrigation of Paddy:
Wet Season: 75 mm, Dry season: 80 mm

Ii 10-day Irrigation requirement

Wi 10-day crop water requirement

Paddy: Evapolation + Percolation

Tobacco, Gircli and Onion: Evaporation x crop coefficient

Overall irrigation efficiency

Paddy: Wet season 46.8%, Dry season. 54.0%

Tobacco, Girlic and Onion. 60%

Growing Stage with 10-day Interval	Irrigation Req (mm)	Equation for Weighted Irrigation Requirement	Paddy: Wet Season Paddy (May-Nov) Weighted 10-day Water Requirement	Average Daily (mm)	Dry Season Paddy (Dec - Apr.) Weighted 10-day Water Requirement	Average Daily Water Req. (mm)
1 Land Soaking Start	P_2	1 10P_2	1 10x175	3.50	1/10x150	3.00
2 Land Soaking Continued	P_1	1 5(P_2+1 5P_1)	1/5(175+1 5x75)	3.80	1/5(150+1/5x80)	3 32
3 Land Preparation	P	1 5(P_2+P_1)	1 5(175+75)	5.00	1/5(150+80)	4.60
4 Transplanting	I_1	1/5(P_2+P_1+P_e+W_2)	1/5(175+75+75+1/2x85	7.35	1/5(150+80+80+2/1x81)	7.01
5 Early Tillering	I_2	1 10(P_2+2P_1+2 +2W_2+W_3)	1/10(2x175+2x75+2x75+2x75+2x85+74)	8.94	1/10(2x150+2x80+2x80+2x81+87)	8.69
6 Active Tillering	I_3	1 10(P_2+3P_1+2P_2+2W_2+3W_3)	1/10(175+3x75+2x75+2x85+3x74)	9.47	1/10(150+3x80+2x80+3x81+3x87)	9 73
7 Maximum Tillering	I_4	1 5(8P_1+10P_2+3W_3)	1/50(8x75+10x75+35x74)	7 88	1/50(8x80+10x80+35x87)	8.01
8 Panicle Initiation	I_5	1 10(P_2+8W_3+W_4)	1/10(2x75+8x74+79)	8.21	1/10(2x80+8x87+84)	9.40
9 Booting Stage	I_6	1 2(W_3+W_4)	1/2(74+79)	7.65	1/2(87+84)	8 55
10 Booting Continued	I_7	1 10(W_3+9W_4)	1/10(74+9x79)	7 85	1/10(87+9x84)	8 43
11 Heading	I_8	1 10(W_4+W_5)	1/10(9x79 77)	7.88	1/10(9x84+80)	8.36
12 Milky Ripe	I_9	1/2(W_4+W_5)	1/2(79+77)	7 80	1/2(84+80)	8 20
13 Dough Ripe		1/10(W_4+8W_5)	1/10(79+8x77)	6 95	1/10(84+8x80)	7.24
14 Yellow Ripe		7/10(W_5)	7/10x77	5 39	7/10x80	5 60
15		1 10(W_5+2W_6)	1/10(77+2x89)	4 09	1/10(3x80+2x88)	4 16
16		1/10(5W_5+2W_6) + 1/10P_2 2/	1/10(5x77+2x89) + 1/5x175	5 63+3.50	1/10(5x80+2x88)	5.76
17		1/10(W_6) + 1/50(10P_2+7P_1) 2/	1/10x89+1/50(10x175+7x75)	0.89+4.55	1/10x88	0.88
				1,073.2		1,085.6

Note : $\frac{9.42 \times 10^{-3} \times 1 \text{ Oha} \times 10^4 \times 10^3 \text{ m. } 00}{(1\text{-}0\ 35\text{H}_2\text{-}0\ 20)(1\text{-}0\ 1)\times 86\ 4 \times 10^7} = 2.33$ lit/sec/ha

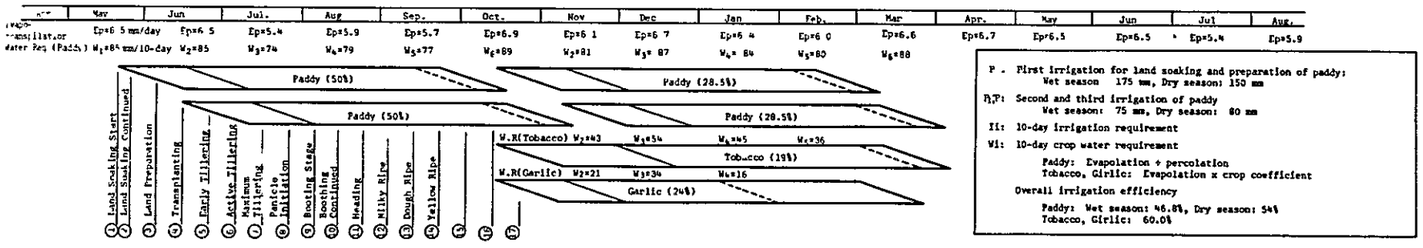
2/ Second term is applied for wet season Paddy only.

Growing Stage	Irrigation Req	Equation for Irrigation Req.	Weighted 10-day Water Req. (mm)	Average Daily Water Req. (mm)
1 Land Preparation				
2. - do -				
3. - do -	P_2	2/5xP_2	2/5x100	4.00
4 - do -	P_1	1/5(2P_2+P_1)	1/5(2x100+100)	6.00
5. - do -	I_1	1/5(P_2+2P_1)	1/5(100+2x100)	6.00
6. Vegetative Growth Stage	I_2	1/5(2P_1+W_2)	1/5(2x100+54)	5.08
7 - do -	I_3	3/5(W_2)	3/5x54	3.24
8. - do -	I_4	W_3	54	5 40
9. - do -	I_5	1/5(4W_3+W_4)	1/5(4x54+45)	5.22
10. - do -	I_6	1/5(2W_3+3W_4)	1/5(2x54+3x45)	4.86
11 - do -	I_7	W_4	45	4.50
12 Harvesting Stage	I_8	1/5(W_4+W_5)	1/5(4x45+36)	4.32
13 - do -	I_9	1/5(W_4+3W_5)	1/5(2x45+3x36)	3.96
14. - do -	I_{10}	W_5	36	3.60
15 - do -		4/5xW_5	4/5x36	2.88
16.		2/5xW_5	2/5x36	1 44
17.				597 9

Growing Stage	Irrigation Req.	Equation for Irrigation Req.	Weighted 10-day Water Req. (mm)	Average Daily Water Req. (mm)
1. Land Preparation				
2. - do -				
3. - do -	P_1+I_1	1/5(2P_1+I_1)	1/5(2x100+21)	4.42
4. Growing Stage	I_2	1/5(2P_1+3W_2)	1/5(2x100+2x21)	4.84
5. - do -	I_3	1/5(P_1+5W_2)	1/5(100+5x21)	4.10
6. - do -	I_4	1/5(4W_2+W_3)	1/5(4x21+34)	2.36
7. - do -	I_5	1/5(2W_2+3W_3)	1/5(2x21+3x34)	2.88
8. - do -	I_6	1/5(5W_3)	1/5(5x34)	3.40
9. - do -	I_7	1/5(4W_3+W_4)	1/5(4x34+16)	3.04
10. Bulb Formation Stage		1/5(W_4)	1/5(4x16)	1.28
11. - do -		2/5W_4	2/5x16	0.64
12. - do -				
13. - do -				
14. - do -				
15. - do -				
16. - do -				
17.				

Growing Stage	Irrigation Req.	Equation for Irrigation Req.	Weighted 10-day Water Req.	Average Daily Water Req.
1. Land Preparation				
2. - do -				
3. - do -	P_1+I_1	1/5(2P_1+W_2)	1/5(2x10+43)	4.86
4. Before Bulb Formation Stage	I_2	1/5(2P_1+3W_2)	1/5(2x100+3x43)	6.58
5. - do -	I_3	1/5(P_1+5W_2)	1/5(100+5x43)	6.30
6 - do -	I_4	1/5(4W_2+W_3)	1/5(4x43+50)	4.44
7. Bulb Formation Stage	I_5	1/5(2W_2+3W_3)	1/5(2x43+3x50)	4.72
8. - do -	I_6	1/5(5W_3)	1/5(5x50)	5.00
9. - do -	I_7	1/5(4W_3+W_4)	1/5(4x50+42)	4.84
10. - do -	I_8	1/5(2W_3+3W_4)	1/5(2x50+3x42)	4.52
11. - do -	I_9	1/5(5W_4)	1/5(5x42)	4.20
12.		1/5(W_4)	1/5(4x42)	3.36
13.		2/5W_4	2/5(42)	1.68
14.				
15.				
16.				
17.				529.3

FIGURE 4B-4 CALCULATION OF WEIGHTED CROP WATER REQUIREMENT FOR PHASE II AREA



P . First irrigation for land soaking and preparation of paddy:
Wet season 175 mm, Dry season: 150 mm

P_1,P: Second and third irrigation of paddy
Wet season: 75 mm, Dry season: 80 mm

Ii: 10-day irrigation requirement

Wi: 10-day crop water requirement

Paddy: Evapolation + percolation
Tobacco, Girlic: Evapolation x crop coefficient

Overall irrigation efficiency

Paddy: Wet season: 46.8%, Dry season: 54%
Tobacco, Girlic: 60.0%

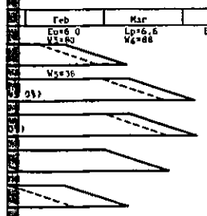
Growing Stage with 10-day Interval	Paddy Irrigation Req	Average Daily Water Req. W/S Paddy (mm)	Average Daily Water Req. D/S Paddy (mm)
1 Land Soaking Start	P_2	3.50	3 00
2 Land Soaking Continued	P_1	3.80	3 32
3 Land Preparation	P	5.00	4.60
4. Transplanting	I_1	7.35	7 01
5 Early Tillering	I_2	8 94	8.69
6 Actual Tillering	I_3	9.47	9 73
7 Maximum Tillering	I_4	7.88	8.01
8 Panicle Initiation	I_5	8.21	9.40
9 Booting Stage	I_6	7.65	8 55
10 Booting Continued	I_7	7.85	8.43
11 Heading	I_8	7.88	8 36
12 Milky Ripe	I_9	7.80	8 20
13 Dough Ripe		6.95	7.24
14 Yellow Ripe		5.35	5.60
15		4.09	4.16
16		5 63+3.50	5.76
17		0.89+4 55	0 88
Total		1,073.2	1,085.6

Growing Stage	Tobacco Irrigation Req.	Average Daily Water Req (mm)
1. Land Preparation		
2. - do -		
3. - do -	P_2	4.00
4. - do -	P_1	6.00
5 - do -	I_1	6.00
6 Vegetable Growth Stage	I_2	5.08
7. - do -	I_3	3.24
8 - do -	I_4	5.40
9 - do -	I_5	5.22
10. - do -	I_6	4.86
11. - do -	I_7	4.50
12. Harvesting Stage	I_8	4.32
13. - do -	I_9	3.96
14. - do -	I_{10}	3.60
15. - do -		2.88
16.		1.44
17.		597 9

Growing Stage	Garlic Irrigation Req	Average Daily Water Req. (mm)
1. Land Preparation		
2. - do -		
3. - do -	P_1+I_1	4.42
4. Growing Stage	I_2	4.84
5. - do -	I_3	4.10
6. - do -	I_4	2.36
7. - do -	I_5	2.88
8. - do -	I_6	3.40
9. - do -	I_7	3.04
10 Bulb Formation Stage		1.28
11. - do -		0.64
12. - do -		
13. - do -		
14. - do -		
15. - do -		
16. - do -		
17. - do -		265.4

Water Requirement per Hectare: Paddy Irrigation Area (%)	Paddy W/S Paddy (lit/sec/ha)	Paddy D/S Paddy (lit/sec/ha)	Tobacco Irrigation Area (%)	Tobacco Water Req. (lit/sec/ha)	Girlic Irrigation Area (%)	Girlic Water Req. (lit/sec/ha)	Weighted Water Requirement per Hectare: Wet Season (lit/sec/ha)	Weighted Water Requirement per Hectare: Dry Season (lit/sec/ha)
5	0.04	0.031	10	-	10	-	0.04	0.02
20	0.19	0.14	40	-	40	-	0.19	0.08
40	0.49	0.39	80	0.62	80	0.68	0.49	0.50
60	1.09	0.90	100	1.16	100	0 93	1 09	0.96
80	1.77	1.49	100	1.16	100	0.79	1.77	1.26
100	2.33	2.09	100	0.98	100	0.46	2.33(max)	1.49
100	1.95	1.72	100	0.62	100	0.56	1.95	1.23
100	2.03	2.01	100	1.04	100	0.66	2.03	1.50 3/
100	1.89	1.83	100	1.01	100	0.59	1.89	1.38
100	1.94	1.81	100	0.94	100	0.25	1.94	1.27
100	1.95	1.79	100	0.87	100	0.12	1.95	1.21
100	1.93	1.76	100	0.83	100	-	1.93	1.16
90	1.55	1.39	100	0.76	100	-	1.55	0.94
70	0.93	0.84	100	0.69	100	-	0.93	0.61
50	0.51	0.45	100	0.55	100	-	0.51	0.36
30+10	0.50	0.37	60	0.17	60	-	0.50	0.24
10+30	0.36	0.02	20	-	20	-	0 36	0.01

3/ 7 01 x 0 57 + 1.04 x 0.09 + 0.66 x 0 24 = 1.50 ℓ/sec/ha



P : First irrigation for land soaking and preparation of paddy:
Wet season 175 mm, Dry season: 150 mm

P_1,P Second and third irrigation of Paddy
Wet Season. 75 mm, Dry season 80 mm

Il 10-day irrigation requirement

Wi: 10-day crop water requirement

Paddy: Evapolation + Percolation

Tobacco, Cirell and Onion: Evaporation x crop coefficient

Overall irrigation efficiency

Paddy: Wet season 46 8%, Dry season: 54.0%

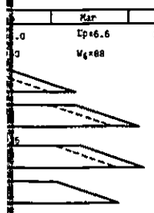
Tobacco, Girlic and Onion 60%

Apr.) Average Daily (mm)	Tobacco: Growing Stage	Irrigation Req.	Equation for Irrigation Req.	Weighted 10-day Water Req (mm)	Average Daily Water Req. (mm)
3.00	1. Land Preparation				
3 32	2 - do -				
4.60	3 - do -	P_2	2/5xP2	2/5x100	4.00
7.01	4. - do -	P_1	1/5(2P2+P1)	1/5(2x100+100)	6.00
8.69	5 - do -	I_1	1/5(P2+2P1)	1/5(100+2x100)	6 00
9 73	6. Vegetative Growth Stage	I_2	1/5(2P1+W3)	1/5(2x100+5%)	5.08
8 01	7. - do -	I_3	3/5(W3)	3/5x5%	3 24
9.40	8 - do -	I_4	W3	5%	5 40
8 55	9. - do -	I_5	1/5(4W3+W4)	1/5(4x5%+45)	5.22
8 43	10 - do -	I_6	1/5(2W3+3W4)	1/5(2x5%+3x45)	4.86
8.36	11 - do -	I_7	W4	45	4.50
8 20	12 Harvesting Stage	I_8	1/5(4W4+W5)	1/5(4x45+36)	4.32
7.24	13. - do -	I_9	1/5(2W4+3W5)	1/5(2x45+3x36)	3.96
5 60	14. - do -	I_{10}	W5	36	3.60
4.16	15. - do -		4/5xW5	4/5x36	2.88
5 76	16.		2/5xW5	2/5x36	1.44
0.88	17.				
1,085.6					597 9

Girlic: Growing Stage	Irrigation Req.	Equation for Irrigation Req.	Weighted 10-day Water Req. (mm)	Average Daily Water Req. (mm)
1. Land Preparation				
2. - do -				
3. - do -	P_1+I_1	1/5(2P1+I1)	1/5(2x100+21)	4.42
4. Growing Stage	I_2	1/5(2P1+3W2)	1/5(2x100+2x21)	4.84
5. - do -	I_3	1/5(P1+5W2)	1/5(100+5x21)	4.10
6. - do -	I_4	1/5(4W2+W3)	1/5(4x21+34)	2.36
7. - do -	I_5	1/5(2W2+3W3)	1/5(2x21+3x34)	2.88
8. - do -	I_6	1/5(5W3)	1/5(5x34)	3.40
9. - do -	I_7	1/5(4W3+W4)	1/5(4x34+16)	3.04
10. Bulb Formation Stage		1/5(4W4)	1/5(4x16)	1.28
11. - do -		2/5W4	2/5x16	0.64
12 - do -				
13. - do -				
14. - do -				
15. - do -				
16. - do -				
17				

Onion: Growing Stage	Irrigation Req.	Equation for Irrigation Req.	Weighted 10-day Water Req.	Average Daily Water Req.
1. Land Preparation				
2. - do -				
3. - do -	P_1+I_1	1/5(2P1+W2)	1/5(2x100+43)	4.86
4. Before Bulb Formation Stage	I_2	1/5(2P1+3W2)	1/5(2x100+3x43)	6.58
5. - do -	I_3	1/5(P1+5W2)	1/5(100+5x43)	6.30
6. - do -	I_4	1/5(4W2+W3)	1/5(4x43+50)	4.44
7. Bulb Formation Stage	I_5	1/5(2W2+3W3)	1/5(2x43+3x50)	4.72
8. - do -	I_6	1/5(5W3)	1/5(5x50)	5.00
9. - do -	I_7	1/5(4W3+W4)	1/5(4x50+42)	4.84
10. - do -	I_8	1/5(2W3+3W4)	1/5(2x50+3x42)	4.52
11. - do -	I_9	1/5(5W4)	1/5(5x42)	4.20
12.		1/5(4W4)	1/5(4x42)	3.36
13.		2/5W4	2/5(42)	1.68
14.				
15.				
16.				
17.				529.3

Water Requirement per Hectare: Paddy W/S Irrigation Area (%)	Paddy W/S Paddy (lit/sec/ha)	Paddy D/S Paddy (lit/ sec/ ha)	Tobacco Irrigation Area (%)	Tobacco Water Req (lit/sec/ ha)	Garlic Irrigation Area (%)	Garlic Water Req. (lit/sec/ ha)	Onion Irrigation Area (%)	Onion Water Req. (lit/sec/ ha)	Weighted Water Requirement per Hectare: Wet Season (lit/sec/ha)	Dry Season (lit/sec ha)
5	0.04	0.03	10	-	10	-	10	-	0 04	0.03
20	0.19	0.14	40	-	40	-	40	-	0.19	0.13
40	0.49	0.39	80	0.62	60	0.68	80	0.75	0.49	0.41
60	1.09	0.90	100	1.16	100	0.93	100	1 27	1.09	0.92
80	1.77	1.49	100	1.16	100	0.79	100	1.22	1 77	1 45
100	2 33	2.09	100	0.98	100	0 46	100	0.86	2 33 (max)	1 98
100	1.95	1.72	100	0.62	100	0.56	100	0.91	1 95	1 62
100	2.33	2.01	100	1.04	100	0.66	100	0 96	2.03	1.95
100	1.89	1.83	100	1.01	100	0.59	100	0 93	1.89	1.73
100	1.94	1.81	100	0.94	100	0.25	100	0.87	1.94	1 70
100	1.95	1.79	100	0.87	100	0.12	100	0.91	1 95	1.67
100	1.93	1.76	100	0.83	100	-	100	0 65	1 93	1.63
90	1.55	1.40	100	0 76	100	-	100	0.32	1 55	1.29
70	0.93	0.84	100	0.69	100	-	100	-	0 93	0.78
50	0.51	0.45	100	0.55	100	-	100	-	0 51	0.41
30+10	0.50	0.37	60	0.17	60	-	60	-	0 50	0 33
10+30	0.36	0.02	20	-	20	-	20	-	0 36	0.02



P : First irrigation for land soaking and preparation of paddy:
Wet season: 175 mm, Dry season: 150 mm

P,P: Second and third irrigation of paddy
Wet season 75 mm, Dry season 80 mm

Il: 10-day irrigation requirement

Wi: 10-day crop water requirement

Paddy Evapolation + percolation
Tobacco, Girlic Evapolation x crop coefficient

Overall irrigation efficiency

Paddy: Wet season: 46.8%, Dry season: 5%
Tobacco, Girlic: 60.0%

verage Daily ater Req. (mm)	Water Requirement per Hectare: Paddy Irrigation Area (%)	Paddy W/S Paddy (lit/sec/ha)	Paddy D/S Paddy (lit/sec/ha)	Tobacco Irrigation Area (%)	Tobacco Water Req. (lit/sec/ha)	Girlic Irrigation Area (%)	Girlic Water Req. (lit/sec/ha)	Weighted Water Requirement per Hectare: Wet Season (lit/sec/ha)	Dry Season (lit/sec/ha)
	5	0.04	0.031	10	-	10	-	0.04	0.02
	20	0.19	0.14	40	-	40	-	0.19	0.08
4.42	40	0.49	0.39	80	0 62	80	0 68	0.49	0.50
4.84	60	1.09	0.90	100	1.16	100	0.93	1.09	0.96
4.10	80	1.77	1.49	100	1.16	100	0.79	1.77	1.26
2.36	100	2.33	2.09	100	0 98	100	0.46	2.33(max)	1.49
2.88	100	1.95	1.72	100	0.62	100	0.56	1.95	1.23
3.40	100	2.03	2.01	100	1.04	100	0.66	2 03	1.50 3/
3.04	100	1.89	1.83	100	1 01	100	0.59	1.89	1.38
1.28	100	1.94	1.81	100	0.94	100	0.25	1.94	1.27
0.64	100	1.95	1.79	100	0.87	100	0.12	1.95	1.21
	100	1.93	1.76	100	0.83	100	-	1.93	1.16
	90	1.55	1.39	100	0.76	100	-	1.55	0.94
	70	0.93	0.84	100	0.69	100	-	0.93	0.61
	50	0.51	0.45	100	0.55	100	-	0.51	0.36
	30+10	0.50	0.37	60	0.17	60	-	0.50	0.24
	10+30	0.36	0.03	20	-	20	-	0.36	0.01

765.4

Table 4B-4 Irrigation Water Requirement in the Probability of 10-year (1965)

Item	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	Wet Season	Dry Season	Total
Phase-1 Area					Paddy					Paddy						
										Tabacco						
										Garlic						
										Onion						
Phase-2 Area					Paddy					Paddy						
										Tabacco						
										Carlic						
A. Water Requirement for Paddy																
Crop Water Requirement (mm)		40.3	192.3	266.2	242.7	206.4	66.6 1/ 125.3 2/	223.5	275.2	259.9	173.7	86.7	-	1,073.2	1,085.6	2,158.8
Effective Rainfall (mm)		60.9	208.8	223.6	206.1	120.2	0.0 4.4	45.2	2.0	0.0	0.3	0.0	0.0	824.0	47.5	871.5
Crop Irrigation Requirement (mm)		-	-	42.6	36.6	86.2	66.6 120.9	178.3	273.2	259.9	173.7	86.7	-	286.3	1,038.4	1,324.7
Overall Irrigation Efficiency (%)		46.8	46.8	46.8	46.8	46.8	54.0 46.8	54.0	54.0	54.0	54.0	54.0	54.0			
Diversion Water Requirement (mm)		-	-	91.0	78.2	184.2	125.3 258.3	330.2	505.9	481.3	321.7	160.6	-	611.7	1,923.0	2,534.7
B. Water Requirement for Upland Crops (1) ... Phase I Area																
Crop Water Requirement (mm)																
Tabacco (30%)							12.0	156.2	142.8	146.5	105.8	36.4			597.9	597.9
Garlic (35%)							13.2	124.5	91.5	37.4					266.6	266.6
Onion (35%)							14.6	176.1	171.8	133.2	33.6				529.3	529.3
Average							13.3	152.1	135.0	103.7	43.5	10.9			458.5	458.5
Effective Rainfall (mm)							0.0	0.0	0.0	0.0	0.0	0.0			0.0	0.0
Crop Irrigation Requirement (mm)							13.3	152.1	135.0	103.7	43.5	10.9			458.5	458.5
Overall Irrigation Efficiency (%)							60.0	60.0	60.0	60.0	60.0	60.0				
Diversion Water Requirement (mm)							22.2	253.5	225.0	172.8	72.5	18.2			764.2	764.2
C. Water Requirement for Upland Crops (2) .. Phase II Area																
Crop Water Requirement (mm)																
Tabacco (43%)							12.0	156.2	142.8	146.5	105.8	34.6			597.9	597.9
Garlic (57%)							13.2	124.5	91.5	37.4					266.6	266.6
Average							12.7	138.1	113.6	82.8	45.5	14.9			407.6	407.6
Effective Rainfall (mm)							0.0	0.0	0.0	0.0	0.0	0.0			0.0	0.0
Crop Irrigation Requirement (mm)							12.7	138.1	113.6	82.8	45.5	14.9			407.6	407.6
Overall Irrigation Efficiency (%)							60.0	60.0	60.0	60.0	60.0	60.0				
Diversion Water Requirement (mm)							21.2	230.2	189.3	138.0	75.8	24.8			679.3	679.3
D. Irrigation Water Requirement (mm)																
Phase I Area							113.1 3/									
Diversion Water Requirement (mm)				91.0	78.2	184.2	258.3	322.5	477.8	450.5	296.8	146.4	-	611.7	1,807.1	2,418.8
Phase II Area							79.4 3/									
Diversion Water Requirement (mm)				91.0	78.2	184.2	258.3	287.2	369.7	333.7	215.9	102.3	-	611.7	1,388.2	1,999.9

1/ : Dry season paddy 2/ : Wet season paddy

3/ : Weighted diversion water requirement in the dry season on the basis of following diversification ratio;

	Paddy	Upland Crops
Phase I	90%	10%
Phase II	57%	43%

Irrigation Efficiency

Water losses for paddy field consist of the following tow losses;

i) Farm application losses
ii) Conveyance losses

The former is considered to be on-farm losses (farm wastes) due to mostly farmer's capacity of farm management and topographic conditions, then in the Project the 35 percent of an average crop water requirement for the wet season paddy and 25 percent for the dry season paddy respectively is taken as on-farm losses.

On the other hand, the latter which is water losses during the conveyance stage, furthermore, can be classified into two factors, namely physical and non-physical factors. Physical factors are composed of seepage, leakage and evaporation losses (conveyance losses) while non-physical losses are rather related to operational factors such as over-application of irrigation water in the fields inscheduled drainage and illegal diversion (operation losses).

However, in the Project Area, no data on the water losses exist entirely, so that the following losses are adopted after making reference to the Report on the Workshop in Water Management prepared by NIA in September 1978, although the Morits empirical formula 1/ could be considered as the procedure for estimation of seepage losses of canal.

Description	Water Losses
Conveyance losses	20 %
Operation losses	10 %

As a result, overall irrigation efficiency for paddy field are decided at 46.8 2/ percent for the wet season paddy and 54 3/ percnet for the dry season paddy.

