FEASIBILITY REPORT
ON
ILOCOS NORTE IRRIGATION PROJECT
IN
THE PHILIPPINES
(PHASE I)
APPENDIX

MAY 1979

JAPAN INTERNATIONAL COOPERATION AGENCY

FEASIBILITY REPORT
O N
ILOCOS NORTE IRRIGATION PROJECT
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THE PHILIPPINES
(PHASE I)
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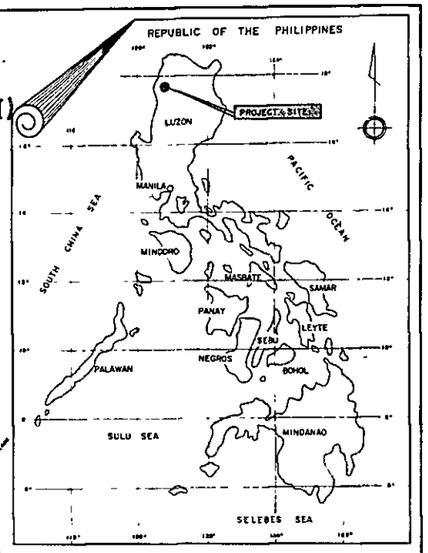
JAPAN INTERNATIONAL COOPERATION AGENCY

GENERAL PLAN FOR ILOCOS NORTE IRRIGATION PROJECT (PHASE I)



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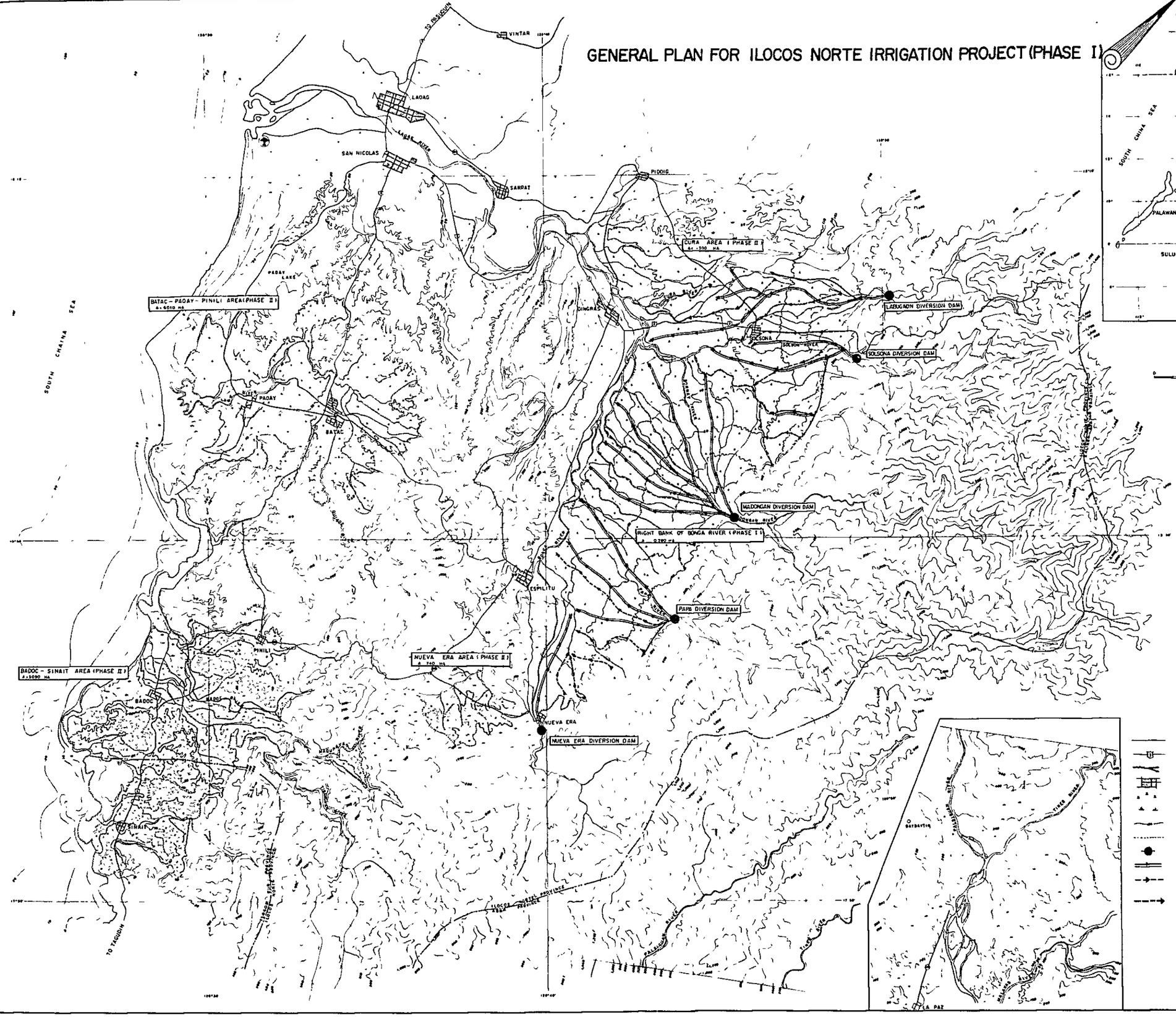
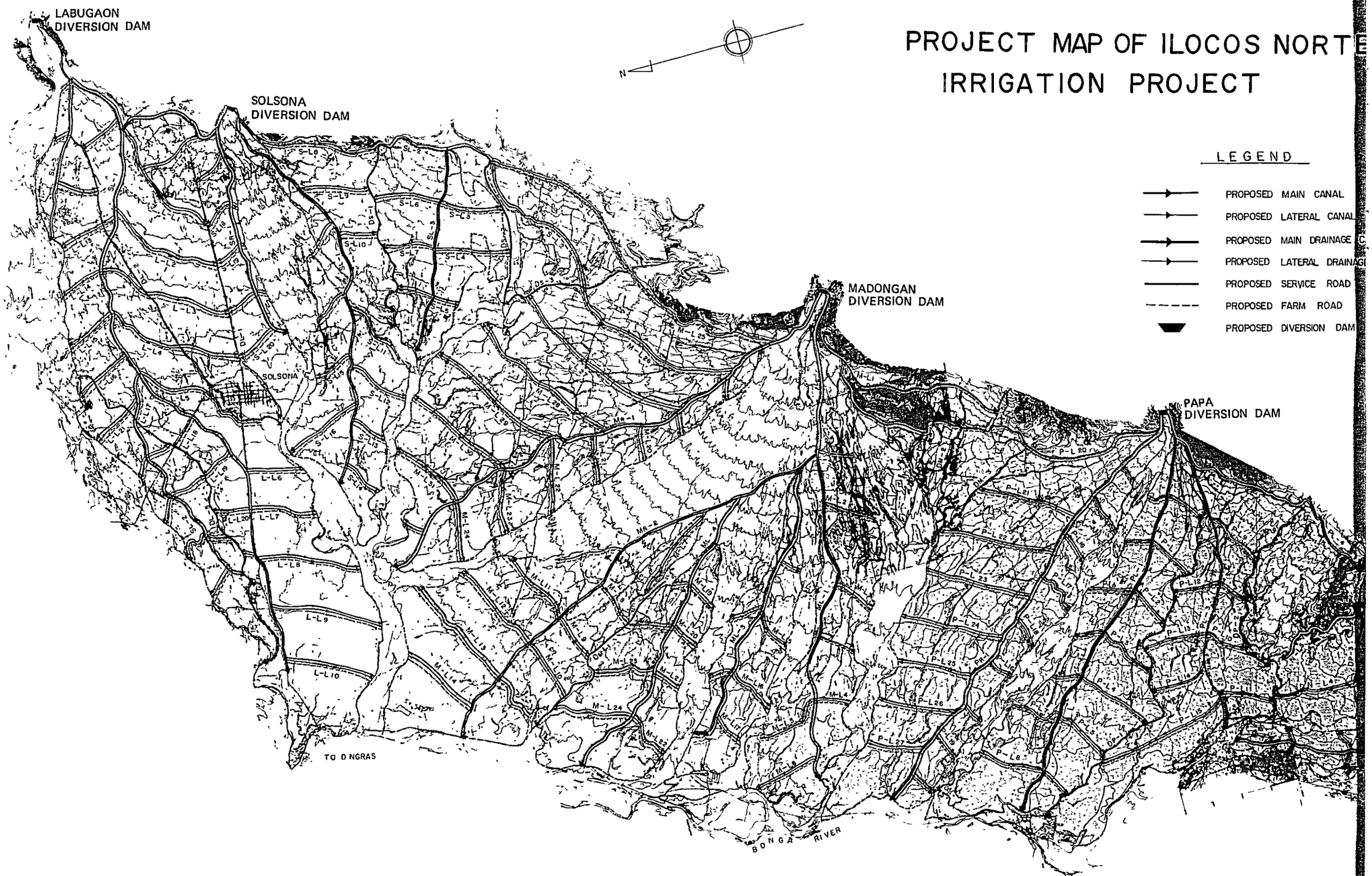


LEGEND

- BOUNDARY OF PROVINCE
- NATIONAL AND PROVINCIAL ROADS
- RIVER AND RIVER WASHED AREA
- TOWN
- EXISTNG PADDY FIELDS
- TROPICAL GRASS LAND
- CONTOUR LINE
- BOUNDARY OF BENEFICIAL AREA
- PROPOSED DIVERSION DAM
- PROPOSED MAIN IRRIGATION CANAL AND ROAD
- PROPOSED MAIN DRAINAGE CANAL (NEWLY CONSTRUCTED)
- PROPOSED MAIN DRAINAGE CANAL (EXISTNG RIVER OR CREEK)

PROJECT MAP OF ILOCOS NORTE IRRIGATION PROJECT



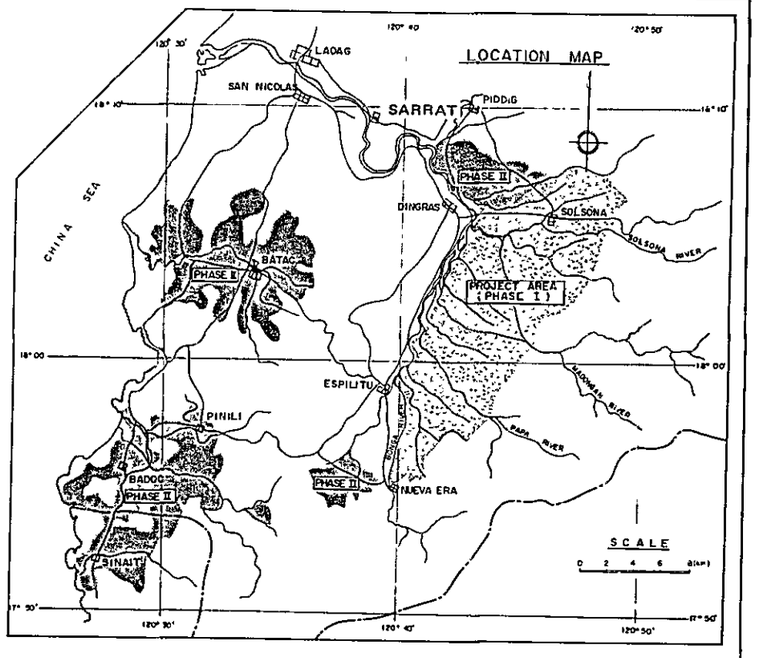
PROJECT MAP OF ILOCOS NORTE IRRIGATION PROJECT

N

LEGEND

- PROPOSED MAIN CANAL
- PROPOSED LATERAL CANAL
- PROPOSED MAIN DRAINAGE CANAL
- PROPOSED LATERAL DRAINAGE CANAL
- PROPOSED SERVICE ROAD
- PROPOSED FARM ROAD
- PROPOSED DIVERSION DAM

LOCATION MAP



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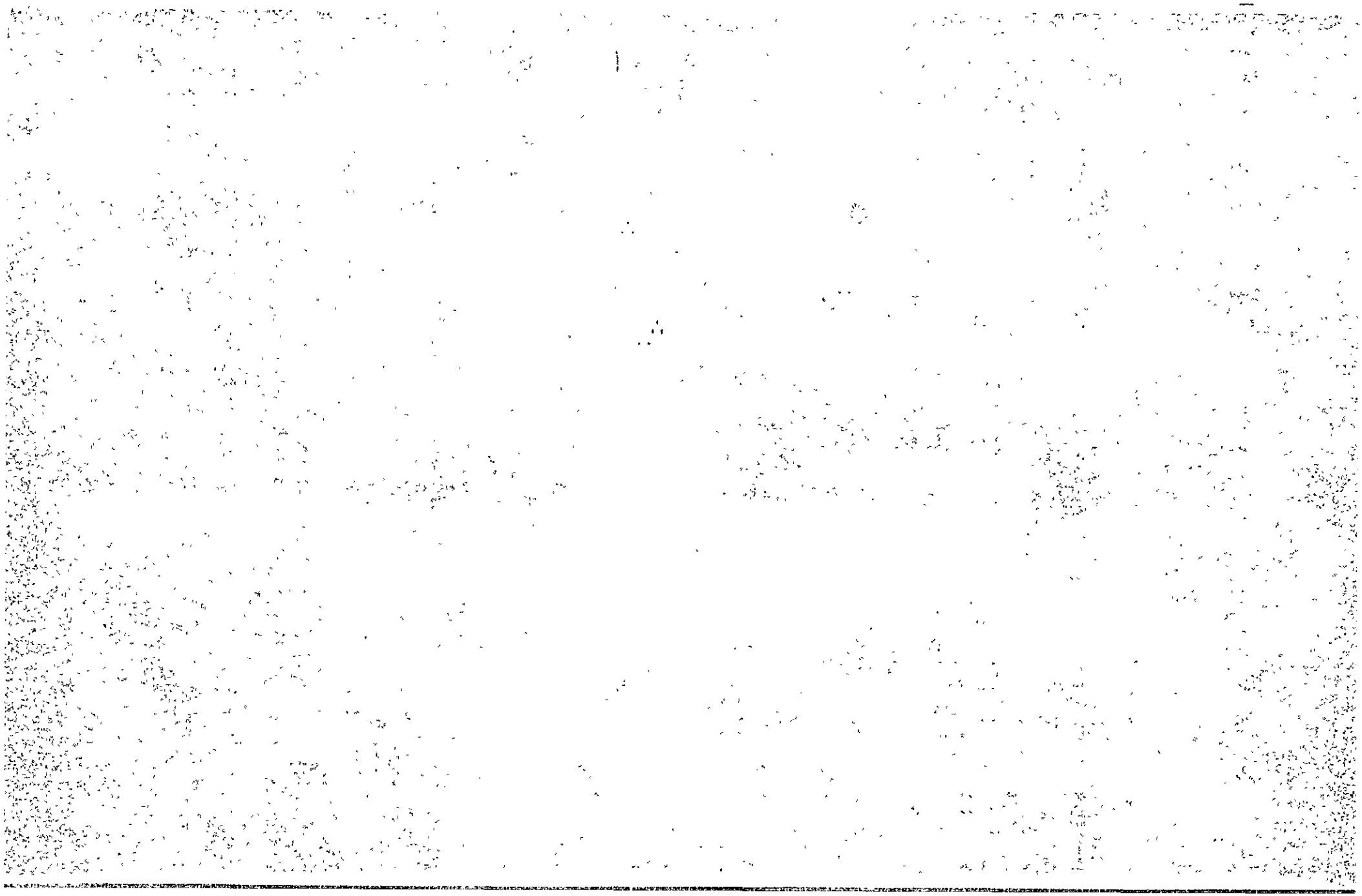

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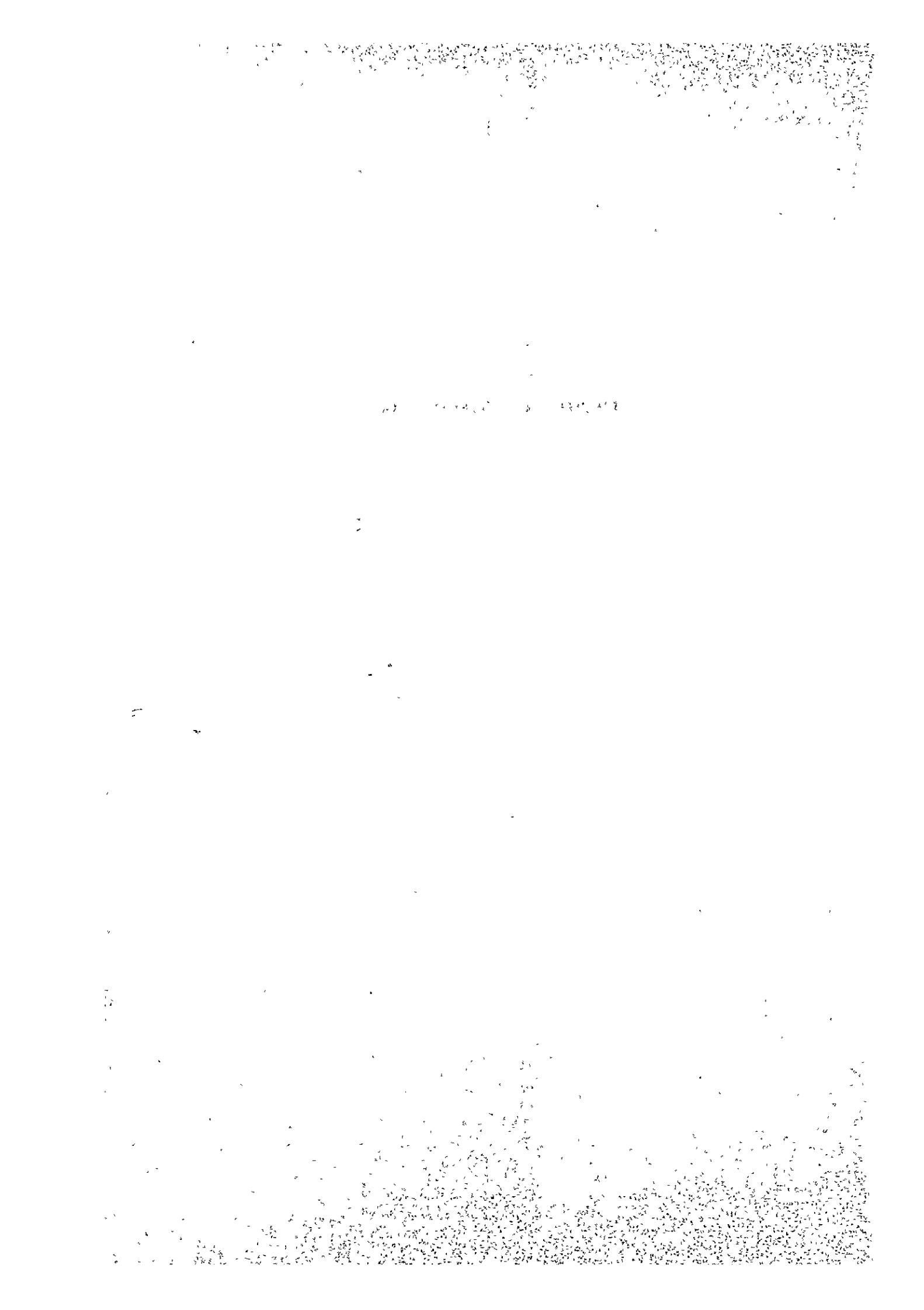

Personnel Concerns the Team Contacted

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Hon Atroy V. Barbero	Governor of Abra Province
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Hon Atty E.P.Acosta Aguinald	Mayor of Manicipality Batac
Hon Felis A. Aguinaldo	Mayor of Manicipality Pasuguin
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Mr. Engr P. Mon Viernes	District Land Officer, BL
Mr. Francisco A. Abad	Provincial Incharge, BAEcon

Data List used for Feasibility Study

A. Hydrology

1. Daily rainfall at Laoag and Vigan, prepared by PAGASA
2. Daily Discharge on Solsona, Bonga, Laoag, Tineg and Abra rivers, prepared by Water Supply Bulletin
3. NISIS, Package I, Appendix A, Hydrology, prepared by NIA

B. Geology and Soil

Geology

4. Result of Boring Test at the Proposed Diversion Sites at Labugaon, Solsona, Papa and Madongan, conducted by NIA, 1977

Soil

5. Summary of Soil and Land Classification (Ilocos Norte Area Development Project), prepared by NIA, 1976
6. Revised Soil Map, prepared by NIA, 1978
7. Revised Present Land Use Map, prepared by NIA, 1978.
8. Revised Land Classification Map, prepared by NIA, 1978

C. Irrigation and Drainage

Maps

9. Military Map showing Province of Ilocos Norte, Ilocos Sur and Abra, 1/50,000
10. Topographic Map of the Project Area, 1/4,000