1/: Morits Formula: water losses (cu.m/sec/km) = 0.04 C. $(Q/V)^{1/2}$
where, Q=discharge (cu.m/sec), V=Velocity of flow (cu.m/sec)
and C=0.16
2/: (100 - 35%) x (100 - 20%) x (100 - 10%)
3/: (100 - 25%) x (100 - 20%) x (100 - 10%)

Table 4B-5 Run-off Volume and Irrigation Water Requirement in Each Sub-Area

(Unit: MCM)

Water Year	Labugaon (1,560 ha)		Solsona (2,140 ha)		Madongan (3,190 ha)		Papa (2,560 ha)		Nueva Era (750 ha)		Total (10,200 ha)	
	Run-off[2/]	I.W.R[3/]	Run-off	I.W.R	Run-off	I.W.R	Run-off	I.W.R	Run-off	I.W.R	Run-off	I.W.R
1960	171.2	44.9	134.6	61.7	183.2	91.7	87.6	73.5	97.1	21.5	673.7	293.3
1961	285.5	36.1	224.5	49.6	306.1	73.8	146.2	59.1	162.0	17.3	1,124.3	235.9
1962	294.6	38.1	231.7	52.3	397.1	77.8	150.7	62.3	167.2	18.2	1,241.3	248.7
1963	238.8	40.7	187.8	55.8	320.8	83.1	122.2	66.6	135.5	19.4	1,005.1	265.6
1964	411.6	36.1	323.5	49.6	459.3	73.8	210.5	59.2	233.4	17.3	1,638.3	236.0
1965	237.4	34.4	186.7	47.3	261.7	68.4	121.5	56.4	134.7	16.5	941.9	223.1
1966	291.9	42.8	229.5	58.8	330.7	87.5	149.3	70.1	165.6	20.4	1,167.0	279.6
1967	317.7	38.7	249.7	53.4	397.7	78.3	162.5	63.1	180.2	18.7	1,307.8	252.2
1968	227.8	43.9	179.2	56.3	240.8	89.8	116.6	71.9	129.3	21.0	893.7	282.9
1969	190.0	45.5	149.3	62.5	246.1	93.0	97.2	74.5	107.8	21.8	790.4	297.3
Mean	266.7	40.1	209.7	54.7	314.4	81.7	136.4	65.7	151.3	19.2	1,078.4	261.4

Note: 1/ e.g. 1960 means the period of May, 1960 to April, 1961.

2/ Run-off in a water year is compiled from Table 3B-11 to 3B-15, Appendix 3B-3.

3/ I.W.R stands for irrigation water requirements.

Table 4B-6 Summary of Water Balance in Phase I Area

(Unit: MCM)

Water Year	Run-off (A)	I.W.R (B)	Available W. (C)	Surplus W. (D)	Shortage W. (E)	Ratio (C)/(A)	(C)/(B)	(D)/(A)	(E)/(B)
1960	673.7	293.3	211.0	462.7	82.3	0.31	0.72	0.69	0.28
1961	1,124.3	235.9	171.2	953.1	64.7	0.15	0.73	0.85	0.27
1962	1,241.3	248.7	191.5	1,049.8	57.2	0.15	0.77	0.85	0.23
1963	1,005.1	265.6	194.5	810.6	71.1	0.19	0.73	0.81	0.27
1964	1,638.3	236.0	224.0	1,414.3	12.0	0.14	0.95	0.86	0.05
1965	941.9	223.1	145.4	796.5	77.7	0.24	0.65	0.85	0.35
1966	1,167.0	279.6	261.8	905.2	17.8	0.22	0.94	0.78	0.06
1967	1,307.8	252.2	219.0	1,088.8	33.2	0.17	0.87	0.83	0.13
1968	893.7	282.9	193.0	700.7	89.9	0.22	0.68	0.78	0.32
1969	790.4	297.3	222.8	567.6	74.5	0.28	0.75	0.72	0.25
Mean	1,078.4	237.9	203.4	874.9	58.0	0.19	0.85	0.81	0.15

Note: 1/ e.g. 1960 means the period of May, 1960 to April, 1961.

2/ Refer to Table 4B-5.

3/ I.W.R stands for irrigation water requirements.

4/ Available Water means supplied water for irrigation though diversion dam.

5/ Surplus Water = Run-off - Available Water

6/ Shortage Water = I.W.R - Available Water

Table 4B-7 Irrigable Area in Each Sub-Area

(Unit: ha)

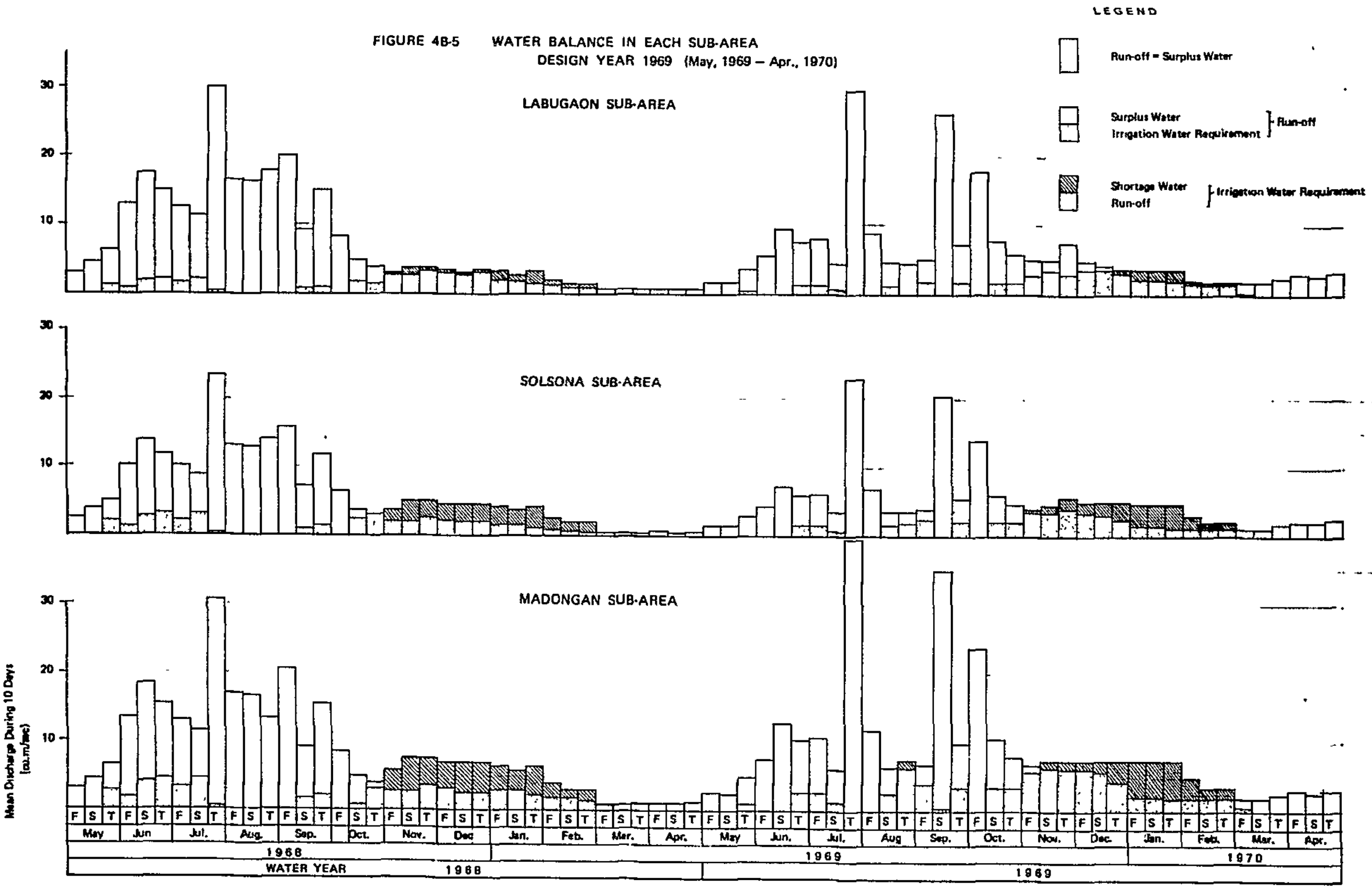
Year	Labugaon (1,500 ha)		Solsona (2,140 ha)		Madongan (3,190 ha)		Papa (2,500 ha)		Nueva Era(R.B) (750 ha)		Total (10,200 ha)		(20,400 ha)
	1st[1/]	2nd[2/]	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st + 2nd
1960[3/]	1,560	600	2,140	740	3,190	990	2,010	550	750	540	9,650	3,420	13,070
1961	1,560	1,080	2,140	850	3,190	1,460	2,350	1,380	750	620	9,990	5,390	15,380
1962	1,560	960	2,140	750	3,190	1,290	1,380	490	750	590	9,020	4,080	13,100
1963	750	800	590	630	1,020	890	380	620	420	460	3,160	3,400	6,560
1964	1,560	1,560	2,140	1,790	3,190	2,510	2,560	1,170	750	750	10,200	7,780	17,900
1965	1,560	570	2,140	390	3,190	540	2,220	250	750	330	9,860	2,080	11,940
1966	1,560	1,560	2,140	1,610	3,190	2,260	1,810	1,050	750	750	9,450	7,230	16,680
1967	1,560	920	2,140	890	3,190	1,170	2,370	590	750	530	10,010	4,100	14,110
1968	1,560	810	2,140	630	3,190	1,220	2,170	610	750	480	9,810	3,750	13,560
1969	1,560	780	2,140	610	2,290	720	1,340	400	750	450	8,080	2,960	11,040
Mean	1,480	960	1,990	890	2,880	1,310	1,860	710	720	550	8,930	4,420	13,350

Note: 1/ 1st Crop: May to October

2/ 2nd Crop: November to March

3/ Water Year, e.g. 1960 means May, 1960 to April, 1961.

FIGURE 4B-5 WATER BALANCE IN EACH SUB-AREA
DESIGN YEAR 1969 (May, 1969 – Apr., 1970)



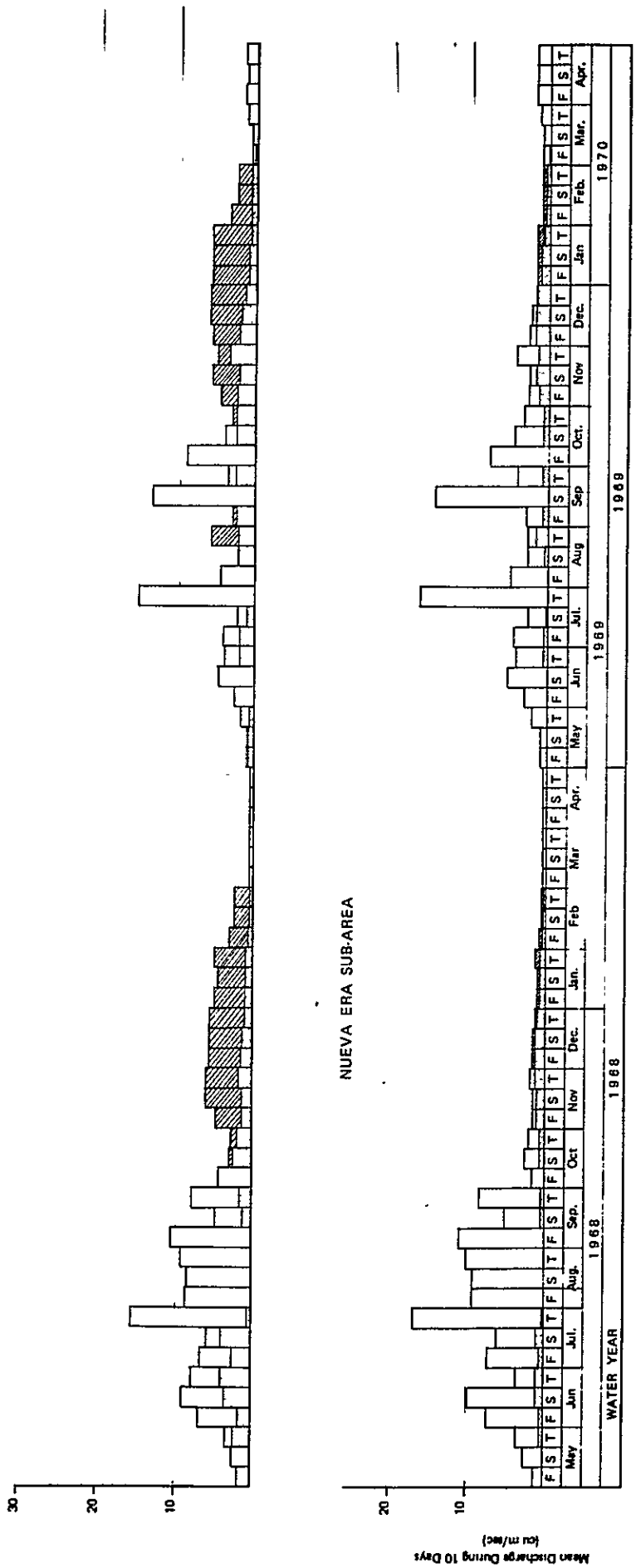

PAPA SUB-AREA
NUEVA ERA SUB-AREA
Mean Discharge During 10 Days
(cu m/sec)
WATER YEAR
1968
1969
1970

Table 4B-8 Probable Analysis on Rainfall and Water Requirement

	Rainfall at Laoag Station							Water Requirement of Paddy						
Order (i)	2i-1/2N[1/]	Year	Annual (mm)	Year	Wet Season[2/] (mm)	Year	Dry Season[3/] (mm)	2i-1/2N	Year	Annual (mm)	Year	Wet Season[4/] (mm)	Year	Dry Season[5/] (mm)
1	0.02	1976	1,163.0	1976	1,147.9	1958	4.1	0.02	1969	3,034.3	1974	963.1	1956	2,584.4
2	0.06	1955	1,198.8	1955	1,149.8	1972	5.4	0.06	1960	2,988.0	1966	929.5	1969	2,344.5
3	0.09	1959	1,442.1	1959	1,257.4	1968	7.8	0.10	1968	2,921.9	1960	823.8	1968	2,201.3
4	0.13	1952	1,519.1	1952	1,467.5	1951	13.0	0.13	1972	2,858.8	1973	771.8	1961	2,167.4
5	0.17	1960	1,541.4	1960	1,497.3	1976	15.1	0.17	1966	2,846.2	1957	744.6	1960	2,164.2
6	0.20	1975	1,635.8	1966	1,523.9	1975	17.9	0.21	1973	2,826.9	1971	743.6	1967	2,145.0
7	0.24	1966	1,724.9	1954	1,603.1	1962	18.9	0.25	1963	2,709.3	1972	728.9	1962	2,141.0
8	0.28	1973	1,728,0	1975	1,617.9	1961	27.5	0.29	1974	2,617.3	1968	718.5	1972	2,129.9
9	0.31	1954	1,737.4	1973	1,666.1	1969	30.7	0.33	1952	2,593.3	1964	713.6	1951	2,119.4
10	0.35	1958	1,840.7	1956	1,741.7	1960	44.1	0.37	1967	2,587.7	1969	689.8	1963	2,070.1
11	0.39	1,70	1,853.5	1970	1,790.7	1963	45.7	0.40	1954	2,585.5	1953	666.1	1958	2,057.8
12	0.43	1956	1,855.7	1964	1,836.2	1955	49.0	0.44	1951	2,584.9	1954	655.4	1973	2,057.1
13	0.46	1965	1,889.9	1958	1,836.6	1952	51.6	0.48	1956	2,584.4	1963	639.3	1952	2,046.3
14	0.50	1971	1,984.3	1965	1,838.1	1965	51.8	0.52	1953	2,577.0	1959	583.9	1965	2,021.0
15	0.54	1977	2,032.5	1971	1,885.5	1973	61.9	0.56	1971	2,548.4	1956	565.1	1970	2,004.0
16	0.57	1957	2,051.4	1977	1,926.1	1970	62.8	0.60	1962	2,546.6	1952	547.0	1976	1,967.1
17	0.61	1964	2,084.9	1957	1,957.7	1957	93.7	0.63	1957	2 538.3	1955	499.3	1975	1,947.3
18	0.65	1968	2,160.3	1968	2,152.5	1971	98.8	0.67	1958	2,474.2	1975	487.0	1954	1,930.1
19	0.67	1972	2,224.1	1953	2,217.3	1977	106.4	0.71	1976	2,439.7	1976	472.6	1966	1,916.7
20	0.72	1963	2,271.2	1972	2,218.7	1956	114.0	0.75	1970	2,436.0	1951	465.4	1953	1,891.4
21	0.76	1951	2,340.8	1963	2,225.5	1954	134.3	0.79	1975	2,434.3	1967	442.7	1955	1,845.4
22	0.80	1953	2,381.8	1951	2,327.8	1974	151.6	0.83	1961	2,427.2	1970	431.9	1959	1,818.2
23	0.83	1962	2,609.1	1974	2,512.0	1967	159.0	0.87	1959	2,402.1	1958	416.4	1971	1,804.7
24	0.87	1974	2,663.6	1962	2,590.2	1953	164.5	0.90	1964	2,401.3	1962	405.6	1957	1,793.7
25	0.91	1969	2,759.4	1967	2,714.5	1959	164.7	0.94	1955	2,344.7	1965	289.4	1964	1,687.7
26	0.94	1967	2,873.5	1969	2,728.7	1966	201.0	0.98	1965	2,310.4	1961	259.8	1974	1,654.2
27	0.98	1961	3,245.3	1961	3,217.8	1964	248.7							

Note: 1/ Probability by Hazen Method N: Number of sample
2/ May to October
3/ November to April
4/ May, 21 to October, 10
5/ October, 11 to March, 10

FIGURE 4B-6 PROBABILITY OF RAINFALL

● Annual rainfall

○ Rainfall in wet season (Jan. – Apr. Nov. – Dec.)

△ Rainfall in dry season (May – Oct.)

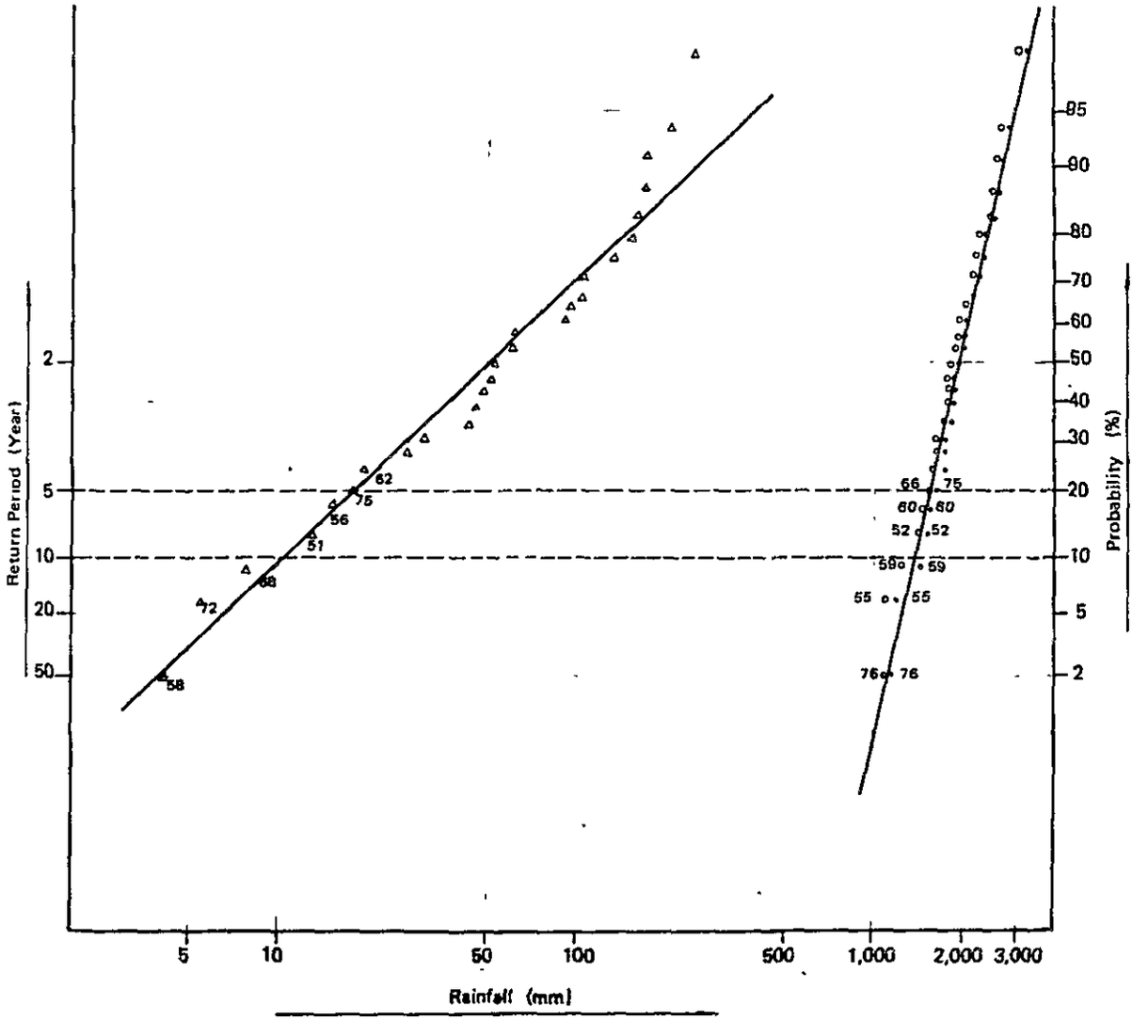


FIGURE 4B-7 PROBABILITY OF WATER REQUIREMENT

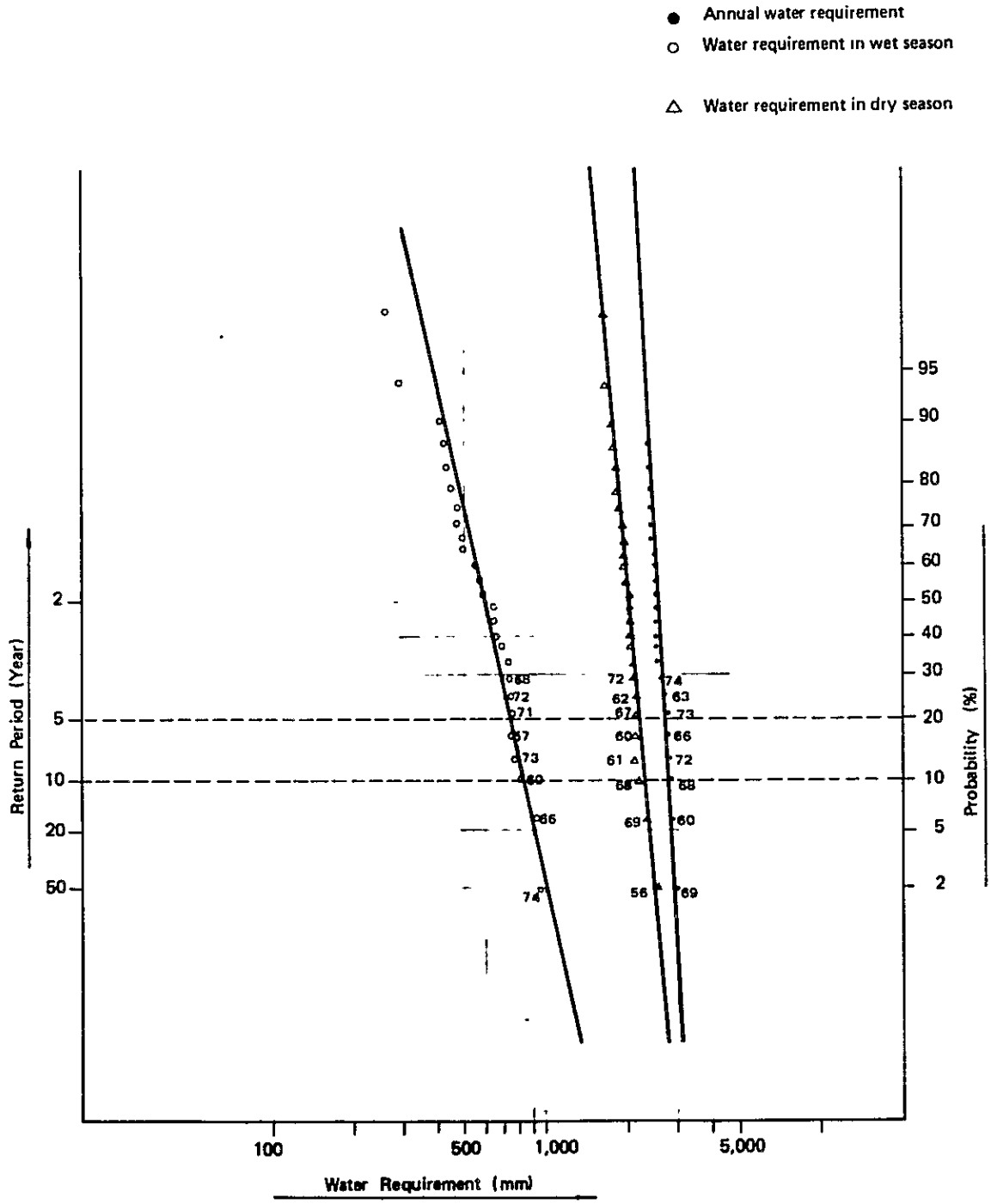


Table 4B-9 Monthly Diverted Water in the Lower Reaches of Bonga River

Year	Month	Dingras RIS		Bonga Pump No.1		Bonga Pump No.2		Bonga Pump No.3		Total Diverted Water (cu.m/sec)
		Diverted Water (cu.m/sec)	Rainfall (mm)	Diverted Water (cu.m/sec)	Rainfall (mm)	Diverted Water (cu.m/sec)	Rainfall (mm)	Diverted Water (cu.m/sec)	Rainfall (mm)	
1977	Jan.	1.07	0	0.25	0	0.35	0	0.11	0	1.78
	Feb.	0.81	0	0.33	0	0.40	0	0.16	0	1.70
	Mar.	0.39	0	0.14	0	0.29	0	0.88	0	0.90
	Apr.	0.06	0	0.17	0	0.31	0	0.08	0	0.62
	May	0	500	0.18	82	0.34	115	0.02	30	0.54
	Jun.	0.87	650	0.04	330	0.22	330	0.03	100	1.16
	Jul.	1.10	351	0.10	265	0.41	185	0.13	245	1.74
	Aug.	0.25	316	0.09	176	0.12	289	0.03	169	0.49
	Sep.	0.05	420	0	383	0	517	0	447	0.05
	Oct.	0.60	0	0.12	0	0.19	0	0.05	0	0.96
	Nov.	0.96	20	0.05	22	0.04	30	0.01	22	1.06
	Dec.	0.99	0	0.07	0	0.11	0	0.01	0	1.18
1978	Jan.	0.86	0	0.16	0	0.25	0	0.01	0	1.28
	Feb.	0.63	0	0.15	0	0.40	0	0.05	0	1.23
	Mar.	0.60	0	0.11	0	0.37	0	0.06	0	1.14
	Apr.	0.18	118	0.11	24	0.03	81	0.05	90	0.37
	May	0.22	112	0.04	4	0.11	44	0.03	70	0.40
	Jun.	1.09	338	0.09	65	0.08	211	0.08	267	1.34
	Jul.	1.06	275	0.02	16	0.57	170	0.12	144	1.77
	Aug.	0.61	333	0.06	53	0.13	267	0	304	0.80
	Sep.	0.43	304	0.01	147	0	185	0.01	201	0.45
	Oct.	0.71	128	0.02	34	0.06	113	0.01	114	0.74
	Nov.									
	Dec.									

Data source; Ilocos Norte, NISIP Sub-Region

Service area;

Dingras	: 1,100 ha
Pump No. 1	: 500 ha
Pump No. 2	: 827 ha
Pump No. 3	: 480 ha

Table 4B-10 Water Balance at Dingras RIS Intake after Completion of Phase I Project

(Unit: cu.m/sec)

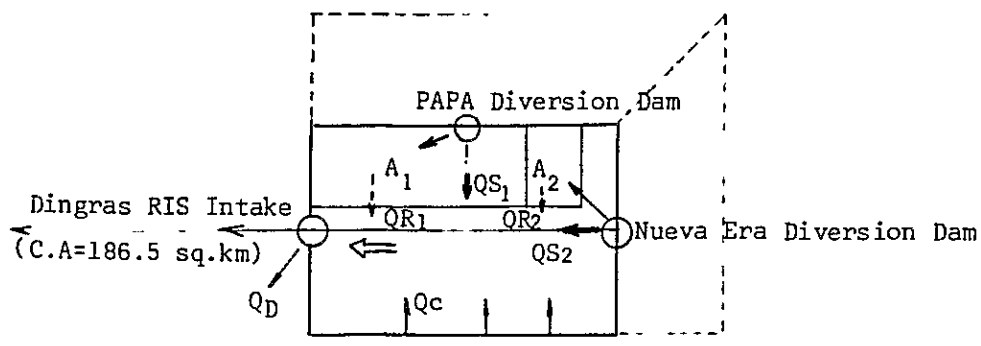
Month	Estimated Run-off at Dingras RIS Intake				Diverted[4/] Water at Intake	Balance
	Run-off[1/] from C-Area	Surplus Water[2/] from D_1,D_2-Area	Return Flow[3/] from A_1,A_2-Area	Total		
Jan.	5.22	0.17	0.51	5.90	1.07	+ 4.83
Feb.	3.13	0.53	0.73	4.39	0.81	+ 3.58
Mar.	1.84	0.81	0.02	2.67	0.39	+ 2.28
Apr.	0.54	0.89	0	1.43	0.06	+ 1.37
May	0.56	0.47	0.07	1.10	0	+ 1.10
Jun.	39.90	18.35	0.22	58.47	0.87	+57.60
Jul.	50.23	18.83	0.13	69.19	1.10	+68.09
Aug.	28.01	11.45	0.72	40.18	0.25	+39.93
Sep.	37.80	20.36	0.14	58.30	0.05	+58.25
Oct.	3.10	3.70	0.58	7.38	0.60	+ 6.78
Nov.	1.30	0.38	0.59	2.27	0.96	+ 1.31
Dec.	1.40	1.23	0.66	3.29	0.99	+ 4.28

Note: 1/ Run-off at Dingras RIS Intake was estimated by drainage proportion with observed run-off at Bangay Station in 1963. (Qc)

2/ Surplus water through Papa and Nueva Era diversion dams in 1963. ($QS_1 + QS_2$)

3/ Return flow amount is estimated at 20% of supplied water through Papa and Nueva Era diversion dams. ($QR_1 + QR_2$)

4/ Values in 1977. (Q_D)



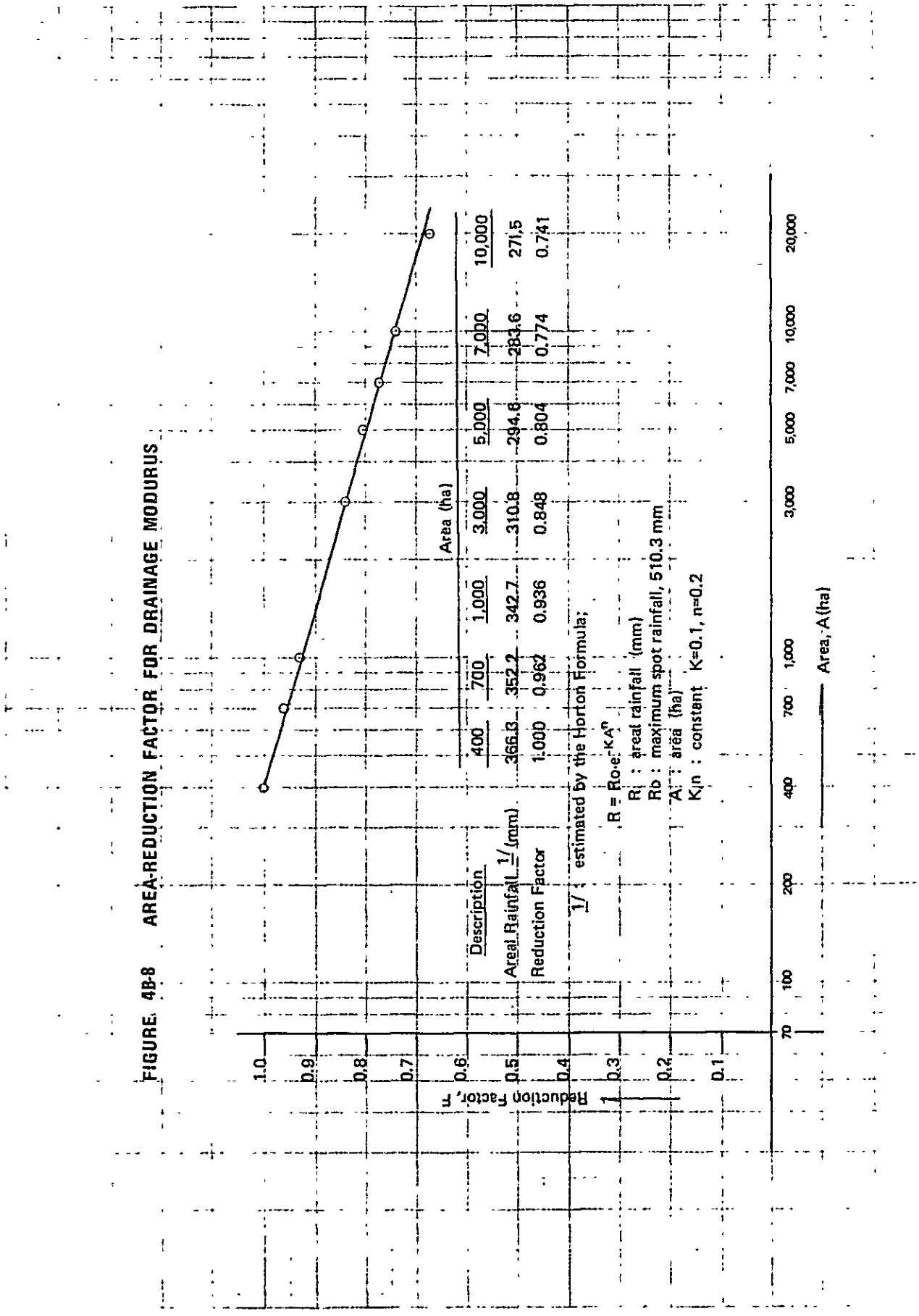


FIGURE 4B-8 AREA-REDUCTION FACTOR FOR DRAINAGE MODURUS

Hydrological Study on Storm Run-off for Drainage in NISIS

1. Annual Dialy Maximum Rainfall

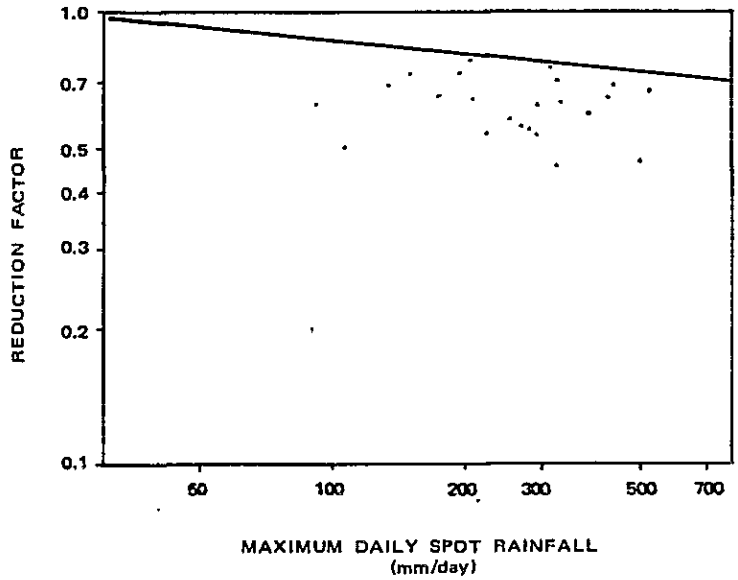
Annual daily maximum rainfall data observed at Laoag station, Ilocos Norte, have been collected as shown in Table 3B-8, Appendix 3B-1. In order to estimate the return periods and corresponding magnitude of rainfall, probability analysis has been made. Each return period and corresponding daily rainfall is shown as below:

Probable Daily Rainfall

Return Period	Probable Rainfall (mm)
1/5	335
1/10	420
1/15	470
1/25	530

The available raingage stations in the Package I regions are so limited that Thiessen polygon method or isohyetal map could not be adopted to estimate an areal rainfall. So arithmetic mean method has been adopted to estimate a reduction factor of spot rainfall to the areal rainfall. The maximum daily rainfall and the reduction rate to the areal rainfall has been plotted on the logarithmic paper as shown below: The estimation of the areal rainfall was based from the envelope curve obtained from the figure, and applied to the spot rainfall observed at the station.

Figure 4B-9 Reduction Factor of Areal Rainfall to Maximum Daily Spot Rainfall



The obtained areal daily maximum rainfall are as follows;

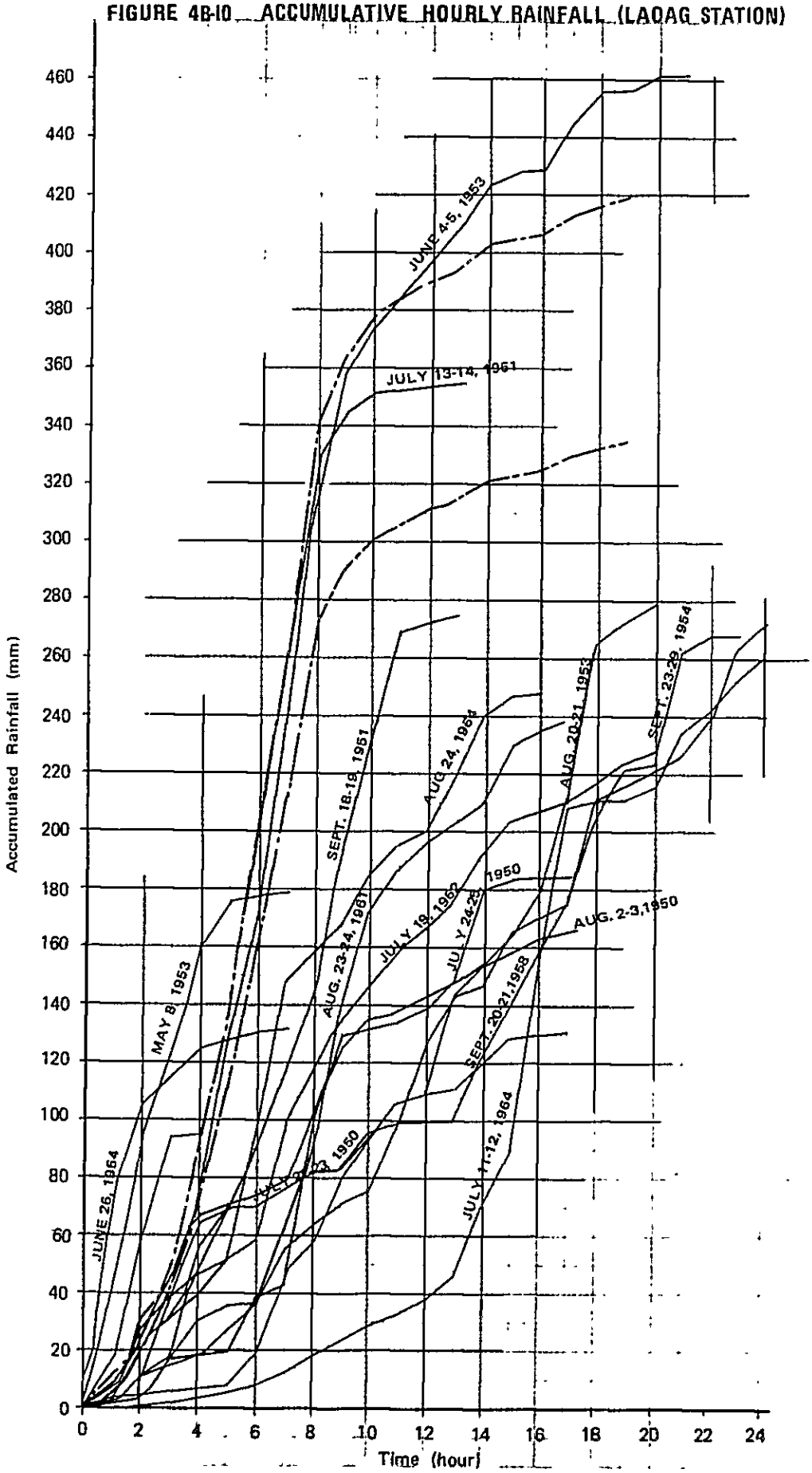
Probable Areal Daily Rainfall

Return Period	Probable Rainfall (mm)
1/5	254.6
1/10	315.0
1/15	347.8
1/25	386.9

2. Hourly Rainfall Distribution

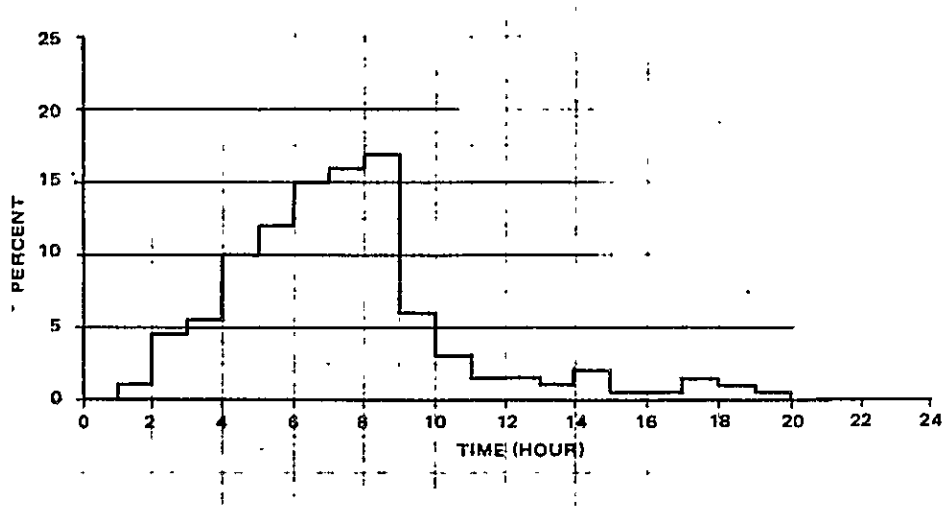
From the available hourly rainfall records, rainfalls above 100 mm/day have been collected and drawn the mass curve of each rainfall as shown in Figure 4B-10.

FIGURE 4B-10 ACCUMULATIVE HOURLY RAINFALL (LAOAG STATION)



As is seen in Figure 4B-10, the figure of rainfall shows no district difference for small and high rainfall intensities. Only one rainfall pattern, therefore, has been adopted. The obtained distibution percentage on each hour has been shown in Figure 4B-11.

Figure 4B-11 Hourly Rainfall Distibution



The hourly rainfall distibution on each return period is given as follows;

Hourly Rainfall Distribution for Each Return Period

(Unit : mm)

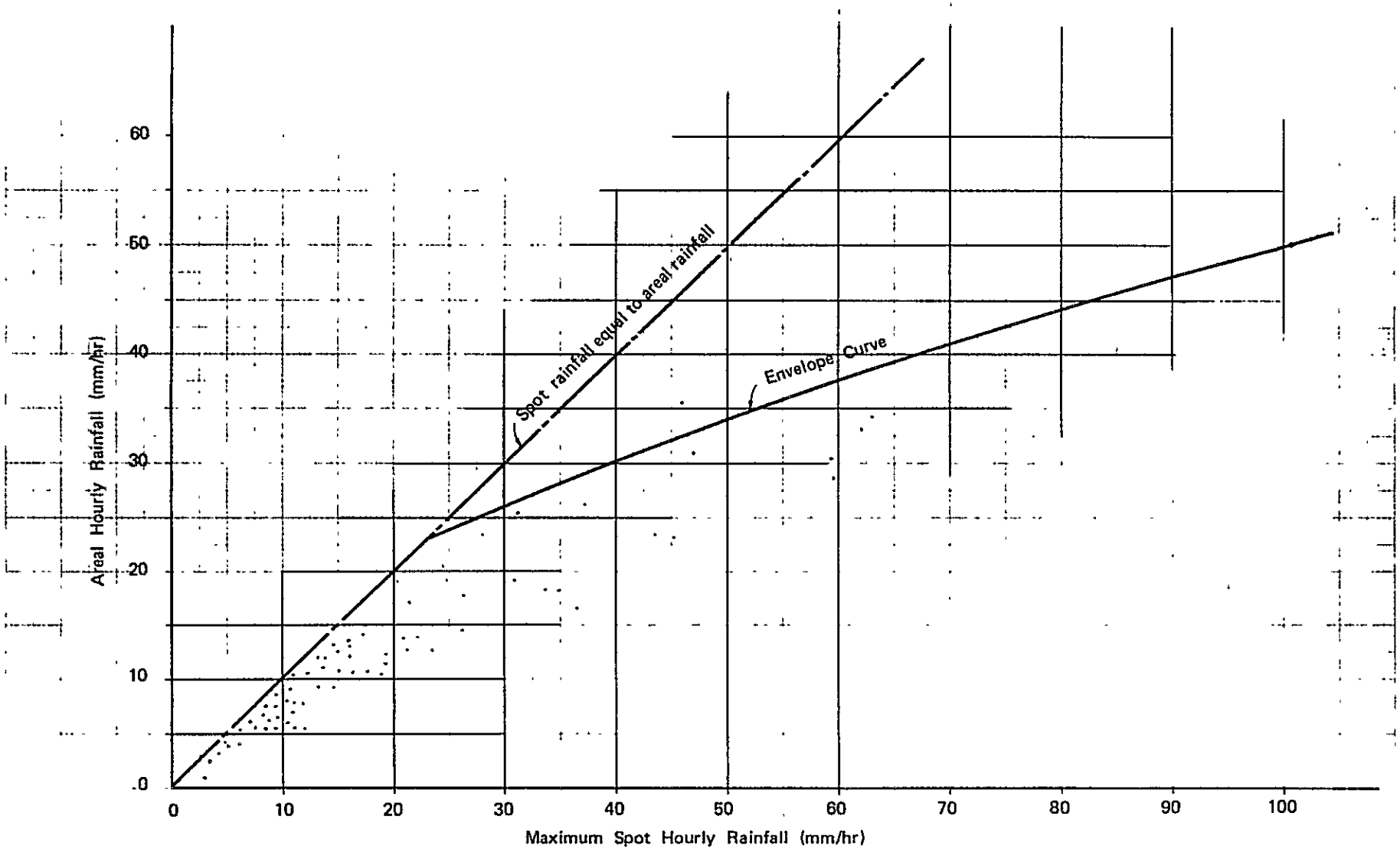
Hour	Percent of Distribution	5-year	10-year	15-year	25-year
0	0	0	0	0	0
1	1.0	3.4	4.2	4.7	5.3
2	4.5	15.1	18.9	21.2	23.8
3	5.5	18.4	23.1	25.8	29.2
4	10.0	33.5	42.0	47.0	53.0
5	12.0	40.2	50.4	56.4	63.6
6	15.0	50.3	63.0	70.5	79.5
7	16.0	53.6	67.2	75.2	84.8
8	17.0	57.0	71.4	79.9	90.1
9	6.0	20.1	25.2	28.2	31.8
10	3.0	10.0	12.6	14.1	15.9
11	1.5	5.0	6.3	7.0	8.0
12	1.5	5.0	6.3	7.0	8.0

Hour	percent of Distribution	5-year	10-year	15-year	25-year
13	1.0	3.4	4.2	4.7	5.3
14	2.0	6.7	8.4	9.4	10.6
15	0.5	1.7	2.1	2.4	2.6
16	0.5	1.7	2.1	2.4	2.6
17	1.5	5.0	6.3	7.0	8.0
18	1.0	3.4	4.2	4 7	5.3
19	0.5	1.5	2.1	2.4	2.6
20	0	0	0	0	0
21					
22					
23					
24					
Total		335.0	420.0	470.0	530.0

Normally, the hourly rainfall in some certain area is not homogeneous because of topographical condition and wind direction. The available hourly rainfall data are quite limited. The hourly rainfall at Laoag and Vigan which occurred simultaneously were collected. The average rainfall between them is considered as areal hourly rainfall. The plotting of maximum hourly rainfall to the areal hourly rainfall is shown in Figure 4B-12, and the envelope curve is shown. The distance between them is about 75 km, which is rather far, indicating that the reduction factor is rather high. Hourly rainfall data are not available near these stations.

Comparing the observed maximum hourly rainfall among the Laoag, Baguio, and Manila i.e., 109.7 mm/hr., 94.0 mm/hr. and 92.5 mm/hr., respectively, the Laoag shows the highest value among them. Also, the maximum daily rainfall in Laoag and Vigan are rather high compared with the other nearest stations. Considering these conditions, the hourly reduction factor will be rather high in Northern Luzon Region. As a consequence, the obtained envelope curve from Laoag and Vigan observed data has been used directly for estimation of areal hourly rainfall from spot hourly rainfall.

FIGURE 4B-12 RELATION OF MAXIMUM SPOT HURLY RAINFALL AND AREAL HOURLY RAINFALL



3. Drainage Discharge from Hilly Land

Drainage areas of the source stream located in the hilly land are mostly less than 100 sq.km. The flood time of concentration for such a small drainage area will be less than one hour. Only hourly peak rainfall therefore has been considered for drainage discharge analysis. Relationships of observed peak discharges from drainage areas less than 100 sq.Km and hourly peak rainfall intensity has been plotted as shown in Figure 4B-13. This shows the peak discharge and hourly rainfall increase in a rather constant rate. So, the run-off coefficient has been estimated as f = 0.269 from Figure 4B-13. This run-off coefficient was adopted to estimate the peak discharge from hourly rainfall.

The obtained run-off coefficient might be on a high side, because the available peak discharges are mostly in the mountainous area. Normally run-off coefficient for small areas in hilly land ranges from 0.1 to 0.3. So, the obtained value of 0.269 is considered to be acceptable.

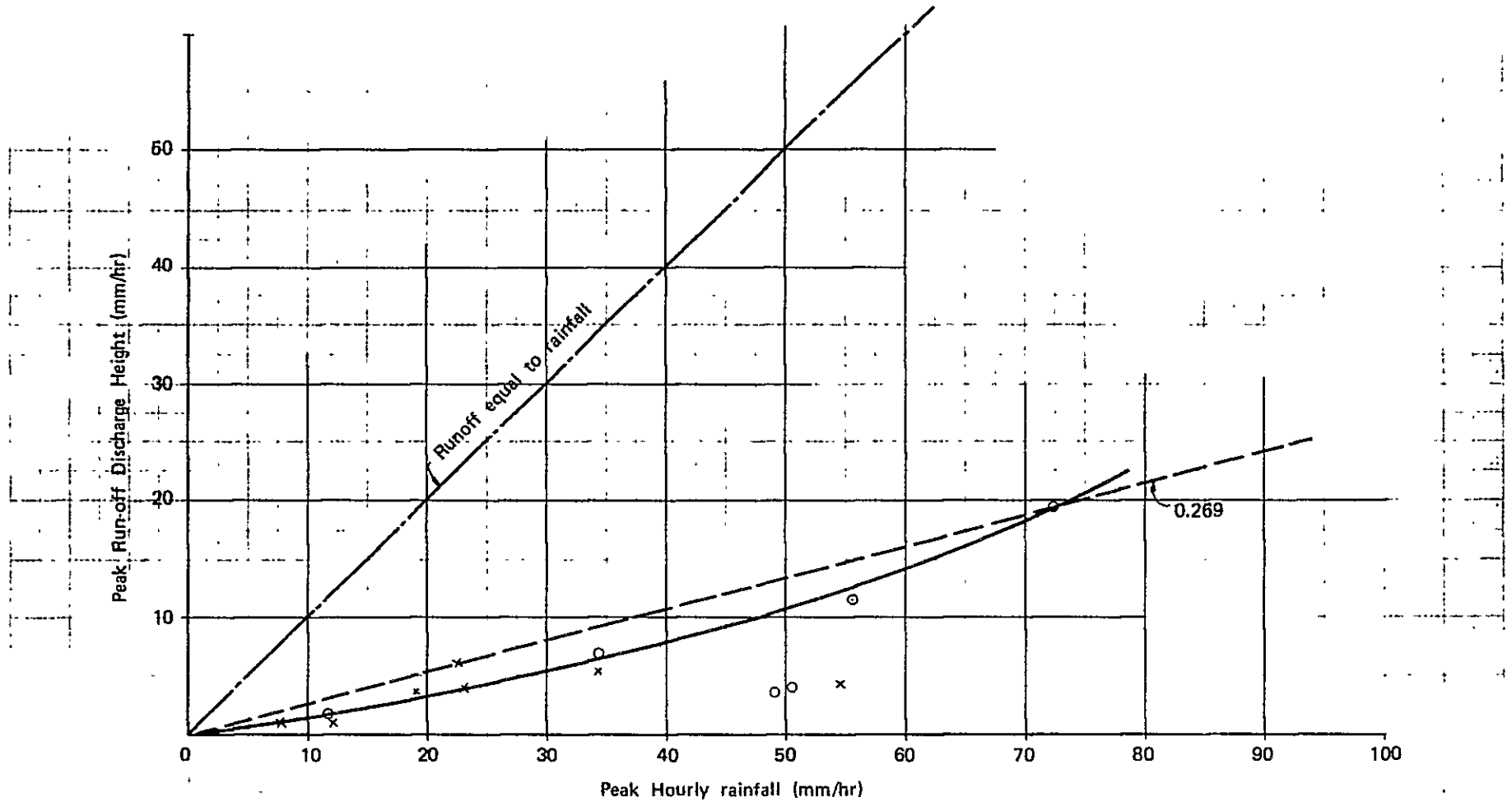
The estimate of peak discharge has been made from the rational formula.

$$Q = \frac{1}{3.6} f.A.r_t$$

Where f : run-off coefficient of 0.269
A : catchment area (sq.km)
r_t: areal hourly peak rainfall intensity (mm/hr)

In order to estimate the peak discharge, the peak rainfall as obtained from the reduction factor of daily rainfall, was considered as average rainfall in the Project Area, and used in the rational formula for areas smaller than 100 hectares. The areal hourly rainfall obtained from the relationship of spot hourly rainfall to areal hourly rainfall has been adopted to estimate the peak discharge for large areas up to 20,000 hectares using as basis for estimation of areal hourly rainfall obtained from Laoag and Vigan. The results are shown as follows;

FIGURE 4B-13 RELATION OF PEAK HOURLY RAINFALL AND PEAK RUN-OFF (LESS THAN 100 sq.KM)



Areal Hourly Rainfall of Each Return Period

Return Period	Spot Peak Hourly Rainfall (mm)	Areal Hourly Rainfall (1) (mm)	Areal Hourly Rainfall (2) (mm)
5-year	57.0	43.3	36.8
10-year	71.4	53.6	41.6
15-year	79.9	59.1	44.5
25-year	90.1	65.8	47.5

(1) : Obtained from the reduction factor of areal daily rainfall.

(2) : Obtained from the relation ship of spot hourly rainfall and areal hourly rainfall.

Peak Discharge of Hilly Land Area

Period	Drainage Area (sq.km)	Hourly Rainfall (mm/hr)	Peak Discharge (cu.m/sec)	Specific Discharge (cu.m/sec/ha)
1/5	1.0	43.3	3.2	3.235
	200.0	36.8	550.0	2.750
1/10	1.0	53.6	4.0	4.005
	200.0	41.6	621.6	3.108
1/15	1.0	59.1	4.4	4.416
	200.0	44.5	665.0	3.325
1/25	1.0	65.8	4.9	4.917
	200.0	47.5	709.8	3.549

On-farm Development

1. Typical Plan of On-farm Facilities

There are many communal irrigation canals in the service area, and these canals are almost aligned across contour lines. In the Project, some communal canals above mentioned are planned to be used as supplementary farm ditch. Based upon the plan, the typical layout on on-farm facilities is illustrated as shown in Figure 4B-14.

2. On-farm Facilities

Turn-out

This is the facility to divert irrigation water from a lateral irrigation canal to main farm ditch, and control and regulate the flow of water to the farm ditch with constant head oritice gate.