Reports and Other Data

11. Project Identification Report "Palsiguan River Multi-purpose Project, prepared by NIA, 1977

12. National Irrigation System Improvement Project, Package I, prepared by NIA, 1976
13. Appraisal Report of the National Irrigation System Improvement Project I, prepared by IBRD, 1977
14. Preliminary Report on Ilocos Norte Irrigation Project, prepared by JICA Survey Team, 1977
15. Appraisal Report of the Technical Assistance to the Republic of the Philippines for the Ilocos Norte Rural Development Project, prepared by ADB, 1976
16. Ilocos Norte Rural Development Project, Road Component, prepared by PPDO, DPH, 1977
17. Communal Irrigation Systems and Their Irrigation Areas in the Project Area as of 1977
18. Nine National Irrigation System Improvement Project in the Vicinity of the Project Area
19. Irrigation Project Plans by FSDC in the Vicinity of the Project Area
20. Quiom-Maypalig Irrigation Project Plan
21. Percolation Test at Paddy Field and Infiltration Test at Upland Fields conducted by NIA.
22. Flood Damages on Agricultural Crops in Ilocos Norte Province

D. Agriculture

23. Estimated Area Harvested, Production, Yield of Palay, Corn, Tabacco, Garlic and Mongo Bean by Manicipality (1972-1978), prepared by BAEcon in Ilocos Norte
24. Barangay Screening Survey by Manicipality, prepared by BAEcon in Ilocos Norte, 1976
25. Number of Farmers, Area Harvested and Production of Paddy Rice under Masagana 99 by Manicipality (Phase VII-X), prepared by BPI in Ilocos Norte

26. Recommended Paddy Rice Varieties in 1978 for Masagana 99 prepared by NFAC, 1977

27. Philippine Virgina Tobacco, Production, Processing and Marketing, prepared by PVTA, 1964

28. Masagana 99 Rice Culture, 16 Steps, prepared by DA, 1978

29. Philippines Recommends for Vegetables, prepared by PCARR, 1977

30. Grow Garlic for Profit, prepared by NFAC/UPLB, 1977

31. Census of Agriculture, 1971, prepared by NCASO, NEDA

32. Agronomic Survey in the Palsiguan Irrigation Project Area, prepared LRED, NIA, 1978

E. Design and Cost Estimate

Maps

33. Profile of Each Diversion Dam Axis, prepared by NIA

34. Parcellary and Topographic Map of Water Management, Laoag-Vintar Irrigation System, 1/4,000, prepared by NIA Provincial Office, Laoag City

35. Topographic Map of Sample Area, No. 1 and No. 2, 1/2,000, prepared by NIA

36. Parcellary and Topographic Map of Water Management, Quiom Maypalig Irrigation System

Reports and Other Data

37. Canals and Related Structures, prepared by U.S. Bureau of Reclamation

38. Criteria for Diversion Dam, prepared by Agricultural Structural Improvement Bureau, Ministry of Agriculture, Forestry and Fishery, Japan

39. Jaraul River Multi-Purpose Project Report, prepared by NIA

40. Report on the Workshop in Water Management, prepared by NIA, 1978

41. Operation Cost of Equipment by Using Heavy Equipment, prepared by Yasuo Itami

42. Construction Planning Equipment and Method, prepared by R.L Peurifoy

F. Economy

43. Integrated Census of the Population and Its Economic Activities, 1975, prepared by Ilocos Norte National Census and Statistical Office, NEDA, 1975

44. Census of Population, Ilocos Norte, prepared by NCSO, NEDA, 1970

45. Population Dimension of Planning, Population Projection of Cities and Manicipalities in the Philippines, 1970-2000, prepared by NEDA, 1975

46. Philippine Statistical Yearbook, prepared by NEDA, 1977

47. The Philippines, Priorities and Prospects for Development, A World Bank Country Economic Report, prepared by NEDA, 1976

48. Long-Term and Five Year (1976-1982) Development Plans Draft Summary, prepared by NEDA, 1977

49. Grain Industry Development Plan, Planning Issue, prepared by NGA, 1976

50. Farm Management Survey, Sum Up Data, prepared by Economic Section, LRED, NIA, 1978

51. The Philippines Gold Leaf, 1978, prepared by PVTA

52. Garlic Marketing, prepared by DA, 1974

53. Garlic Production and Marketing, prepared by DA, 1978

54. Philippine Economic Indicators, prepared by NEDA, 1978

CHAPTER II. ECONOMIC AND SECTORAL BACKGROUND

Table 2B-1 Regional Population Targets, 1975-2000

(Unit: '000₱)

	1975	1977	1982	1987	2000
1. Philippines	42,517	45,252	52,348	59,204	83,444
2. Luzon	22,927	24,551	28,606	32,344	44,485
Region I	3,310	3,437	3,778	4,170	5,387
II	1,933	2,039	2,324	2,642	3,660
III	4,402	4,908	6,041	6,735	8,940
IV - (MMA)	5,212	5,692	6,904	8,043	11,905
IV - A	4,823	5,117	5,868	6,639	9,180
V	3,247	3,358	3,691	4,115	5,413
3. Visayas	9,791	10,088	10,958	11,937	15,479
Region VI	3,896	3,998	4,313	4,739	6,029
VII	3,371	3,500	3,867	4,312	5,704
VIII	2,524	2,590	2,778	2,922	3,746
4. Mindanao	9,799	19,613	12,784	14,887	23,480
Region IX	2,233	2,387	2,803	3,265	2,891
X	2,421	2,634	3,197	3,797	5,966
XI	2,812	3,088	3,817	4,555	7,274
XII	2,333	2,504	2,967	3,270	5,349

Source: Long-Term and Five Year (1978-82) Development Plans (Draft Summary), 1977

Table 2B-2 Gross Domestic Products by Industry (1971-1976)
(1972 year Constant Price)

Industry	G D P (10 peso)						Growth Rate (%)				
	1971	1972	1973	1974	1975	1976	1971/72	1972/73	1973/74	1974/75	1975/76
Agriculture etc.	15,457	16,040	17,026	17,465	18,095	19,144	3.77	6.15	2.58	3.61	5.80
Mining	1,282	1,346	1,400	1,403	1,423	1,457	4.99	4.01	2.14	1.43	2.39
Manufacture	12,611	13,388	15,252	15,981	16,537	17,464	6.16	13.92	4.78	3.48	5.61
Construction	1,889	2,240	2,433	2,665	4,059	4,952	18.58	8.62	9.54	52.31	22.00
Electric etc.	440	468	501	581	618	664	6.37	7.05	15.97	6.37	7.44
Commercial	12,484	12,688	13,589	14,200	14,991	15,786	1.63	7.10	4.50	5.57	5.30
Service	7,179	7,487	8,073	8,680	9,124	9,525	4.29	7.83	7.52	5.12	4.40
Transportation	2,184	2,418	2,657	2,933	3,263	3,491	10.71	9.88	10.39	11.25	6.99
G D P	53,526	56,075	60,931	63,908	68,291	72,576	4.76	8.66	4.80	6.87	6.27

Source: NEDA, Philippine Economic Indicators, Sept. 1976

Table 2B-3 Per Capita Gross Regional Domestic Product, 1975-2000

Item	In Pesos at 1972 Prices per Person				
	1975	1977	1982	1987	2000
1. Philippines	1,601	1,734	2,150	2,807	5,617
2. Luzon	1,911	2,047	2,483	3,207	6,122
Region I	955	1,026	1,226	1,834	3,655
II	917	1,016	1,312	2,013	3,970
III	1,300	1,324	1,701	2,295	5,505
IV - (MMA)	4,515	4,637	5,087	5,848	9,174
IV - A	1,529	1,719	2,329	3,004	6,637
V	791	886	1,163	2,019	3,463
3. Visayas	1,333	1,462	1,828	2,346	5,239
Region VI	1,728	1,877	2,285	2,666	5,442
VII	1,257	1,405	1,842	2,390	6,163
VIII	825	896	1,098	1,764	3,504
4. Mindanao	1,141	1,269	1,680	2,311	4,911
Region IX	928	1,018	1,291	1,934	3,834
X	1,098	1,230	1,662	2,145	4,871
XI	1,629	1,821	2,461	3,211	6,960
XII	800	867	1,064	1,627	3,155

Source: NEDA

Table 2B-4 Average Size of Farm by Province

Region and Province	Total No. of Farms (A)	Area of all Arable Land (B)	Land Planted to Permanent Crops (C)	Total Farm Area (B)+(C)	Average Size of Farms $(\frac{B+C}{A})$
I. Ilocos					
Abra	13,405	22,616	889	23,505	1.75
Benguet	12,315	18,600	2,567	21,167	1.72
Ilocos Norte	31,047	32,335	2,683	35,018	1.13
Ilocos Sur	27,671	32,207	1,705	33,912	1.23
La Union	27,285	28,190	2,688	30,878	1.13
Mt. Province	14,085	17,679	2,085	19,764	1.40
Pangasinan	89,305	148,530	9,025	157,555	1.76
II. Cagayan Valley					
Batanes	1,447	2,376	414	2,790	1.93
Cagayan	53,389	133,182	6,251	139,433	2.61
Ifugao	10,310	16,596	2,182	18,778	1.82
Isabela	69,704	187,055	8,004	195,059	2.80
Kalinga-Akayas	16,921	32,703	3,958	36,661	2.17
Nueva Viscaya	20,287	38,278	4,183	42,461	2.09
III. Central Luzon					
Bataon	8,176	22,785	4,959	27,744	3.39
Bulacan	28,694	58,869	1,282	60,151	2.10
Nueva Ecija					
Pampanga	23,841	87,237	411	87,648	3.68
Tarlac	35,596	99,812	1,423	101,235	2.84
Zambales	15,504	24,341	2,400	26,741	2.13

Source: 1971 Agricultural Census

CHAPTER III. THE PROJECT AREA

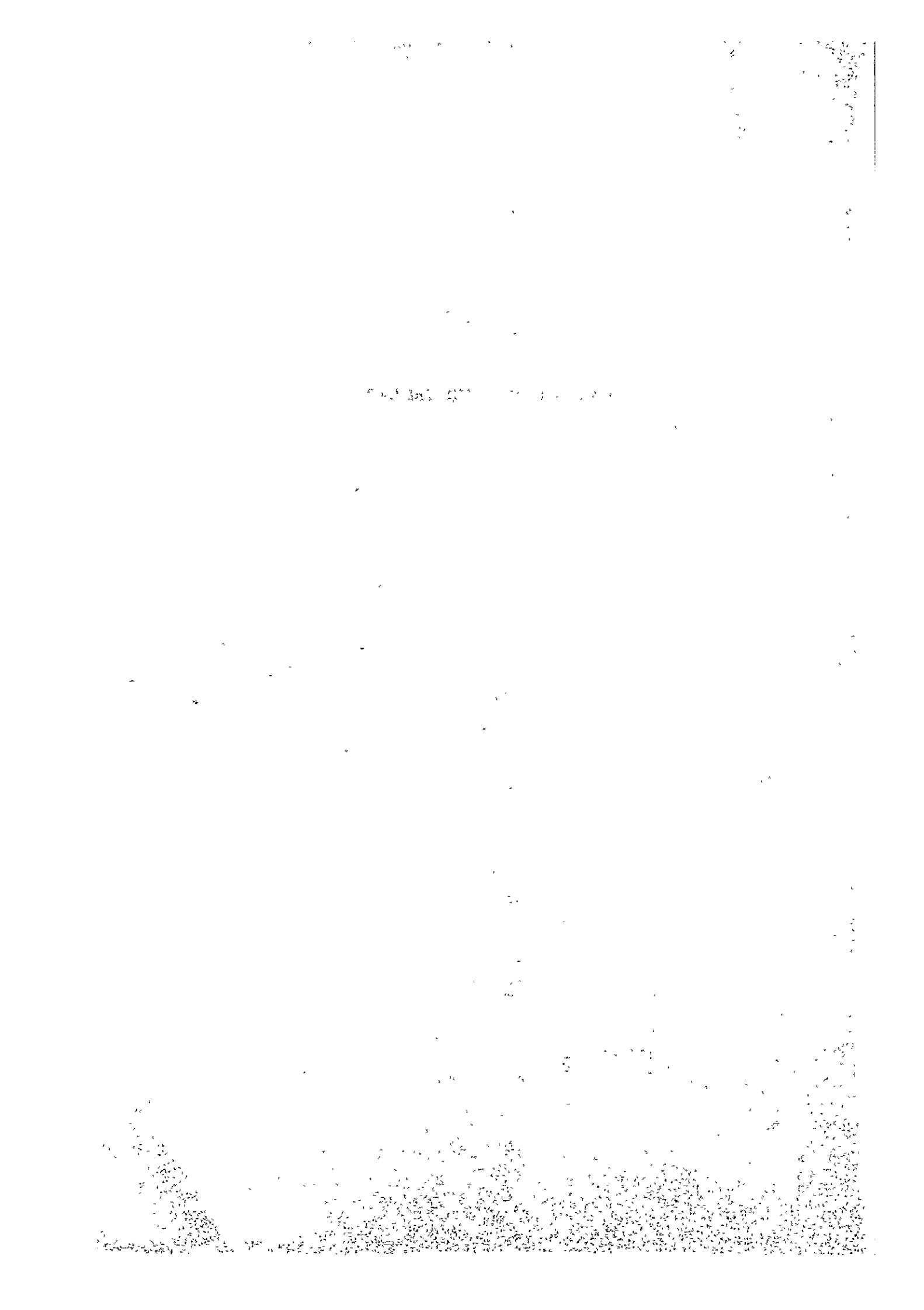


FIGURE 3B-1 CLIMATE MAP

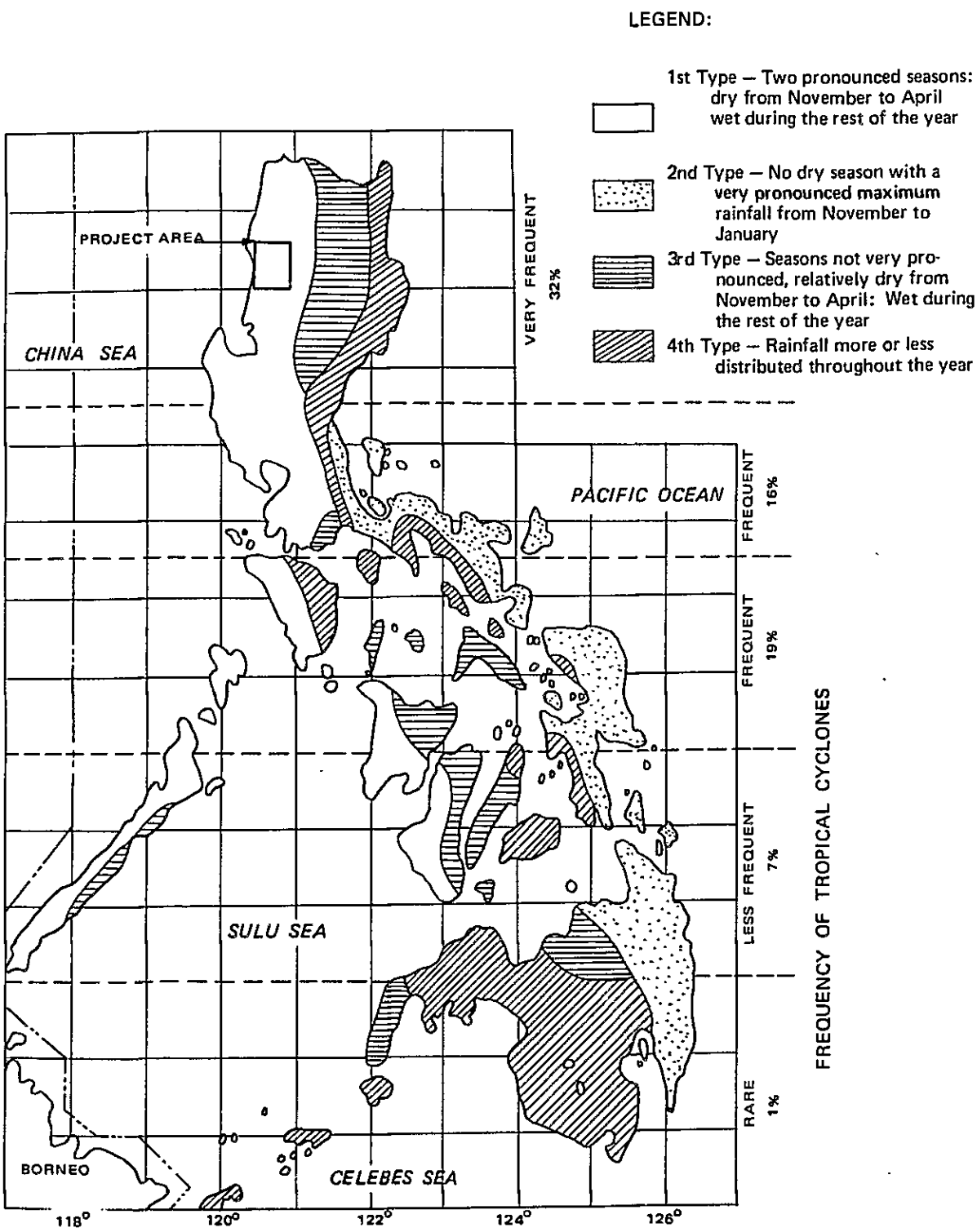


Table 3B-1 Monthly Rainfall at Laoag, Ilocos Norte[1/]

(Unit: mm)

	Dry Season				Wet Season						Dry Season		
Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1949	-[2/]	3.3	0	-	11.9	343.4	321.6	240.8	717.6	357.1	19.8	31.2	-
1950	1.3	3.0	-	1.8	126.5	267.7	797.6	666.8	202.4	36.3	7.4	-	-
1951	1.5	0	0	0	110.1	510.8	282.4	799.1	508.6	116.8	10.4	1.1	2,340.8
1952	0.5	0	0	3.0	122.8	311.4	300.0	523.1	199.5	10.7	43.5	4.6	1,519.1
1953	0.3	1.3	1.0	0	276.6	579.2	316.5	775.4	199.4	70.8	147.3	14.6	2,381.8
1954	10.1	0.5	2.8	16.0	12.5	357.8	98.9	566.8	481.9	86.8	103.9	1.0	1,737.4
1955	1.0	6.3	0	0	74.7	281.0	355.6	265.6	123.3	49.6	35.6	6.1	1,198.8
1956	32.7	2.1	0	67.0	66.2	181.6	296.6	553.9	523.2	120.2	12.2	0	1,855.7
1957	0	0	0	0	117.0	712.6	113.2	571.8	389.2	53.9	84.8	8.9	2,051.4
1958	0	4.1	0	0	143.8	694.4	387.9	264.8	281.7	64.0	0	0	1,840.6
1959	3.1	1.0	0	41.6	64.4	87.2	287.3	602.7	170.4	45.4	138.7	0.3	1,442.1
1960	1.5	0	1.0	4.1	266.9	121.3	295.4	699.0	80.7	72.4	0	0	1,541.4
1961	0	0	18.3	0	101.0	529.5	1,306.8	921.3	352.6	6.6	6.9	2.3	3,245.3
1962	3.6	0	0	0.8	22.9	282.0	1,252.9	914.6	89.7	20.1	14.5	0	2,609.1
1963	0.6	0	0.5	0	10.7	1,134.5	369.7	76.2	628.0	6.4	0.9	43.7	2,271.2
1964	18.3	0.7	20.8	0	38.1	304.1	139.6	648.4	601.5	104.3	88.4	120.5	2,084.9
1965	0	0	0	4.6	250.3	582.2	395.4	209.1	393.6	7.5	45.2	2.0	1,889.9
1966	0	0.3	1.3	0.3	217.4	49.8	122.8	517.8	600.5	15.6	194.8	4.3	1,724.9
1967	0	0	0	122.9	210.5	1,082.7	231.3	727.1	233.6	229.3	36.1	0	2,873.5
1968	0	1.0	0	6.8	25.4	108.3	582.4	914.6	497.4	24.4	0	0	2,160.3
1969	9.4	2.8	4.9	0.8	215.8	327.6	733.7	328.7	1,007.3	115.6	12.8	0	2,759.4
1970	0.5	0	0	7.1	81.4	481.0	217.5	494.8	438.6	77.3	27.9	27.3	1,853.5
1971	0	6.2	0	0	37.2	140.2	269.7	344.0	590.1	495.5	27.5	65.1	1,984.3
1972	1.1	1.0	0	2.8	94.3	323.5	1,456.8	303.6	40.2	0.3	0.5	0	2,224.1
1973	0	0	0	12.7	22.2	164.3	320.0	218.2	564.7	376.5	49.2	0	1,728.0
1974	0	0	0.3	28.5	125.4	424.3	25.5	988.8	454.0	494.0	118.3	4.5	2,663.6
1975	0	0	0	12.2	55.7	375.4	175.7[3/]	812.9	65.6	132.6	0	5.7	1,635.8
1976	0	0	0	3.3	261.3	284.1	211.1	173.3	154.7	63.4	11.8	0	1,163.0
1977	9.6	0	0	20.4	33.2	189.0	456.8	627.3	619.8	0	86.0	0	2,032.5
Mean	3.4	1.1	1.8	12.7	106.7	387.3	418.0	543.1	386.5	112.2	45.7	12.3	2,030.8
Percent(%)	0.2	0.1	0.1	0.6	5.3	19.1	20.5	26.7	19.0	5.5	2.3	0.6	100.0

Note: 1/ Observations are made at Laoag Airport and records are compiled at PAGASA
2/ No record
3/ Data were interporated, applying monthly mean ratio to Vigan, Ilocos Sur.