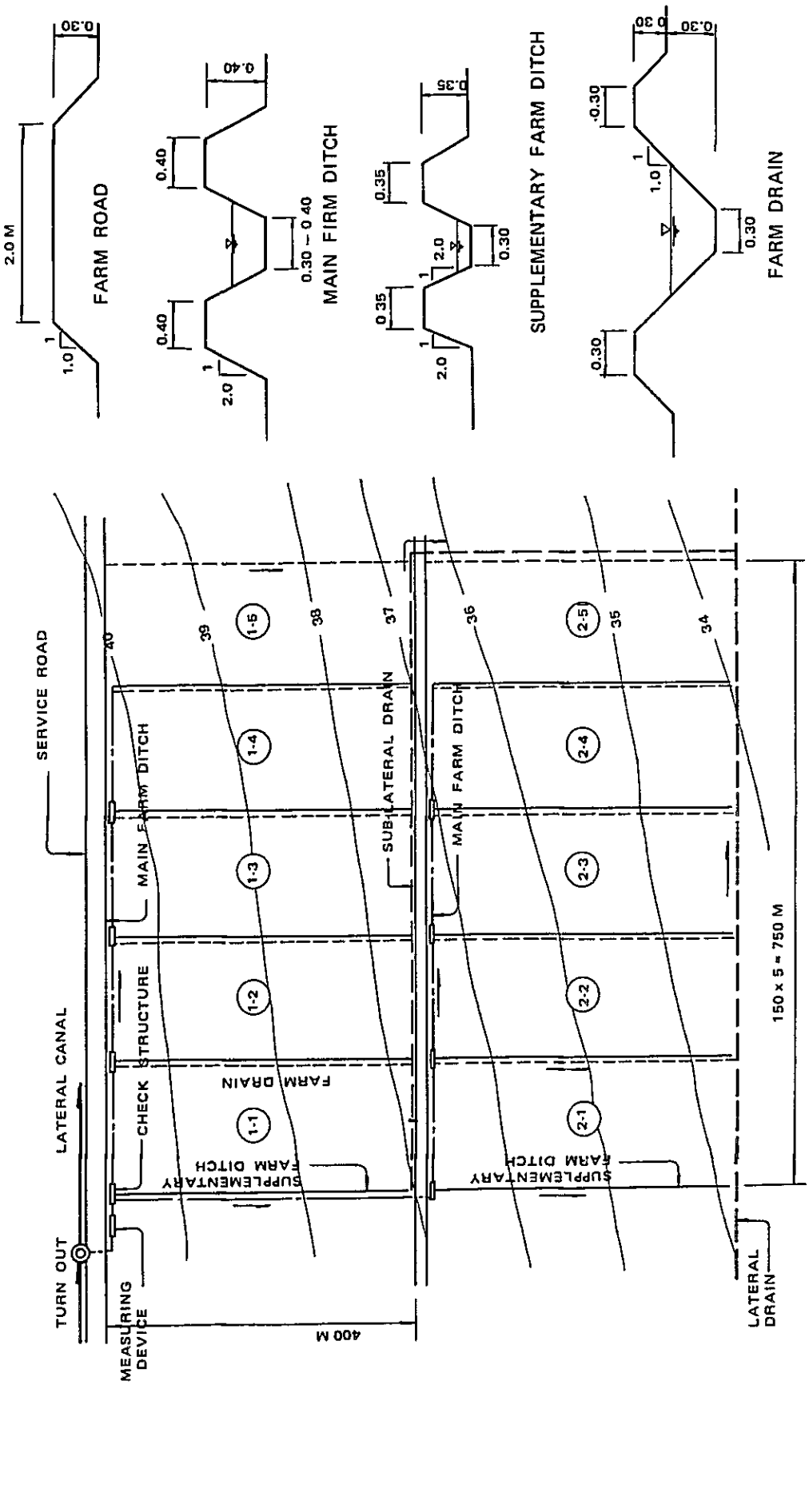
The ideal location of a turn-out is at the inlet of a check structure although in certain instance, when there is sufficient head and irrigable area is at the downstream side of the structure, it will be more economical to locate the turn-out at the outlet of a road clossing provided with a check. When a turn-out is necessary further upstream of a check structure, its operating head is to be based on a water surface elevation equal to the checking height of the downstream.

The turn-out is to be designed twice the designed discharge of main farm ditch at normal irrigation to take care of increased flow during peak demand. In the case of this project, the orifice size of 35 x 60 centimeters and R.C pipe diameter ϕ24" is adopted, which is enough to irrigate the area more than 60 ha.

Main Farm Ditch (MFD)

This is the irrigation canal to convey water from the turn-out to the supplementary farm ditch (SFD). The water supply from the MFD to the SFD is simultaneously made. Consequently the size of the main

FIGURE 4B-14 TYPICAL LAYOUT OF ON-FARM FACILITIES



farm ditch is designed such that it is tapering from the turn-out to the head of the last supplementary farm ditch, but the ditch bottom after the water profile corresponding to the crop maintenance stage has been drawn which should at least be 15 cm above the ground surface. It should be set using the value of "d cm" (water depth during Crop Maintenance) and the top bank should be set by adding 15 cm freeboard above the water profile or water depth during land soaking "d ℓs". Typical section of the MFD is shown in Figure 4B-14.

Supplementary Farm Ditch (SFD)

This is the irrigation canal to convey water from the SFD to farm lots. Each supplementary farm ditch has different size of service area and hence different discharge. Consequently it is designed independently. Each supplementary farm ditch is uniform in cross-section but like in the MFD the ditch bottom is set using "d cm" and the total depth of the embankment is equal to "d ℓs" plus 20 cm freeboard.

Both the main and supplementary farm ditches are provided with a sideslope of one horizontal to two vertical (1 : 2) at inner and outer sides with top bank width equal to 40 cm for the former and 35 cm for the later. Each head of the supplementary farm ditches is provided with check structures.

The velocity on a farm ditch is computed using a value of coefficient of roughness 0.030 to be applied in Manning's Formula. Minimum velocity and maximum velocity is 0.25 m/s and 0.65 m/s respectively. Typical section of the SFD is shown in Figure 4B-14.

Farm Drain

Farm drains are to be provided at the lowest portion of the survice area. Excess water in each farm lots is drained through a notch with a width of about 30 cm to a farm drain which is aligned along the SFD. Farm drain is the terminal drainage canal made of earth and installed in each rotation unit. For designing of farm drain, a value of coefficient

of roughness 0.030 is applied in Manning's Formula. Typical section of farm drain is shown in Figure 4B-14.

Check Structure

This is the facility to check water from the MFD and divert it to the SFD. Each head of the SFD is provided with this check structure (Precast Check).

End check

This is the facility to prevent escape of irrigation water in the supplementary farm ditch to the drainage canal.

Farm Ditch Crossing

This is the facility to provide for access of farm machinaries from a road to the fields in a rotation area. The structure consists of inlet, conduit R.C. Pipe 18" conveying water through the road and outlet transition. Farm ditch crossing is installed only on main farm ditch and in the case of this project one rotation area has one farm ditch crossing when it is needed.

Road Crossing

This is the facility to convey water under farm roads. Water in the farm ditch or farm drain can flow through road crossing without being intercepted by the roads.

3. On-farm Facilities in Sample Area

Present and proposed land uses in the sample areas are classified as follows:

Land Use in the Sample Area

(Unit: ha)

Item	Sample Area No. 1		Sample Area No. 2	
	Present	Proposed	Present	Proposed
Paddy Fields	120.5	115.1	97.3	91.5
Road - Existing Road	-	-	1.2 1/	1.2
Farm Road	-	0.5	-	0.4
Canal - Existing Canal	1.5	1.5	1.7	1.7
Lateral Canal	-	2.2	-	2.7
Farm Ditch	-	1.6	-	1.2
Farm Drain	-	1.5	-	1.7
Bamboo	-	-	5.1	5.1
Residential Area	0.4	0.4	1.3	1.3
Total	122.8	122.8	106.8	106.8

Note: 1/ Barrio road

Land parcelling of the sample area was made on the map of 1 : 2,000 in scale. Following table shows the area within rotation area, and also required on-farm facilities in the sample area are summarized in Table 4B-11 to 4B-12.

Area of Rotation Area

(Unit: ha)

Rotation Block No.	Rotation Unit No. 1	2	3	4	5	Total
Sample Area No. 1						
1	5.8	5.0	7.0	3.7	4.4	25.9
2	9.2	4.6	3.2	8.2	4.5	29.7
3	6.2	5.4	5.3	3.5	3.0	23.4
4	2.9	8.6	11.0	4.9	8.7	36.1
Total						115.1
Sample Area No. 2						
1	3.7	6.6	5.6	4.1	4.0	24.0
2	5.0	4.1	2.6	3.2	3.0	17.9
3	4.5	5.2	9.2	6.2	4.4	29.5
4	4.9	3.5	5.8	2.9	3.0	20.1
Total						91.5

Table 4B-11 Quantities of On-farm Facilities

Rotation Block No.	Farm Ditch MFD[1] (m)	Farm Ditch SFD[2] (m)	Farm Ditch Total (m)	Farm Drain	Farm Road	Turn-Out	F.R.[3] Crossing	Road Crossing	Check Structure
Sample Area No. 1									
1	400 (750)	1,780 (440)	2,180 (1,190)	520 (1,250)	360	1	1	-	6
2	340 (400)	1,360 (670)	1,700 (1,070)	(390)	710	1	1	-	7
3	710	1,600 (350)	2,310 (350)	1,620	780	-	1	1	8
4	540	590 (1,670)	1,130 (1,670)	2,230 (690)	-	1	1	-	6
Sub-total	1,990 (1,150)	5,330 (3,130)	7,320 (4,280)	4,370 (2,330)	1,850	3	4	1	27
Intensity (m/ha)	16 (9)	44 (26)	60 (35)	36 (19)	15				
Sample Area No. 2									
1	(960)	1,300 (920)	1,300 (1,880)	540	280	1	-	1	8
2	265 (230)	250 (900)	515 (1,130)	1,670 (110)	390	1	-	1	8
3	590 (170)	1,020 (1,510)	1,610 (1,680)	2,560	200	1	-	1	8
4	900	1,050 (530)	1,950 (530)	560	590	1	1	1	6
Sub-total	1,755 (1,360)	3,620 (3,860)	5,375 (5,220)	5,330 (110)	1,460	4	1	4	30
Intensity (m/ha)	18 (14)	36 (38)	54 (52)	53 (1)	15				

Note: Figure in parenthesis shows the length of existing canal which will be utilized even after the completion of the project.
1/ Main Farm Ditch, 2/ Supplementary Farm Ditch, 3/ Farm Road Crossing

Table 4B-12 Proposed Length of On-farm Facilities

Rotation Area No.	Main Farm Ditch (m)	Supplementary Farm Ditch Rotation Unit 1 (m)	2 (m)	3 (m)	4 (m)	5 (m)	Sub-total (m)	Total (m)	Farm Drain (m)	Farm Road (m)
Sample Area No. 1										
1	400 (750)	400	140 (390)	460	500	280 (50)	1,780 (440)	2,180 (1,190)	520 (1,250)	360
2	340 (400)	400	400	-	320 (420)	240 (250)	1,360 (670)	1,700 (1,070)	- (390)	710
3	710	170 (350)	470	470	280	210	1,600 (350)	2,310 (350)	1,620	780
4	540	- (640)	- (580)	-	380	210 (450)	590 (1,670)	1,130 (1,670)	2,230 (670)	-
Total	1,990 (1,150)						5,330 (3,130)	7,320 (4,280)	4,370 (2,330)	1,850
Sample Area No. 2										
1	- (960)	140 (330)	660	500	- (240)	- (350)	1,300 (920)	1,300 (1,880)	540	280
2	265 (230)	150	100	- (310)	- (280)	- (310)	250 (900)	515 (1,130)	1,670 (110)	390
3	590 (170)	450	450	- (780)	120 (260)	- (470)	1,020 (1,510)	1,610 (1,680)	2,560	200
4	900	410	290	(420)	230	120 (110)	1,050 (530)	1,950 (530)	560	590
Total	1,755 (1,360)						3,620 (3,860)	5,375 (5,220)	5,330 (110)	1,460

Note: Figure in parenthesis shows the length of existing canal which will be utilized even after the completion of the Project.

The lay-out of sample area was executed on the map with a scale of 1 : 2,000 prepared by NIA. The results of it are shown in Table 4B-11 to 4B-12, which are applied to the whole Project Area.

4. Design Criteria

Main Farm Ditch

The water discharge in main farm ditch depends on the extension of its service area. Water supply from the main farm ditch to the supplementary farm ditch is simultaneous, so the size of main farm ditch becomes small towards the down stream and terminal section of the canal corresponds with that of the supplementary farm ditch in its water depth.

Design Capacity:

Land soaking stage	1.78 Lit/sec/ha
Crop maintenance stage	1.40 lit/sec/ha
Manning formula's roughness	n = 0.030

On the assumption that rotation area consists of five units, the design discharge of the main farm ditch is calculated as shown belows:

Design Discharge of Main Farm Ditch

		Service Area (ha)				
Item	Unit	30	24	18	12	6
Q&s	cu.m/s	53.42	42.74	32.05	21.37	10.68
Qcm	cu.m/s	42.00	33.00	25.20	16.80	8.42
B	m	0.40	0.40	0.30	0.30	0.30
d&s	m	0.23	0.20	0.17	0.14	0.09
dcm	m	0.20	0.17	0.15	0.12	0.07
db	m	-	-	-	0.05	0.10

Note: Q&s: Water discharge of land soaking stage
Qcm: Water discharge of crop maintenance stage
B : Bottom width of ditch
d&s: Water depth of land soaking stage
dcm: Water depth of crop maintenance stage
db : Bottom height above paddy fields

4C-1 Balance of Supply and Demand of Rice at Present

- Ilocos Norte Province -

Year	Cropped Area	Supply 1/ Products		Population 3/	Demand Capita rice consumption		Surplus or Deficit Capita rice Comsumption	
		Palay	Rice 2/		100 kg 4/	130 kg 5/	100 kg	130 kg
	(10^3 ha)	(10^3 tons)	(10^3 tons)	(10^3 persons)	(10^3 tons)	(10^3 tons)	(10^3 tons)	(10^3 tons)
1972	34.7	72.7	45.8	354	35.4	46.0	10.4	(-) 0.1
1973	34.5	70.0	44.1	360	36.0	46.8	8.1	(-) 2.7
1974	35.2	83.5	52.6	366	36.6	47.6	16.0	5.0
1975	33.3	50.9	32.1	371	37.1	48.3	(-) 5.1	(-)16.2
1976	36.4	7.24	45.6	378	37.8	49.1	7.8	(-) 3.5
1977	37.5	83.6	52.7	384	38.4	49.9	14.3	2.8

Sources: 1/ BAEcon, Laoag.

2/ Conversion rate of palay to rice is 63%

3/ Figures of 1975 is based on Population Census. Annual growth rate from 1972 to 1974 is 1.6%, and 1976 to 1977 is 1.8%.

4/ NGA, Laoag and Farm Management Survey, LRED, NIA. (No. of Sample is 385).

5/ Regional Consumption Patterns for Major Foods, 1974-1976. May 1978 SSDPS, DA.

Estimation of Target Yield for the Proposed Crops

1. Paddy Rice

a) Experimental Yield

There is no experimental station which provides the experimental yield data at each level of applied nitrogen amount in the Project Area and its vicinity. Therefore, following data, which is based on the results of FAO/NFAC Fertilizer Trial in Ilocos Norte (1978, partial results), are referred to have the quadratic equations for the regression between yield (y) and each amount of applied nitrogen (x), as shown as follows:

Yield at Each Amount of Applied-Nitrogen

(Unit: ton/ha)

Crop Season	Applied Nitrogen (kg/ha) 0	35	70	105
Wet 1/	4.1	5.2	5.8	6.1
Dry 2/	4.3	5.5	6.1	6.6

Note: 1/: Mean yield from the result of FAO/NFAC Fertilizer Trial in Ilocos Norte, 1978

2/: Estimated yield from above yields and average yields for the latest 6 HYVs at three national experimental stations BPI, 1975 (Maligaya Rice Research and Training Center, Bicol Rice and Corn Experimental Station and Visaya Rice Experimental Station)

The quadratic equations for the regression between yield (y) and each amount of applied nitrogen (x) for wet and dry season crops are:

Wet season crop: $y = 4.11 + 0.036x - 0.0002x^2$

Dry season crop: $y = 4.32 + 0.040x - 0.0002x^2$

b) Attained Yield in the Project Area and its Vicinity

The attained yield under Masagana 99 (1975-1978) in the five

municipalities concerned is 3.7 ton/ha for wet season crop and 3.6 ton/ha for dry season crop as shown in Appendix 3D-2 Table 3D-9. Almost all the same level of average yields are attained in the existing national irrigation system areas which are located near the Project Area as shown below:

Attained Yield in Existing National Irrigation System Areas (1977)

Area	Yield (cavan/ha)	Area Coverage of HYVs
Laoag-Vintar	70	more than 70%
Dingras	70	more than 75%
Cura	40	less than 50%
Bonga Bump #2	73	more than 70%
Mean	71 (3.6 ton/ha, excluding yield in Cura Area)	

Note: (1) The yields refer to the average yields for wet ans dry season crops

(2) The mean yield is exclusive of the yield in Cura area because of small area coverage of HYVs.

The attained yield in the foundation seed farm at BPI Dingras Experimental Station (1977) was 3.8 ton/ha for wet season crop and 3.5 ton/ha for dry season crop. But the station has attained more high yield. (4.4 ton/ha for wet season crop) a few years ago.

On the other hand, the yield of 4.4 ton/ha was attained at 70 kg of applied nitrogen in one of the municipalities concerned according to the yield record of FAO/NFAC Fertilizer Trial. The irrigation conditions in the existing national irrigation system areas shall be improved under NISIP because of the inadequate irrigation water amount and on-farm facilities. Also, at BPI Dingras experiment station, the irrigation water supply during dry season is not sufficient, for what reason, the irrigation supply to the station is depended upon one of the existing national irrigation systems. These unfavorable irrigation

conditions are considered to be the main reason why the comparatively low yield in the existing national irrigation system areas and also at BPI Dingras Experimental Station during dry season have been attained.

The proposed irrigation development of the Project would supply enough irrigation water so as to attain high yield, at least such level of attained yield of 4.4 ton/ha at 70 kg of applied nitrogen by the FAO/NFAC Fertilizer Trial in one of the municipalities concerned. The following equation is assumed to represent the quadratic equation for the regression between potential yield (y) and amount of applied nitrogen (x) in the Project, which is produced by substituting the above yield data into the said equation for the experimental yield data of wet season crop:

$$y = 2.86 + 0.036x - 0.0002x^2$$

For dry season crop, such kind of yield data for the substitution is not available. Therefore, the estimated potential yield of 4.6 ton/ha is used to have the equation as follows:

The estimated potential yield for dry season crop:

4.4 ton/ha (potential yield of the wet season crop) x
6.1 ton/5.8 ton = 4.6 ton/ha

where; 6.1 tons and 5.8 tons are the above-mentioned experimental yields at 70 kg of applied nitrogen

Thus the new equation with regard to potential yield in the Project Area is as follows:

$$y = 2.78 - 0.040\,x - 0.0002x^2$$

c) Yield at Optimum Amount of Nitrogen Application

Optimim amount of nitrogen application and their yields for the above-mentioned new equations are computed as follows:

Wet season crop:

$$\text{Opt. nitrogen (kg/ha)} = \frac{0.030Py - Pn}{2(0.0002 \times Py)} = 82$$

Yield at the nitrogen application = 4.5 ton/ha

Dry season crop:

$$\text{Opt. nitrogen (kg/ha)} = \frac{0.040\ Py - Pn}{2(0.0002 \times Py)} = 92$$

Yield at the nitrogen application = 4.8 ton/ha

where; Py: ₱1,385 (Paddy price per ton)
Pn: ₱4.25 (Nitrogen price per kg)

d) Estimated Yield at Different Land Class

The yields at optimum amount of nitrogen application are regarded as the potential yield after Project. Hence, the yield at different land classes are estimated as follows:

Yield at Different Land Classes

Land Class	Range of Productivity (%)	Average Productivity Rating (%)	Estimated Yield (ton/ha)	
			Wet Season	Dry Season
Potential	100	100	4.5	4.8
1R	90 - 100	95	4.3	4.6
2R	80 - 90	85	3.8	4.1
3R	70 - 80	75	3.4	3.6

Based on above yields, the total amount of paddy production is estimated at about 78,000 tons per year as shown in the following table. And the average yield in the Project is 3.9 tons/ha and

Table 4C-2 Paddy Rice Production "after the Project" by Land Class

Sub-Project	Season	1R Area (ha)	1R Yield (ton/ha)	1R Production (ton)	2R Area (ha)	2R Yield (ton/ha)	2R Production (ton)	3R Area (ha)	3R Yield (ton/ha)	3R Production (ton)	Total Area (ha)	Total Yield (ton/ha)	Total Production (ton)
Madongan	Wet	2,200	3.9	8,580	240	3.4	816	760	3.1	2,356	3,200	(3.7)	11,752
	Dry	1,880	4.6	8,648	240	4.1	984	760	3.6	2,736	2,880	(4.2)	12,368
Except for Madongan	Wet	3,790	4.3	16,297	790	3.8	3,002	2,420	3.4	8,228	7,000	(3.9)	27,527
	Dry	3,411	4.6	15,691	711	4.1	2,915	2,178	3.6	7,841	6,300	(4.2)	26,447
Total	Wet	5,990		24,877	1,030		3,818	3,180		10,584	10,200		39,279
	Dry	5,391		24,399	927		3,899	2,862		10,577	9,180		38,815

Note: The yields for wet season crop in Madongan area are estimated at 90 percent of the yields in other areas.

4.2 tons/ha for wet and dry seasons, respectively. But the average yield of wet season crop in Madongan sub-Project area is 3.7 tons/ha because the production conditions during wet season is inferior to that in other sub-Project Areas.

2. Diversified Crops

a) Tobacco

The potential yields of virginia tobacco varieties to be introduced in the Project are as follows:

Potential Yields of Selected Varieties

Variety	Growth Period[1/] (day)	No. of Harvested Leaves	Potential Yield[2/] (ton/ha)
NC Blight Yellow	80 - 90	29	2.08
Coker 254	90 - 100	26	2.27
Coker P-11-1	N.A.	N.A.	2.05
MRS-3	90 - 100	25	1.89
Golden Harvest	80 - 90	26	1.91
Average			2.04

Note: 1/: From transplanting to flowering

2/: Data source: "Three Years of Cooperative Research on Philippine Virginia Tobacco, UPCA.PVTA Research & Training Program, 1973"

On the other hand, the attained yield of virginia tobacco in 8 locations in Ilocos Reageon is 1.425 ton. The San Pedro PVTA Compact Farm, which is located in Badoc, attained an average yield of 1.5 ton per ha in 1977. (23 farmers, 13 ha of planted area)

The weighted average target yield of tobacco in the Project is estimated at 1.3 tons/ha as follows, based on 1.5 ton of assumped potential yield per ha and target yield by land class.

Estimated Target Yield of Tobacco

Land Class	Cropping Area of Diversified crops (ha)	Yield (ton/ha)	Production (ton)
potential		1.5	
1R	699	1.4	979
2R	79	1.3	103
3R	242	1.1	266
Total	1,020	(1.3)	1,348

b) Garlic

The potential yield of garlic is estimated at 3.0 ton/ha from both yield data of the outstanding farmers surveyed by the NIA Farm Management Survey (1978) and NEDA Farm Management Survey (1977) in Ilocos Norte.

The weighted average target yield of garlic is computed at 2.7 tons/ha as follows:

Estimated Target Yield of Onion

Land Class	Cropping Area of Diversified Crops (ha)	Yield (ton/ha)	Production (ton)
Potential		3.0	
1R	699	2.9	2,027
2R	79	2.6	205
3R	242	2.3	557
Total	1,020	(2.7)	2,789

c) Onion

According to the BPI guide book on the farm management of onion culture, the target yield of onion is 14.0 ton/ha. In terms of potential yield in the Project Area, the weighted average target yield

of onion is estimated at 12.5 ton/ha as follows:

Estimated Target Yield of Onion

Land Class	Cropping Area of Diversified Crops (ha)	Yield (ton/ha)	Production (ton)
Potential		14.0	
1R	699	13.3	9,297
2R	79	11.9	940
3R	242	10.5	2,541
Total	1,020	(12.5)	12,778

To have those weighted average of target yield, whole area to be planted with the three kinds of diversified crops in the Project is used as expedient measure because the cropping areas by land class for each crop are not able to be specified. And the same ratings of average productivity by land class to those in case of paddy rice was used to have the estimated target yield of each crop by land class.

Table Recommended Farm Practices and Input Materials, Paddy Rice

Operation	Recommended Practices	Input Materials per Hectare
1. Preparation of Seedbed	(a) Form and size of seedbed; There are two recommendable methods in raising seedlings, which are wet and dapog seedbed. In case of wet seedbed, prepare puddled plots having one to 1-1/2 m width and any convenient length. The total plot area is 400 m^2 per hectare of transplanting area.	
	(b) Mix in the seedbed plots the recommended amount of fertilizer.	Fertilizer for seedbeds; 10 kg of 14-14-14
2. Sowing	Seed rate and seed preparation; - Seed rate: 110 g per m^2 of seedbed - Selection: Remove unfilled grains by soaking seeds in water - Soaking: In fungicided clean-water or running water for at least 24 hours. Be sure to change the water every 8 hours in case of clean water. - Incubation: Drain off water and incubate the seeds at warm, moist place for 36 - 48 hr.	Seeds: 50 kg
3. Care of Seedlings	(a) 3 days after sowing, start irrigation in filmy shallow water level. And increase gradually the water level up to 2-3 cm as the seedlings grow tall.	
	(b) 10 days after sowing, apply insecticides to protect insects/pests such as green leafhoppers, brown planthoppers, whorl maggots, stemborers, etc.	Insecticides for seedlings; Monocrotophos (e.g. 0.12 quart of Azodrin 20.2%, EC in 13 gallon of water) or any other kinds of recommended insecticides.

Operation	Recommended Practices	Input Materials per Hectare
	(c) The age of seedlings for transplanting; 16 days after sowing for the early maturing varieties (115 days or less) and 21 days for the medium maturing varieties (120 - 140 days)	
4. Land Preparation	(a) Irrigate the soils if it is too dry to plow.	
	(b) Repair all dikes to destroy rat dwellings and also to minimize seepage.	
	(c) For the fields which are very weedy or having plenty of plant stubbles, start plowing 3 weeks before transplanting to allow these materials to decompose. After plowing, flood the fields to prevent the loss of nitrogen and to prevent further growth of weeds.	
	(d) Harrowing shall be performed as follows; 1st step: Within 3 to 5 days after plowing, harrow the fields longitudinally and cross-wide with enough flooded water to break up and to puddle the clods partially while burying the weeds. Continue to keep the water about one cm deep. 2nd step: 5 to 7 days after the 1st harrowing, harrow the fields again to puddle fully and make the field relatively level. Be sure to keep the field flooded. 3rd step: One day before transplanting, drain most of the water from the field and apply basal fertilizer. Immediately after the application, harrow the field to mix the fertilizer with soil. Then level the field very well.	Basal fertilizer: - Wet & dry season: 150 kg of 16-20-0 (N: 24, P_2O_5: 30 kg)

Operation	Recommended Practices	Input Materials per Hectare
4. Land Preparation	(a) Irrigate the soils if it is too dry to plow.	
	(b) Repair all dikes to destroy rat dwellings and also to minimize seepage.	
	(c) For the fields which are very weedy or having plenty of plant stubbles, start plowing 3 weeks before transplanting to allow these materials to decompose. After plowing, flood the fields to prevent the loss of nitrogen and to prevent further growth of weeds.	
	(d) Harrowing shall be performed as follows; 1st step: Within 3 to 5 days after plowing, harrow the fields longitudinally and cross-wide with enough flooded water to break up and to puddle the clods partially while burying the weeds. Continue to keep the water about one cm deep. 2nd step: 5 to 7 days after the 1st harrowing, harrow the fields again to puddle fully and make the field relatively level. Be sure to keep the field flooded. 3rd step: One day before transplanting, drain most of the water from the field and apply basal fertilizer. Immediately after the application, harrow the field to mix the fertilizer with soil. Then level the field very well.	Basal fertilizer: - Wet & dry season: 150 kg of 16-20-0 (N; 24, P_2O_5: 30 kg)
5. Transplanting	(a) Soak roots of pulled seedlings in fungicided water for 24 hours before transplanting to protect the seedings from insects/pests as mentioned in 3, (b).	Insecticides for treatment of seedlings: Carbofuran (e.g. 0.65 quart of Furadan Flowable 22% in 130 liters of water) or any kinds of recommended chemicals.

Operation	Recommended Practices	Input Materials per Hectare
	(b) Transplant 2 - 3 seedlings per hill at a depth of 2-3 cm with a spacing of 20cm x 20cm (in case of wet-seedbed seedlings).	
	(c) 3 days after transplanting, start irrigating the field to have 3 cm of standing water depth and gradually increase the standing water depth up to 5-7 cm as the crops grow taller. Be sure to maintain continuously shallow irrigation up to milk-ripe stage. Especially during the period from panicle initiation to one week after flowering, sustain water depth of approximately 5cm.	
6. Weed Control	(a) 3-6 days after transplanting, apply the pre-emergence herbicides. For the maximum results, maintain water in the field with a depth of 3-5 cm at least 2 weeks after the application.	Pre-emergence herbicides; 2,4-D Amine (e.g. 2.0 quart of Hednal 40%, EC in 100 galons water) or any kinds of recommended hervicides
	(b) Within 20 to 25 days after transplanting, control remnant weeds by hand weeding and rotary weeding or application of any of the post-emergence herbicides.	
7. Spraying	(a) At 15 and 35 days after transplanting, apply insecticides to protect the plant from the insects/pests including whorl maggots, green leafhopper, brown leafhoppers and stemborers, etc.	Insecticides; - 15 and 35 days after transplanting; Carbophenothion (e.g. 0.5 and 0.75 qts of Lethox EC, 48%, in 100 and 150 gallons of water respectively) or any other kinds of insecticides.

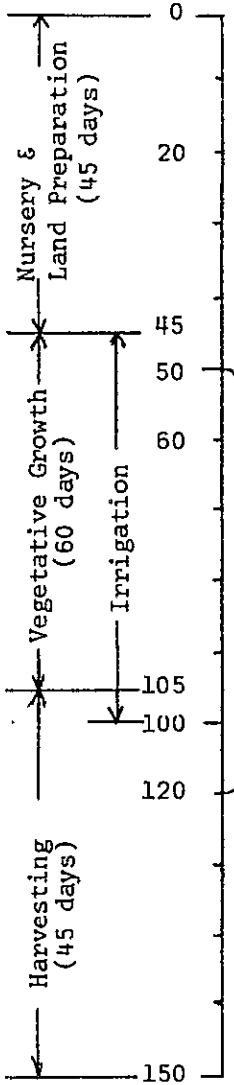
Operation	Recommended Practices	Input Materials per Hectare
	(b) At early booting stage (65 days after sowing for 115 days or less maturing varieties and 75 days for 120 - 140 maturing varieties), apply insecticides to protect the plant from the insects/pests such as brown planthoppers, stemborers and rice bug, etc.	- 65 or 75 days after transplanting: BPMC + chlorphyrifos (e.g. 5.0 quart of Brodan 21.0% + 10.5%, EC in 300 gallons of water) or any other kinds of recommended insecticides.
8. Top dressing	(a) 1st top dressing: 35 days (for the early maturing varieties) or 50 days (for the medium maturing varieties) after sowing.	1st top dressing: - Wet season: 28 kg of urea (N: 13 kg) - Dry season: 40 kg of urea (N: 18 kg)
	(b) 2nd top dressing: 50 days (for the early maturing varieties) or 65 days (for the medium maturing varieties after sowing.	2nd top dressing: - Wet season: 62 kg of ammonium sulfate (N: 13 kg) - Dry season: 86 kg of ammonium sulfate (N: 18 kg)
9. Drainage	At the hard dough stage (10 days before harvesting), stop irrigation and drain the water in the field completely.	
10. Harvesting & Threshing	(a) When at least 80% of the grains in panicle have turned yellow, start to harvest the rice (do not delay harvesting beyond 30 days after flowering to minimize much harvesting losses)	
	(b) Thresh the harvests immediately, at least within 3 days after harvesting especially during the rainy season to prevent deterioration of grain quality and viability.	
11. Cleaning & Drying	Clean and dry the paddy promptly to assure quality grains. Reduce the moisture content to 14% by sunshine or dryer.	

Note: (1) For rat control, Chronic rodenticides (e.g. 0.25kg of Ratoxin, 0.5%) may be necessary for the sustained baiting after transplanting to harvesting.

(2) The total fertilizer requirement per hectare is estimated from the soil survey for this study, as shown below.

	N	P_2O_5	K_2O
Wet season	50 kg	30 kg	0 kg
Dry season	60 kg	30 kg	0 kg

Table 4C-4 Recommended Farm Practices and Input Materials, Tobacco

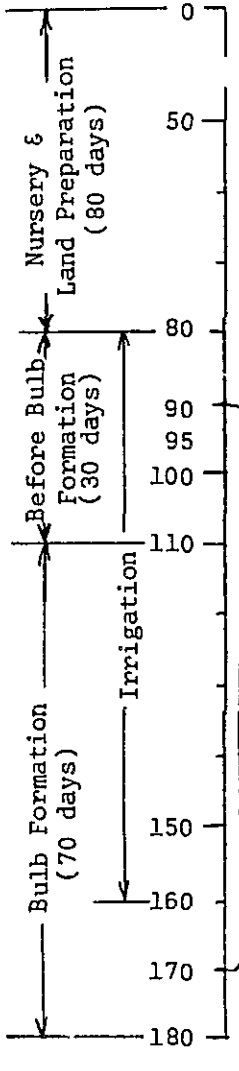


Growth Stage	Operation & Recommended Farm Practices	Input Materials per Hectare
0	◁ Seeding: Area of seedbed for 1 ha. of transplanting area = 80 m^2	Seeds: 30 g
	◁ Land Preparation: (a) Plowing (two passings) (b) Harrowing (four passings) (c) Land soaking (optional) (d) Furrowing/Basal fertilizer application	Based Fertilizer: 200 kg of compound (6-9-15) 29 kg of ammosul (21-0-0) 39 kg of superphosphate (0-18-0)
45	◁ Ttansplanting/Watering Spacing: 1.0 m (between rows) x 0.5 m (between hills), 20,000 hills/ha.	
60	◁ Side-dressing of Fertilizer/Off-burying & Hilling-up	Side-dressing Fertilizer: 200 kg of compound (6-9-15) 29 kg of ammosul (21-0-0) 39 kg of superphosphate (0-18-0)
	Insecticides Application (50th - 120th day after seeding) Once a week (12 times)	Insecticides 1st - 2nd: one quart 3rd - 8th: two quart 9th -12th: three quart
	Irrigation (48th - 100th after seeding): 3 days interval (at maximum)	
105	◁ Topping/1st Primming	
100	Removal of Suckers (105th - 140th day after seeding)	Note: Recommended varieties (a) Carolina Bright Yellow (b) Coker 254 (c) Coker P-7-1 (d) MRS-3 (e) Golden Harvest
120		
150	◁ Last (8th) Primming	

Table 4C-5 Recommended Farm Practices and Input Materials, Garlic

Growth Stage	Operation & Recommended Farm Practices	Input Materials per Hectare
Land Preparation (25 days)	Land Preparation;	
	(a) Cutting rice stubbles & weeds/Scraping the root systems at soil surface level (b) Applying irrigation water after exposing the soil to the sun for three days (c) Applying basal fertilizer (d) Mulching by spreading rice straw at the thickness of 5 cm.	Basal Fertilizer; 12 kg of urea (45-0-0) 165 kg of potassium chloride (0-0-60) 356 kg of compound (16-20-0)
25 / 0	Seeding;	Seeds: 400kg
	(a) Spacing: 25 cm x 25 cm (160,000 hills per hectare) (b) Planting depth: 1/4 of cloves with the roots downward (c) Seed treatment: Soaking bulblets in insecticide solution	Insecticides for Seed Treatment; 30 cc of Mathation in 5 gallons water
20	Start of Irrigation; 3 to 4 times untill bulb formation stage	
Before Bulb Formation (60 days) / Irrigation		
35	Insecticides Application (35th - 70th day after seeding);	Insecticides;
50	Every 7 to 10 days (4 times)	Acaricides EC one quart Mathation EC three quart
60 / 70		
Bulb Formation (55 days)		
100		
115	Harvesting	

Table 4C-6 Recommended Farm Practices and Input Materials, Onion



Growth Stage	Operation & Recommended Fram Practices	Input Materials per Hectare
0	◁Seeding; Area of seedbed: 100 m^2 per one ha. of transplanting area	Seeds: 5 kg
50	◁Land Preparation (a) Plowing (two passings) (b) Harrowing (four passing) (c) Applying of basal fertilizer & lime (d) Raising of transplanting beds	Lime: Ground limestone, 2.5 tons Basal Fertilizer: 150 kg of urea (45-0-0) 550 kg of superphosphate (0-18-0) 200 kg of potassium chloride (0-0-60)
80	Transplanting & Watering (a) Spacing: 20 cm x 20 cm (250,000 hills/ha.) (b) Mulching	
90 95	◁Applying of Post-Emergence Herbicides	Post-Emergency Herbicides: Nitrofen: 1.5 kg
100 110	◁Side-Dressing of Fertilizer/Earthing-up	Side-Dressing Fertilizer: 150 kg of urea (45-0-0)
	Insecticides Application for Thrips; Every 7 to 10 days (12 times)	Insecticides: Sevin 85S (2.0kg/time x 12)
150 160 170		
180	◁Harvesting	

Table 4C-7 Projection of Total Population - Medium Assumption

Area & Municipality	Growth rate by terms (%) 1975~1980	1980~1985	1985~1990	1990~1995	1995~2000	Projection of Population (persons) 1975	1980	1985	1990	1995	2000
I. Right of Bonga River											
Solsona	1.08	1.072	1.060	1.069	1.062	12,118	13,087	14,030	14,872	15,898	16,883
Dingras	1.09	1.080	1.068	1.076	1.068	9,527	10,384	11,215	11,978	12,888	13,765
Marcos	1.11	1.105	1.090	1.096	1.086	5,538	6,147	6,793	7,404	8,115	8,813
Espiritu	1.10	1.092	1.079	1.086	1.077	4,562	5,018	5,480	5,913	6,421	6,916
Nueva Era	1.11	1.105	1.090	1.096	1.086	2,217	2,461	2,719	2,964	3,249	3,528
Total						33,962	37,097	40,237	43,131	46,571	49,905
II. Nueva Era	1.11	1.105	1.090	1.096	1.086	1,112	1,234	1,364	1,487	1,629	1,770
III. Paoay-Batac											
Paoay	1.11	1.100	1.088	1.095	1.086	10,967	12,173	13,391	14,569	15,953	17,325
Batac	1.11	1.106	1.091	1.097	1.087	18,242	20,249	22,395	24,433	26,803	29,135
Sub-total						29,209	32,422	35,786	39,002	42,756	46,460
IV. Pinili-Badoc-Sinait											
Pinili	1.11	1.102	1.088	1.095	1.086	6,557	7,278	8,021	8,726	9,555	10,377
Badoc	1.17	1.155	1.136	1.138	1.122	16,402	19,190	22,165	25,179	28,654	32,150
Sinait	1.06	1.066	1.055	1.074	1.067	8,622	9,139	9,742	10,278	11,038	11,778
Sub-total						31,581	35,607	39,928	44,183	49,247	54,305
V. Cura Area											
Solsona	1.08	1.072	1.060	1.069	1.062	1,666	1,799	1,929	2,045	2,186	2,321
Dingras	1.09	1.080	1.068	1.076	1.068	3,020	3,292	3,555	3,797	4,085	4,362
Sub-total						4,686	5,091	5,484	5,842	6,271	6,683
Total (II - V)						66,588	74,354	82,562	90,514	99,903	109,218
Grand Total						100,550	111,451	122,799	133,645	146,474	159,123

Table 4C-8 Projection of Farm household Population by Area and Municipality (excluding Temporaly Farm)

Area and Municipality	Total Population 1975 1/	Ratio of Farm Population 2/ (%)	Population of Farm household (person) 3/ 1975	1978	1985	1990	1995	2000
I. Right of Bonga River								
Solsona	12,118	82	9,937	10,295	11,288	11,965	12,790	12,708
Dingras	9,527	86	8,193	8,537	9,455	10,098	10,865	11,604
Marcos	5,538	93	5,150	5,449	6,237	6,798	7,450	8,091
Espiritu	4,562	93	4,243	4,447	5,015	5,411	5,877	6,329
Nueva Era	2,217	76	1,685	1,783	2,040	2,224	2,438	2,647
Total	33,962	86	29,208	30,511	34,035	36,496	39,420	41,379
II. Nueva Era	1,112	84	934	988	1,131	1,233	1,351	1,467
III. Paoay-Batac								
Paoay	10,967	71	7,787	8,184	9,368	10,192	11,161	11,069
Batac	18,242	65	11,857	12,545	14,371	15,679	17,200	18,696
Sub-total	29,209	68	19,644	20,729	23,739	25,871	28,361	29,765
IV. Pinili-Badoc-Sinait								
Pinil	6,557	85	5,573	5,857	6,704	7,294	7,987	8,674
Badoc	16,402	85	13,942	15,141	18,529	21,049	23,954	26,876
Sinait	8,622	85	7,329	7,505	8,121	8,568	9,202	9,818
Sub-total	31,581	85	26,844	28,503	33,354	36,911	41,143	45,368
V. Cura Area								
Solsona	1,666	85	1,416	1,467	1,609	1,706	1,823	1,936
Dingras	3,020	98	2,960	3,084	3,416	3,648	3,925	4,192
Sub-total	4,686	93	4,376	4,551	5,025	5,354	5,748	6,128
Total (II - V)	66,588	78	51,798	54,771	63,249	69,369	76,603	82,728
Grand total	100,550	81	81,006	85,282	97,284	105,865	116,023	124,107

Source: 1/ Population Census, 1975, NEDA

2/ Correspond to the ratio of number of farm household based on Barrio Screen Survey, BAEcon, 1976

3/ Growth rates of population were based on "Population Dimension of Planning, NEDA, 1975.

Table 4C-9 Projection of Number of Farm Household to Cultivate in The Project Area

Municipality	1975 Permanent 1/	1975 Temporary 2/	1975 Total	1978 3/ Permanent	1978 Temporary	1978 Total	1985 Permanent	1985 Temporary	1985 Total	1990 Permanent	1990 New Settler 4/	1990 Temporary	1990 Total	1995 Permanent	1995 New Settler	1995 Temporary	1995 Total
I. Right of Bonga River																	
Solsona	1,858	415	2,273	1,880	415	2,295	1,933	415	2,348	1,972	125	290	2,387	2,012	42	373	2,427
Dingras	1,424	350	1,774	1,441	350	1,791	1,482	350	1,832	1,512	105	245	1,862	1,542	35	315	1,892
Marcos	999	130	1,129	1,011	130	1,141	1,040	130	1,170	1,061	39	91	1,191	1,082	13	117	1,212
Espiritu	814	278	1,092	824	278	1,102	847	278	1,125	864	83	195	1,142	881	28	250	1,159
Nueva Era	337	169	506	341	169	510	351	169	520	358	51	118	527	365	17	152	534
Total	5,432	1,342	6,774	5,497	1,342	6,839	5,653	1,342	6,995	5,767	403	939	7,109	5,882	135	1,207	7,224
II. Nueva Era	174	53	227	176	53	229	181	53	234	185	-	53	238	189	16	37	242
III. Paoay-Batac																	
Paoay	1,611	287	1,898	1,630	287	1,917	1,676	287	1,963	1,710	-	287	1,997	1,744	86	201	2,031
Batac	2,160	75	2,235	2,186	75	2,261	2,248	75	2,323	2,293	-	75	2,368	2,339	23	52	2,414
Sub-total	3,770	362	4,132	3,816	362	4,178	3,924	362	4,286	4,003	-	362	4,365	4,083	109	253	4,445
IV. Pinili-Badoc-Sinait																	
Pinili	1,042	51	1,093	1,055	51	1,106	1,085	51	1,136	1,107	-	51	1,158	1,129	15	36	1,180
Badoc	2,700	133	2,833	2,733	133	2,866	2,810	133	2,943	2,867	-	133	3,000	2,925	40	93	3,058
Sinait	1,437	57	1,494	1,454	57	1,511	1,495	57	1,552	1,525	-	57	1,582	1,556	17	40	1,613
Sub-total	5,179	241	5,420	5,242	241	5,483	5,390	241	5,631	5,499	-	241	5,740	5,610	72	169	5,851
V. Cura Area																	
Solsona	257	46	303	260	46	264	267	46	313	272	-	46	318	277	14	32	323
Dingras	578	112	690	585	112	697	602	112	714	614	-	112	726	626	34	78	738
Sub-total	835	158	993	845	158	1,003	869	158	1,027	886	-	158	1,044	903	48	110	1,061
Total (II - V)	9,958	814	10,772	10,079	814	10,893	10,364	814	11,178	10,573	-	814	11,387	10,785	245	569	11,599
Grand Total	15,390	2,156	17,546	15,576	2,156	17,732	16,017	2,156	18,173	16,340	403	1,753	18,496	16,667	380	1,776	18,823

Note: 1/ Permanent farmers means the inhabitants living in each barrio of the Project Area.
2/ Temporary farmers means the farmers living outside the said barangay, but operating farm inside the said barangay.
3/ Growth rate of permanent farmer was estimated at 0.4 percent which indicates the rate from 1960 to 1975 by Agricultural Census.
4/ New settler means temporary farms to settle in the said barrio after completion of the Project. Ratio to be settled would be assumed as 30% by 1990, 10% by 1995 in the Phase I area, and as 30% by 1995 in the Phase II area.
Number of temporary farmers would be assumed as constant until 1985.

Table 4-10 Household Population-Gainful Workers of 10 years Old and Over by Major and Minor Industries - 1970, 1975 - Ilocos Norte

	Industry	1970	(%)	1975	(%)	1975/1970
1.	Agriculture, Hunting Forestry & Fishing	66,172	63.4	68,247	65.5	103.1
	Agricultural Production	63,464	(60.8)	64,667	(62.0)	(101.9)
2.	Mining & Quarrying	527	0.5	514	0.5	97.5
	Coal Mining	-		-		
	Metal Mining	-		-		
	Other Mining	527	(0.5)	514	(0.5)	(97.5)
3.	Manufacturing	8,361	8.0	5,232	5.0	62.6
	Food Manufacture	515	(0.5)	686	(0.7)	(133.2)
	Tobacco Products	57	(0.0)	172	(0.2)	(301.8)
	Textiles	1,919	(1.8)	899	(0.9)	(46.8)
	Footwear, Apparel	2,806	(2.7)	1,620	(1.6)	(57.7)
	Wood and Cork	461	(0.3)	130	(0.1)	(28.2)
	Non Metalic Mineral	348	(0.3)	529	(0.5)	(152.0)
	Metal Products	388	(0.4)	124	(0.1)	(32.0)
	Machinery	93	(0.1)	133	(0.1)	(143.0)
	Electrical Machinery	234	(0.2)	138	(0.1)	(59.0)
4.	Electricity, Gas	112	0.1	278	0.3	248.2
5.	Construction	4,586	4.4	3,861	3.7	84.2
6.	Commerce	5,402	5.2	5,403	5.2	100.0
	Wholesale	1,028	(1.0)	731	(0.7)	(71.7)
	Retail	4,014	(3.8)	4,068	(3.9)	(101.3)
7.	Transport	2,618	2.5	3,550	3.3	135.60
8.	Services	14,408	13.8	15,186	14.6	105.40
9.	Industry not adequately described	2,148	2.1	2,010	1.9	93.6
	Total	104,334	100.0	104,271	100.0	99.9

Source: Population Census

Table 4C-11 Population of 10 Years Old and Over, Municipality and Type of Activity: 1970

Province Minicipality	All Persons of 10 years and over	Economic Active			Ratio of Unemployment	Total Population
		Employed	Unemployed	Total		
Ilocos Norte						
Badoc	14,001	5,907	633	6,540	9.7	19,000
Batac	24,685	11,008	538	11,546	4.7	33,114
Paoay	11,894	4,143	61	4,204	1.5	15,218
Pinili	8,995	4,014	316	4,330	7.3	12,211
Sinait	13,085	5,032	526	5,558	9.5	16,429
Dingras	16,421	6,895	603	7,498	8.0	22,751
Espiritu	8,340	3,068	380	3,448	11.0	11,671
Nueva Era	2,280	935	21	956	2.2	3,413
Solsona	9,732	3,653	468	4,121	11.4	12,803
Marcos	7,014	3,166	491	3,657	13.4	9,406
Laoag City	45,877	15,985	1,123	17,108	6.6	
San Nicolas	15,481	5,650	846	6,490	13.0	
Currimao	5,674	1,896	157	2,053	7.6	
Bacarra	15,414	5,601	573	6,174	9.3	
Pidding	9,409	4,027	343	4,370	7.8	
Carasi	242	183	-	183	0	
Total	253,569	100,201	9,313	109,514	8.5	343,427
Ilocos Sur						
Vigan	22,489	10,478	1,012	11,490	8.8	
Vabugao	15,785	7,567	1,493	9,057	16.5	
San Juan	10,852	8,386	318	8,704	3.8	
Total	281,228	140,678	14,362	155,040	9.3	

Note: Not economic active consists of housekeepers, students and others.

Farm Mechanization

1. Proposed Farm Operation System

The proposed farm operation systems as shown in Figure 4C-1 will be employed to carry out the intensive farming with high production after the Project. These systems require mechanization of such major farm operations as land preparation, threshing and drying. The areas where mechanization will be applied in each of these operations are forecasted as shown below, taken into consideration the present mechanization condition and the prospected level of mechanization in the Project Area by the governmental agencies concerned:

Forecast on Farm Mechanization in the Project

Operation	Mechanization Area (%)	Machinery to be introduced 1/
Land preparation	40	Hand tractor (7-8 HP)
Threshing	50	Powered thresher (7-8 HP, Throw-in type)
Threshing	50	Pedal thresher
Drying	50	Dryer (Flat-bed type, 2.0 ton bim)

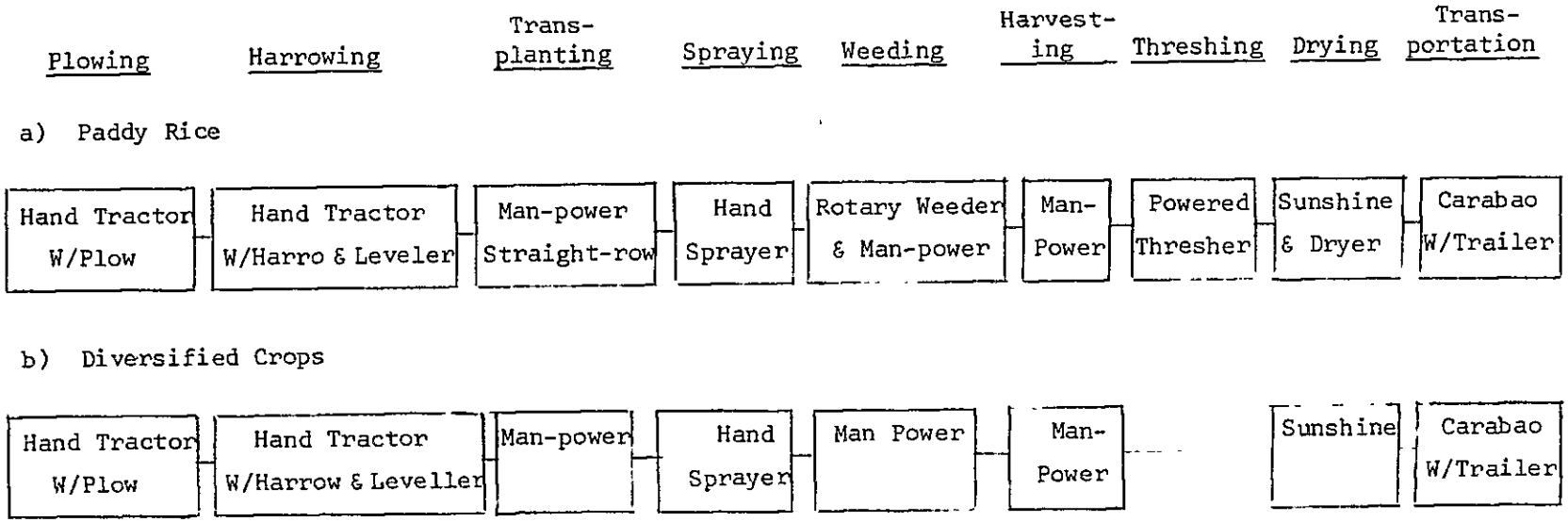
Note: 1/ For all these machineries, the local-made ones will be introduced.

The traditional way of land preparation by carabao, drying by sunshine will remain in non-mechanization area even after the Project. Each operation capacity and efficiency for the mechanized operations and also for land preparation by carabao are shown in Table 4C-12.

2. Number of Necessary Machinery Unit per Compact Farm

It is planned that the necessary units of the machineries will be introduced in each compact farm on the basis of utilizing them collectively with minimum machinery costs. The required units of the machineries per compact farm (60 ha.) are computed as follows;

Figure 4C-1 Proposed Farm Operation System



Note: (1) Area coverage of mechanization for the operations of plowing and harrowing by hand tractor is estimated at 40 percent of cultivatied area in both cases of paddy rice and diversified crops.

(2) Area coverage of mechanization for threshing by the powered thresher and pedal thresher is estimated at 50 percent of cultivated area respectively.

Table 4C-12 Efficiency of Farm Operation

Operation	Machinery/ Animal	(1) Ope. Width (m)	(2) Ope. Speed (km/hr)	(3)= (1)x(2)/10 Theoretic Ope. Capacity (ha/hr.)	(4) Efficiency in Field (%)	(5)= (3)x(4) Ope. Capacity in Field (ha/hr.)	(6) Operation Efficiency (%)	(7)= (5)x(6) Actual Ope. Capacity (ha/hr.)	(8) Hours per ha. (hr./ha)	(9) Ope. Times (time)	(10)= (8)x(9) Hours per ha. (hr./ha.)	(11) Ope. Hours per day (hr/day)	(12)= (10)÷(11) Days per ha. (day/hr)
a) Plowing	Carabao w/ Plow	0.12	2.2	0.026	84	0.022	80	0.018	55.6	1	55.6	8	7.0
	Hand tractor w/ Plow (7-8 pH)	0.24	4.3	0.103	84	0.087	70	0.061	16.4	1	16.4	8	2.0
b) 1st Harrowing & 2nd Harrowing	Carabao w/ Harrow	1.0	2.0	0.200	80	0.160	65	0.104	9.6	2	19.2	8	2.4
	Hand tractor w/ Harrow (7- pH)	1.0	2.5	0.250	80	0.200	70	0.140	7.1	2	14.2	8	1.8
c) Final Harrowing inclusive of Leveling	Carabao w/Harrow/ Leveler	0.7	2.0	0.140	80	0.112	65	0.073	13.7	2	27.4	8	3.4
	Hand tractor w/ (7-8 pH) Hallow/Leveler	0.7	2.5	0.175	80	0.140	70	0.098	10.2	2	20.4	8	2.6
d) Threshing	Powered Thresher (7-8 pH, Throw-in type)	-	-	0.222 (1.0ton)	80	0.178 (0.8ton)	75	0.134 (0.6ton)	7.5	1	7.5	6	1.2
	Pedal Thresher	-	-	0.070 (0.32ton)	80	0.056 (0.25ton)	75	0.042 (0.19ton)	24.0	1	24.0	6	4.0
e) Drying	Dryer (Flat bed type, 2.0tons bin)	-	-	0.111 (0.50ton)	80	0.089 (0.40ton)	80	0.071 (0.32ton)	14.0	1	14.0	16	0.9
f) Transportation	Carabao + Cart	-	2.5	0.2 ton	80	0.16 ton	0.1 ton	-	-	-	-	-	-

a) Hand Tractor

Two units of hand tractor are required for the operation of land preparation in 40 percent area (24.0 ha) of 60 ha as follows:

Efficiency: 8.2(= 2.0 + 1.8 + 1.8 + 2.6) days/ha/unit
(See Table 4C-12)

Possible operation days per crop season: 71 days

Required units per 24 ha: 8.2 days/ha x 24 ha ÷ 71 days ≒ 3 units

b) Thresher

One unit of powered thresher and 4 units of pedal threshers will cover each half area of compact farm as follows;

Powered Thresher

Efficienty: 1.2 days/ha/unit (See Table 4C-12)

Possible operation days per crop season: 50 days x 0.75[1/] = 38 days

Required units per 30 ha: 1.2 days/ha x 30 ha ÷ 38 days ≒ one unit

Pedal Thresher

Efficiency: 4.0 days/ha/unit (See Table 4C-12)

Possible operation days per crop season: 38 days

Required units per 30 ha: 4.0 days/ha x 30 ha ÷ 38 days ÷ 0.6[2/]
≒ 5 units

Note: 1/: 0.75 is the estimated ratio of the possible operation days to full operation period.