Table 3B-2 Mean Monthly Temperature at Laoag Station

(Unit: °C)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
1949	23.90	25.05	26.35	28.00	29.30	28.90	27.95	27.55	27.20	27.20	26.45	25.65
1950	24.90	25.30	26.00	28.20	28.60	27.90	27.10	27.08	27.45	27.15	26.10	24.65
1951	24.60	24.65	26.30	28.30	28.35	27.80	27.45	27.35	27.35	27.35	27.60	26.20
1952	25.20	26.00	27.00	31.40	29.20	29.85	28.35	27.35	27.35	28.45	26.30	26.00
1953	24.80	25.80	27.10	28.10	28.55	28.55	27.65	27.45	27.20	27.65	26.95	26.35
1954	25.10	25.90	27.80	28.55	29.65	29.00	28.10	27.60	27.00	26.80	25.40	25.40
1955	24.65	24.35	25.50	28.00	29.00	28.10	27.45	27.10	27.90	27.20	26.55	23.50
1956	24.40	24.70	26.40	28.20	28.20	28.00	27.60	27.10	26.60	27.20	27.20	26.20
1957	25.00	24.30	26.80	28.20	28.50	28.00	26.80	27.60	27.00	27.40	25.20	25.50
1958	24.90	24.40	26.20	28.20	29.40	27.40	27.60	27.80	27.20	27.60	26.60	24.80
1959	23.50	25.70	27.00	27.80	29.00	29.00	27.80	27.20	27.40	26.80	26.40	26.20
1960	25.20	26.40	26.60	28.50	29.20	28.40	28.20	27.00	27.50	27.30	26.70	25.30
1961	23.30	24.30	26.50	23.10	28.90	27.90	26.40	26.90	26.70	26.80	26.20	25.20
1962	23.90	23.70	26.50	27.70	29.10	28.40	27.20	27.30	27.50	27.40	26.70	24.70
1963	22.50	23.80	24.80	26.50	28.80	27.20	27.20	28.20	27.60	27.10	26.70	25.70
1964	25.00	25.20	26.20	27.90	29.20	27.90	27.90	27.10	27.40	27.30	26.30	24.20
1965	23.90	24.90	25.70	27.70	28.50	27.40	27.40	27.60	27.30	27.10	27.00	25.40
1966	24.70	25.90	26.70	28.30	28.50	28.50	28.10	27.70	26.60	27.30	26.90	26.00
1967	24.40	24.40	26.00	27.40	28.40	27.20	27.90	27.20	27.00	26.40	26.20	24.00
1968	23.80	23.30	25.70	27.20	28.60	28.80	28.00	26.00	26.40	26.60	25.60	24.40
1969	24.80	24.40	26.70	28.10	29.30	28.90	27.90	27.60	27.40	27.00	26.30	25.80
1970	24.60	24.70	27.00	28.60	29.60	27.90	28.30	27.50	27.20	27.60	27.30	26.60
1971	23.60	25.20	25.80	27.50	29.00	28.00	27.50	27.60	27.40	27.00	26.20	26.00
1972	24.70	25.20	25.50	28.50	29.50	29.10	27.20	27.30	28.40	28.20	28.40	26.00
1973	25.00	26.30	26.90	29.20	30.00	29.00	28.00	27.40	28.10	27.60	26.90	25.10
1974	23.30	24.80	25.70	27.90	29.00	27.80	28.60	27.20	27.40	27.40	26.60	26.10
Mean	24.4	24.9	26.3	28.0	29.0	28.3	27.2	27.4	27.3	27.3	26.6	25.4

Annual Mean 26.8

Table 3B-3 Mean Monthly Relative Humidity

(Unit: %)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
1949	72	70	68	70	71	78	84	86	88	82	87	76
1950	74	75	73	74	76	89	80	88	68	78	76	71
1951	76	70	70	64	63	80	85	85	85	79	70	73
1952	76	72	71	71	76	81	84	88	87	78	80	80
1953	73	73	75	71	79	82	85	88	87	81	82	74
1954	78	75	70	76	73	79	83	86	87	81	78	69
1955	70	75	72	72	78	81	84	89	87	80	75	74
1956	75	73	72	72	78	81	84	89	87	80	75	74
1957	74	73	72	72	74	84	84	86	86	80	76	81
1958	78	79	74	73	75	87	86	85	88	82	71	76
1959	76	76	68	71	74	80	84	86	83	76	74	74
1960	76	69	72	72	75	81	83	88	83	75	73	70
1961	68	74	73	72	78	83	88	88	87	75	76	74
1962	71	66	72	70	78	84	88	86	85	77	73	68
1963	67	63	69	69	72	82	84	82	87	72	74	73
1964	74	68	69	72	73	80	82	85	86	80	78	76
1965	69	72	70	72	74	85	83	84	84	74	74	71
1966	75	73	72	72	78	78	82	84	84	74	83	80
1967	71	68	72	77	75	84	83	87	85	80	74	72
1968	72	70	74	69	73	76	83	86	85	71	65	74
1969	77	77	75	72	73	82	84	84	86	78	72	71
1970	73	72	72	71	74	80	81	86	87	84	78	78
1971	73	70	66	71	74	82	83	84	86	82	76	74
1972	74	75	67	68	74	79	89	84	81	74	70	74
1973	73	72	68	70	70	78	84	86	85	80	78	69
1974	69	72	72	76	71	81	76	87	84	84	79	77
Mean	73.2	72.0	71.1	71.5	74.6	81.4	83.7	86.0	84.9	78.3	75.7	74.0
Annual Mean												77.2

Table 3B-4 Mean Monthly Wind Direction at Laoag Station

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
1950	NNE	N	NW	NW	SW	SW	SW	SW	SW	NE	NW	NW
1951	NNW	N	SW	NW	SSW	SSW	S	S	SW	W	N	NNE
1952	N	N	N	N	E	SSW	SSW	SW	SE	NNE	NNE	NNE
1953	N	NNE	N	NNW	NNW	SW	SW	SSW	S	SW	N	N
1954	NNE	NNE	NNW	SE	NNW	SW	SW	SW	SW	NNE	SW	N
1955	NNE	N	N	N	NW	SW	SW	SW	NNE	N	NNE	NE
1956	N	N	NNW	S	NNW	W	NW	ENE	SSW	N	NNE	N
1957	N	N	N	NNW	SW	NW	S	SSW	N	N	N	N
1958	N	N	N	E	S	SW	WSW	SSW	SW	W	N	N
1959	N	N	N	W	SSW	SW	S	SW	SW	N	SW	N
1960	N	N	NW	N	NNW	S	S	SSW	WSW	N	NNW	N
1961	N	N	N	NW	NNW	SW	SW	SSW	SSW	N	N	N
1962	N	N	N	NW	N	SW	S	SW	SSW	N	E	N
1963	N	N	N	N	W	S	NW	N	SW	N	N	N
1964	N	N	N	W	NW	S	SW	N	S	N	N	N
1965	N	E	N	NW	SW	SW	N	SW	N	NE	N	NNE
1966	N	N	NNW	N	SSW	SSW	SW	SW	W	N	NNE	N
1967	N	N	N	WNW	SW	SW	S	SW	N	NNW	N	N
1968	N	N	N	NNW	SSW	WSW	S	SSW	N	N,ENE	NNE	N
1969	N	NNW	WNS	NNW	SW	W	WSW	SW	SSW	NW	NE	N
1970	N	N	N	N	NW	SW	SSW	SSW	ENE	NNE	N	N
1971	NNE	N	E	N	SW	SE	WSW	NNE	SW	NNE	N	N

Table 3B-5 Monthly Maximum Wind Speed at Laoag Station

(Unit: Mile/hr)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
1950	30	36	28	35	24	45	45	40	19	44	31	34
1951	28	32	30	25	40	40	73	40	65	28	34	33
1952	37	39	31	30	25	33	33	32	44	27	41	34
1953	32	40	29	32	31	54	45	48	32	20	67	36
1954	32	39	35	28	26	35	20	62	30	35	60	33
1955	30	32	30	30	30	30	26	30	40	27	35	28
1956	29	35	30	46	21	29	30	50	34	38	45	34
1957	35	34	30	32	32	50	48	36	50	31	36	31
1958	35	40	36	30	32	30	37	29	28	33	36	31
1959	40	35	36	37	27	30	29	40	30	35	50	36
1960	40	35	32	32	27	35	36	49	30	37	33	42
1961	40	35	33	34	33	26	40	37	30	30	40	40
1962	36	40	37	39	32	34	50	65	37	38	32	50
1963	30	38	33	39	26	56	39	25	45	33	40	32
1964	26	35	35	17	26	30	20	78	56	32	31	36
1965	33	28	37	23	31	44	90	39	40	23	41	37
1966	35	32	39	36	46	44	25	48	39	44	44	37
1967	39	48	39	55	46	66	47	39	33	75	41	39
1968	35	37	33	35	40	39	55	55	85	29	37	30
1969	30	32	31	26	37	37	62	39	48	33	35	39
1970	33	30	36	41	32	40	38	39	21	30	36	37
1971	35	37	38	38	36	35	55	41	48	41	33	41

Table 3B-6 Monthly Total Evaporation by Penman Method (Vigan City Ilocos Sur)

(Unit: mm/month)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1951	155.0	154.0	187.6	195.0	197.8	161.4	164.3	137.0	148.5	155.0	151.5	144.2	1,951.3
1952	161.8	171.1	204.6	211.5	207.1	176.4	164.3	138.0	147.0	175.2	147.0	144.2	2,048.2
1953	164.3	158.2	207.7	214.5	203.1	189.0	179.8	155.0	142.5	158.1	144.0	153.5	2,069.7
1954	168.0	158.2	193.8	210.0	225.7	168.0	172.1	180.1	127.2	139.8	123.6	136.7	2,003.2
1955	155.0	151.2	197.8	207.0	208.0	165.0	155.0	146.3	153.6	151.9	129.0	133.9	1,953.7
1956	137.0	153.7	207.7	200.7	191.4	190.5	181.0	155.0	123.0	167.7	141.6	133.6	1,982.9
1957	155.0	163.5	194.7	210.0	213.9	165.0	174.2	151.9	135.6	161.2	137.4	133.3	1,995.7
1958	133.3	134.4	190.7	201.0	204.6	135.0	161.2	153.5	130.5	158.1	150.0	136.4	1,888.7
1959	151.9	141.4	190.7	204.0	195.3	174.0	155.0	139.5	148.5	165.9	162.0	145.7	1,973.9
1960	136.4	158.1	189.1	198.0	195.3	165.0	162.8	151.9	147.6	159.7	147.6	152.8	1,964.3
1961	173.6	148.4	195.3	207.0	201.5	174.0	130.2	134.9	123.0	159.7	153.9	151.6	1,953.1
1962	161.2	166.9	191.9	208.8	229.4	171.9	145.7	167.4	148.5	167.4	156.0	150.4	2,065.5
1963	151.9	169.7	210.8	237.0	232.5	139.5	157.5	120.9	135.0	133.3	148.5	139.5	1,976.1
1964	169.9	179.8	203.1	214.5	203.1	162.0	157.8	141.4	146.4	164.3	129.0	130.2	2,001.5
1965	155.0	150.6	181.4	203.4	189.1	143.1	151.9	152.8	146.4	176.7	143.1	152.8	1,946.3
1966	143.5	157.6	191.6	206.4	157.5	168.0	164.3	163.7	167.4	192.2	144.6	138.0	1,994.8
1967	198.4	180.6	217.6	217.5	231.9	174.6	171.1	138.0	146.1	170.5	164.7	175.2	2,186.2
1968	167.4	195.8	215.1	217.5	238.7	192.6	181.4	168.6	174.0	204.6	210.0	153.5	2,319.2
1969	157.2	154.0	240.9	253.5	240.3	168.0	142.6	179.8	222.0	188.5	192.3	170.5	2,309.6
1970	182.9	182.0	209.3	234.0	215.5	177.0	177.3	128.6	125.4	134.9	138.0	137.0	2,011.9
1971	163.7	207.8	221.7	210.7	184.5	126.9	160.3	149.4	114.6	129.6	136.2	103.9	1,909.3
1972	160.6	158.1	197.2	208.5	166.8	168.0	113.2	134.9	150.0	177.9	163.2	156.2	1,954.6
1973	140.1	147.0	200.9	212.4	223.2	170.1	165.9	139.8	135.3	139.5	137.4	163.1	1,974.7
1974	153.5	169.4	231.9	198.0	218.6	168.0	176.7	108.5	157.5	144.2	136.5	127.1	1,989.9
1975	131.8	140.0	201.5	198.0	192.2	150.0	155.0	124.0	150.4	130.2	132.0	138.0	1,843.1
1976	131.8	130.2	181.4	180.0	186.0	162.0	142.3	122.5	125.4	138.9	125.7	127.1	1,753.3
1977	147.3	145.6	173.6	193.2	207.4	176.4	143.2	142.6	124.8	165.9	147.0	139.2	1,906.2
Mean	155.8	160.3	201.1	209.3	205.9	166.0	259.5	145.4	144.3	159.7	147.8	143.2	1,998.3

Table 3B-7 Comparison of Evaporation Data

Vigan, Ilocos Sur (Observed Open-pan Evaporation) (A)

(Unit: mm/month)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1970	182.9	182.0	209.3	234.0	215.5	177.0	177.3	128.7	125.4	134.9	138.0	137.0	2,042.0
1971	163.7	207.8	221.7	210.6	184.5	126.9	160.3	149.4	114.6	129.6	136.2	103.9	1,909.2
1972	160.6	158.1	197.2	208.5	166.8	168.0	113.2	134.9	150.0	177.9	163.2	156.2	1,954.6
1973	140.1	147.0	200.9	212.4	223.2	170.1	165.9	139.8	135.3	139.5	137.4	163.1	1,974.7
1974	153.5	169.4	231.9	198.0	218.6	168.0	176.7	108.5	157.5	144.2	136.5	127.1	1,989.9
Mean	160.2	172.9	212.2	212.7	201.7	162.0	158.7	132.3	136.6	145.2	142.3	137.5	1,974.3

Laoag, Ilocos Norte (Observed Open-pan Evaporation) (B)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1970	215.9	175.3	224.3	213.9	190.5	198.5	126.8	165.6	144.5	190.8	174.2	189.2	2,209.5
1971	200.9	202.2	214.4	191.3	189.0	169.4	159.0	156.7	197.9	200.4	191.3	200.2	2,272.7
1972	201.4	178.3	209.8	208.0	218.2	217.9	214.1	174.0	143.0	194.0	160.5	205.5	2,324.7
1974	200.2	173.0	215.6	203.4	196.1	174.8	-	-	-	-	-	-	
Mean	204.6	182.2	216.0	204.2	198.5	190.2	166.6	165.4	161.8	195.0	175.3	198.3	2,258.1
Ratio (B/A)	1.28	1.05	1.02	0.96	0.98	1.17	1.05	1.25	1.18	1.34	1.23	1.44	1.14

Table 3B-8 Monthly Total of Adjusted Evaporation

(Unit: mm/month)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1951	198.4	161.7	197.6	187.2	193.8	188.8	172.5	171.3	175.2	207.7	186.3	207.6	2,248.1
1952	207.1	179.6	211.8	203.4	203.0	206.4	172.5	172.5	173.4	234.8	180.8	207.6	2,352.9
1953	210.3	166.1	211.9	205.9	199.0	221.1	188.8	193.8	168.2	211.9	177.1	221.0	2,355.1
1954	215.0	166.1	197.7	201.6	221.2	196.6	180.7	225.1	150.1	187.3	152.0	196.8	2,290.2
1955	198.4	158.8	201.8	198.7	203.8	193.1	162.8	182.9	181.2	203.5	158.7	192.8	2,236.5
1956	175.4	161.4	211.9	192.7	187.6	222.9	190.1	193.8	145.1	224.7	174.2	192.4	2,272.2
1957	198.4	171.7	198.6	201.6	209.6	193.1	182.9	189.9	160.0	216.0	169.0	191.5	2,282.3
1958	170.6	141.1	194.5	193.0	200.5	157.9	169.3	191.9	153.9	211.9	184.5	196.4	2,165.5
1959	194.4	148.5	194.5	195.8	191.4	203.6	162.8	174.4	175.2	222.3	199.3	209.8	2,271.7
1960	174.6	166.0	192.8	190.1	191.4	193.1	170.9	189.9	174.2	213.9	181.5	220.0	2,258.4
1961	222.2	155.8	199.2	198.7	197.5	203.6	136.7	168.7	145.1	213.9	189.3	218.3	2,249.0
1962	206.3	175.2	195.7	200.5	224.8	201.1	152.9	209.3	175.2	224.3	191.9	216.6	2,373.8
1963	194.4	178.2	215.0	227.5	227.9	163.2	165.4	151.1	159.3	178.6	182.7	200.9	2,244.2
1964	217.4	188.8	207.2	205.9	199.0	189.5	165.7	176.7	172.7	220.2	158.7	187.5	2,289.3
1965	198.4	158.1	185.0	195.3	185.3	167.4	159.5	191.0	172.8	236.7	176.0	220.0	2,245.5
1966	183.7	165.5	195.4	198.1	154.4	196.6	172.5	204.6	197.5	257.5	177.9	198.7	2,302.4
1967	253.9	189.6	221.9	208.8	227.3	204.2	179.6	172.5	172.4	228.5	202.6	252.2	2,513.5
1968	214.3	205.6	219.4	208.8	233.9	225.3	190.5	210.8	205.3	274.1	258.3	221.0	2,667.3
1969	201.2	161.7	245.7	243.4	245.5	196.5	149.7	224 5	261.9	252.6	236.5	245.5	2,664.7
1970	234.1	191.1	213.4	224.6	211.2	207.1	186.1	160.8	147.9	180.8	169.7	197.3	2,324.1
1971	209.5	218.2	226.1	202.2	180.8	148.5	168.3	186.8	135.2	173.7	167.5	149.6	2,166.4
1972	205.6	166.0	201.1	200.2	163.5	196.6	118.9	108.6	177.0	239.4	200.7	224.9	2,261.5
1973	179.3	154.4	204.9	203.9	218.7	199.0	174.2	174.8	159.6	186.9	169.0	234.9	2,259.6
1974	196.5	177.9	236.5	190.1	214.2	196.5	185.5	135.6	185.9	193.2	167.9	183.0	2,262.8
1975	168.7	147.0	205.5	190.1	188.4	175.5	162.8	155.0	177.5	174.5	162.4	198.7	2,106.1
1976	168.7	136.7	185.0	172.8	182.3	189.5	149.4	153.1	147.9	186.1	154.6	183.0	2,009.1
1977	188.5	152.9	177.1	185.5	203.2	206.4	150.4	178.3	147.3	222.3	180.8	200.4	2,193.1
Mean	199.5	168.3	205.1	201.0	202.2	194.2	167.5	181.8	170.3	213.9	181.8	206.2	2,291.8

Table 3B-9 Status of Hydro-Meteorological Observation Relevant to Phase I Project

Item	Station	Location	Recorder	Installed Date	Agency	Available Period	Note
Rainfall							
	Laoag	Laoag Airport, Laoag City	Automatic	1935	PAGASA	1949-present	
	Bonga	Bonga RGS Bangay, Dingras	Standard	1948	BPW & PAGASA	1950-present	No record period included
	Lumbad	Lumbad, Dingras	- do -	Aug. 11, 1976	NIA	1976-present	- do -
	Alabaan	Alabaan, Dingras	- do -	Apr. 1, 1976	BPW & NIA	1946-present	- do -
	Solsona	Manalpac, Solsona	- do -	Sept. 1976	NIA	1976-	- do -
	Madongan	San Marcelino, Padong, Dingras	Automatic	July 11, 1978	- do -	1978	Newly installed Station
Evaporation							
	Lumbad	Lumbad, Dingras	- do -	July 5, 1978	- do -	1978	- do -
	Alabaan	Alabaan, Dingras	- do -	June 22, 1978	- do -	1978	- do -
River-stage							
	Labugaon	Maananteng, Solsona	Staff Gauge	Aug. 9, 1978	- do -	1978	No cable way
	Solsona	Manalpac, Solsona	Automatic	June 20, 1978	- do -	1978	Newly installed Station
	- do -	- do -	Staff Gauge	Apr. 1, 1946	BPW	1946-present	
	Madongan	San Marcelino, Padong, Dingras	Automatic	July 24, 1978	NIA	1978	Newly installed Station
	Bangay	Bangay, Dingras	Staff Gauge		BPW	1946-1976	
	Pablacion	Pablacion, Laoag City	- do -		- do -	1959-1974	