2/: 0.6 is the estimated reduction rate of operation efficienty

c) Dryer

One unit of dryer can dry up 2.0 ton of threshed paddy in moisture content from 26% to 14% and will take 8 hours. Then, two rotation a day is possible. One unit of drier is required to cope with the amount of harvested paddy in half area (30 ha) of compact farm, as follows:

Efficiency: 2.0 tons x two rotations per day per unit
÷ 4.0 tons (ave. yield of wet season paddy rice)
= 1.0 day/ha/unit (See Table 4C-12)

Possible operation days per crop season = 50 days x 0.75
≒ 38 days

Required unit per 30 ha: 1.0day/ha/unit x 30 ha ÷ 38 days
≒ one unit

The amount of harvested paddy in another half area of compact farm will be dried up in the traditional way of drying up by sunshine. But practically speaking, the mixture method of drying up by dryer and sunshine should be taken because it is preferable to dry up the high moisture content paddy at least in the first-half of the drying-up process with drier during wet seasons.

d) Working Carabao

The operation of land preparation in non-mechanization area (36 ha) will be performed by animal power (carabao). The required heads of working carabao per compact farm is computed as follows:

Efficienty:	Plowing:	7.0 animal-days/ha
	1st harrowing:	2.4 animal-days/ha
	2nd harrowing:	2.4 animal-days/ha
	3rd harrowing:	3.4 animal-days/ha
	Total	15.2 animal-days/ha

Possible operation days per crop season = 74 days
Required heads of working carabao: 15.2 animal-days/ha x 36 ha
÷ 74 days ≒ 8 heads

3. Labor Requirement and Machinery Cost

The labor requirements for paddy rice and concerned diversified crops are estimated as follows:

Table 4C-13 Labor Requirement of Paddy cultivation with Project in Future

(Unit: day/ha)

Operation	Man-day	Machinery or Animal-day	Remarks
1. Seed-beadding			
a. Land preparation/Sowing	1.5	0.5	same as item 2
b. Care of seedlings	1.5		
Sub-total	(3.0)	(0.5)	
2. Land Preparation			
a. Plowing (1x)	5.0	5.0	
b. 1st harrowing (2x)	2.2	2.2	by hand tractor (40%)
c. 2nd harrowing (2x)	2.2	2.2	& animal power (60%)
d. Final Harrowing/Leveling	3.4	3.4	
e. Repair of dikes	3.2		
Sub-total	(16.0)	(12.8)	
3. Transplanting			
a. Pulling/Delivery of seedlings	7.5	0.5	
b. Transplanting	20.0		
Sub-total	(27.5)	(0.5)	
4. Fertilizer Application			
a. Basal fertilizer	1.0	0.2	
b. Top dressing	1.0	0.2	
Sub-total	(2.0)	(0.4)	
5. Spraying			
a. Insecticides (3x)	3.0		] by hand sprayer
b. Herbicides (1x)	1.0		
Sub-total	(4.0)		
6. Weeding			
a. 1st weeding (2x)	7.0		by rotary weeder
b. 2nd weeding	6.0		by hand
Sub-total	(13.0)		
7. Irrigation/Drainage	5.0		
8. Harvesting			
a. Cutting/Bundling	16.0		
b. Hauling/Piling	3.0	2.0	
c. Threshing	8.5	2.6	by powered (50%) &
Sub-total	(27.5)	(4.6)	pedal thresher (50%)
9. Post Harvesting			
a. Drying	3.5	2.5	by driver (50%) &
b. Sacking	2.0		sunshine(50%)
c. Piling/Delivery	1.5	0.3	
Sub-total	(7.0)	(2.8)	
Total	105.0	21.6	

Table 4C-14 Labor Requirement of Tobacco Cultivation, with Project, in Future

(Unit: day/ha)

Operation	Man-day	Machinery or Animal-day	Remarks
1. Seed-bedding:			
a. Land Preparation/Sowing	2.8	0.5	
b. Care of Seedlings	22.2		
Sub-total	(25.0)	(0.5)	
2. Land Preparation:			
a. Plowing (2x)	10.0	10.0	by hand tractor (40%)
b. Harrowing(4x)	4.3	4.3	& animal power (60%)
c. Furrowing	2.7	2.7	
Sub-total	(17.0)	(17.0)	
3. Transplanting:			
a. Preparing of seedlings	3.0		
b. Transplanting/Replanting	30.0		
Sub-total	(33.0)		
4. Fertilizer Application:			
a. Basal fertilizer	2.0		
b. Side-dressing	2.0		
Sub-total	(4.0)		
5. Weeding/Hilling-up:	8.0	8.0	by hand tractor (40%) & animal power (60%)
6. Spraying (8x):	8.0		by hand sprayer
7. Irrigation (5x):	10.0		
8. Harvesting (8x):			
a. Priming/Gathering	45.0	4.0	
b. Sorting/Sticking	37.5		
Sub-total	(82.5)	(4.0)	
9. Post Harvesting:			
a. Curing	70.0		
b. Grading/Bundling	19.0		
c. Packing/Storing	1.5		
Sub-total	(90.5)		
Total	278.0	29.5	

Table 4C-15 Labor Requirement of Garlic Cultivation, with Project

(Unit: day/ha)

Operation	Man-day	Machinery or Animal-day	Remarks
1. Land Preparation:			
a. Cutting/Hauling rice stocks	8.0	2.0	] by animal power
b. Mulching	14.0	2.0	
Sub-total	(22.0)	(4.0)	
2. Planting:			
a. Preparing of seeds	10.0		
b. Planting 37.0			
Sub-total	(47.0)		
3. Fertilizer Application (1x):	1.0	0.2	by animal power
4. Thinning:	5.0		
5. Spraying of insecticides (4x):	4.0		by animal power
6. Irrigation (4x):	8.0		
7. Harvesting:			
a. Pulling/Gathering bulls	20.0		
b. Hauling 2.0	2.0	2.0	by animal power
Sub-total	(22.0)	(2.0)	
8. Post Harvesting:			
a. Drying	4.0		
b. Cleaning/Cutting of roots	15.0		
c. Classifying/Grading	10.0		
d. Bundling	15.0		
e. Trimming	4.0		
Sub-total	(48.0)		
9. Removal of hay (rice straw)	15.0		
Total	172.0	6.2	

Table 4C-16 Labor Requirement of Onion Cultivation, with Project, Future

(Unit: day/ha)

Operation	Man-day	Machinery or Animal-day	Remarks
1. Seed-bedding:			
a. Land preparation	4.0	0.5	
b. Care of seedlings	5.0		
Sub-total	(9.0)	(0.5)	
2. Land Preparation:			
a. Plowing (2x)	10.0	10.0	by hand tractor (40%)
b. Harrowing (4x)	4.3	4.3	& animal power (60%)
c. Furrowing	2.7	2.7	
Sub-total	(17.0)	(17.0)	
3. Transplanting:			
a. Preparing of seedlings	5.0		
b. Transplanting/Replanting	40.0		
Sub-total	(45.0)		
4. Fertilizer Application:			
a. Basal fertilizer	2.0		
b. Top dressing	2.0		
Sub-total	(4.0)		
5. Application of herbicides:	2.0		
6. Mulching:	16.0	2.0	by animal power
7. Spraying (12x):	24.0		by hand sprayer
8. Weeding:	13.0		
9. Irrigation (10x):	20.0		
10. Harvesting:			
a. Harvesting	20.0		
b. Hauling	2.0	2.0	by animal power
Sub-total	(22.0)	(2.0)	
11. Post Harvesting:			
a. Drying, Curing	15.0		
b. Classification/Grading	10.0		
c. Clipping of tops/bundling	15.0		
Sub-total	(40.0)		
Total	212.0	21.5	

Crop	Labor Requirement per ha. Man-day	Machinery or animal day
Paddy Rice	105.0	21.6
Tobacco	278.0	29.5
Garlic	172.0	6.2
Onion	212.0	21.5

Remarks: The detailed labor requirements by crop and operation are indicated in Table 4C-13 to 4C-16.

The machinery cost of paddy rice cultivation is calculated at ₱65 per ha. This is the average cost for the mechanized area and non-mechanized area. The cost for the diversified crops is computed at ₱52 per ha because the machinery cost for threshing and drying are excluded. (See Appendix 4C-6)

Table 4C-17 Farm Machinery Cost

1. Fixed Cost

Machinery	Purchasing Price (₱)	Durable Period (Year)	Depreciation Cost[1/] (₱/year)	Repair Cost (₱/year)	Other Fixed Cost[2/] (₱/year)	Total Cost (₱/year)	Coverage per unit (ha)	Total cost per hectare (₱)	Area Coverage (%)	Fixed Cost per hectare (₱)
Hand tractor	9,550	5	1,719	764 (8%)	96	2,579	Wet 24 Dry 24	54	40	22
Thresher	17,200[3/]	8	1,935	516 (3%)	172	2,623	Wet 30 Dry 27	46	50	23
Pedal thresher	500	6	75	-	5	80	Wet 6 Dry 5	7	50	4
Dryer	7,500	8	844	375 (5%)	75	1,294	Wet 30 Dry 27	23	50	12
Total									130	61

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.

2. Variable Cost

Operation	Machinery	(1) Ope. hours per ha (hr/ha)	(2) Fuel Consumption (ℓ/hr)	(3) Fuel (ℓ)	(4) Unit Cost (₱/ℓ)	(5) Cost of Fuel (₱)	(6)=(5)x1.3 Cost inclusive pf oil (₱)	(7) Area Coverage (%)	(8) Variable Cost per hectare (₱)
Plowing & Harrowing for seedbed	Hand tractor with plow	0.4	G. 4.0	1.6	1.70	2.7	3.5	40	1.4
Plowing & harrowing	Hand tractor with plow	8.2	G. 4.0	32.8	1.70	55.8	72.5	40	29.0
Threshing	Powered thresher	1.2	G. 4.0	4.8	1.70	8.2	10.7	50	5.4
Drying	Drier	14.1	G+O 0.75 K 1.5	G+O 10.6 K 21.2	2.20 1.30	23.3 27.7	30.3 36.0	50)	33.2
	Total:						153.0		69.0

Note: G: Gasoline, O: Oil, K: Kerosin.

3. Machinery Cost per Hectare

Fixed cost + Variable cost = ₱61 + ₱69 = ₱130

Table 4C-18 Farm Labor Balance with Project, In Future

Items	Area (ha.)	Jan.			Feb.			Mar.			Apr.			May		Jun.			Jul.			Aug.			Sep.			Oct.			Nov.			Dec.			Total
1. Labor Requirement per ha. (man-day)																																				
(a) Paddy Rice, Wet	1													3.2	2.8	6.9	10.4	10.6	10.6	11.2	3.9	2.1	2.4	2.2	2.2	6.3	7.4	7.1	7.7	6.9	1.1					105.0
(b) Paddy Rice, Dry	1	2.1	2.2	2.4	2.2	5.5	6.0	7.1	7.1	7.6	3.9																	2.3	3.3	5.6	9.5	10.4	10.4	10.4	7.0	105.0
(c) Tobacco	1	14.5	24.9	26.3	24.9	23.9	18.5	23.1	18 4	6.8															2.9	3.6	6.4	7.6	13.1	22.9	25.6	6.6	4.6	3.4	278.0
(d) Garlic	1	0.9	0.9	1.0			2.1	21.3	21.3	17.2	11.7	8.7	2.7															3.6	4.9	14.7	25.4	26.4	3.7	2.7	1.8	172.0
(e) Onion	1	5.7	5.7	6.6	5.7	12.3	17.7	17.7	9.8	7.1	2.7											0.3	0.9	0.9	0.9	0.9	0.9	4.3	4.3	15.0	33.7	35.9	8.7	6.9	7.4	212.0
2 Total Labor Requirement (x 1,000 man-day)																																				
(a) Paddy Rice, Wet	10,200													32.6	28.6	70 4	106.1	108.1	108.1	114.2	39.8	21.4	24.5	22.4	22.4	64.3	75.5	72.4	78.5	70.4	11.2					1,070.9
(b) Paddy Rice, Dry	9,200	19.3	20.2	22.1	20.2	50.6	55.2	65.3	65.3	69.9	35.9																	21.2	30.4	51.5	87.4	95.7	95.7	95.7	64.4	966.0
(c) Tobacco	300	4.4	7.5	7.9	7.5	7.2	5.6	6.9	5.5	2.0															0.9	1.1	1.9	2.3	3 9	6.9	7.7	2.0	1.4	1.0	83.6
(d) Garlic	350	0.3	0.3	0.4			0.7	7.5	7.5	6.0	4.1	3.0	0.9															1.3	1.7	5.1	8.9	9.2	1.3	1.3	0.6	60.1
(e) Onion	350	2.0	2.0	2.3	2.0	4.3	6.2	6.2	3 4	2.5	0.9											0.1	0.3	0.3	0.3	0.3	0.3	1.5	1.5	5.3	11.8	12.6	3.0	2.4	2.6	74.1
Total		26.0	30.0	32.7	29.7	62.1	67.7	85.9	81.7	80.4	40.9	3.0	0.9	32.6	28.6	70.4	106.1	108.1	108.1	114.2	39.8	21.5	24.8	22.7	22.7	65.5	76.9	98.3	114.4	136.2	126.2	125.2	102.0	100.8	68.6	2,254.7
3. Supply of Farm Labor 1/		148.3	148.3	163.1	148.3	148.3	118.6	148.3	148.3	163.1	148.3	148.3	148.3	148.3	148.3	163.1	148.3	148.3	148.3	148.3	148.3	148.3	163.1	148.3	148.3	148.3	148.3	148.3	163.1	148.3	148.3	148.3	148.3	148.3	163.1	5,412.7
4. Balance		122.3	118.3	130.4	118.6	86.2	50.9	62.4	66.6	82.7	107.4	145.3	147.4	148.3	148.3	130.5	119.7	77.9	42.2	40.2	40.2	48.9	108.5	126.8	138.3	125.6	125.6	82.8	71.4	50.0	48.7	12.1	22.1	23.1	46.3	47.5	94.5	3,158.0

Note: 1/: Farm labor force per month 7,188 (total farm family) x 25 (farm lbaor force/family) x 25 days
= 444.875 man-day (148.292 man-day/10 days)

Table 4C-19 Total Amount of Input Material in the Project, with Project, In Future

Input Materials	Paddy Rice, Wet (10,200 ha) Per ha.	Paddy Rice, Wet (10,200 ha) Total	Paddy Rice, Dry (9,200 ha) Per ha.	Paddy Rice, Dry (9,200 ha) Total	Tobacco (300) Per ha.	Tobacco (300) Total	Garlic (350) Per ha.	Garlic (350) Total	Onion (350) Per ha.	Onion (350) Total	Ground Total (20,400 ha.)
1. Seeds	50 kg	510 tons	50 kg	460 ton	0.03 kg	9 kg	400 kg	140 tons	5 kg	1,750 kg	Paddy 970 tons Tobacco 9 kg Garlic 140 tons Onion 1,750 kg
2. Fertilizer											
Urea (45-0-0)	28 kg	286 tons	40 kg	368 tons	-	-	12 kg	4 tons	300 kg	105 tons	763 tons
Ammosul (21-0-0)	62 kg	632 tons	86 kg	791 tons	58 kg	17 tons	-	-	-	-	1,440 tons
Superphosphate (0-18-0)	-	-	-	-	78 kg	23 tons	-	-	550 kg	193 tons	216 tons
Postassium chloride (0-0-60)							165.0	58 tons	200 kg	70 tons	128 tons
Compound (16-20-0)	150 kg	1,530 tons	150 kg	1,380 tons	-	-	356 kg	125 tons	-	-	3,035 tons
Compound (14-14-14)	10 kg	102 tons	-	-							102 tons
Compound (6-9-15)	-	-	-	-	400 kg	120 tons	-	-	-	-	120 tons
Total		2,550 tons		2,539 tons		160 tons		187 tons		368 tons	5,804 tons
3. Insecticides											
Liquid	7.1 qt.	724 x100qt.	7.1 qt.	653 x100qt.	28.0 qt.	84 x100qt.	4.0 qt.	14 x100qt.	-	-	1,475 x100qt.
Water Soluble Powder	-	-	-	-	-	-	-	-	24.0 kg	8,400 kg	8,400 kg
4. Herbicides											
Liquid	2.0 qt.	204 x100qt.	2.0 qt.	184 x100qt.	-	-	-	-	-	-	
Water Soluble Powder	-	-	-	-	-	-	-	-	1.5 kg	525 kg	525 kg

Note: (1) The figures in the parenthesis shows the cropping areas concerned.

(2) The amount of input materials per hectare are shown in detail in Table 4C-3 to Table 4C-6.

Proposed Facilities

A. Diversion Dams

1. Madongan Diversion Dam (Floating Type)

a) Design of Scouring Sluice

(1) Elevation

Elevation of scouring sluice shall be determined based on the averaged river bed slope of the stream center line after constructing diversion dam. Accordingly, the elevation was calculated at EL. 117.80 based on the averaged river bed slope derived from the elevations at the 100 m upstream point and the 150 m lowerstream point of the dam site.

(2) Design Discharge for Flushing Sediment

In order to flush away sediment even during irrigation period, the normal water discharge in irrigation periods (Qo = 27.0 cu.m/sec), is adopted.

(3) Required Water Velocity for Flushing Sediment

$$Vc = 1.5\ c\sqrt{d}$$

where; Vc: required velocity (m/sec)
C : coefficient by sand/gravel condition 4.5
d : max. particle size of sediment (m)

$$Vc = 1.5 \times 4.5 \times \sqrt{0.15} = 2.61 \text{ m/sec}$$

(4) Width

The width should be determined to secure the required velocity mentioned above to lead the water course and to flow driftwood, etc.

$$Lmc = \frac{Q0}{q}$$

$$q = \frac{Vc^3}{g}$$

where; Lmc: width (m)

q : traction discharge per unit width (cu.m/sec/m)

g : acceleration of gravity (m/sq.sec)

Q_0: design discharge for flushing away sediment (cu.m/sec)

Vc: required water velocity for flushing away sediment (m/sec)

$$q = \frac{2.61^3}{9.8} = 1.81 \text{ cu.m/sec/m}$$

$$Lmc = \frac{27}{1.81} = 14.93 \text{ (m)}$$

width = 7.00 m x 2 sets = 14.0 m

(5) Slope

The slope is determined to secure the critical velocity in the scouring sluice canal, setting the control point on the upstream end of this canal as follows:

$$Ic \geqq \frac{n^2 g}{hc^{1/3}}$$

where; Ic: critical slope

g : acceleration of gravity (m/sq.sec)

n : roughness coefficient of the apron 0.025

qc: traction discharge per unit width (cu.m/sec/m)

hc: critical depth (m)

$$hc = \frac{q^2}{g} = \frac{1.81^2}{9.8} = 0.33$$

$$Ic \geqq \frac{0.025^2 \times 9.8}{0.33^{1/3}} = 0.0089 \fallingdotseq \frac{1}{113} \qquad Ic = 1/100$$

(6) Length of Fore-apron (ℓf_1)

By Bligh Method:

$$\ell f_1 = 1.5 \times (0.6\, c \sqrt{D_1}$$

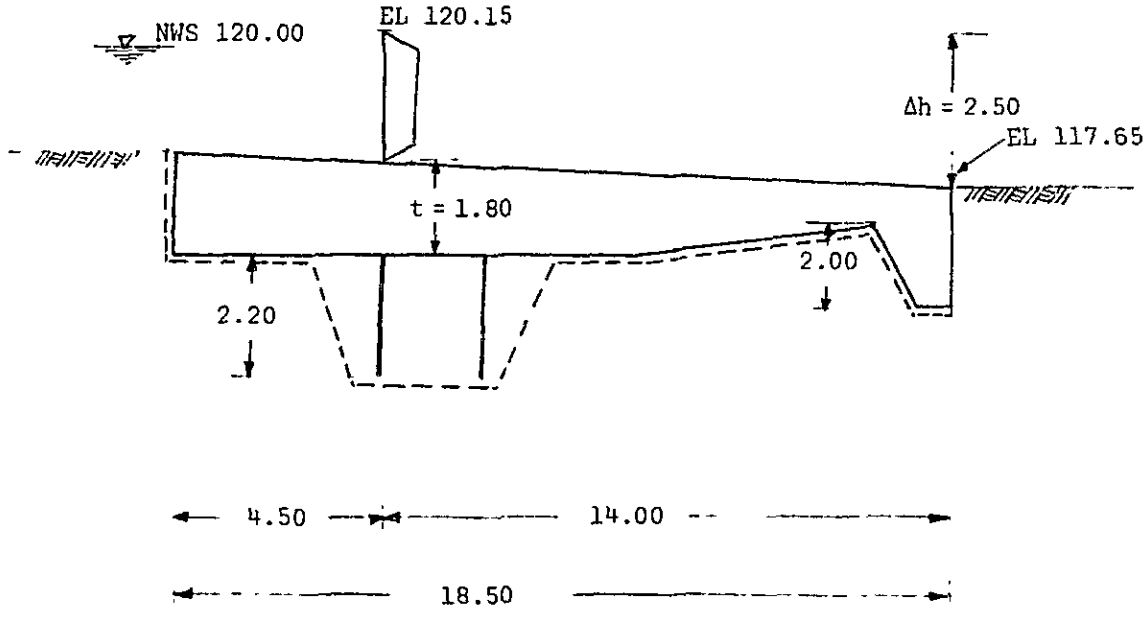
where; D_1: distance from the lowest end of the apron to the crest EL120.15 - 117.65 = 2.50 (m)

C : bligh coefficient, 9

1.5: safty ratio

$$\ell f_1 = 1.5(0.6 \times 9 \times \sqrt{2.50}) = 12.80 < 14.00 \text{ (m)}$$

Length = 14.00 m



(7) Piping (Creep Length)

By Bligh Method

$$S \geqq C \cdot \Delta h$$

where; S: necessary length of stream line (m)
C: bligh coefficient 9
Δh: difference of head EL120.15 - 117.65 = 2.50 (m)
S': design length of stream line (m)
1.80 + 18.50 + 2.20 + 2.20 + 2.00 = 26.70

$S = 9 \times 2.50 = 22.50 < 26.70$ (m) O.K

By Lane Method

$$L \geqq C \cdot \Delta h$$

where; L: necessary weighted creep length (m)
C: weighted creep ratio by material 3.5
Δh: difference of head 2.50 (m)
L': $\ell v + \frac{1}{3} \ell h$
ℓv: length of steam-line in vertical direction
ℓh: length of steam-line in horizontal direction

$L = 3.5 \times 2.50 = 8.75 < 14.37$ (m) O.K

$L' = (1.80 + 2.20 + 2.20 + 2.00) + 1/3 \times 18.50 = 14.37$ (m)

(8) Thickness of Fore-apron

$$T_A = \frac{4}{3} \times \frac{\Delta h - hf}{r-1}$$

where; T_A: thickness of apron at an optional point (m)
r : specific gravity of the apron material 2.3
$\frac{4}{3}$: safety ratio
Δh: difference of head 2.50 (m)

hf: head loss at the optional point

$$= \frac{\Delta h}{S} \times s' = \frac{2.50}{26.70} \times 15.70 = 1.47 \text{ (m)}$$

S: total length of stream line 26.70 (m)

S': length of stream line to the optional point

$= 1.80 + 2.20 + 2.20 + 9.50 = 15.70$ (m)

$$T_A = \frac{4}{3} \times \frac{2.50 - 1.47}{2.3 - 1} = 1.06 \text{ m} < 1.80 \text{ (m)}$$

However, 1.80 m shall be adopted because of required thickness of footing foundation of pier.

(9) Apron Protection Works

By Bligh Method:

$$\ell = 0.67\, C \sqrt{D_1 \cdot q}$$

$$\ell fr = \ell - \ell f_1$$

where; ℓ: fore-apron length + apron protection works length (m)

D_1: (see the above-mentioned) 2.50 (m)

q : designed high discharge per with width

$$= \frac{390}{14} \fallingdotseq 28 \text{ (cu.m/sec)}$$

C : (see the above-mentioned), 9

$$\ell = 0.67 \times 9 \times \sqrt{2.50 \times 28} = 50.45 \text{ (m)}$$

$\ell fr = 50.45 - 14.00 = 36.45$ (m)

Considering allowances, 40 m shall be applied.

b) Designed Intake Water Level

This water level shall satisfy the followings.

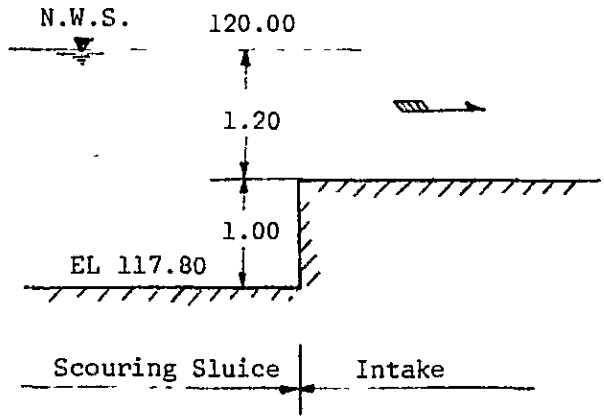
i) Intake water level as required from irrigation network

ii) Intake water level as required from the function of the diversion dam.

As the river bed elevation at the dam site is high enough to supply irrigation water for the service area, the intake water level for this diversion dam shall be determined from the latter requirement.

Designed intake water level = Elevation of sill of scouring sluice + Difference between the scouring sluice sill and Intake sill + Intake water depth

Designed intake water level = EL117.80 + 1.00 + 1.20
= EL120.00 (m)



c) Determination of Crest Elevation

Crest Elevation = Designed Intake Water Level + Freeboard
= EL120.00 + 0.15 = EL120.15

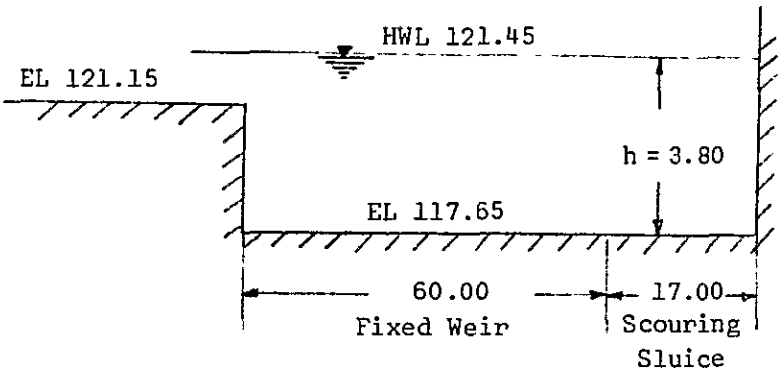
The freeboard is given to cope with the defacement of concrete, to protect the weir from waves and to cover a possible aberration in the accuracy of construction.

d) River Water Level after Constructing Diversion Dam (Backwater)

Flood discharge Qf = 2,000 cu.m/sec

(1) HWL at Downstream Side (HWL 120.95)

Calculation is to be made assuming the discharge to the low-water channel at 1,650 cu.m/sec and to the high-water channel at 350 cu.m/sec.



$A = (60.00 + 17.00) \times 3.80 = 292.60\ (m^2)$

$P = 77.00 + 2 \times 3.80 = 84.60\ (m)$

$R = \frac{292.60}{84.60} = 3.46 \qquad R^{2/3} = 2.29$

$V = \frac{1}{n} \cdot R^{2/3} \cdot I^{1/2} = \frac{1}{0.04} \times 2.29 \times \left(\frac{1}{100}\right)^{1/2} = 5.73\ (m/s)$

$Q = 292.60 \times 5.73 = 1,675 > 1,650\ (cu.m/s)$ O.K

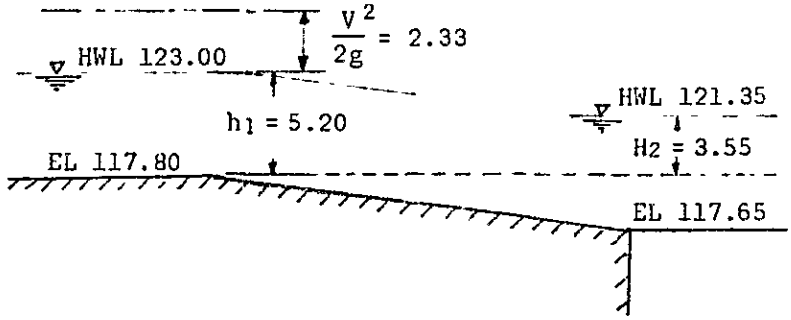
(2) HWL at Upperstream Side (HWL 123.00)

Approaching velocity

$$V = \frac{Q}{A} = \frac{1,650}{14.00 \times 5.20 + 60.00 \times 2.85} = 6.76\ (m/sec)$$

$$\frac{V^2}{2g} = \frac{6.56^2}{2 \times 9.8} = 2.33\ (m)$$

Scouring Sluice



$$h_2 = 3.55 > \frac{2}{3}h_1 = \frac{2}{3} \times 5.20 = 3.47 \quad \text{(Submerged overflow)}$$

$$Qm = 0.95 b_0 h_2 \sqrt{2g(h_1 + \frac{V^2}{2g} - h_2)}$$

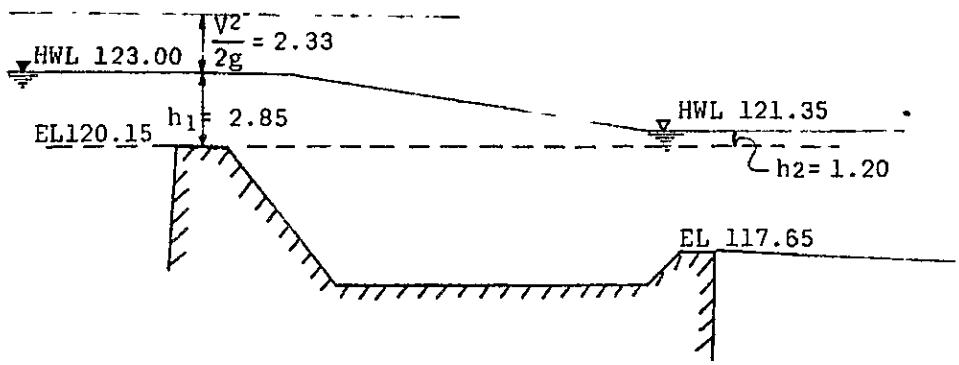
$$= 0.95 \times 13.17 \times 3.55 \times \sqrt{2 \times 9.8(5.20 + 2.33 - 3.55)}$$

$$\fallingdotseq 390 \text{ cu.m/sec}$$

where; $b_o = b - 0.04 n h_1$

$= 14.00 - 0.04 \times 4 \times 5.20 = 13.17$

Fixed Weir



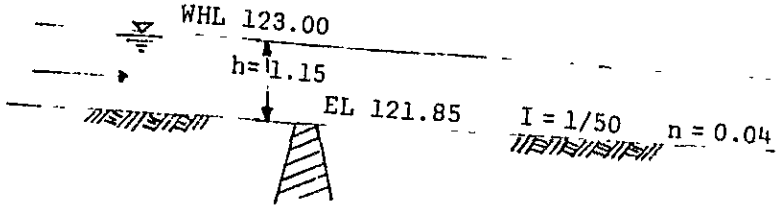
$$h_2 = 1.20 < \frac{2}{3}h_1 = \frac{2}{3} \times 2.85 = 1.90 \quad \text{(Complete overflow)}$$

$$Qf = kb\left(h_1 + \frac{v^2}{2g}\right)^{3/2}$$

$$= 2.0 \times 60.00 \times (2.85 + 2.33)^{3/2} \fallingdotseq 1,410 \text{ cu.m/sec}$$

$$Qm + Qf = 390 + 1,410 = 1,800 > 1,650 \text{ cu.m/sec} \quad O.K$$

Major Bed



$$A = 104.00 \times 1.15 = 119.60 \text{ (sq.m)}$$

$$P = 104.00 + 1.15 = 105.15 \text{ (m)}$$

$$R = \frac{119.60}{105.15} = 1.14 \text{ (m)} \quad R^{2/3} = 1.09 \text{ (m)}$$

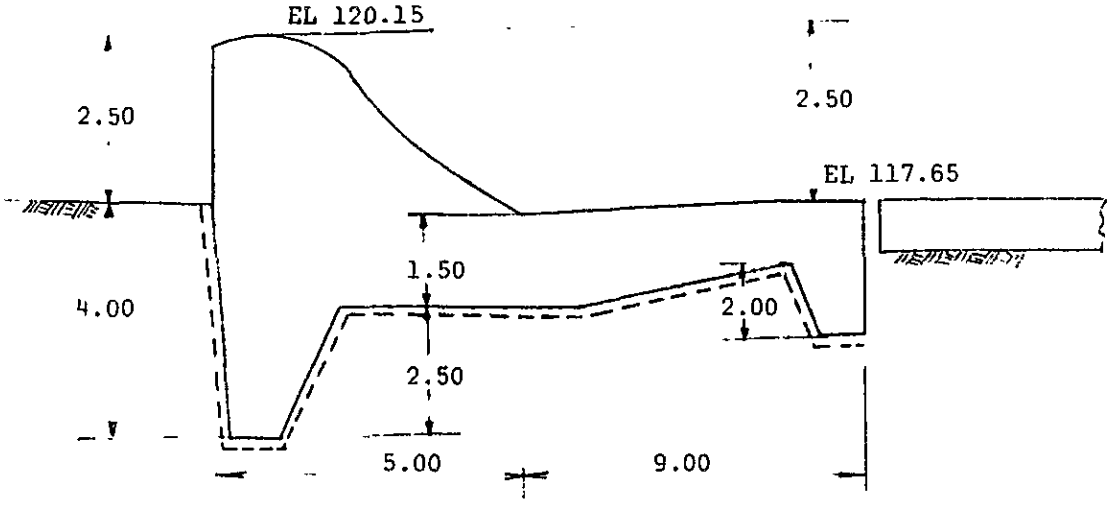
$$V = \frac{1}{n} \cdot R^{2/3} \cdot I^{1/2}$$

$$= \frac{1}{0.04} \times 1.09 \times \left(\frac{1}{80}\right)^{1/2} = 3.05 \text{ (m/sec)}$$

$$Q = 119.60 \times 3.05 \fallingdotseq 360 > 350 \text{ (cu.m)} \quad O.K$$

Therefore, back water shall be determined at HWL 123.00 as assumed.

e) Design of Fixed Weir



(1) Length of Fore-apron

By Bligh Method;

$$\ell f_1 = 0.6 \cdot C \sqrt{D_1}$$

$$= 0.6 \times 9 \times \sqrt{2.50} = 8.53 < 9.00 \text{ (m)}$$

Length = 9.00 m

(2) Piping (Creep Length)

By Bligh Method

$$S = C \cdot \Delta h$$

$$= 9 \times 2.50 = 22.50 \text{ (m)}$$

$$S' = 4.00 + 2.50 + 14.00 + 2.00 = 22.50 \text{ (m)}$$

$S = S'$ O.K

By Lane Method

$$L = c \cdot \Delta h$$

$$= 3.5 \times 2.50 = 8.75 \text{ (m)}$$

$$L' = (4.00 + 2.50 + 2.00) + 1/3 \times 14.00 = 20.66 \text{ (m)}$$

$L < L'$ O.K

(3) Thickness of Fore-apron

$$T_A = \frac{4}{3} \times \frac{\Delta h - hf}{r - 1}$$

$$= \frac{4}{3} \times \frac{2.50 - 1.28}{2.3 - 1} = 1.25 < 1.50 \text{ (m)}$$

$$hf = \frac{\Delta h}{S} \times S' = \frac{2.50}{22.50} \times (4.00 + 2.50 + 5.00) = 1.28 \text{ (m)}$$

Thickness = 1.50 m

(4) Apron Protection Works

By Bligh Method

$$\ell = 0.67 c \sqrt{D_1 q}$$

$\ell fr = \ell - \ell f_1$

$\ell = 0.67 \times 9 \times \sqrt{2.50 \times 23.5} = 46.22$ (m)

where; $q = \frac{1,410}{60} \fallingdotseq 23.5$

$\ell fr = 46.22 - 9.00 = 37.22$ (m)

Length = 40.00 m

2. Other Diversion Dams

The same procedures have been applied to design the scouring sluice of other diversion dams, and its result is given in Table 4D-1. Drawing No. 001 to No. 010 shows the layout of diversion dams.

Table 4D-1 Summary of Scouring Sluice of Diversion Dams

Description	Diversion Dam				
	Labugaon	Solsona	Madongan	Papa	Nueva Era
1. Design discharge for flushing away sediment, Qo: (cu.m/sec)	18	14	27	9	10
2. Gate span, B(m)	8.00	7.00	7.00 x 2	7.00	7.00
3. Traction discharge per unit width, q = (cu.m/sec/m)	2.25	2.00	1.93	1.29	1.43
4. Water velocity for flushing away sediment, Vc: (m/sec)	2.80	2.69	2.66	2.32	2.41
5. Max. particle size of sediment, d(m)	0.17	0.16	0.15	0.12	0.13
6. Critical depth, hc: (m)	0.52	0.41	0.38	0.17	0.21
7. Hight of guide wall, H (m)	1.00	1.00	1.00	1.00	-
- do - (calculated) (m)	(0.77)	(0.61)	(0.57)	(0.25)	-
Elevation of guide wall (m)	EL 112.20	EL 108.85	EL 118.80	EL 133.50	-
8. Slope of scouring sluice canal, I	0.01	0.01	0.01	0.01	-
- do - (calculated)	(0.0077)	(0.0082)	(0.01)	(0.011)	-

Procedure of hydraulic computation on Design of Scouring Sluice

1. Design discharge for flusing away sediment (cu.m/sec): Qo
2. Gate span (m): B
3. Traction discharge per unit width (cu.m/sec/m): $q=\frac{Qo}{B}$
4. Water velocity for flushing away sediment (m/sec): $Vc = (q \times g)^{1/3}$
5. Max. particle size of sediment (m): $d = (\frac{Vc}{6.75})^2$
6. Critical depth (m): $hc = \frac{q^2}{g}$
7. Hight of guide wall (m): $H = \frac{3}{2}hc$
8. Slope of scouring sluice canal (%): $I \geqq \frac{n^2 g}{hc^{1/3}}$

Where; g: acceleration of gravity, 9.8

n: coefficient of roughness, 0.025

Geological Conditions fo the Proposed Diversion Dam Sites

Study on Performed Investigation

The following investigations at the proposed diversion damsites of Labugaon, Solsona, Papa and Madongan have been implement up to date.

Labugaon diversion damsite;

° Bore-hole drillings for the dam axis.

Solsona diversion damsite;

° Bore-hole drillings for the damsite..Bore-hole logs.

Papa diversion damsite;

° Bore-hole drillings for the dam axis..Bore-hole logs.

Madongan diversion damsite;

° Bore-hole drillings for the damsite..Bore-hole logs.

Moreover, 2 bore-hole drillings in total at the site of Labugaon are implementing at present. However, the geological investigation at the diversion damsite of Nueva Era has not been conducted by NIA up to date.

Brief descriptions of the investigation executed are as follows.

1. Bore-hole Drillings

a) Labugaon Diversion Dam Site

1 bore-hole has been drilled by NIA, as shown in the following table.

Location	Hole Number	Drilled Length	Remarks
River Bed	DDH-1		Vertical

b) Solsona Diversion Damsite

5 bore-holes in total as shown in the following table were drilled by NIA.

Location	Hole Number	Drilled Length	Remarks
River Bed	DDH-1	7.70 m	Vertical
River Bed	DDH-2	7.00	Vertical
River Bed	DDH-3	9.00	Vertical
River Bed	DDH-4	10.20	Vertical
River Bed	DDH-5	10.50	Vertical

Location of all bore-holes and each log are indicated in the Figure 4D-2 and Figure 4D-3 respectively.

c) Madongan Diversion Dam Site

5 bore-holes in total as shown in the following table were drilled by NIA.

Location	Hole Number	Drilled Length	Remarks
Left Abutment	DDH-1	91.50 m	Vertical
Left Abutment	DDH-2	45.00	Vertical
River Bed	DDH-3	60.00	Vertical
Right Abutment	DDH-4	45.00	Vertical
Right Abutment	DDH-5	34.50	Vertical

Location of all bore-holes and each log are indicated in the Figure 4D-4 and Figure 4D-5 respectively.

d) Papa Diversion Dam Site

3 bore-holes in total as shown in the following table were drilled by NIA.

Location	Hole Number	Drilled Length	Remarks
River Bed	DDH-1	19.00 m	Vertical
River Bed	DDH-2	14.10	Vertical
River Bed	DDH-3	14.30	Vertical

Location of all bore-holes and each log are indicated in the Figure 4D-6 and Figure 4D-7 respectively.

FIGURE 4D-1 LOCATION MAP OF BORE-HOLE DRILLING AT LABUGAON DAMSITE (SCALE 1:4000)

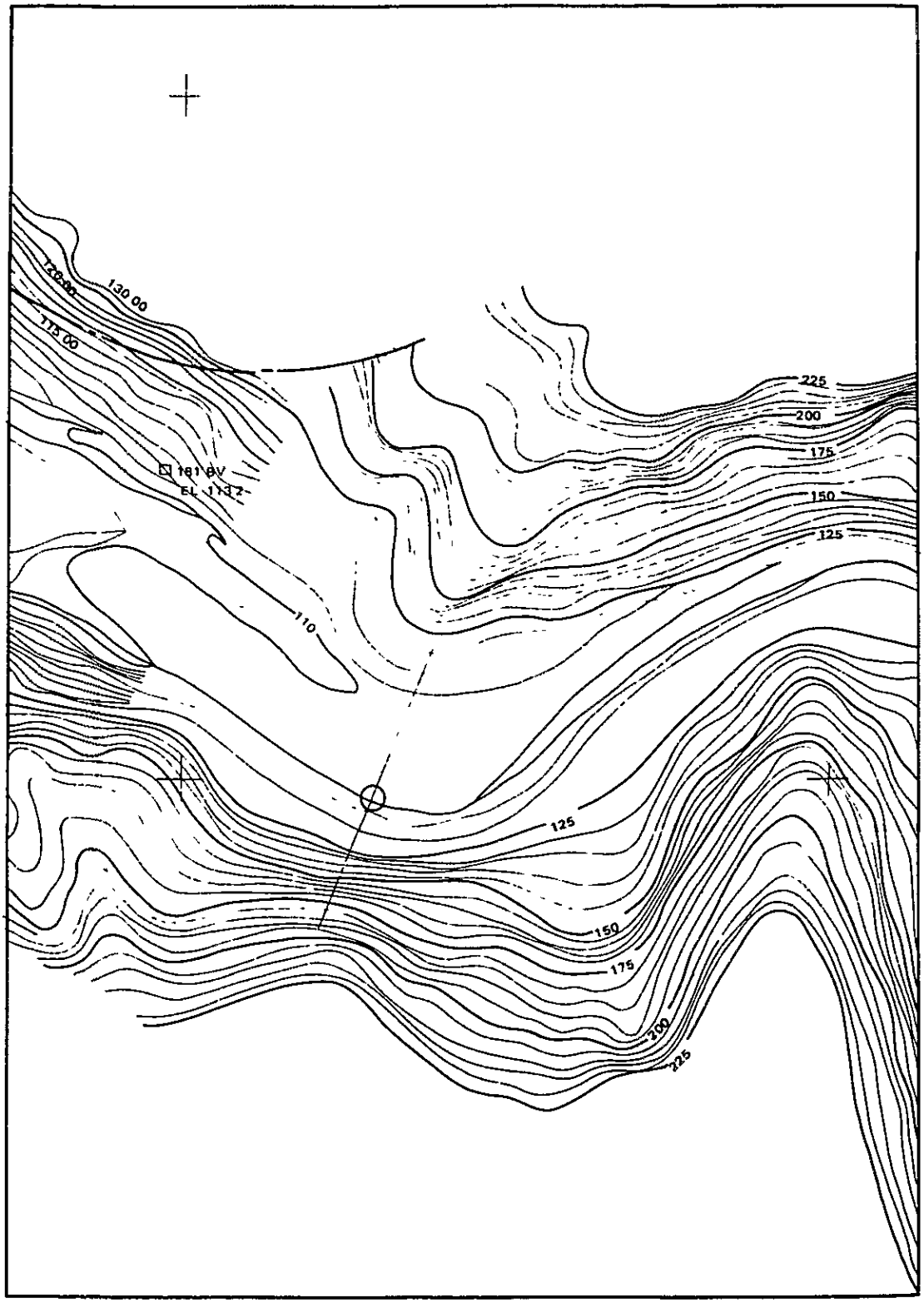


FIGURE 4D-2 LOCATION MAP OF BORE-HOLE DRILLING AT SOLSONA DAMSITE (SCALE 1:4000)

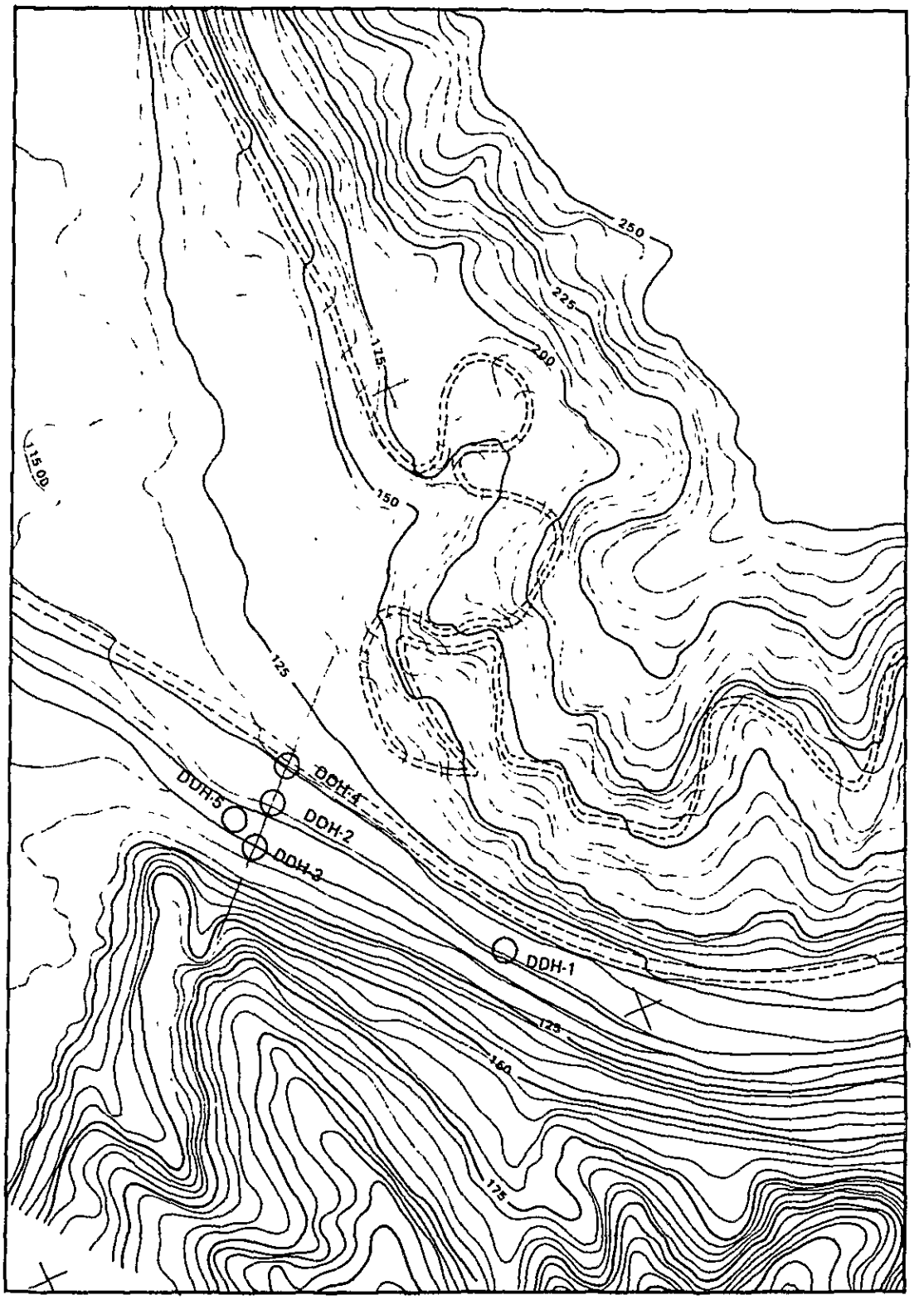
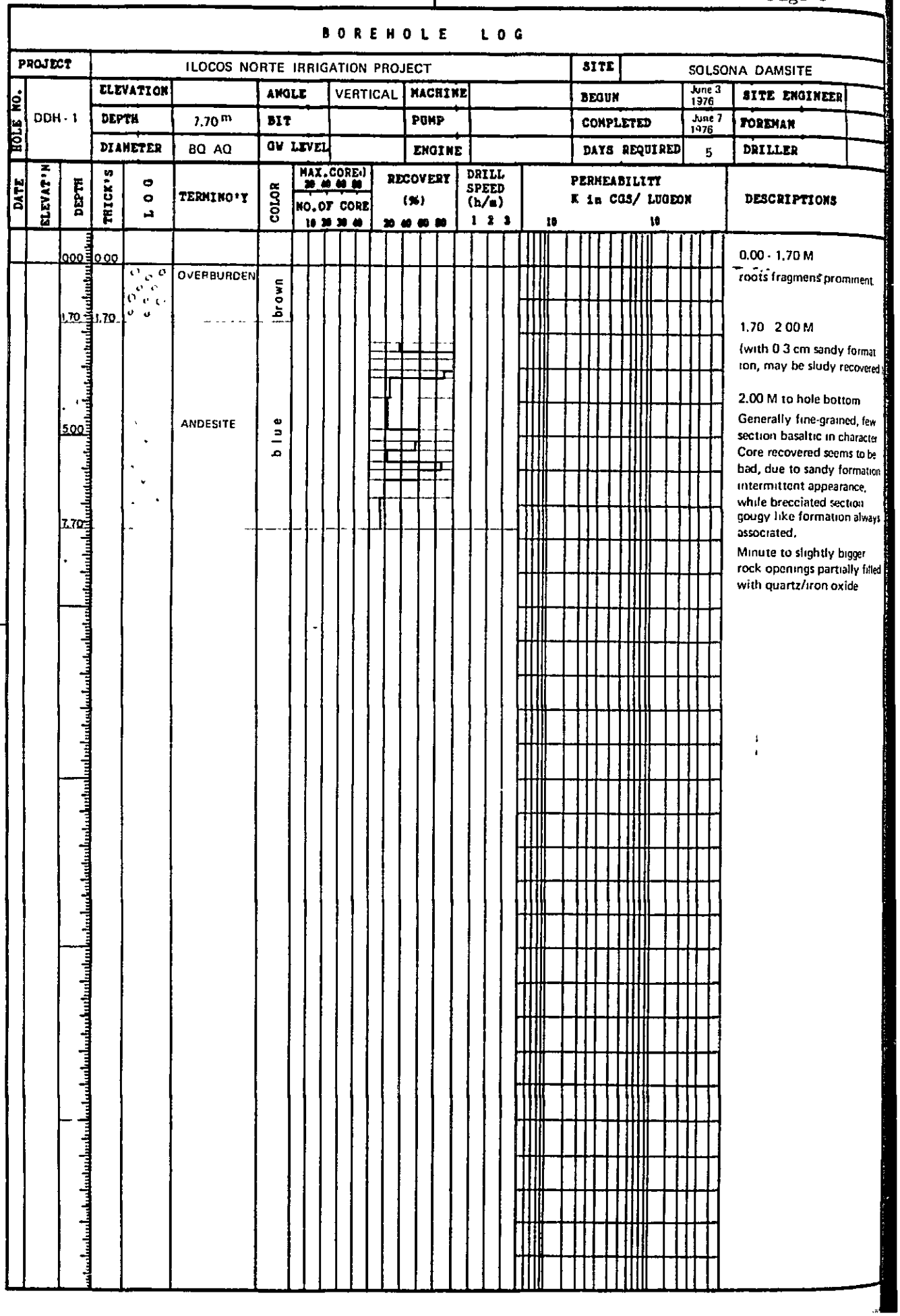


FIGURE 4D-3 BOREHOLE LOG AT SOLSONA DIVERSION DAM SITE



BOREHOLE LOG

PROJECT	ILOCOS NORTE IRRIGATION PROJECT					SITE	SOLSONA DAMSITE		
HOLE NO.	ELEVATION		ANGLE	VERTICAL	MACHINE		BEGUN	June 11 1976	SITE ENGINEER	
DDH 2	DEPTH	7.00 m	BIT		PUMP		COMPLETED	June 15 1976	FOREMAN	
	DIAMETER		GW LEVEL		ENGINE		DAYS REQUIRED	5	DRILLER	

DATE ELEVAT'N	DEPTH	THICK'S	LOG	TERMINO'Y	COLOR	MAX. CORE) NO. OF CORE	RECOVERY (%)	DRILL SPEED (h/m)	PERMEABILITY K in CGS/ LUGEON	DESCRIPTIONS
	0.00	0.00				10 20 30 40	20 40 60 80	1 2 3	10 10	
	1.10	1.10		OVERBURDEN	brown					0.00 - 1.10 M Recovered core composed mostly of hornblende diorite Moderately weathered surfaces covered with iron staining
	2.20	2.20		ANDESITE	white blue					1.10 1.70 M to 2.20 M Hard core recovered slightly fresh with amount of minute quartz/calcitic veins. Gimonitic
	5.00			DIORITE						2.20 M to hole bottom Medium to coarse grained, core slightly in good condition except between 3.86 3.96 meters to 4.71 meters, recognizable gougy like formation intercalated. Slightly becomming silicified in few section
	7.00									

BOREHOLE LOG

PROJECT	ILOCOS NORTE IRRIGATION PROJECT			SITE	SOLSONA DAMSITE		
HOLE NO. DDH - 3	ELEVATION		ANGLE VERTICAL	MACHINE		BEGUN	SITE ENGINEER
	DEPTH	12.30 m	BIT	PUMP		COMPLETED	FOREMAN
	DIAMETER	BQ, AQ	GW LEVEL	ENGINE		DAYS REQUIRED	DRILLER

DATE	ELEVAT'N	DEPTH	THICK'S	LOG	TERMINO'Y	COLOR	MAX. CORE 20 40 60 80 / NO. OF CORE 10 20 30 40	RECOVERY (%) 20 40 60 80	DRILL SPEED (h/m) 1 2 3	PERMEABILITY K in CGS/ LUGEON 10 ... 10
		0.00	0.00							
		3.55	3.55		OVERBURDEN					
		5.00			ANDESITE					
		10.00								
		12.30								

DESCRIPTIONS

0.00 - 3.55 M

Mixture of hard and sub angular to variable sizes/ shapes

Andesite and diorite fragment cores recovered are irregularly traversed by coring bits, expressing boulders encountered

3.55 M to hole bottom

Composed of mostly broken core

Fracture minutes but mostly tight, some are open containing iron oxide with occasional gougy brecciation enclosure.