FIGURE 3B-2 LOCATION OF HYDRO-METEOROLOGICAL STATIONS

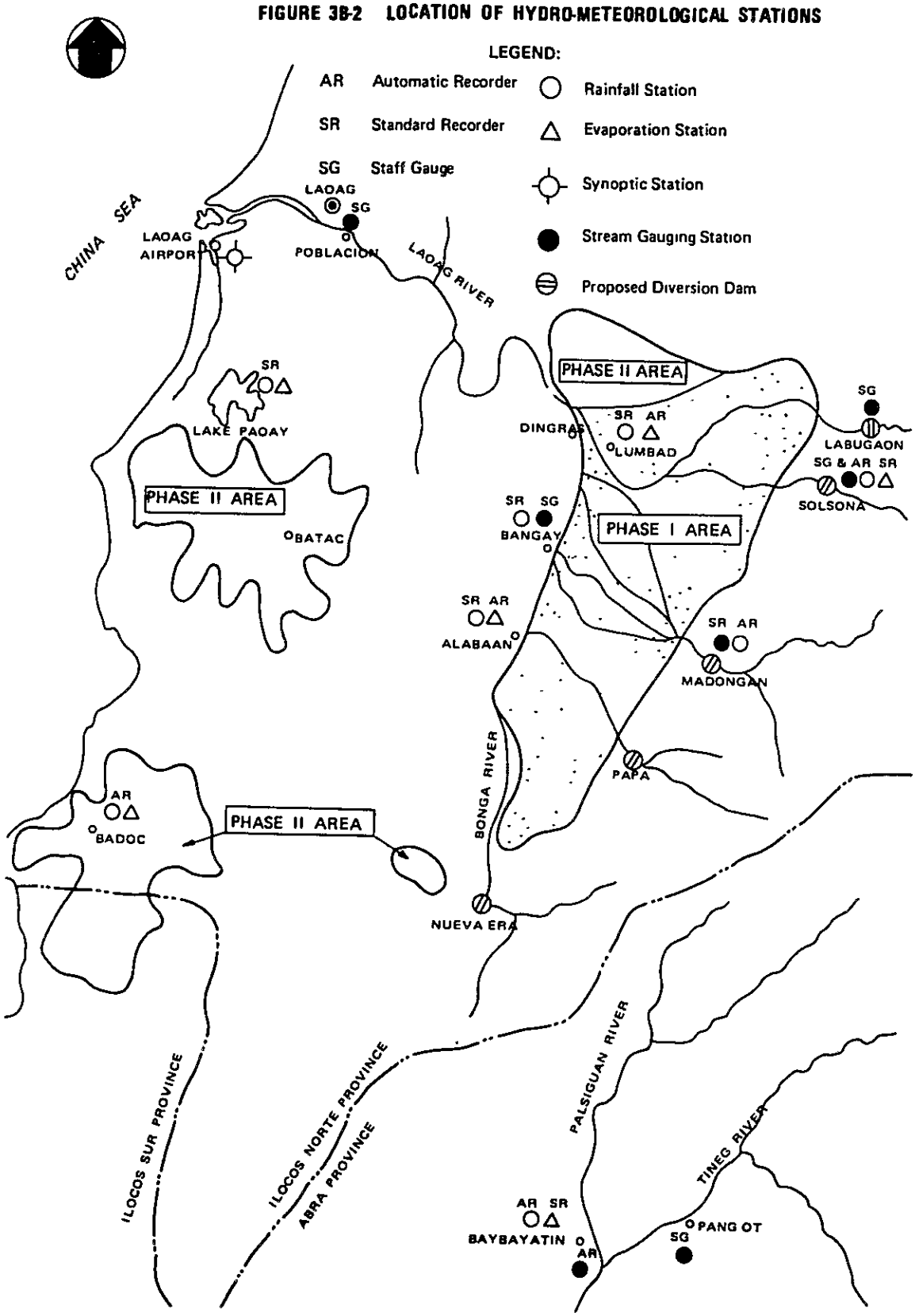


Table 3B-10 Monthly Run-off Data of the Solsona River

Catchment Area: 73 sq.km (Unit: MCM)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total	Depth of Run-off (mm)(A)	Rainfall at Langangilang (mm)(B)	Run-off Coefficient (A)/(B)
1946	-	-	-	17.56	10.70	41.50	89.71	43.36	29.49	15.25	8.18	7.10	-	-	-	-
1947	3.14	2.01	3.33	3.77	10.58	56.49	33.05	38.13	31.27	99.19	115.13	23.80	419.89	5,752	-	-
1948	9.61	3.62	2.20	3.80	7.66	23.10	40.64	34.83	46.90	26.94	37.38	20.85	257.53	3,528	-	-
1949	5.98	3.30	2.12	2.31	1.73	8.71	13.71	22.46	63.15	35.76	12.46	17.51	189.20	2,592	-	-
1950	6.70	4.62	4.05	2.42	14.10	28.02	40.41	39.89	25.00	24.07	16.42	9.08	214.78	2,942	-	-
1951	7.22	3.30	3.59	3.29	15.49	24.38	20.33	42.13	73.29	24.54	11.62	10.15	239.33	3,278	-	-
1952	3.31	2.51	1.57	2.18	8.31	19.74	19.98	45.05	43.78	29.29	35.97	23.22	234.91	3,218	-	-
1953	9.27	4.99	3.95	3.99	12.76	66.50	48.91	57.91	35.99	32.04	32.67	17.73	326.71	4,475	-	-
1954	46.14	5.64	4.75	8.62	9.55	20.30	30.61	47.38	26.50	21.09	25.05	13.28	258.91	3,547	3,709	0.96
1955	10.33	3.65	2.90	3.50	5.35	11.04	18.80	21.99	20.29	18.19	23.98	10.83	150.85	2,066	-	-
1956	4.22	2.92	3.39	4.39	6.88	7.15	21.04	35.84	38.54	18.92	20.14	13.92	177.35	2,429	3,662	0.66
1957	7.74	3.09	2.62	3.80	5.55	27.23	26.00	29.23	85.90	22.80	17.80	9.31	241.07	3,302	3,780	0.87
1958	5.62	2.89	2.27	1.80	3.22	26.78	25.13	21.18	38.85	20.14	10.11	6.14	164.14	2,248	3,188	0.71
1959	3.68	2.13	4.31	1.77	4.14	11.91	23.48	51.41	26.78	13.07	27.75	13.12	183.55	2.514	2,663	0.94
1960	8.94	8.75	3.28	2.30	4.02	16.32	13.43	35.44	14.27	17.91	6.03	6.16	136.85	1,875	3,115	0.60
1961	4.84	2.26	2.24	1.46	7.27	13.18	57.93	42.41	34.00	24.79	9.37	7.20	206.95	2,835	3,447	0.82
1962	4.87	2.94	1.63	1.86	3.97	20.33	46.12	44.48	44.61	22.88	11.38	7.73	212.80	2,915	3,758	0.78
1963	5.13	4.20	1.66	1.56	1.44	33.93	35.16	26.96	36.75	11.84	5.83	8.18	172.64	2,365	3,089	0.77
1964	4.43	4.05	2.85	2.08	12.00	35.25	20.27	56.59	63.47	24.36	34.91	30.06	290.32	3,977	3,602	1.10
1965	10.78	4.81	2.38	4 06	12.11	46.76	31.41	21.38	28.05	13.31	6.97	6.32	188.34	2,580	3,266	0.79
1966	2.88	1.73	0.92	0.65	12.49	16.31	14.03	46.85	31.25	8.31	30.78	12.91	179.11	2,454	4,029	0.61
1967	16.95	10.14	6.43	5.61	5.50	30.62	88.36	17.65	17.50	19.44	17.24	16.18	251.62	3,447	3,281	1.05
1968	8.83	4.03	2.03	3.36	9.52	28.83	35.91	32.57	27.98	11.03	5.73	5.50	175.32	2,402	2,760	0.87
1969	3.78	2.15	1.24	1.33	4.95	14.20	28.10	11.61	24.20	19.99	10.62	7.81	129.98	1,781	3,450	0.52
1970	4.06	3.08	3.83	5.56	11.67	14.55	9.56	13.44	14.04	11.89	16.02	16.37	124.07	1,700	4,094	0.42
1971	9.06	5.71	4.70	2.67	3.67	4.96	30.66	18.76	10.87	10.26	6.54	6.40	114.26	1,565	2,620	0.60
1972	4.53	3.14	3.29	3.71	6.64	8.34	28.18	11.89	5.79	5.57	5.81	6.47	93.36	1,279	2,650	0.48
1973	4.70	3.28	2.96	2.80	4.57	5.61	4.47	7.61	9.02	26.00	4.40	2.64	78.06	1,069	-	-
1974	1.33	0.63	0.39	0.71	1.24	2.26	3.90	7.24	8.01	15.14	15.57	3.93	60.35	827	-	-
1975	4.02	2.68	1.37	1.07	2 24	6.28	4.62	13.46	4.78	4.73	3.60	11.63	60.48	828	-	-
1976	3.28	3.61	2.03	1.17	6.11	15.47	13.07	11.61	6.88	7.39	11.60	4.11	86.33	1,183	-	-
Mean	7.51	3.73	2.81	3.39	7.27	22.13	29.58	30.67	31.20	21.17	19.26	11.47	190.19	2,483	3,342	0.75

Table 3B-11 Monthly Run-off of the Labugaon River
(Labugaon Diversion Dam Site: C.A=100.5 sq.km)

(Unit: MCM)

Year	Dry Season				Wet Season						Dry Season		Total
	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	
1960	12.30	12.04	4.51	3.16	5.53	22.47	18.49	48.79	19.64	24.65	8.29	8.48	188.35
1961	6.67	3.11	3.08	2.01	10.01	18.15	79.75	58.39	46.81	34.13	12.90	9.91	284.92
1962	6.71	4.04	2.25	2.56	5.46	27.99	63.49	61.23	61.42	31.50	15.67	10.64	292.96
1963	7.06	5.78	2.28	2.15	1.99	46.71	48.41	37.12	50.59	16.30	8.03	11.26	237.68
1964	6.10	5.58	3.92	2.87	16.53	48.53	27.90	77.91	87.39	33.54	48.05	41.38	399.70
1965	14.84	6.63	3.28	5.59	16.68	64.37	43.24	29.44	38.62	18.33	9.59	8.70	259.31
1966	3.96	2.39	1.27	0.89	17.19	22.45	19.32	64.50	43.02	11.44	42.37	17.77	246.57
1967	23.33	13.96	8.85	7.72	7.57	42.16	121.65	24.30	24.09	26.76	23.74	22.28	346.41
1968	12.16	5.55	2.79	4.63	13.10	39.68	49.43	44.84	38.51	15.18	7.89	7.57	241.33
1969	5.20	2.97	1.71	1.84	6.81	19.55	38.68	15.98	33.32	27.52	14.62	10.76	178.96
1970	5.59	4.24	5.27	7.66	16.07	20.03	13.16	18.50	19.32	16.37	22.06	22.54	170.81
Mean	9.45	6.03	3.56	3.73	10.63	33.83	47.59	43.73	42.07	23.25	19.38	15.57	258.82

Table 3B-12 Monthly Run-off of the Solsona River
(Solsona Diversion Dam Site: C.A=79.0 sq.km)

(Unit: MCM)

Year	Dry Season				Wet Season						Dry Season		Total
	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	
1960	9.67	9.47	3.55	2.49	4.35	17.66	14.53	38.35	15.44	19.38	6.53	6.67	148.09
1961	5.24	2.45	2.42	1.58	7.87	14.26	62.69	45.90	36.79	26.83	10.14	7.79	223.96
1962	5.27	3.18	1.76	2.01	4.30	22.00	49.91	48.14	48.28	24.76	12.32	8.37	230.30
1963	5.55	4.55	1.80	1.69	1.56	36.72	38.05	29.18	39.77	12.81	6.31	8.85	186.84
1964	4.79	4.38	3.08	2.25	12.99	48.15	21.94	61.24	68.69	26.36	37.78	32.53	314.18
1965	11.67	5.21	2.58	4.39	13.11	50.60	33.99	23.14	30.36	14.40	7.54	6.84	203.83
1966	3.12	1.87	1.00	0.70	13.52	17.65	15.18	50.70	33.82	8.99	33.31	13.97	193.83
1967	18.34	10.97	6.96	6.07	5.95	33.14	95.62	19.10	18.94	21.04	18.66	17.51	272.30
1968	9.56	4.36	2.20	3.64	10.30	31.20	38.86	35.25	30.28	11.94	6.20	5.95	189.74
1969	4.09	2.33	1.34	1.44	5.36	15.37	30.41	12.56	26.19	21.63	11.49	8.45	140.66
1970	4.39	3.33	4.14	6.02	12.63	15.75	10.35	14.54	15.19	12.87	17.34	17.72	134.27
Mean	7.43	4.74	2.80	2.93	8.36	26.59	37.41	34.37	33.07	18.27	15.24	12.24	203.45

Table 3B-13 Monthly Run-off of the Madongan River
(Madongan Dam Site: C.A=153.8 sq.km)

(Unit: MCM)

Year	Dry Season				Wet Season						Dry Season		Total
	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	
1960	13.18	12.90	4.83	3.39	5 93	24.07	19.80	52.26	21.04	26.41	8.89	9.08	201.78
1961	7.04	3.28	3.26	2.13	10.57	19.16	84.21	61.66	49.42	36.04	13.62	10.46	300.85
1962	9.03	5.45	3.03	3.45	7.36	37.70	85.50	82.46	82.71	42.42	21.10	14.33	394.54
1963	9.61	7.88	3.11	2.93	2.71	63.63	65.93	50.55	68.90	22.20	10.94	15.33	323.72
1964	6.81	6.23	4.38	3.20	18.46	54.22	31.17	87.04	97.62	37.47	53.68	46.23	446.51
1965	16.35	7.30	3.61	6.16	18.37	70.93	47.64	32.44	42.55	20.20	10.57	9.58	285.70
1966	4.36	2.63	1.40	0.98	18.94	24.74	21.28	71.06	47.40	12.61	46.68	19.58	271.66
1967	29.64	17.73	11.25	9.80	9.61	53.55	154.52	30.87	30.59	33.99	30.15	28.29	439.99
1968	12.65	5.77	2.90	4.81	13.63	41.30	51.44	46.66	40.08	15.80	8.21	7.88	251.13
1969	7.00	4.00	2.30	2.47	9.17	26.33	52.10	21.52	44.87	37.06	19.69	14.48	240.99
1970	5.14	3.89	4.84	7.03	14.75	18.39	12.08	16.99	17.74	15.03	20.26	20.69	156.83
Mean	10.98	7.01	4.08	4.21	11.77	39.46	56.88	50.32	49.36	27.20	22.16	17.81	301.25

Table 3B-14 Monthly Run-off of the Papa River
(Papa Diversion Dam Site: C.A=51.4 sq.km)

(Unit: MCM)

Year	Dry Season				Wet SEason						Dry Season		Total
	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	
1960	6.29	6.16	2.31	1.62	2.83	11.49	9.46	24.95	10.05	12.61	4.25	4.34	96.36
1961	3.41	1.59	1.58	1.03	5.12	9.28	40.79	29.86	23.94	17.45	6.60	5.07	145.72
1962	3.43	2.07	1.15	1.31	2.80	14.31	32.47	31.32	31.41	16.11	8.01	5.44	149.83
1963	3.62	2.96	1.17	1.10	1.01	23.89	24.76	18.98	25.88	8.34	4.10	5.76	121.57
1964	3.12	2.85	2.01	1.46	8.45	24.82	14.27	39.85	44.69	17.15	24.58	21.17	204.42
1965	7.59	3.39	1.68	2.86	8.53	32.92	22.12	15.05	19.75	9.37	4.91	4.45	132.62
1966	2.03	1.22	0.65	0.46	8.79	11.48	9.88	33.00	22.00	5.65	21.67	9.09	126.12
1967	11.93	7.14	4.53	3.95	3.87	21.56	62.22	12.43	12.32	13.69	12.14	11.39	177.17
1968	6.22	2.84	1.43	2.37	6.70	20.30	25.28	22.93	19.70	7.77	4.03	3.87	123.44
1969	2.66	1.51	0.87	0.94	3.49	10.00	19.79	8.17	17.04	14.08	7.48	5.50	91.53
1970	2.86	2.17	2.70	3.91	8.22	10.24	6.73	9.46	9.89	8.37	11.28	11.53	87.36
Mean	4.83	3.08	1.83	1.91	5.44	17.30	24.34	22.36	21.52	11.89	9.91	7.96	132.38

Table 3B-15 Monthly Run-off of the Bonga River
(Nueva Era Diversion Dam Site: C.A=57.0 sq.km)

(Unit: MCM)

Year	Dry Season				Wet Season						Dry Season		Total
	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	
1960	6.98	6.83	2.56	1.80	3.14	12.74	10.49	27.67	11.14	13.98	4.71	4.81	106.85
1961	3.78	1.76	1.75	1.14	5.68	10.29	45.23	33.11	26.55	19.36	7.32	5.62	161.59
1962	3.80	2.30	1.27	1.45	3.10	15.87	36.01	34.73	34.83	17.87	8.89	6.04	166.16
1963	4.01	3.28	1.30	1.22	1.12	26.49	27.45	21.05	28.70	9.24	4.55	6.39	134.80
1964	3.46	3.16	2.23	1.62	9.37	27.52	15.83	44.19	49.56	19.02	27.26	23.47	226.69
1965	8.42	3.76	1.86	3.17	9.46	36.51	24.53	16.69	21.90	10.39	5.44	4.93	147.06
1966	2.25	1.35	0.72	0.51	9.75	12.74	10.95	36.58	24.40	6.49	24.03	10.08	139.85
1967	13.23	7.92	5.02	4.38	4.29	23.91	68.99	13.78	13.66	15.18	13.46	12.63	196.45
1968	6.89	3.15	1.59	2.62	7.43	22.51	28.04	25.43	21.85	8.61	4.47	4.29	136.88
1969	2.95	1.68	0.97	1.04	3.87	11.09	21.94	9.07	18.90	15.61	8.29	6.10	101.51
1970	3.17	2.40	2.99	4.34	9.11	11.36	7.46	10.49	10.96	9.28	12.51	12.78	96.85
Mean	5.36	3.42	2.02	2.12	6.03	19.18	26.99	24.80	23.86	13.18	10.99	8.83	146.78

Table 3B-16 Flood Peak in Laoag River Basin

(Unit: cu.m/sec)

Year	Solsona R. (73 sq.km[1/]) Qp[4/]	Date	Bonga R. (534 sq.km[2/]) Qp	Date	Laoag R. (1,355 sq.km[3/]) Qp	Date
1946	481.3	6/17	256.0	6/21	-	-
1947	1,041.0	10/6	4,392.0	10/6	-	-
1948	187.0	11/9	774.0	11/9	-	-
1949	487.3	9/4	2,960.0	10/3	-	-
1950	94.2	8/9	758.0	8/9	-	-
1951	682.3	9/19	1,060.0	7/31	-	-
1952	72.3	11/13	196.0	9/1	-	-
1953	395.9	6/5	3,200.0	6/5	-	-
1954	314.5	8/28	1,080.0	9/24	-	-
1955	32.9	11/29	136.0	7/17	-	-
1956	103.2	8/14	440.0	8/15	-	-
1957	321.0	9/12	1,418.0	6/24	-	-
1958	52.0	9/8	450.0	8/22	-	-
1959	355.6	8/22	878.0	8/22	4,400.0	11/18
1960	41.1	10/13	766.0	8/14	4,536.0	8/18
1961	72.0	8/24	2,114.0	8/23	8,694.0	8/25
1962	243.0	8/30	2,455.0	8/30	15,525.0	8/30
1963	83.8	9/5	1,070.0	9/5	8,991.0	9/5
1964	314.5	9/9	2,242.0	9/4	7,090.0	9/9
1965	87.0	6/18	830.0	9/3	4,013.0	9/3
1966	58.0	8/16	614.0	8/12	-	-
1967	174.0	6/6	2,404.0	7/29	7,090.0	10/17
1968	144.2	7/25	1,018.3	9/29	6,630.0	7/25
1969	145.2	7/27	1,131.7	7/27	5,020.0	7/27
1970	120.0	9/6	155.3	6/14	472.0	9/7
1971	161.0	7/20	520.0	8/9	3,656.0	10/11
1972	72.0	7/18	621.4	7/28	6,584.0	7/19
1973	49.5	10/9	930.1	10/9	8,999.0	10/9
1974	38.4	11/7	769.6	9/26	3,654.0	10/2
1975	10.3	8/16	393.7	8/15	-	-
1976	94.2	5/2	571.0	7/1	-	-
1977	115.0	7/24	-	-	-	-

Note: 1/ observation station Manalpac, Solsona, Ilocos Norte (BPW)
2/ - do - Bangay, Dingras, Ilocos Norte (BPW)
3/ - do - Poblacion, Laoag, Ilocos Norte (BPW)
4/ Qp stands for flood peak.