Rock condition seen between 5.80 - 6.00 meters, also 7.25 meters and 7.15 8.15 meters brecciation with gougy formation enclosure.

8.15 to hole bottom mostly broken core

BOREHOLE LOG

PROJECT	ILOCOS NORTE IRRIGATION PROJECT				SITE	SOLSONA DAMSITE			
HOLE NO. DDH - 4	ELEVATION		ANGLE	VERTICAL	MACHINE		BEGUN		SITE ENGINEER	
	DEPTH	10.20 m	BIT		PUMP		COMPLETED		FOREMAN	
	DIAMETER		GW LEVEL		ENGINE		DAYS REQUIRED		DRILLER	

DATE	ELEVATION	DEPTH	THICKNESS	LOG	TERMINOLOGY	COLOR	MAX. CORE (20 40 60 80) / NO. OF CORE (10 20 30 40)	RECOVERY (%) (20 40 60 80)	DRILL SPEED (h/m) (1 2 3)	PERMEABILITY K in CGS/ LUGEON (10 — 10)	DESCRIPTIONS
		0.00	0.00								
		1.50	1.50		OVERBURDEN						0.00 - 1.50 M OVERBURDEN (River deposit)
		5.00			ANDESITE						1.50 10 20 M Rock itself is hard. Crack surfaces have been polluted by oxide of iron and of red color Core recovered is under gravel like conditions
		10.20									

BOREHOLE LOG

PROJECT	ILOCOS NORTE IRRIGATION PROJECT			SITE	SOLSONA DAMSITE		
HOLE NO.	DDH - 5	ELEVATION		ANGLE	VERTICAL	MACHINE	
		DEPTH	10.50 m	BIT		PUMP	
		DIAMETER		GW LEVEL		ENGINE	

BEGUN		SITE ENGINEER	
COMPLETED		FOREMAN	
DAYS REQUIRED		DRILLER	

DATE	ELEVAT'N	DEPTH	THICK'S	LOG	TERMINO'Y	COLOR	MAX. CORE i) 20 40 60 80 / NO. OF CORE 10 20 30 40	RECOVERY (%) 20 40 60 80	DRILL SPEED (h/m) 1 2 3	PERMEABILITY K in CGS/ LUGEON 10 10	DESCRIPTIONS
		0.00	0.00								
		1.70	1.70		OVERBURDEN						0.00 - 1.70 M OVERBURDEN (River deposit)
		5.00			DIORITE						1.70 - 10.50 M Core recovered is broken and under gravel - like. Rock itself is hard, fresh and compacted
		10.50									

FIGURE 4D-4 LOCATION MAP OF BORE-HOLE DRILLING AT MADONGAN DAMSITE (SCALE L:4000)

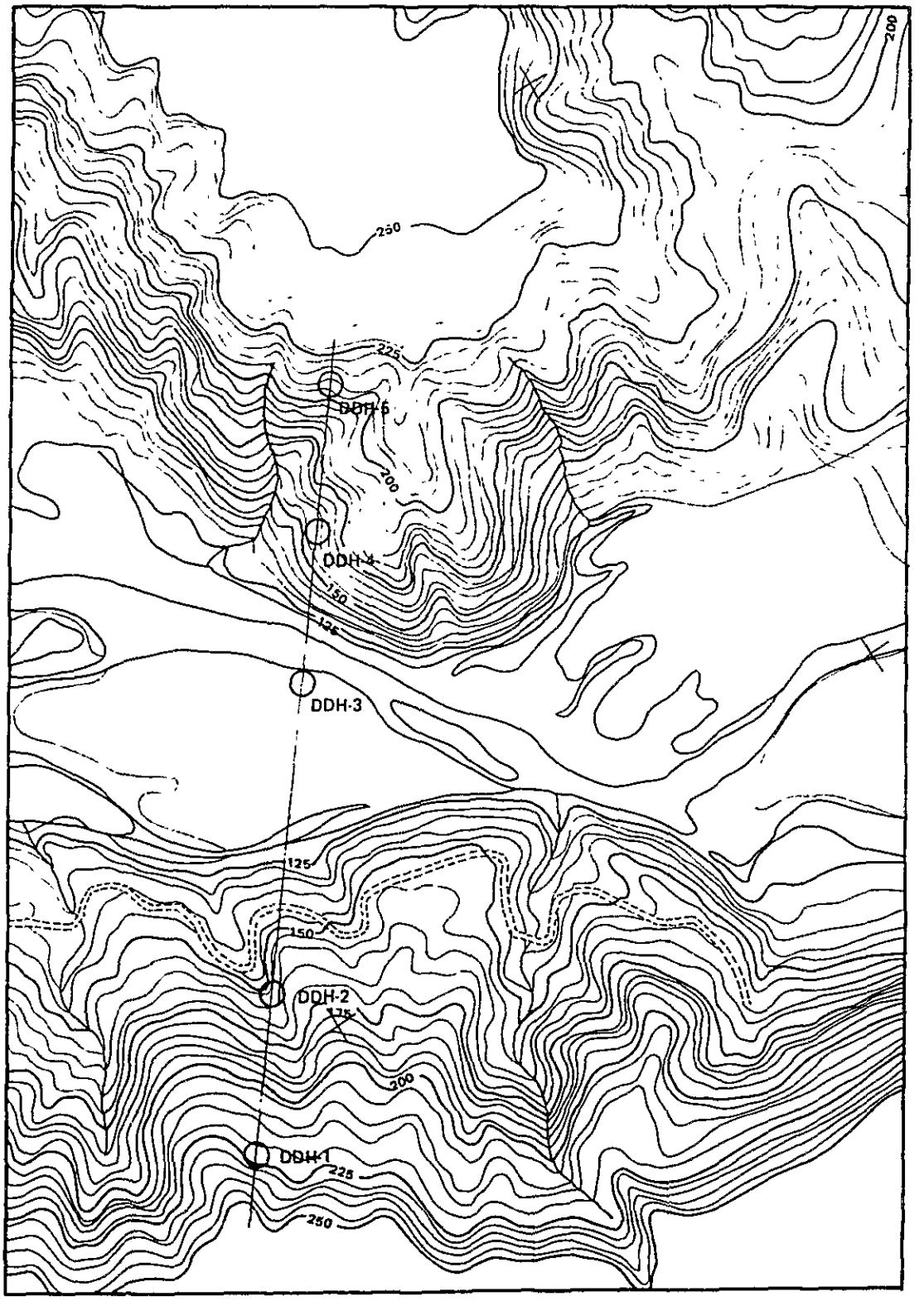
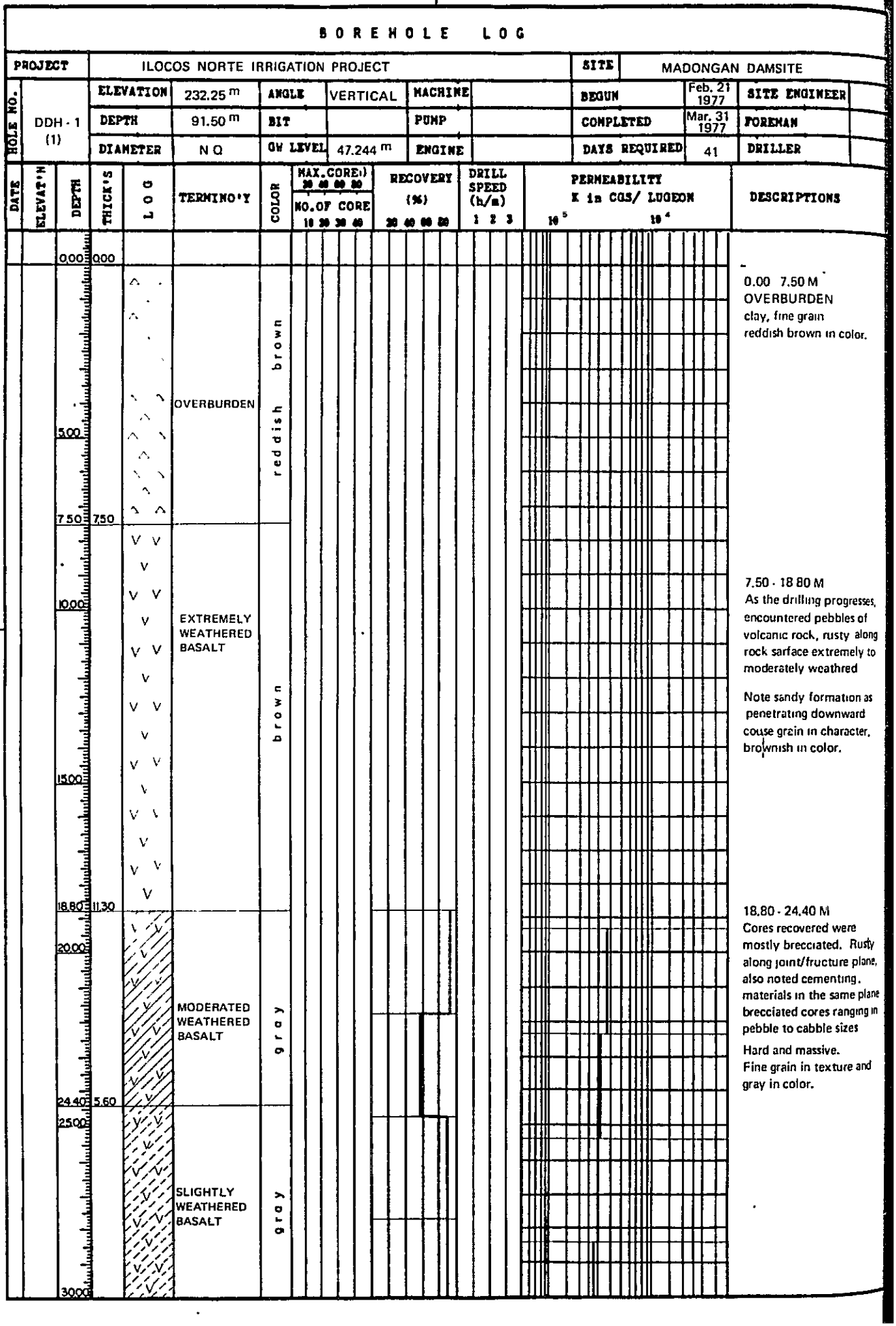


FIGURE 4D-5 BOREHOLE LOG AT MADONGAN DIVERSION DAM SITE



BOREHOLE LOG

PROJECT						SITE					
HOLE NO.	ODH 1 (2)	ELEVATION		ANGLE		MACHINE		BEGUN		SITE ENGINEER	
		DEPTH		BIT		PUMP		COMPLETED		FOREMAN	
		DIAMETER		GW LEVEL		ENGINE		DAYS REQUIRED		DRILLER	

DATE	ELEVAT'N	DEPTH	THICK'S	LOG	TERMINO'Y	COLOR	MAX. CORE/ NO. OF CORE (10 20 30 40)	RECOVERY (%) (20 40 60 80)	DRILL SPEED (h/m) (1 2 3)	PERMEABILITY K in CGS/ LUGEON (10^{-5} – 10^{-4})	DESCRIPTIONS
		30.00									
		35.00									
		40.00			SLIGHTLY WEATHERED BASALT						
		45.00				gray					
		50.00									
		55.00									
	57.95	59.55			BASALT						
		60.00									

24 40 57 95 M
Cores recovered at this section have more solid than the previous run

Maximum length of core is 18 CM and minimum length is 2 5 CM

Note disappiarance of cementing materials along joint plane, but abundant presemt of iron stains

Brecciated cores noted with sharp edges and ranging in pebble and cobble sizes.

Hard and massive fine grain, gray in color

BOREHOLE LOG

PROJECT						SITE			
HOLE NO. DDH-1 (3)	ELEVATION		ANGLE		MACHINE		BEGUN		SITE ENGINEER	
	DEPTH		BIT		PUMP		COMPLETED		FOREMAN	
	DIAMETER		GW LEVEL		ENGINE		DAYS REQUIRED		DRILLER	

DATE	ELEVAT'N	DEPTH	THICK'S	LOG	TERMINO'Y	COLOR	MAX. CORE (20 40 60 80) / NO. OF CORE (10 20 30 40)	RECOVERY (%) (20 40 60 80)	DRILL SPEED (h/m) (1 2 3)	PERMEABILITY K in CGS/ LUGEON (10^5 – 10^4)	DESCRIPTIONS
		6000									
		6500									
		7000			BASALT	gray					
		7500									
		8000									
		8500									
		9000									

57.95 91.00 M

Cores recovered at this section are broken that with sharp edges ranging their sizes from cobbles to pebbles.

Chloritized/epidotized easily disturved with finger pressure.

Noted few cementing materials and iron stains

Cementing materials are more present than the iron stains

Porphyritic in texture

Gray, Massive and Hard

Maximum length of solid core 13 CM and minimum length 3 CM

Water pressure test was not good at section 77.25 m down to 89.45 M becouse the double packer was out of orders or disconnected

BOREHOLE LOG

PROJECT	ILOCOS NORTE IRRIGATION PROJECT					SITE	MADONGAN DAMSITE		
HOLE NO.	ELEVATION	155.00 m	ANGLE	VERTICAL	MACHINE		BEGUN	Apr 14 1977	SITE ENGINEER	
DDH 2 (1)	DEPTH	45.00 m	BIT		PUMP		COMPLETED	May. 23 1977	FOREMAN	
	DIAMETER	NQ	GW LEVEL	40.80 m	ENGINE		DAYS REQUIRED	38	DRILLER	

DATE	ELEVAT'N	DEPTH	THICK'S	LOG	TERMINO'Y	COLOR	MAX. CORE (1) / NO. OF CORE	RECOVERY (%)	DRILL SPEED (h/m)	PERMEABILITY K in CGS/ LUGEON	DESCRIPTIONS
		0.00	0.00								
		3.60	3.60		OVERBURDEN	gray					
		5.00			MODERERATELY WEATHERED BASALT	gray					
		8.10	4.50								
		10.00			SLIGHTLY WEATHERED BASALT	gray					
		12.20	4.10								
		15.00									
		20.00			BASALT	gray					
		25.00									
		30.00									

'0.00 - 3.60 M

Pebbles, cobbles and boulders. The boulders are mostly from diorite.

Medium to coarse grain

Light gray to gray in color.

3.60 - 12.20 M

Gray, moderately hard but breaks at moderately hammer blows

Heavily fractured to intensive jointing note abundant presece of iron stains especially along joint planned

Maximum length of solid core is 18 CM and minimum length is 3 CM.

Porphyritic texture

12.20 - 30.00 M

Core recovered are more solid than the previous run.

Noted epidote/chlorite along the core still with presence of iron stains but as penetrete + deeper fewer presence of iron stains and sometimes none.

Also noted cementing materials.

Gray in color.

Moderately to hard that also hard with hammer blows.

Maximum length of solid core is 18 CM and minimum length is 4 CM.

BOREHOLE LOG

PROJECT						SITE			
HOLE NO.	DDH - 2 (2)	ELEVATION		ANGLE		MACHINE		BEGUN		SITE ENGINEER	
		DEPTH		BIT		PUMP		COMPLETED		FOREMAN	
		DIAMETER		GW LEVEL		ENGINE		DAYS REQUIRED		DRILLER	

DATE	ELEVAT'N	DEPTH	THICK'S	LOG	TERMINO'Y	COLOR	MAX.CORE) 20 40 60 80 / NO.OF CORE 10 20 30 40	RECOVERY (%) 20 40 60 80	DRILL SPEED (h/m) 1 2 3	PERMEABILITY K in CGS/ LUGEON 10^{-5} 10^{-4}	DESCRIPTIONS
		3000									
		3500			BASALT	gray					
		4000									
		4500									

30 0 45 00 M

Hard and massive, gray in color.

Noted chlorite/epidote along this section

Chloritized section easily disturved with finger pressure noted only few cementing materials and iron stains

Porphyritic in texture

Maximum length of solid core is 13 CM and minimum length is 5 CM

BOREHOLE LOG

PROJECT	ILOCOS NORTE IRRIGATION PROJECT					SITE	MADONGAN DAMSITE		
HOLE NO.	ELEVATION		ANGLE	VERTICAL	MACHINE		BEGUN	Feb 1 1977	SITE ENGINEER	
DDH - 3 (1)	DEPTH	60.00 m	BIT		PUMP		COMPLETED	May 21 1977	FOREMAN	
	DIAMETER		GW LEVEL	0.92 m	ENGINE		DAYS REQUIRED	49	DRILLER	

DATE	ELEVATION	DEPTH	THICKNESS	LOG	TERMINOLOGY	COLOR	MAX. CORE (%) 20 40 60 80 / NO. OF CORE 10 20 30 40	RECOVERY (%) 20 40 60 80	DRILL SPEED (h/m) 1 2 3	PERMEABILITY K in CGS/ LUGEON 10^{5} 10^{4}	DESCRIPTIONS
		0.00	0.00								
		5.00	5.40		OVERBURDEN	light gray					0.00 - 6.40 M Pebbles, cobbles and boulders The boulders are mostly from diorite and qurtz diorite. Medium to coarse grain Light gray to gray in color.
		5.40									6.40 - 12.20 M Slightly grading to basaltic andesite. Fine grain. Gray in color. Core generally brocken Presence of iron stain and calcite along joint and fracture plane.
		10.00			SLIGHTLY WEATHERED BASALT	gray					
		12.20	5.80								
		15.00									
		20.00			BASALT	gray					12.20 - 60.00 M Joints/Fracture dipping staply. 18 to 33 meters chloritized or epidotited core generally in poor condition when finger pressure is applied comparable to those non-cholritized/ epidotized. Porpyritic texture is also noted with quartz as phenocryst. Section 18.0 meters - 33.0 meters are brecciated zone.
		25.00									
		30.00									

BOREHOLE LOG

PROJECT					SITE		
HOLE NO.	DDH - 3 (2)	ELEVATION		ANGLE		MACHINE		BEGUN		SITE ENGINEER	
		DEPTH		BIT		PUMP		COMPLETED		FOREMAN	
		DIAMETER		GW LEVEL		ENGINE		DAYS REQUIRED		DRILLER	

DATE	ELEVATION	DEPTH	THICKNESS	LOG	TERMINOLOGY	COLOR	MAX. CORE (20 40 60 80) / NO. OF CORE (10 20 30 40)	RECOVERY (%) (30 40 60 80)	DRILL SPEED (h/m) (1 2 3)	PERMEABILITY K in CGS/ LUGEON (10^{-5} – 10^{-4})	DESCRIPTIONS
		3000									
		3500									Cores recovered were mostly brecciated and broken Rocks itself are hard and massive
		4000			BASALT						
		4500				gray					Intermetent appearance of pyrite on solid core
		5000									
		5500									
		6000									

BOREHOLE LOG

PROJECT	ILOCOS NORTE IRRIGATION PROJECT					SITE	MADONGAN DAMSITE		
HOLE NO.	ELEVATION		ANGLE	VERTICAL	MACHINE		BEGUN	Jul 9 1977	SITE ENGINEER	
DDH - 4 (1)	DEPTH	45.00 m	BIT		PUMP		COMPLETED	Jul 22 1977	FOREMAN	
	DIAMETER	NQ	GW LEVEL		ENGINE		DAYS REQUIRED	24	DRILLER	

DATE	ELEVAT'N	DEPTH	THICK'S	LOG	TERMINO'Y	COLOR	MAX. CORE: NO. OF CORE	RECOVERY (%)	DRILL SPEED (b/s)	PERMEABILITY K in CGS/ LUGEON	DESCRIPTIONS
		000	0.00				10 20 30 40	20 40 60 80	1 2 3	10 10	
		5.00			OVERBURDEN	yellowish brown					0.00 14.00 M Glay, yellowish brown with few pebbes and cobbles of moderately to extremely andesitic rock Pebbles exibit different degrees of weathering and hardness
		10.00			OVERBURDEN EXTREMELY WEATHERED BASALT	yellowish brown					
		14.00	14.00								
		15.00			SLIGHTLY WEATHERED BASALT	light gray					14.00 - 21.35 M Light gray. Heavily fractured due to intensive jointings Moderately hard but breaks at moderate hummer blows Joints/fracture generally filled up with qtz. and calcite materials.
		20.00									
		21.35	7.35								
		25.00			BASALT	light gray					
		30.00									

BOREHOLE LOG

PROJECT						SITE			
HOLE NO.	DDH 4 (2)	ELEVATION		ANGLE		MACHINE		BEGUN	SITE ENGINEER
		DEPTH		BIT		PUMP		COMPLETED	FOREMAN
		DIAMETER		GW LEVEL		ENGINE		DAYS REQUIRED	DRILLER

DATE	ELEVAT'N	DEPTH	THICK'S	LOG	TERMINO'Y	COLOR	MAX. CORE: 20 40 60 80 / NO. OF CORE 10 20 30 40	RECOVERY (%) 20 40 60 80	DRILL SPEED (h/m) 1 2 3	PERMEABILITY K in CGS/ LUGEON 10^{5} – 10^{4}	DESCRIPTIONS
		3000									-
		3500			BASALT	light gray					21 35 45 00 M Rock generally hard and massive with minor broken section Longest core is 18 CM Joint planes exhibt very few limonite stains Rock massive with few steeply dipping irregular cracks with calcites and qtz fillings Joint with calcites fillings and oriented 50 70 degrees from the horizontal Note Water pressure test was not conducted at section 41 05 44 10 because the double packer was disconnected
		4000									
		4500									

BOREHOLE LOG

PROJECT	ILOCOS NORTE IRRIGATION PROJECT				SITE	MADONGAN DAMSITE	
HOLE NO. DDH - 5 (1)	ELEVATION		ANGLE	VERTICAL	MACHINE	BEGUN	SITE ENGINEER
	DEPTH	34.50 m	BIT		PUMP	COMPLETED	FOREMAN
	DIAMETER	NQ	GW LEVEL		ENGINE	DAYS REQUIRED	DRILLER

DATE	ELEVAT'N	DEPTH	THICK'S	LOG	TERMINO'Y	COLOR	MAX. CORE (%) 20 40 60 80 / NO. OF CORE 10 20 30 40	RECOVERY (%) 20 40 60 80	DRILL SPEED (h/m) 1 2 3	PERMEABILITY K in CGS/ LUGEON 10^{-5} 10^{-4}	DESCRIPTIONS
		0.00	0.00								
		5.00			OVERBURDEN	brown					0.00 - 15.25 M Clay, light brown to dark brown in color with few pebbles of moderately to extremely weathered basalts. Exibits platicity when wet and when dry friable with finger print
		10.00	10.00								
		15.00			OVERBURDEN EXTREMELY WEATHERED BASALT	brown					15.25 - 25.40 M Cores recovered were mostly brecciated. Abundant presence of iron stains along joint/fracture planes. Joints oriented 40 - 50 degrees from horizontal. Moderately hard to very hard Gray in color.
		15.25	5.25								
		20.00			MODERATELY WEATHERED BASALT	gray					
		25.00									
		25.40	10.15								25.40 - 26.50 M Encountered moderately weathered diorits. Friable with finger prints, easily disturved whitish brown in color this is probably asill.
		29.00	3.60		SLIGHTLY WEATHERED BASALT	gray					
		30.00			BASALT						

BOREHOLE LOG

PROJECT								SITE			
HOLE NO.	DDH - 5 (2)	ELEVATION		ANGLE		MACHINE		BEGUN		SITE ENGINEER	
		DEPTH		BIT		PUMP		COMPLETED		FOREMAN	
		DIAMETER		GW LEVEL		ENGINE		DAYS REQUIRED		DRILLER	

DATE	ELEVATION	DEPTH	THICKNESS	LOG	TERMINOLOGY	COLOR	MAX. CORE / NO. OF CORE	RECOVERY (%)	DRILL SPEED (h/m)	PERMEABILITY K in CGS/ LUGEON	DESCRIPTIONS
		30.00			BASALT	Gray					29.00 - 34.50 M -Gray, noted-chlorite/epidote along this section. Massive with minor broken sections. Difficult with hammer blows Still abundant presence of iron stains especcially along the joint planes
		34.50									

FIGURE 4D-6 LOCATION MAP OF BORE-HOLE DRILLING AT PAPA DAMSITE (SCALE 1:4000)

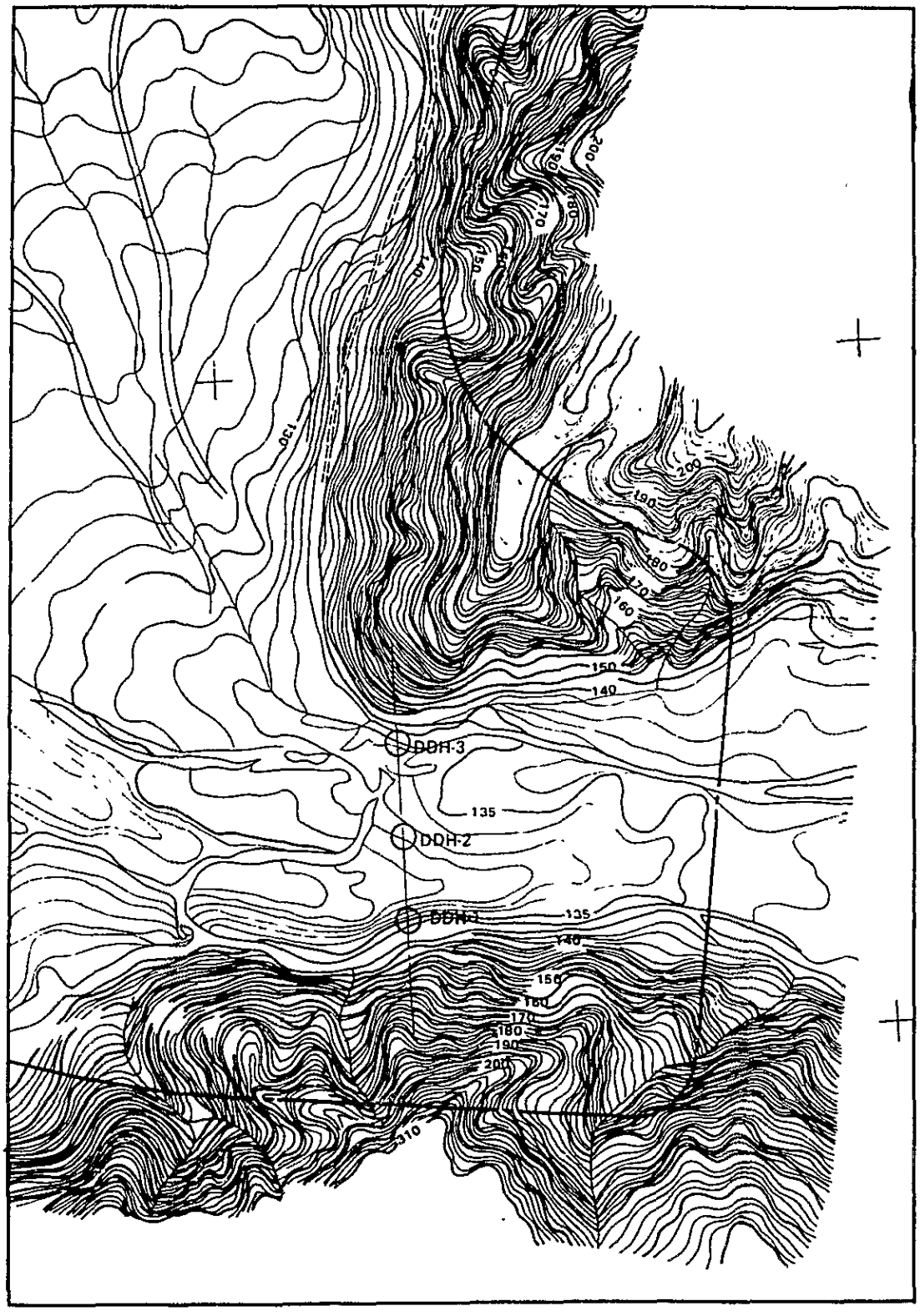


FIGURE 4D-7 BOREHOLE LOG AT PAPA DIVERSION DAM SITE