Table 3B-17 Flood-Frequency Analysis by Hazen Method
Laoag River Basin

	Solsona River			Bonga River			Laoag River		
Order	2i-1 [1/] / 2N	Year	Qp (cu.m/sec)	2i-1 / 2N	Year	Qp (cu.m/sec)	2i-1 / 2N	Year	Qp (cu.m/sec)
1	0.02	1947	1,041.0	0.02	1947	4,392.0	0.03	1962	15,525.0
2	0.05	1951	682.3	0.05	1953	3,200.0	0.10	1973	8,999.0
3	0.08	1946	481.3	0.08	1949	2,960.0	0.17	1963	8,991.0
4	0.11	1949	478.3	0.11	1962	2,455.0	0.23	1961	8,694.0
5	0.14	1953	395.9	0.15	1967	2,404.0	0.30	1964	7,090.0
6	0.17	1959	355.6	0.18	1964	2,242.0	0.37	1967	7,090.0
7	0.20	1957	321.0	0.21	1961	2,114.0	0.43	1968	6,630.0
8	0.24	1954	314.5	0.24	1957	1,418.0	0.50	1972	6,584.0
9	0.27	1964	314.5	0.27	1969	1,131.7	0.57	1969	5,020.0
10	0.30	1962	243.0	0.31	1954	1,080.0	0.63	1960	4,536.0
11	0.33	1948	187.0	0.34	1963	1,070.0	0.70	1959	4,400.0
12	0.36	1967	174.0	0.37	1951	1,060.0	0.77	1965	4,013.0
13	0.39	1971	161.0	0.40	1968	1,018.3	0.83	1971	3,656.1
14	0.42	1969	145.2	0.44	1973	930.1	0.90	1974	3,654.0
15	0.45	1968	144.2	0.47	1959	878.0	0.97	1970	472.0
16	0.48	1970	120.0	0.50	1965	830.0			
17	0.52	1977	115.0	0.53	1948	774.0			
18	0.55	1956	103.2	0.56	1974	769.6			
19	0.58	1950	94.2	0.60	1960	766.0			
20	0.61	1976	94.2	0.63	1950	758.0			
21	0.64	1965	87.0	0.66	1972	621.4			
22	0.67	1963	83.8	0.69	1966	614.0			
23	0.70	1952	72.3	0.73	1976	571.0			
24	0.73	1961	72.0	0.76	1971	520.0			
25	0.77	1972	72.0	0.79	1958	450.0			
26	0.80	1966	58.0	0.82	1956	440.0			
27	0.83	1958	52.0	0.85	1975	393.7			
28	0.86	1973	49.5	0.89	1946	256.0			
29	0.89	1960	41.1	0.92	1952	196.0			
30	0.92	1974	38.4	0.95	1970	155.3			
31	0.95	1955	32.9	0.98	1955	136.0			
32	0.98	1975	10.3						

Note: 1/ i: Order, N: Number of Samples

FIGURE 3B-3 FLOOD-FREQUENCY FOR EACH RIVER

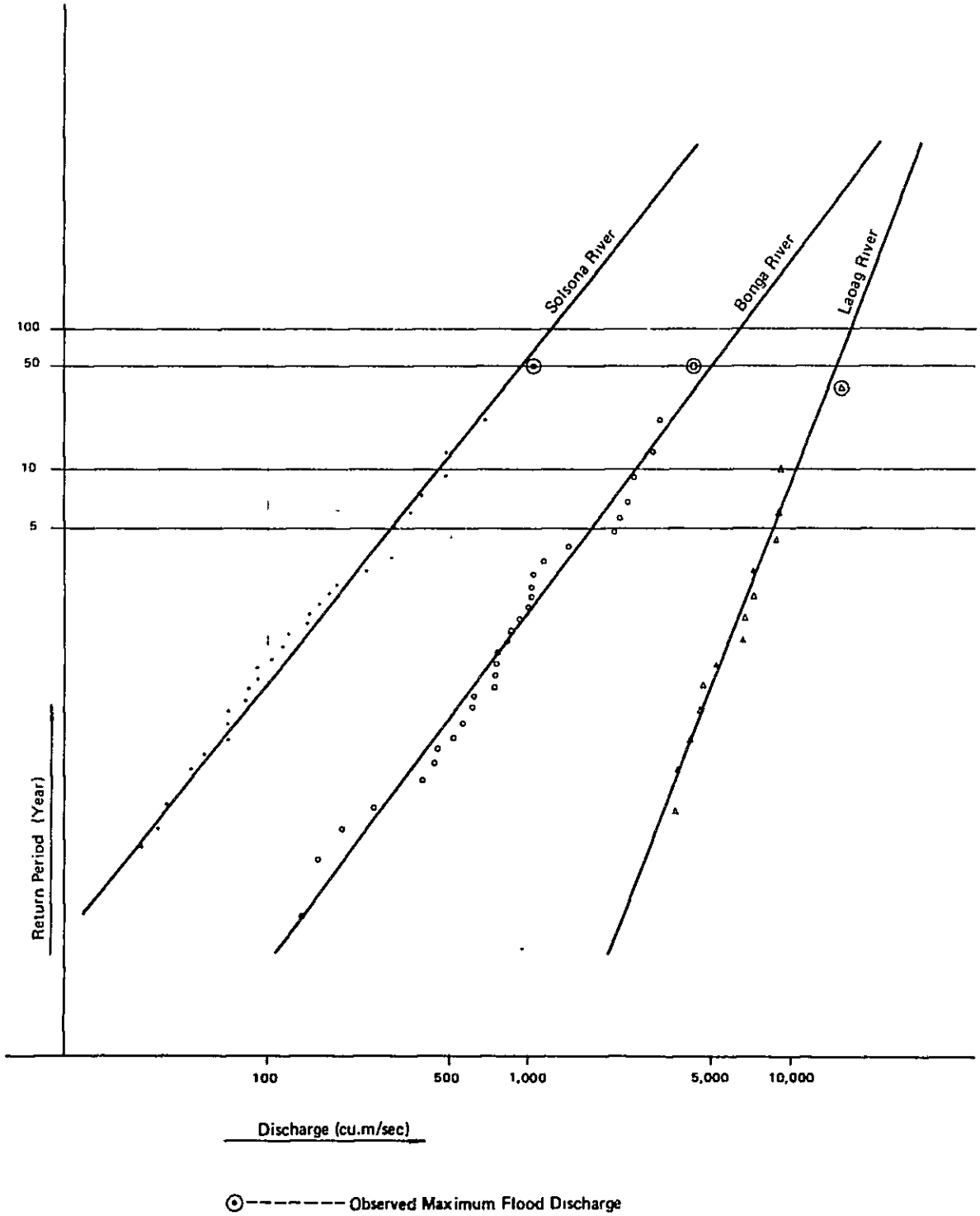
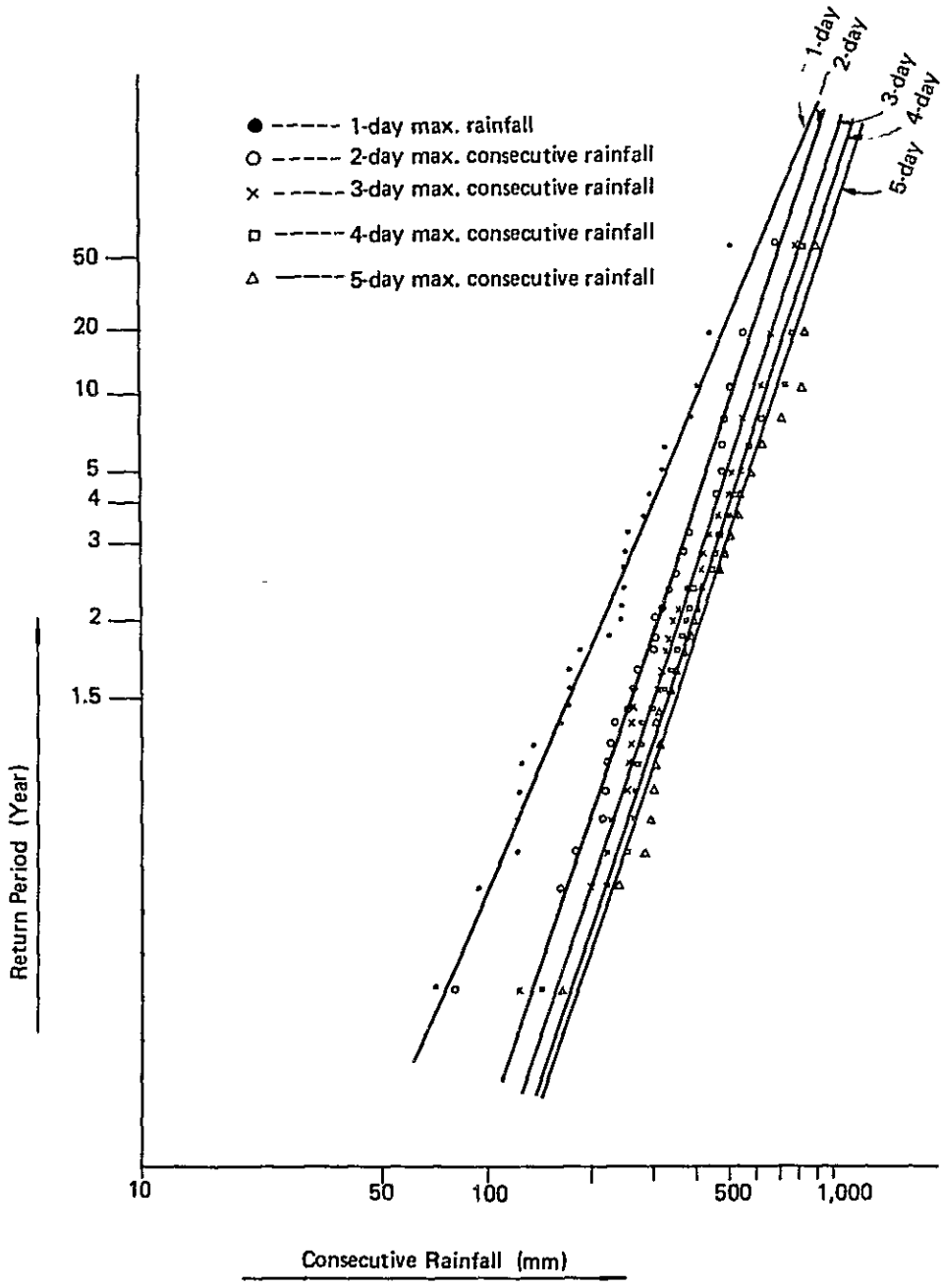


Table 3B-18 Maximum Consecutive Rainfall (1951-1977)

Station: Laoag Rainfall Gauging Station

Year	1-Day	2-Day	3-Day	4-Day	5-Day	6-Day	7-Day
1951	253.7	305.3	332.0	335.0	336.3	349.5	372.6
1952	254.0	257.6	257.9	264.0	312.7	321.1	333.5
1953	392.4	515.6	515.6	515.6	516.1	516.1	516.1
1954	170.9	268.4	268.4	294.9	300.5	318.5	319.5
1955	71.9	81.5	127.5	142.5	163.6	199.2	219.8
1956	173.7	320.0	381.2	388.3	412.0	435.4	441.0
1957	186.2	371.4	426.8	450.7	511.7	539.4	551.1
1958	127.0	237.5	321.6	366.0	391.9	409.4	422.6
1959	250.7	337.6	345.5	349.8	366.8	374.7	480.5
1960	122.2	183.9	200.4	250.4	287.5	343.1	363.4
1961	494.8	670.8	785.1	810.5	821.2	895.1	1,009.4
1962	409.2	491.3	672.1	778.0	879.1	893.3	901.4
1963	294.9	471.7	629.4	736.3	842.5	931.9	934.4
1964	162.9	221.3	268.6	268.6	301.8	405.0	407.5
1965	280.6	304.5	317.3	320.1	320.4	320.4	338.7
1966	136.2	229.2	261.2	273.9	295.5	306.7	324.6
1967	510.3	557.2	557.5	576.0	584.1	584.4	587.0
1968	248.5	308.2	337.1	384.9	404.5	434.5	454.1
1969	323.6	482.1	526.6	629.1	718.0	803.3	879.8
1970	93.5	165.6	226.8	271.6	318.0	362.8	394.1
1971	225.2	393.3	472.1	474.6	474.6	476.4	483.9
1972	249.7	358.7	438.7	557.0	615.2	666.8	716.9
1973	320.6	496.4	516.8	524.0	527.1	544.1	561.9
1974	176.5	274.7	359.3	382.9	394.6	431.4	498.3
1975	125.7	221.5	262.4	275.1	330.8	371.7	448.3
1976	128.4	219.1	228.2	231.6	234.7	236.3	237.1
1977	243.0	396.2	428.5	463.0	495.3	509.3	516.9

FIGURE 3B-4 FREQUENCY FOR EACH MAXIMUM CONSECUTIVE RAINFALL AT LAOAG



Soil and Land Classification

A. Introduction

The soil survey has been carried out to classify the following items:

i) To review the report on the soil survey which is conducted in the Project Area by NIA.

ii) To re-examine the present soil condition

iii) To collect the necessary data for the feasibility study

As to the field survey, topographic map with the scale of 1 : 4,000 and soil map with the scale of 1 : 50,000 prepared by NIA were used as the base map. And also the soil survey and land classification reports on Ilocos Norte Area Development Project (NIA, 1976) and Palsiguan River Multi-Purpose Project (NIA, 1978) were collected for the study.

During the field survey, land use survey, topographic survey and boring test were conducted and necessary data and informations were collected.

B. The Project Area

The Project area is located in the right bank area of the Bonga river, the main tributary of the Laoag river which runs in the province of Ilocos Norte. It is bounded in the north by the Labugaon and Cura rivers, in the west by the Bonga river and in the east to south by the mountainfoot of the Cordillera Central Mountain.

The Project Area is drained by the Bonga river and its tributaries such as the Labugaon, Solsona, Madongan and Papa river. These rivers make a remarkable alluvial fan, alluvial flat and river wash zone. The damage to farm lands by big flood is serious. This problem could be solved only by major flood control works.

Climate is characterized by two extremes: very dry from November to April and very wet during the rest of the year. Typhoon usually occurs during the months of June to September. The average annual rainfall in the area is 2,600 millimeters with the greatest precipitation occuring in August. The average temperature is 26.9°C and average humidity is 79 percent.

C. Geology and Parent Material

The geology of the mountains and hills surrounded the Project Area is composed of the sedimentary, intrusive and metamorphic rocks. Their geological age is mainly Pliocene to Middle Miocene. The kind of rocks is diorite, gabbro, andesite, basalt, conglomerate, limestone, tuffacious shale, mudstone, sandstone and others. The parent materials of soil in the Project Area are mainly derived from these formations.

Outlines of geological feature of the Project Area is divided into the alluvial plain and higher terrace. The alluvial plain is covered with fine to coarse alluvial sediments, while the higher terrace consists of diluvial gravelly formation.

D. Topography

The topography of the Project Area is divided into four major area-categories, namely: 1) Alluvial fan, 2) Alluvial flat, 3) High terrace and Older alluvial fan, and 4) River wash.

The alluvial fan is the most dominant topography in the Project Area. Three big corn-shaped alluvial fans were formed through the Labugaon, Solsona, Madongan and Papa rivers issued from the Cordillera Central Mountains.

The areas of the alluvial flat were mainly formed in downstream areas of the Labugaon, Solsona and Madongan rivers. These areas are topographically the same as the Dingras National Irrigation Area located on the opposite bank of the Bonga river.

The high terrace and older alluvial fan are developed along the mountain foots of the eastern border of the Project Area. They make the topographic relief vary from sloping, rolling to hilly.

The river wash is developed predominantly along the major river tributaries including the Bonga river. They are the washed areas adjacent to river at the time of flooding.

E. Land Use

1. Introduction

Out of about 15,880 hectares, gross area of the project, 10,200 hectares is used as the cultivated area and remaining 5,680 hectares comprises the un-cultivated area such as 6-class lands (river wash, rolling and steep slopes, hilly area etc.), residential areas and Rights-of-way (public roads and irrigation canals).

The cultivated areas are cropped with paddy rice as first crop and secondarily with tobacco, corn, sugarcane, mongo bean, vegetables and other upland crops such as coconut.

2. Cultivated Area

a) Paddy Field

The paddy fields are almost situated on the alluvial fan, alluvial flat and older alluvial fan, while very limited extent of the upland paddy fields is located on the high terrace.

Most of paddy fields (about 8,100 hectares) are irrigated by the communal irrigation system while remaining 1,900 hectares are under the rainfed condition. Double cropping of rice is practiced within limited area of about 3,400 hectares serviced by the existing communal irrigation systems. However paddy rice is grown mostly during only the wet season. Most areas are left as follow during the dry season due to lack of irrigation water supply.

Among the diversified crops grown in the Project area, corn and tobacco cover relatively big area, but sugarcane, mongo bean and vegetables are grown in more limited scale. Tobacco is mainly cultivated at the upstream areas of the Madongan alluvial fan. Corn is generally grown at the areas adjacent to the river wash (see Figure 3B-5).

b) Upland Field

The higher portions on slightly undulating alluvial plain and terrace are used for upland crops such as corn, upland rice, vegetables, root crops and coconut. Vegetables and root crops are are primarily for family consumption and supplemental source of income of the farmers.

3. Un-cultivated Area

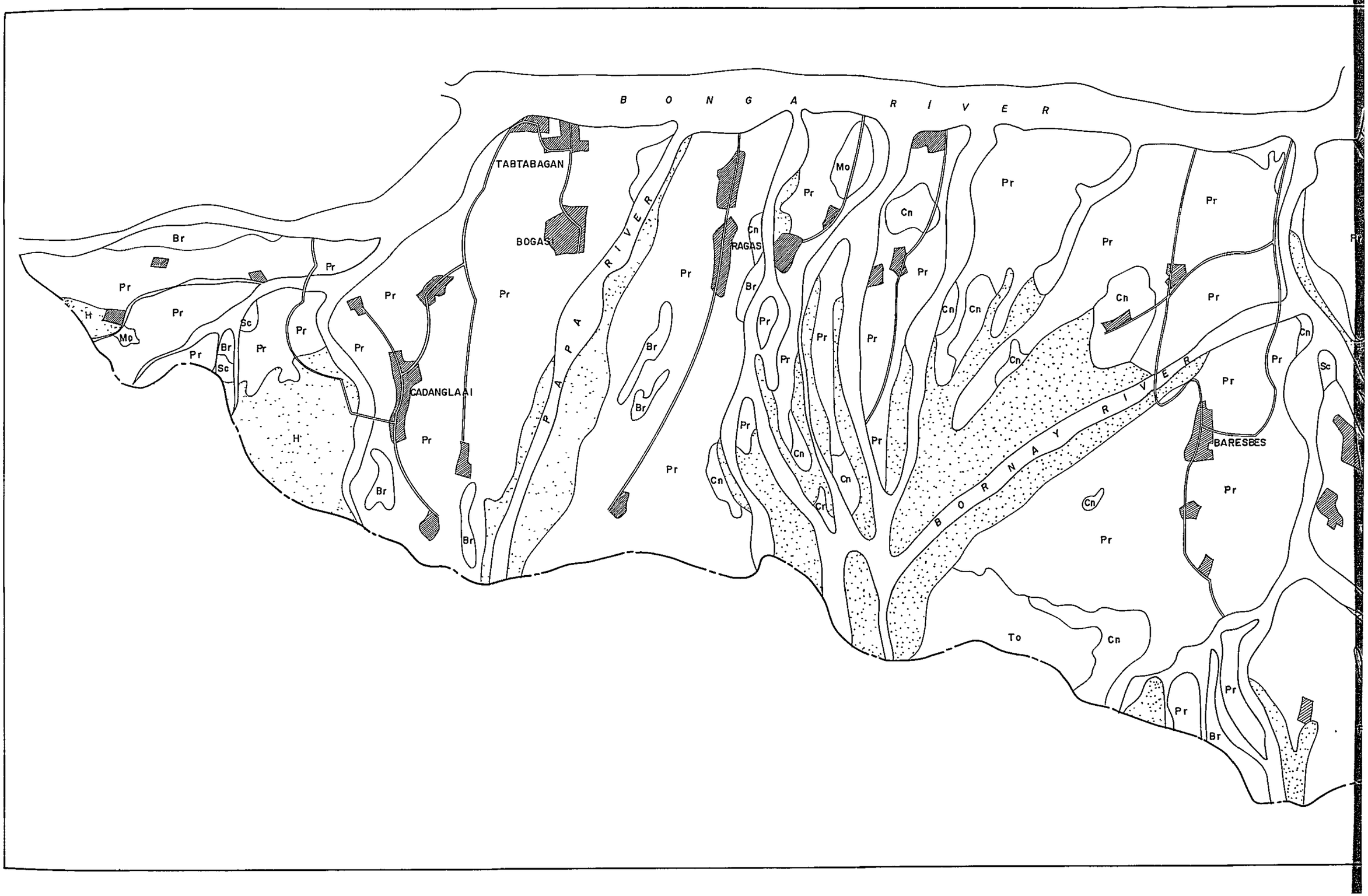
Un-cultivated areas are located on the river wash, steep slope and rolling land. The river wash areas are widely developed along the Bonga river and its major tributaries. Un-cultivated areas consist of barren strip, brush or grass growth and secondary forest.

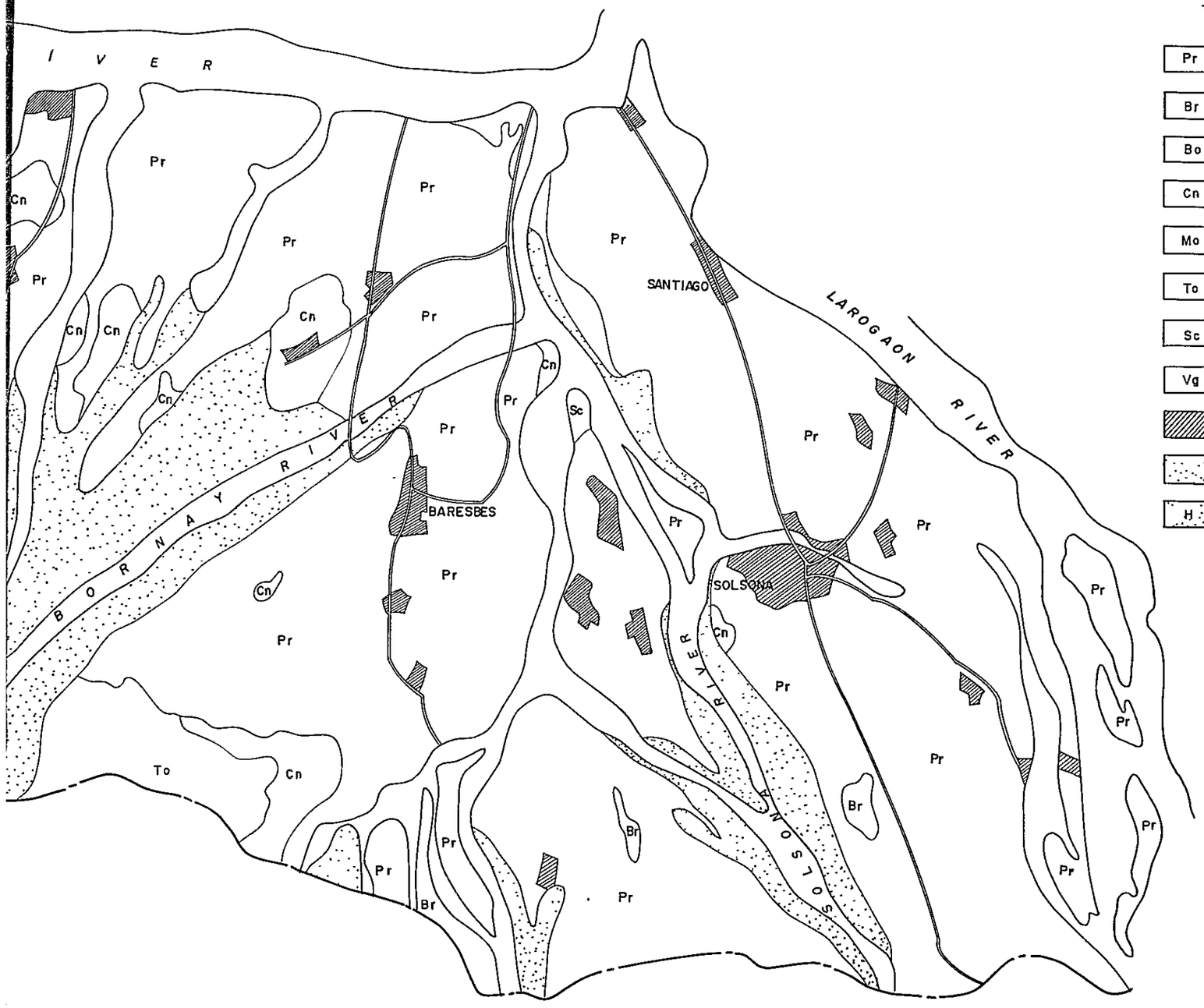
F. Soil Classification and Description

1. Introduction

The soils of the Project Area are predominantly composed of alluvial deposits derived from adjacent hills and mountains. The parent materials of soil are fine to coarse sediments silting on gravelly alluvial strata. The residual red soils are developed on the high terrace with a limited extent.

Generally the soils of the Project Area were classified into three main groups based on landscape and physiographic position, namaly: 1) Soils of the alluvial fan and alluvial flat which constitute the alluvial plain, 2) Soils of the uplands (high terrace) which comprise the rolling and hilly areas and 3) Soils of the river wash. (See Figure 3B-6)

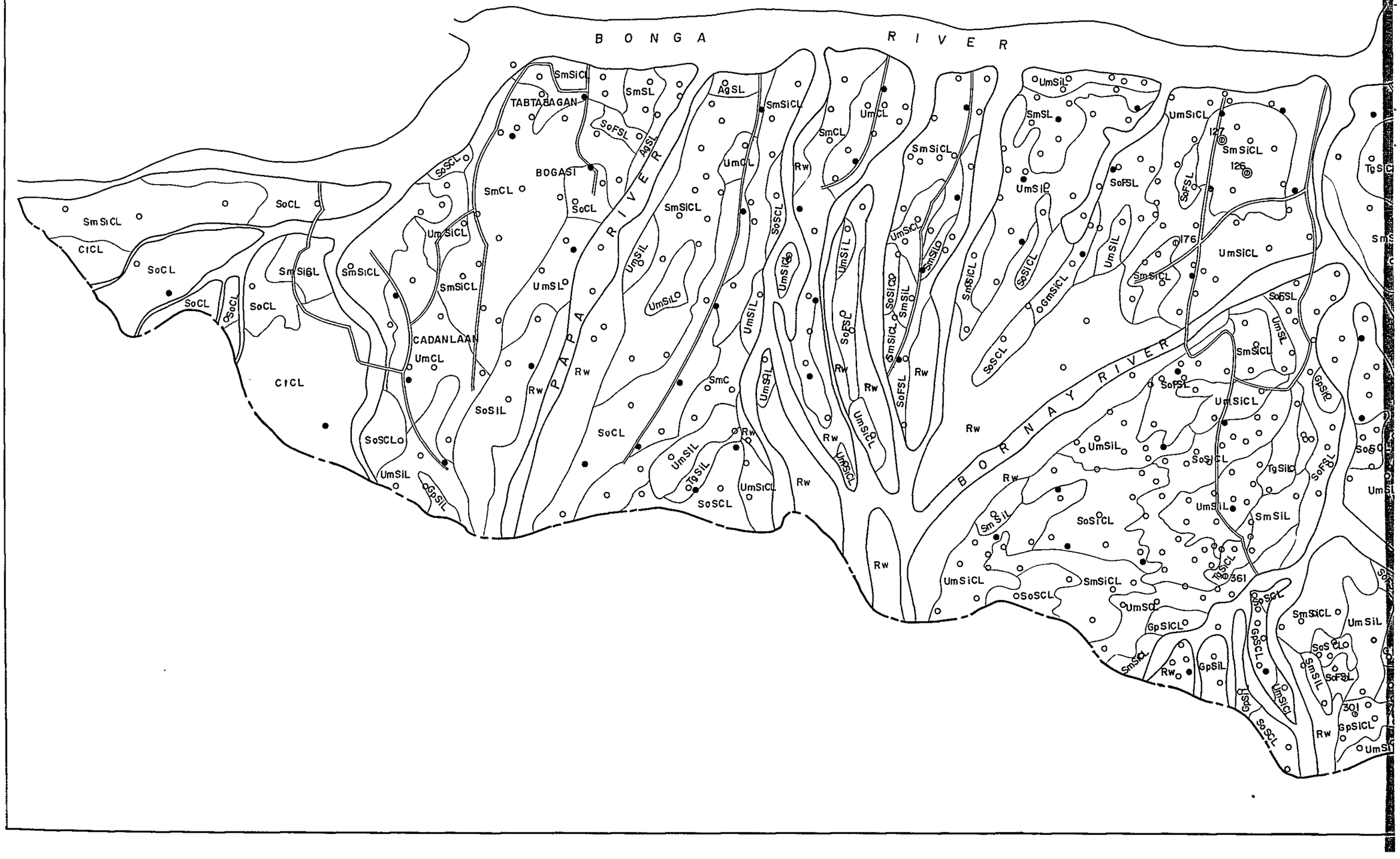

B O N G A R I V E R
TABTABAGAN
BOGASI
RAGAS
CADANGLAAI
A P A R I V E R
B O R N A Y R I V E R
BARESBES
Br
Pr
Sc
Mo
H
Cn
To



EXPLANATION:

- Pr — PADDY RICE
- Br — BRUSH OR TREES
- Bo — BAMBOO
- Cn — CORN
- Mo — MONGO
- To — TOBACCO
- Sc — SUGAR CANE
- Vg — VEGETABLE
- TOWN OR BABRIOS
- RIVER WASH
- H — HILLS & UPLANDS

FIGURE 3B-5 LAND USE MAP


BONGA RIVER
PAPA RIVER
BORNAY RIVER
TABTABAGAN
BOGASI
CADANLAAN
SmSiCL
SmSL
AgSL
SoFSL
AgSL
SoSCL
SmCL
SoCL
UmSiCL
SmSiCL
UmSL
UmSiL
SmSiCL
SoCL
SoCL
SoCL
SoCL
SmSiCL
SmSiCL
SmSiCL
CtCL
CtCL
SoCL
SoCL
SoSCL
UmSiL
GpSiL
UmCL
SoSiL
Rw
Rw
SoCL
SmC
UmSiL
UmSiL
TgSiL
SoSCL
UmSiCL
Rw
Rw
UmSiL
UmSiCL
Rw
SoFSL
Rw
Rw
Rw
SmCL
UmCL
SmSiCL
UmSiCL
SmSiCL
SoSiCL
SmSiL
SmSiCL
UmSiL
SmSiCL
SoSCL
GmSiCL
UmSiL
SmSiCL
SoSCL
UmSiL
SoFSL
TgSiL
SoSCL
UmSiL
SmSiCL
127
126
SmSiCL
UmSiL
176
UmSiCL
SoSSL
UmSiL
SmSiCL
SoFSL
UmSiCL
SoFSL
GpSiL
SoSiCL
TgSiL
SoFSL
UmSiL
SmSiL
SoSiCL
SmSiL
TgSiCL
361
UmSiCL
SmSiCL
SoSCL
UmSiCL
SoSCL
UmSiL
GpSiCL
SmSiCL
GpSiL
Rw
GpSCL
SoSCL
SmSiL
SoFSL
UmSiCL
301
GpSiCL
SoSCL
Rw
UmSiL

LEGEND :

AgSL	AGUSTIN SANDY LOAM	SoSCL	SOLSONA SANDY CLAY LOAM
CtCL	CERVANTES CLAY LOAM	SoCL	SOLSONA CLAY LOAM
GpSiL	GAPAN SILT LOAM	SoSiCL	SOLSONA SILTY CLAY LOAM
GpSiCL	GAPAN SILTY CLAY LOAM	SoSL	SOLSONA SANDY LOAM
GpSCL	GAPAN SANDY CLAY LOAM	TgSiL	TAGULOD SILT LOAM
SmSiCL	SAN MANUEL SILTY CLAY LOAM	TgC	TAGULOD CLAY
SmSiL	SAN MANUEL SILT LOAM	TgSiCL	TAGULOD SILTY CLAY LOAM
SmSL	SAN MANUEL SANDY LOAM	UmSL	UMINGAN SANDY LOAM
SmCL	SAN MANUEL CLAY LOAM	UmCL	UMINGAN CLAY LOAM
SmC	SAN MANUEL CLAY	UmSCL	UMINGAN SANDY CLAY LOAM
SoSiL	SOLSONA SILT LOAM	UmSiCL	UMINGAN SILTY CLAY LOAM
SoFSL	SOLSONA FINE SANDY LOAM	UmSiL	UMINGAN SILT LOAM

Rw RIVER WASH

◎ TEST PIT SITE

o AUGER BORING SITE

● STICK BORING SITE

251 ⊕ SOIL SAMPLING SITE

N

1 0 1 2km

SCALE 1: 50,000

FIGURE 3B-6 SOIL MAP

2. Identified Soil Series

The soils of the alluvial fan and alluvial flat were classified into the six soil series such as the Agustin, Gapan, San Manuel, Solsona, Taguld and Umingan series.

The residual red soils on the upland area were named as the cervantes series.

The soils of the river wash have no development of soil profiles where lands are covered with clean sands and gravels.

The procedures on soil classification and soil mapping were based on the criteria which were established in the previous soil survey of this project conducted by NIA and BS.

3. Agustin Series

This soil series is a member of the fine loamy, moderately deep and well drained soils. Solum thickness ranges from 50 to 100 cm over sandy to gravelly skeletals. They are developed along the river levees of the Labugaon, Papa and Bonga rivers.

The surface soils have brown to dark brown silt loam and sandy loam texture. Subsoils range from brown, grayish to yellowish brown stratified loamy fine sand to sandy loam. External drainage is fair while internal drainage is good. The area is nearly level to level.

A horizons are mainly grayish brown or brown silt loam, sandy loam or silty clay loam with few to common dark brown mottlings, slightly sticky, slightly plastic and friable, pH reaction 4.3.

B horizons 50 to 100 cm deep are brown, grayish brown or yellowish brown silt loam or sandy loam, slightly sticky, slightly plastic and friable, pH reaction 4.3.

C horizon are dominantly stratified gray, yellowish brown or brown sandy loam or loamy sand, pH reaction 4.8.

Agustin sandy loam has the only one soil type mapped in the Project Area.

4. Gapan Series

This soil series is a member of the five loamy, moderately deep and well drained soils. Solum thickness ranges from 100 to 150 cm over sandy skeletals. They are mainly distributed in the Labugaon and Solsona areas. The relief is generally level.

The surface soils are brown to dark brown silty clay loam to silt loam. Subsoils range from yellowish brown to pale brown silty clay loam to fine sandy loam. External drainage is fair and internal drainage is good. The substrata are brown to grayish brown sandy skeletal with stratified gravelly sand.

A horizons are 20 to 50 cm thick, dark grayish or dark brown loam or silt loam with few to common strong brown or yellowish brown mottlings, slightly sticky, slightly plastic and friable, pH reaction 5.7.

B horizons are chiefly grayish brown, brown or yellowish brown sandy loam or loam, slightly sticky, slightly plastic and friable, pH reaction 5.8.

C horizons are mainly stratified sandy and gravelly skeletals.

The two soil types classified under this soil series are Gapan silt loam and Gapan silty clay loam.

5. San Manuel Series

This soil series is a member of the fine loamy, deep and well

drained soils over stratified sandy strata. Solum thickness ranges from 100 to 150 cm. This soil series is most widely distributed in the Project Area.

The surface soils are generally brown to dark brown silt loam, sandy loam, loam and silty clay loam and these being used for paddy rice exhibit gray to grayish brown colors. It is relatively loose and very friable. Subsoils are chiefly brown to yellowish brown friable clay loam to fine sandy loam. Underneath the subsoils are weak stratified yellowish brown to brown silty clay loam or silt loam. Drainage condition is good both externally and internally.

A horizons are 20 to 40 cm deep, brown or dark brown sandy loam, silt loam or silty clay loam with few to common strong brown or yellowish brown mottlings, slightly sticky, slightly plastic and friable, pH reaction 5.3. Where used for paddy rice the A horizons are gray or grayish brown.

B horizons 100 cm deep are characteriatically brown or yellowish brown clay laom, silty clay loam or sandy loam with strong brown and gray mottlings, slightly sticky, slightly plastic and friable, pH reaction 5.8.

C horizons are stratified grayish brown, brown or gray silty clay loam, clay loam, silt loam or sandy loam, slightly sticky, slightly plastic and friable, pH reaction 5.8.

The San Manuel series is subdivided into the three soil types such as San Manuel silt loam, San Manuel silty clay loam and San Manuel sandy loam. These soils are the most ideal for crop diversification in the Project Area.

6. Solsona Series

This soil series was developed from the most recent alluvial

deposits. They belong to a member of the fine loamy, shallow and well drained soil over gravelly substrata. Solum thickness ranges from 30 to 50 cm. The surface soils are moderately deep dark grayish brown, gray to dark gray sandy clay loam, fine sandy loam and silt loam. It has a weak structural profile development with the absence of B horizon. Subsoils are mainly gravelly sandy loam, loamy sand and sometimes with the presence of gravels.

A horizons 30 to 50 cm deep are grayish brown or brown sandy loam, silt loam, loam or clay loam with few strong brown or reddish brown mottlings, slightly sticky, slightly plastic and friable, pH reaction 5.7.

C horizon are mainly stratified sand and gravels.

The six soil types classified under this soil series are Solsona silt loam, Solsona fine sandy loam, Solsona sandy clay loam, Solsona clay loam, Solsona silty clay loam and Solsona sandy loam. Also included in this soil series are shallow soil with poor natural drainage.

7. Tagulod Series

This soil series is a member of the five clayey, very deep and somewhat poorly drained soils. Solum thickness ranges from 150 to 200 cm. It occures on slightly elevated landscapes and its relief is nearly level. External drainage is fair and internal drainage is poor. The surface soils are chiefly dark gray or gray clay, clay loam or silty clay loam. Consistency is sticky and plastic when wet with common to many yellowish brown mottlings. The subsoils are grayish brown light clay with many yellowish brown mottlings. Beneath the subsoils gray weak stratified light clay with yellowish brown mottlings. Structure is sub-angular blocky to angular blocky in the surface soils and subsoils.

A horizons 20 to 50 cm thick are gray, dark gray or grayish brown

silty clay, clay or silty clay loam with few to common yellowish brown mottlings, sticky, plastic and firm, pH reaction 6.3.

B horizons are generally grayish brown, very dark grayish brown or light brownish grey silty clay or clay with yellowish brown mottlings, very sticky, very plastic and firm. Few Mn concretions are present, pH reaction 6.7.

C horizons below 150 cm deep are weakly stratified gray or light clay or clay loam with common yellowish brown mottlings, sticky, plastic and firm, pH reaction 5.1.

The Tagulod series is subdivided to the three soil types such as Tagulod clay, Tagulod silt loam and Tagulod silty clay loam.

8. Umingan Series

The soils of the Umingan series belong to a member of the fine loamy, moderately deep and well drained soils. Solum thickness ranges from 50 to 100 cm, the root limiting zone. Umingan soils are usually located along cources of rivers, streams and gently undulating lands on the foot of mountains. External and internal drainage are good. The surface soils are generally pale brown, light brownish gray to yellowish brown sandy loam, clay loam or silt loam. The subsoils are light yellowish to light olive gray clay loam, silty clay loam or fine sandy loam with few yellowish brown mottlings.

A horizons 20 to 30 cm deep are characteristically brown, dark brown or yellowish brown sandy loam, clay loam or silt loam, slightly sticky, slightly plastic and friable. Where used for paddy rice, the A horizons are gray or grayish brown, pH reaction 5.3.

B horizons 50 to 100 cm depth are dark yellowish brown clay loam, silty clay loam or fine sandy loam with few yellowish brown mottlings, slightly sticky, slightly plastic and friable, pH reaction 6.1.

C horizons are stratified sand and gravels.

The Umingan series is subdivided into the five soil types such as Umingan sandy loam, Umingan clay loam, Umingan sandy clay loam, Umingan silty clay loam and Umingan silt loam.

9. Cervantes Series

Cervantes soils are residual upland soils developed through the weathering and leaching. It occupies the rolling and hilly sections (high terrace) in the northeast border of Nueva Era. The distinguishing characteristics of this soil are its very friable A and B horizons and reddish color. External drainage is good and internal drainage is fair to good. The surface soils are reddish brown clay loam, friable when moist and slightly sticky when wet, ranging from 10 to 20 cm deep. The subsoils are yellowish red to red clay loam or clay extending up to 120 cm from the surface. Gravels are present in the B horizons.

Cervantes clay loam is the only soil type delineated in the Project Area. This soil is not suited to the most agricultural crops because of its relief and low natural fertility.

10. Soils of the River Wash

The soils of the river wash areas which developed along the major river tributaries including the Bonga river are composed of clean sand and gravels. There are not developed the soil cover and soil profile. The land use of this areas is barren strip, brush or grass growth and secondary forest.

The river wash areas are not suited for farming by the traditional method. This problem could be corrected only by flood control works and introducing fine soils to the land.

G. Physical and Chemical Properties

The summarized physical and chemical properties of the soils in the Project Area was shown in Table 3B-19. This results show the physical and chemical characteristics of the alluvial soils of paddy field in the Project Area.

The general characteristics on the analytical items of each soil series was shown in Table 3B-20.

Most of the soils in the Project Area belong to medium moderately fine textured soils. The depth of surface soil (Ap horizons) is 10 to 20 cm in paddy field. The effective depth of soil is more than 50 cm except for a part of the Solsona series. From these fact, it appears that the alluvial plain of the Project Area has enough soil depth for paddy rice production.

The pH and percentage of base saturation are correlated as shown in Figure 3B-8. The percentage of base saturation is very useful criteria in depicting the fertility conditions in the soil colloid-root environment. The base saturation of the soils in the Project Area is generally in the range 50 to 80 percent. This may be indicate that the leaching under rainfed and irrigated condition is medium to moderately high.

Cation Exchange Capacity (CEC) is medium to high. Avairable phosphate is medium to high except for few samples. Exchangeable calcium and magnesium are high while exchangeable potassium content is very low.

H. Land Classification for Irrigated Paddy Field

1. Objective of the Study

The main objectives of land classification are: a) to identify the arable lands which are suited for irrigation development, b) to

Table 3B-19 Physical and Chemical Properties of Soils in the Project Area (After NIA, 1976)

Pit. No.	Soil Series	Horizon	Depth (cm)	Particle Size Distribution: Total Sand (%)	Silt (%)	Clay (%)	Texture	Available Moisture (%)	Setting Volume (%)	Organic Carbon (%)	pH: 1 : 1 H_2O	pH: 1 : 20.01 M $CaCl_2$	Exchangeable Cation (me/100g): Ca + Mg	Na	K	Cation Exchange Capacity (me/100g)	Available P_2O_5 (ppm)	Free Fe_2O_3 (%)	Base Saturation (%)
176	Agustin	Ap	0- 15	6.2	58.6	35.2	SiCL	17.7	26.5	0.10	5.5	5.3	9.68	0.52	0.05	14.65	16	0.89	64.97
		B1	15- 50	10.4	63.4	26.2	SiL	17.7	22.0	1.12	4.3	4.1	8.68	0.48	0.03	19.09	14	0.34	48.14
		B2	50- 70	68.2	19.6	12.2	SL	1.7	16.0	0.97	4.4	4.3	9.00	0.46	0.03	19.29	Trace	0.43	49.20
		C	70-220	56.6	34.1	9.3	SL	5.4	15.5	0.36	4.8	4.6	7.42	0.50	0.04	14.66	3	1.79	54.30
66	Ganan	Apg	0- 30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		B1	30- 55	48.2	29.0	22.8	L	14.3	21.5	0.59	5.8	5.3	9.43	0.16	0.03	16.32	14	0.14	55.88
		B3	55- 75	32.0	49.2	18.8	L	16.5	19.5	0.36	5.7	5.3	8.05	0.19	0.03	15.47	28	0.66	53.46
		C	75-140	65.8	15.4	18.8	SL	9.7	17.5	0.53	5.8	5.3	8.05	0.13	0.03	14.61	11	0.48	56.19
701	Ganan	Apg	0- 30	44.7	38.8	16.5	L	15.2	22.5	2.36	6.2	5.7	15.29	0.39	0.17	26.15	7	1.09	60.61
		B1	30- 75	54.0	34.2	11.8	SL	13.3	23.0	3.02	6.2	5.8	14.30	0.35	0.03	26.08	4	0.70	56.29
		B2	75-135	47.0	42.2	10.8	L	12.7	23.0	1.14	6.7	6.1	15.43	0.26	0.03	24.62	-	0.25	63.85
126	San Manuel	Apg	0- 12	32.8	42.2	25.0	L	14.6	22.5	0.43	5.8	5.6	9.67	0.14	0.03	22.54	3	0.15	43.66
		A3g	12- 30	78.8	1.6	19.6	SL	4.1	16.0	1.58	6.3	6.0	19.00	0.54	0.00	29.84	2	1.14	65.48
		B1	30- 90	82.4	82.4	17.6	SiL	3.8	15.0	0.08	5.9	5.8	10.50	0.36	0.05	24.30	6	0.63	45.15
		B2	90-110	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		B3	110-170	16.6	70.4	13.0	SiL	18.2	17.0	0.28	5.9	5.4	12.46	0.10	0.05	31.91	6	0.07	48.92
		C1	170-220	4.8	67.6	27.6	SiCL	40.5	21.0	0.34	6.1	6.0	21.45	0.87	0.05	31.77	7	0.21	60.83
		C2	220-260	8.2	65.2	26.6	SiL	22.5	22.0	0.77	6.1	6.0	22.13	0.62	0.03	38.58	12	1.75	59.02
		C3	260-300	17.0	49.0	34.0	SiCL	18.1	21.5	0.79	6.3	6.0	21.75	0.48	0.03	34.66	9	2.29	64.22
127	San Manuel	A 1p	0- 11	10.3	47.2	42.0	SiC	27.4	26.0	5.54	6.2	6.0	18.00	0.39	0.00	25.59	4	0.09	71.86
		A 2p	11- 22	1.0	56.0	38.0	SiCL	22.2	25.0	0.80	6.3	6.0	17.48	0.54	0.03	22.25	4	1.82	81.12
		A3p	22- 50	6.6	65.4	28.0	SiCL	24.6	23.0	0.90	6.0	5.3	16.86	0.69	0.03	25.58	8	1.84	68.73
		B1	50- 85	62.1	23.3	14.6	SL	1.5	14.0	0.29	5.4	5.0	8.30	0.22	0.03	13.85	4	0.05	66.54
		B21	85-100	7.4	81.0	11.4	SiL	20.5	17.5	0.29	6.3	5.9	13.75	0.78	0.03	17.36	9	1.21	83.87
		B22	100-120	4.2	39.2	56.5	C	26.5	27.0	0.62	6.2	5.9	25.28	0.46	0.03	34.67	7	1.88	74.33
		B3	120-140	29.6	42.4	28.6	CL	24.4	21.0	0.62	6.2	5.9	18.69	0.89	0.04	26.42	8	1.57	74.26
		C	140-	91.4	0	8.6	S	1.1	13.0	0.12	6.0	5.4	4.28	0.31	0.03	6.52	6	0.54	70.86
52	Solsona	A 1	0- 20	76.1	6.3	17.6	SL	3.3	15.5	0.46	6.4	6.3	9.90	0.43	0.12	13.75	3	0.25	76.00
		A3	20- 35	69.5	22.2	11.3	SL	6.7	17.0	0.93	6.6	6.3	12.00	0.44	0.08	15.32	3	0.29	81.72
		C	35- 50	69.2	18.7	12.1	SL	5.7	16.0	0.52	6.3	6.0	10.71	0.40	0.10	14.81	2	0.21	75.69
93	Solsona	Ap	0- 20	31.0	40.4	28.6	CL	31.2	26.0	5.91	5.2	4.9	11.06	0.39	0.04	22.39	1	0.52	51.32
		A3g	20- 35	36.8	35.6	27.6	CL	11.8	24.0	1.55	5.2	5.0	11.22	0.38	0.06	20.56	4	0.70	56.71
		C	35- 50	46.0	30.4	23.6	L	10.1	21.0	0.80	5.7	5.6	11.11	0.36	0.04	18.21	2	2.36	63.21
21	Tapulod	Ap	0- 30	0.8	50.6	48.6	SiC	30.2	29.5	2.1	6.0	5.7	25.19	0.47	0.05	33.71	Trace	1.02	76.27
		B1	30- 55	2.6	43.0	54.4	SiC	20.1	30.0	5.54	6.7	6.2	27.92	0.54	0.04	34.30	4	0.39	83.09
		B21	55- 80	2.2	50.2	47.6	SiC	25.5	27.0	0.71	7.0	6.6	30.00	0.58	0.00	32.28	2	0.84	94.73
		B22	80-100	2.9	52.5	44.6	SiC	24.3	23.0	0.90	7.3	6.9	33.95	0.73	0.03	35.26	1	0.82	98.44
		B3g	100-160	26.2	38.2	35.6	CL	19.1	-	1.14	6.9	6.4	27.16	0.46	0.03	33.15	6	1.21	83.41
		C1g	160-180	26.6	50.8	22.6	SiL	17.4	19.0	0.69	5.6	5.4	12.45	0.48	0.03	19.96	2	0.82	64.93
		C2g	180-220	54.0	30.4	15.6	SL	11.4	19.0	0.28	5.1	5.0	10.06	0.48	0.03	19.97	3	0.89	52.93
361	Tapulod	Apg	0- 25	4.6	41.8	53.6	SiC	31.3	27.0	1.22	4.6	4.4	10.89	0.33	0.07	21.59	8	1.18	52.29
		A3g	25- 50	3.8	44.2	52.0	SiC	25.4	26.0	0.55	6.0	5.5	21.63	0.24	0.03	28.30	16	1.09	77.38
		B1	50- 90	4.0	49.0	47.0	SiC	24.1	24.0	0.52	5.7	5.4	16.85	0.27	0.03	24.35	19	1.25	70.43
		B21g	90-115	-	-	-	-	-	-	1.12	5.7	5.4	20.50	0.35	0.03	28.08	17	1.18	74.36
		B22	115-165	13.0	31.4	55.6	C	-	-	1.57	6.0	5.8	30.01	0.36	0.09	39.06	12	1.23	77.98
		B3	165-190	13.2	35.8	51.0	C	19.9	29.5	0.70	5.1	4.7	12.93	0.37	0.08	23.08	12	1.25	57.97
		C	190-220	39.4	24.6	36.0	CL	15.4	31.0	0 41	5.9	5.7	20.89	0.33	0.07	27.69	21	1.18	76.89
58	Umingan	Apg	0- 20	34.8	34.6	30.6	CL	18.9	23.0	1.90	5.2	5.2	5.15	0.30	0.08	15.83	3	0.96	34.93
		B1	20- 50	60.4	29.2	10.4	SL	19.2	19.0	0.91	6.4	6.0	14.95	0.25	0.05	23.25	1	0.38	65.59
		B2	50- 80	74.1	11.3	14.6	SL	4.9	15.5	0.52	6.7	6.6	16.17	0.33	0.04	21.84	1	0.34	75.73
		B3	80- 90	82.7	5.1	12.2	SL	3.0	15.5	0.43	6.3	6.0	8.55	0.40	0.09	17.34	4	0.23	52.13
		C	90-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
251	Umingan	Apg	0- 10	8.8	48.6	42.6	SiC	27.7	28.0	2.01	5.4	5.2	17.20	0.04	0.05	27.49	9	0.89	62.90
		Ap2g	10- 23	12.0	39.4	48.6	C	20.3	26.0	2.07	6.1	5.7	23.60	0.36	0.03	34.49	4	3.30	69.56
		A3g	23- 40	17.6	43.8	38.6	SiCL	21.1	25.0	1.66	6.1	5.7	21.00	0.38	0.03	30.91	6	3.84	69.27
		B1	40- 50	18.8	51.6	29.6	SiCL	25.8	21.0	1.00	6.3	5.8	20.10	0.40	0.02	29.02	6	2.61	70.71
		B2	50- 63	51.6	30.8	17.6	L	16.9	19.0	0.94	6.0	5.6	19.30	0.29	0.02	29.29	4	3.59	66.88
		B3	63- 85	39.8	41.6	18.6	L	21.7	19.5	1.52	5.8	5 6	16.45	1.12	0.05	26.82	6	2.14	65.70
		C	85-	62.2	25.2	12.6	SL	15.6	18.0	1.34	5.7	5.5	14.35	0.27	0.05	22.53	5	1.00	64.73

FIGURE 3B-7 REPRESENTATIVE SOIL PROFILES OF EACH SOIL SERVICES IN THE PROJECT AREA

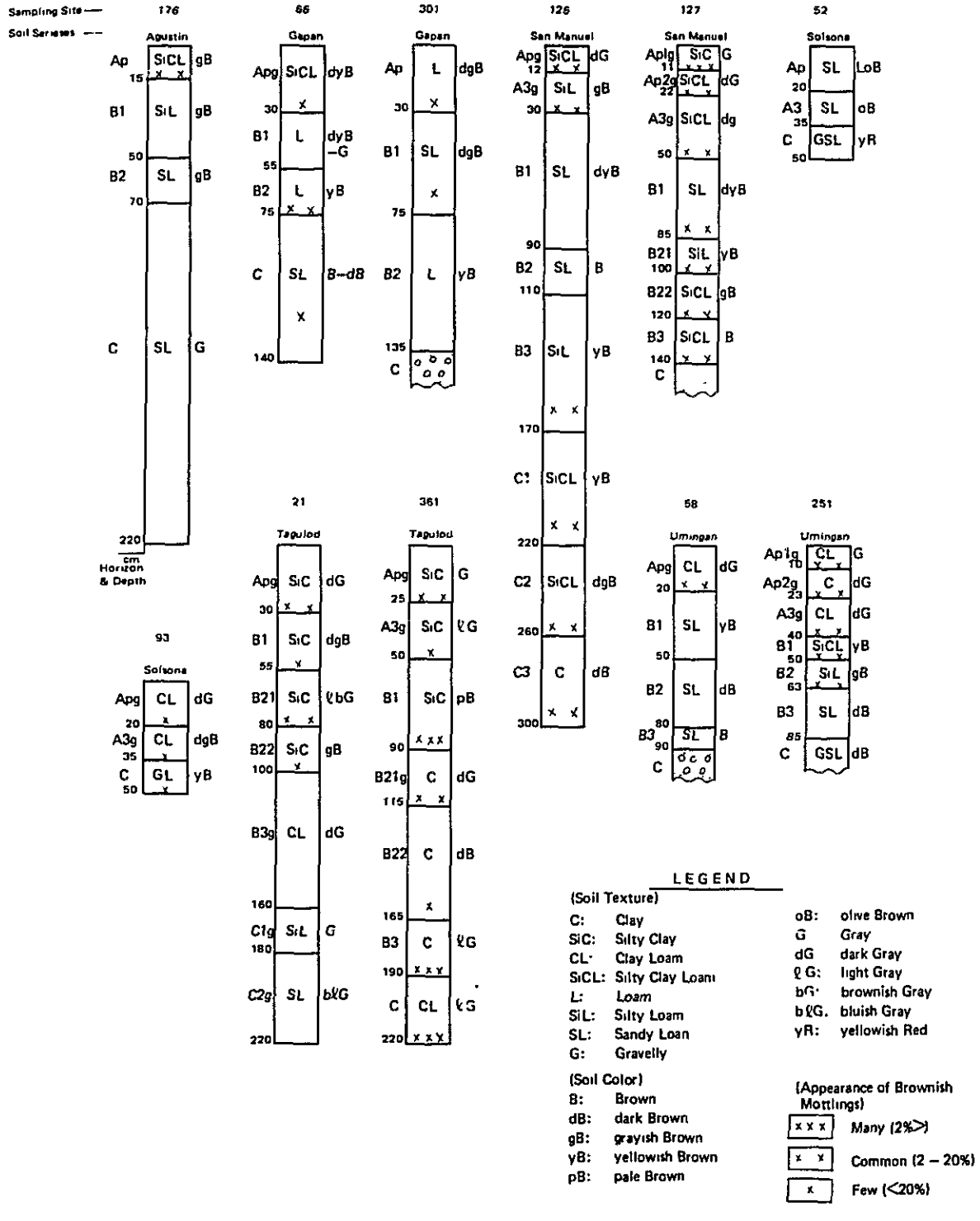


Table 3B-20 Soil Characteristics on Analytical Items

Soil Series	Solum Thickness (cm)	pH Reactiion of Top Soils	Natural Fertility	Content of Organic Matter (O.C. x 1.72)	Cation Exchange Capacity	Base Saturation
Agustin	50 - 100	5.5	medium	low	medium	high
Gapan	100 - 150	5.7	high	moderately high	high	high
San Manuel	100 - 150	5.3	moderately high	moderately high	moderately high	medium
Solsona	30 - 50	5.7	moderately high	high	medium	high
Tagulod	150 - 200	6.3	moderately high	medium	high	high
Umingan	50 - 100	5.3	medium	medium	moderately high	medium

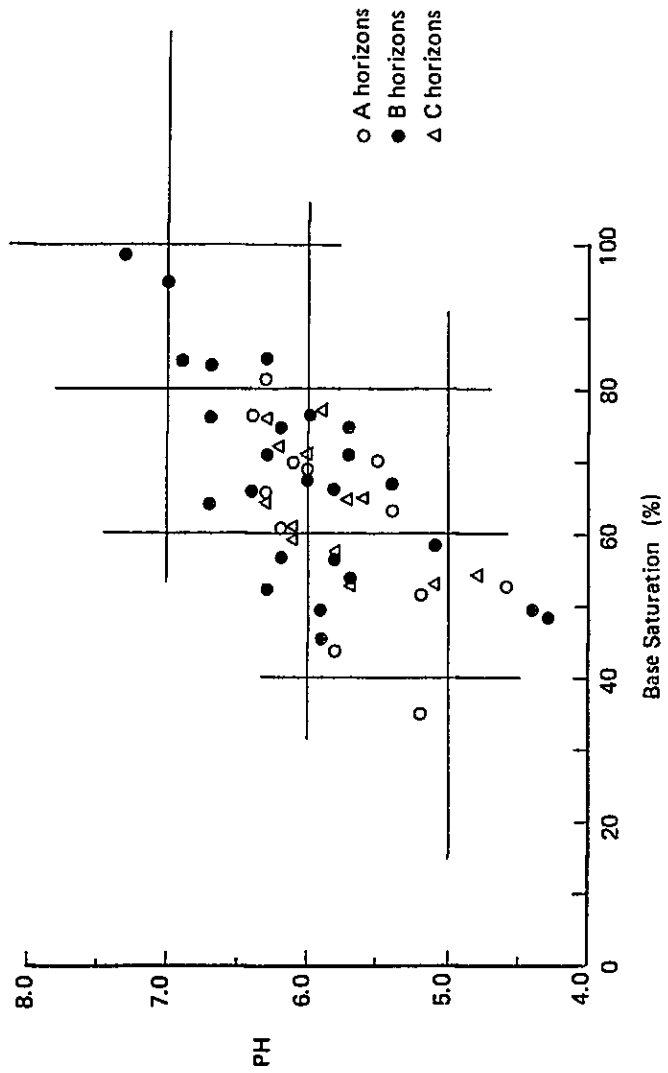


FIGURE 3B-8 RELATION BETWEEN PH AND BASE SATURATION

separate and identify the arable lands according to classes and their best ultimate use under irrigation.

2. Mapping Simbols

The land classification scheme of the Project Area was in accordance with the U.S. Bureau of Reclamation Land Classification Standard with some adjustment to suit local project conditions.

The suitability of the land for irrigation development is greatly affected by crop adaptability, yield and production cost. Crop adoptability and yield are reflected by the physical and chemical characteristics of the soil and topographic limitation, while cost of production is affected by farm labor and cost in connection with cultivation, providing irrigation and capital outlay prior to irrigation development.

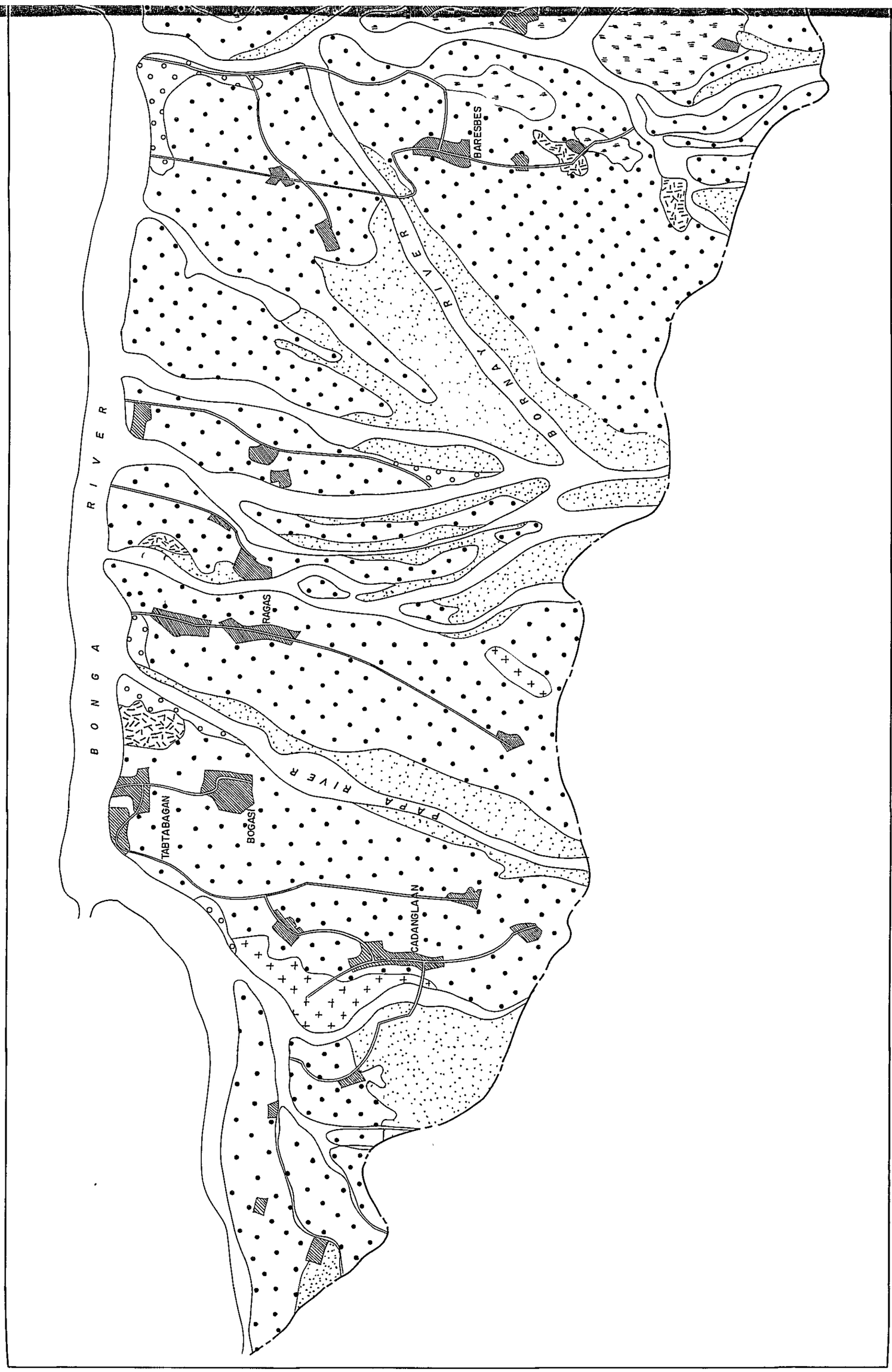
Basically, the land classification survey involved identification and delineation of arable and non-arable lands. The land classes were delineated reflecting the productive capacity of the lands. They were further subdivided into appropriate subclasses according to such limitation in soil, topography and drainage condition. (See Figure 3B-9)

The soil factor includes: a) texture, b) structure, c) soil color and d) presence of mottlings and concretions. The topographic appraisal includes: a) slope class, b) position and c) surface irregularities. The drainage is evaluated in term of a) duration and frequency of flooding, b) soil drainability and c) depth of water table.

The followings are the mapping symbols used in this project study.

a) Land Class Symbols

1R : Highly suitable for irrigated paddy rice
2R : Moderately suitable for irrigated paddy rice
3R : Marginally suitable for irrigated paddy rice


BARESBES
RIVER
BORNAYA
RIVER
BONGA
RAGAS
PAPA
RIVER
TABTABAGAN
BOGASI
CADANGLAAN

EXPLANATION:

- IR RICELAND
- 2R RICELAND
- 3R RICELAND
- DUAL CLASSLAND
- 3. DIVERSIFIED CROPLAND
- 6 NON-ARABLE LAND
- M. RESIDENTIAL LAND

N

1 0 1 2 km.
SCALE 1 50.000

FIGURE 3B-9 LAND CLASSIFICATION MAP

2 : Moderately suitable for diversified crops

3 : Marginally suitable for diversified crops

1R(2) : Highly suitable for irrigated paddy rice and moderately suitable for diversified crops

2R(2) : Moderately suitable for irrigated paddy rice and moderately suitable for diversified crops

3R(2) : Marginally suitable for irrigated paddy rice and moderately suitable for diversified crops

6 : Non-arable

The specification for land classification which were adapted to the study on irrigation project conducted by NIA, is shown in Table 3B-21.

The semi detailed land classification study was conducted to separate the arable lands as those having potential for irrigation development and the non-arable lands having no potential to be developed in the project scheme.

The arable lands were categorized into three major groups based on their crop suitability with basic consideration on the soil, topography, drainage and other physical factors. These are: a) diversified cropland, b) rice land and c) dual class lands.

The non-arable lands consist of three major classes namely: a) class 6, b) M-lands and c) Rights-of-Way (ROW).

Aggregated areas of each groups and land classes are summarized in Table 3B-22.

3. Description of Land Classes

a) Diversified Cropland

This land class is characterized by good external and internal drainage. The soils are chiefly medium to coarse texture, or shallow

Table 3B-21 Land Classification Specification for the Project Area

Land Specification	For Paddy Rice Crops			For Diversified Crops	
	Class 1R	Class 2R	Class 3R	Class 2	Class 3
Soils (dominant texture of surface layer 0-30 cm)	fine sandy loam to clay	fine sandy loam to clay	loamy sand to clay	fine sandy loam to clay	loamy sand to clay
Soil Depth	more than 60 cm	more than 45 cm	more than 20 cm	more than 60 cm	more than 30 cm
Cation Exchange Capacity (CEC at surface layer 0-30 cm)	more than 10me/100g	more than 5me/100g	more than 4me/1ppg	more than 5me/100g	more than 4me/100g
pH (anaerobic)	more than 5.5	more than 5 maybe less	more than 5 maybe less	more than 4.5 less than 8.5	more than 4.5 less than 8.5
Reduction Product	low	low	-	-	-
Topography					
Slope in general gradient	less than 2%	less than 5%	less than 8%	less than 5%	less than 8%
land leveling	low	medium	high	medium	high
land clearing	low	medium	high	medium	high
land terracing	low	medium	high	medium	high
Internal Drainage	slow	slow	slow	well	well

Table 3B-22 Hectares Summary of Major Land Classes of the Project Area

Land Class	Sub Areas				Total
	Labugaon area	Solsona area	Madongan area	Papa area	
Arable Lands[1/]					
a) Diversified crop land	-	-	140	50	190
3	-	-	140	50	190
b) Rcie land	160	610	40	170	980
1R	160	580	-	-	740
2R	-	-	30	130	160
3R	-	30	10	40	80
c) Dual class land	2,130	2,000	3,030	1,870	9,030
1R(2)	1,170	860	2,200	1,020	5,250
2R(2)	-	210	210	450	870
3R(2)	960	930	620	400	2,910
Total Arable	2,290	2,610	3,210	2,090	10,200
Non-arable lands					
6	316	1,185	2,240	685	4,426
M	105	75	120	145	445
ROW	183	209	258	166	816
Total Non-arable	604	1,469	2,618	996	5,687
Grand total	2,894	4,079	2,828	3,086	15,887

Note: 1/ Exclusive of the ROW (Rights-of-Way) which is estimated at 7.5% of area classified as arable land.

depth underlain by stratified sandy and gravelly strata which allow excessive water to drain out readily. They appear on small spots distributed on depressions or depressed river levees. These lands are productive for diversified crops such as corn, root crops and legumes. Class 3 is the only diversified land class delineated in the Project Area.

Class 3

The lands under this class are marginaly suitable for diversified crops. Crop adoptability and yield would be limited because of its soil depth and flooding hazard, especially surface flooding is the main problems in this area. Soil is characterized by shallow depth underlain by coarse fragment of gravelly and sandy materials with presence of stone in most places.

b) Rice Land

These are the lands best suited for rice production both during the wet and dry season under full irrigation water supply. The pre-requisite is a soil which can hold water in a longer time with slow percolation rate. This is attributed by poor internal drainage and slow permeability. In the Project Area, these are distributed into three major land classes.

Class 1R

This is the lands highly suited for irrigated paddy rice production both during the wet and dry season. The soils belong to the fine clayey, deep and poorly drained soils with color ranging from brown to dark gray. Presence of mottlings is characteristics of the soil under this class.

The class 1R lands are suitable for rice and diversified crops both during the wet and dry season, but in the Project Area most of these lies idle during the dry season due to lack of irrigation water supply.

Class 2R

This class is the lands moderately suitable for irrigated paddy rice production. These are good quality lands having moderate production lower than the class 1R lands because of its minor deficiency in topography and drainage. These deficiency factors include surface flooding and topographic irregularities.

Class 3R

This class is the lands marginally suitable for irrigated paddy rice production. The deficiency factors such as surface irregularity and surface flooding are more serious than in the class 2R lands.

c) Dual Class Land

The dual class land is the biggest group mapped in the Project Area. They have restricted subsurface drainage condition having good to excellent productivity for both rice and diversified crops.

Dual land classes differ from riceland classes in its drainability characteristics. The surface soils and subsoils are medium texture and have good soil permeability. They are classed 1R(2), 2R(2) and 3R(2).

Class 1R(2)

This class is the lands highly suitable for irrigated paddy rice production and moderately suitable for diversified crops. For rice it has no deficiency in soil, topography and drainage. The only deficiency is sub-surface drainage which needs to be improved for successful diversified crop production.

Class 2R(2)

This class is the lands moderately suitable for irrigated paddy rice production and moderately suitable for diversified crops. This is suited for good production both rice and diversified crops but

downgraded because of topographic limitation. The lands of this class are slightly sloping and undulating with slopes not more than 3 percent.

Class 3R(2)

This class is the lands marginally suitable for irrigated paddy rice production and moderately suitable for diversified crops. The lands of this class are level to slightly sloping with slopes not to exceed 5 percent. Soils of this class are characterized by shallow depth and subjected to flooding.

d) Class 6 Land

These are the lands not suitable for irrigation development because of various physical and economic limitations. They consist of the stream channels, rolling or steep slopes, hilly areas and river wash areas. Especially the river wash areas are widely developed in the Project Area.

Not all class 6 lands are totally non-productives. Some may be valuable for agricultural use, although not suit for farming by the usual method. The sloping or hilly section could be made productive for upland crops and fruit trees.

e) M-Land

These are the lands occupied by the town, barrios, residential or industrial areas.

f) Rights-of Way (ROW)

This includes existing and future public roads, irrigation canals and farm to market roads which are part of the project constructions.

The figure of Rights-of-Way was derived at 7.5 percent of the total arable lands surveyed. This is the same percentage used for the Upper Pampanga River Project based on measurements of existing and planned Rights-of-way in representative sample areas.

I. Summary of Conclusions and Recommendations

1) Of the cultivated 10,200 hectares, about 8,100 hectares are irrigated paddy field, 1,900 hectares rainfed paddy field, and 190 hectares are upland field. The un-cultivated areas consist of residential areas, Rights-of-Way, and other non-arable lands such as river wash, rolling or steep slopes, hilly areas and others. They comprise the gross area of about 5,700 hectares.

2) Double cropping of rice is practiced within limited area of about 3,400 hectares. Remaining paddy fields lie mostly idle during the dry season due to lack of irrigation water supply.

3) Corn, tobacco, sugarcane, mongo beans and vegetables are cultivated as diversified crops in the Project Area, but they are grown in very limited scale. The river wash areas are almost lacked in crops. These consist of barren strip, brush or grass growth and secondary forest.

4) The soils of alluvial plain were classified into the six soil series such as the Agustin, Gapan, San Manuel, Solsona, Taglod and Umingan series. These soils are considered the most productive for both paddy rice and diversified crops productions.

5) The cervantes series is the only identified upland soil in the Project Area. This soil is the residual soils with reddish color.

6) The river wash includes the lands without any soil cover or soil profile development where lands are covered with clean sand and gravels. This land don't suit for farming by usual method.

7) According to the land classification study, a total of 980 hectares suited for paddy rice and 9,200 hectares capable for dual crops, paddy rice and diversified crops. The class 1R and 2R cover 7,020 hectares or 69 percent of the total arable lands. This shows as to

soils, both paddy and diversified crops will produce fairly good in the most of the Project Area.

8) The natural fertility of alluvial soils in the Project Area ranges from medium to high in root zones of crops, but the exchangeable potassium content is very low. This is recommended that potassium would be fertilized throughout the area especially for diversified crops.

9) The river wash areas were widen by the big flood which over-ran even the cultivated areas. This shows the vital necessities of flood control works in the Project Area, especially in the Madongan area.

10) The soil profiles in the Project Area were investigated by 3 test pits, 611 auger boring holes (NIA, 1976) and 78 stick boring holes (JICA, 1978). In next stage, it is recommended that the more detailed survey by digging test pits would be given to study.

Table 3C-1 Area of Communal Irrigation System (CIS) in the Project Area

Manicipality	No. of CIS	Wet Season: Potential Area (ha)	Wet Season: Irrigated Area (ha)	Wet Season: Non-Irri. Area (ha)	Wet Season: Sub-Total (ha)	Dry Season: Irrigated Area: Gravity: Paddy (ha)	Dry Season: Irrigated Area: Gravity: Upland (ha)	Dry Season: Irrigated Area: Pump (ha)	Dry Season: Non-Irrigated Area: Non-Cultivated Area (ha)	Dry Season: Non-Irrigated Area: Upland Crop (ha)	Dry Season: Sub-Total (ha)
Solsona	49	2,373	2,373	-	2,373	1,436	-	-	937	-	2,373
Dingras	47	2,476	2,476	-	2,476	1,136	-	-	-	1,340(O)[1/]	2,476
Marcos	22	1,791	1,791	-	1,791	548	100(V.C)[2/]	O(C)	1,123	20	1,791
Espiritu	16	1,407	1,351	56	1,407	281	-	73(V.T)	953	100(V.T)[3/]	1,407
Nueva Era	4	50	50	-	50	10	-	-	40	-	50
Total	138	8,097	8,041	56	8,097	3,411	100	73	3,254	1,460	8,097

Source: Provincial Irrigation Offices in Ilocos Norte and Ilocos Sur as of 1977

Note: 1/ Other crops

2/ Vegetable, corn

3/ Vegetable, Tabacco

Table 3C-2 National Irrigation Project in Ilocos Norte (As of 1977)

	System	Town Serve	Service Area (ha)	Irrigated Area Wet (ha)	Irrigated Area Dry (ha)	Benefited Area Wet (ha)	Benefited Area Dry (ha)	Total Rehabilitation & Extension Cost (₱'000)
1.	Bolo RIS	Bangui	487	451	436	451	436	7,380
2.	NMC-Pasuquin Extension RIS	Pasuquin, Vintar Bacarra	670	580	298	580	298	6,910
3.	Laoag-Vinter RIS	Laoag-Vintar, Bacarra, Sarrat	2,364	2,364	1,431	2,364	1,431	22,080
4.	Cura RIS	Pidding	814	560	179	560	123	8,250
5.	Dingras RIS	Dingras, Marcos	1,100	1,075	1,000	1,075	1,000	8,890
6.	Laoag-Sarrat-San Nicolas Pump Irrigation System							
	Bonga No. 1	Sarrat, San Nicolas	500	385	285	385	285	
	Bonga No. 2	San Nicolas, Laoag	827	671	500	657	500	8,040
	Bonga No. 3	Laoag	480	210	202	210	202	
	Total		7,242	6,296	4,331	6,282	4,275	

Source: Ilocos Norte, NISIP Sub-Region Office

Table 3D-1 Population and Household of Farmers and Non Farmers in Project Area

Name of Municipality and Barangay	Population (1)	Household (2)	Farmers Total Household (3) (%)	Farm Household (2) x (3) = (4)	Inside Farmers (5)	Outside Farmers (6)	(5) - (4) (7)	Net Farmers (4)+(7)= (8)	Samahang Nayong	Electrification
A. Solsona										
1. Aquitap	526	104	97	101	15	0	15	116	*	E
2. Bagbago	365	69	97	67	10	10	0	67	*	E
3. Barcelona	908	175	65	112	15	0	15	127	*	E
4. Catangraran	586	112	84	95	50	0	50	145		
5. Darasonas	872	161	92	149	75	60	15	164	*	E
6. Laureta (Pof.)	947	166	1	19	15	15	0	19		E
7. Tipay	469	91	86	78	5	2	3	81	*	E
8. Ma-ananteng	881	166	74	128	60	50	10	133	*	E
9. Manalpac	890	169	76	129	100	10	90	219	*	E
10. Nagpatpatan	363	72	93	67	58	2	56	123		
11. Puttao	634	109	94	102	15	1	14	116		
12. Santa ana	598	114	98	112	60	30	30	142	*	
13. Tolgtog	715	125	91	114	30	10	20	134	*	E
14. Santiago	917	160	91	146	30	0	30	176	*	E
15. Juan (Pof.)	1,396	277	97	269	37	0	37	306	*	E
16. Maliquet	530	100	79	79	30	0	30	109		E
17. Malsin	521	105	92	96	20	20	0	96	*	E
Sub-total	12,118	2,275	82	1,858	625	210	415	2,273	12	13
B. Marcos										
1. Aquinit	1,001	194	90	175	20	0	20	195	*	
2. Culao	815	152	91	138	30	25	5	143		E
3. Escodo	1,118	212	99	209	20	15	5	214	*	E
4. Ferdinand	690	141	89	126	25	25	8	126		E
5. Ragos	1,024	204	87	178	60	10	50	228	*	E
6. Santiago	890	176	98	173	70	20	50	223	*	E
Sub-total	5,538	1,079	93	999	225	95	130	1,129	4	5
C. Dingras										
1. Baresbes	1,001	209	81	169	110	10	100	269	*	E
2. Borong	1,429	298	85	254	70	50	20	274	*	E
3. Ehithabes	1,216	238	92	219	25	25	0	219	*	E
4. Fog	681	130	92	119	25	25	0	119		E
5. Lumbad	695	115	66	76	-	-	0	76	*	E
6. San Marcelino	1,576	299	97	289	200	0	200	489		
7. Surrate	1,166	237	96	228	25	10	15	243		
8. Naglayaan	763	137	51	70	20	5	15	85	*	
Sub-total	9,527	1,663	86	1,424	475	125	350	1,774	5	5
D. Espilitu										
1. Balioeg	685	129	83	107	125	15	110	217	*	
2. Bagasi	556	115	100	115	100	100	-	115	*	E
3. Calstebanan	585	116	93	107	6	6	0	107	*	E
4. Macayepuep	794	136	93	127	30	20	10	137		E
5. Sinamar	607	115	95	110	100	2	98	208	*	
6. Tabtabagan	701	144	93	133	50	20	30	163	*	E
7. Valdez	634	119	97	115	30	0	30	145	*	
Sub-total	4,562	874	93	814	441	163	278	1,092	6	4
E. Nueva Era										
1. Poblacion	643	137	50	69	45	8	37	106	*	E
2. Barikir	238	47	82	39	75	25	50	89		
3. Caray	366	63	98	62	8	8	0	62	*	
4. Cabittaran	409	75	100	75	20	0	20	95	*	
5. Sto Nino	188	34	62	21	58	10	48	69		
6. Acnam	373	90	79	71	20	6	14	85	*	
Sub-total	2,217	446	76	337	226	57	169	506	4	1
Total	33,962	6,334	86	5,432	1,992	650	1,342	6,774	31	28

Source: 1975 Sencus; 1976 Jul. BAEcon Screening Survey

Table 3D-2 Present Cultivated Area and Arable Area in Each Minicipality

Municipality	Name of Irrigation Area	Benefit Area: Present Cultivated Area (1) (ha)	Benefit Area: Arable Area (2)(ha)	Total Area: Present Cultivated Area (3) (ha)	Total Area: Arable Area (4)(ha)	Numbers of Farmers: Without Project (5)	Numbers of Farmers: With Project (6)	Average Cultivated Area: Without Project (7) (ha)	Average Cultivated Area: With Project (8) (ha)
Solsona	Labugaon	2,013	1,890	3,056	2,869	2,273	2,426	1.34	1.18
	Solsona	1,043	979						
Gingras	Labugaon	427	400	3,132	2,941	1,774	1,860	1.77	1.58
	Solsona	1,737	1,631						
	Madongan	968	910						
Marcos	Madongan	2,326	2,184	2,326	2,184	1,129	1,190	2.06	1.84
Espilitu	Papa	1,732	1,630	1,732	1,630	1,092	1,148	1.59	1.42
Nueva Era	Madongan	126	116	614	576	506	529	1.21	1.09
	Papa	488	460						
Total		10,860	10,200	10,860	10,200	6,744	7,153	1.60	1.43

Note: 1/: (5) (6) Include Inside Farmers

2/: (7) = $\frac{(3)}{(5)}$, (8) = $\frac{(4)}{(6)}$

Table 3D-3 Gradal Number of Farm Size

Farm Size (ha)	FO		PO - L		ST - L		Lease		PO - ST		ST		Total Farmers		Total Area		Ha/ Farmers (ha)
	Farmers	Area (ha)	Farmers	Area (ha)	Farmers	Area (ha)	Farmers	Area (ha)	Farmers	Area (ha)	Farmers	Area (ha)	Farmers	%	Area (ha)	%	
Under 1.0	165	70.03	7	4.0	-	-	9	5.0	159	78.10	742	328.77	1,082	42.5	494.90	19.5	0.46
1.0-1.99	94	103.75	10	10.5	-	-	5	5.0	369	439.67	682	780.70	1,160	45.6	1,339.62	52.7	1.16
2.0-2.99	18	38.00	4	8.0	1	2.0	-	-	122	253.06	108	231.30	253	10.0	532.36	21.0	2.10
3.0-3.99	2	6.0	-	-	-	-	-	-	10	30.73	20	61.93	32	1.3	98.66	3.9	3.08
4.0-4.99	-	-	-	-	-	-	-	-	7	28.89	4	16.21	11	0.4	45.10	1.8	4.10
5.0 over	2	10.25	-	-	-	-	-	-	1	5.00	2	13.75	5	0.2	29.00	1.1	5.80
Total	281	228.03	21	22.5	1	2.0	14	10.0	668	844.45	1,558	1,432.66	2,543	100.0	2,539.64	100.00	1.0 (357)

Source: NIA Agricultural Economic Survey

FO..... Full owner
PO-L.... Partial owner and Lease
ST-L.... Share tenant and Lease
Po-ST... Partial and Share Tenant
ST ..... Share Tenant