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

DECEMBER 1980

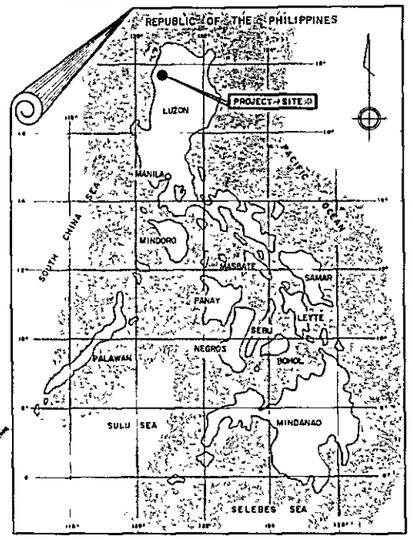
JAPAN INTERNATIONAL COOPERATION AGENCY

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

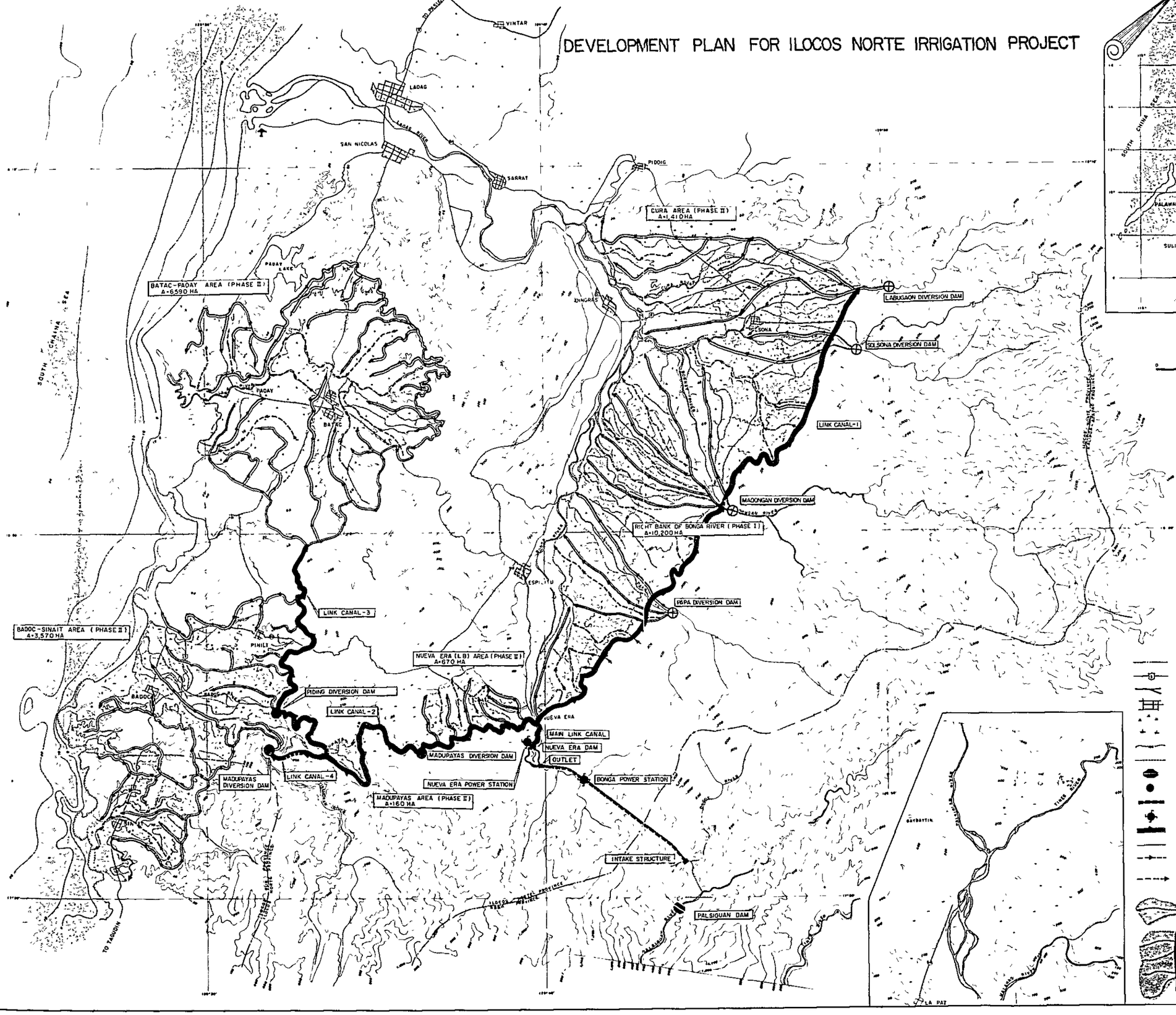
DECEMBER 1980

JAPAN INTERNATIONAL COOPERATION AGENCY

DEVELOPMENT PLAN FOR ILOCOS NORTE IRRIGATION PROJECT



SCALE



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 DAM
- PROPOSED DIVERSION DAM
- PROPOSED TUNNEL
- PROPOSED POWER STATION
- PROPOSED LINK CANAL AND ROAD
- PROPOSED MAIN AND LATERAL IRRIGATION CANAL AND ROAD
- PROPOSED MAIN DRAINAGE CANAL (NEWLY CONSTRUCTED)
- PROPOSED MAIN DRAINAGE CANAL (EXISTNG RIVER OR CREEK)
- PHASE-I PROJECT AREA AND FACILITIES
- PHASE-II PROJECT AREA AND FACILITIES

CONTENTS

CHAPTER VII. ALTERNATIVE PLAN OF PHASE II PROJECT

7A-1. Staged Development Plan of Phase II Project

LIST OF TABLE

LIST OF FIGURE

CHAPTER VII. ALTERNATIVE PLAN OF PHASE II PROJECT

7A-1. Staged Development Plan of Phase II Project

7A-1 Schematic Diagram of Staged Development

7A-2 Implementation Schedule for the Project

CHAPTER 1. INTRODUCTION

Data List Used for Feasibility Study[1/]

A. Climate and Hydrology

1. Meteological Data (Laoag), 1974 - 1979
2. Water Level Record Observed at Baybaytin
3. Tropical Cyclon

B. Geology

4. Groundwater Observation Records in the Right Bank Area of Bonga River
5. Mechanical Tests of Dam Embankment Materials
6. Geological Data of Proposed Nueva Era Dam Site
7. Seismic Prospecting Data of Proposed Palsiguan Dam Site
8. Geological Data of Madupayas and Tibangran Diversion Dams

C. Irrigation and Drainage

9. Topographic Map of Project Area and Its Vicinity (1/50,000)
10. Topographic Map of Project Area (1/4,000)
11. Communal Irrigation System in the Phase II Area
12. Existing Pumping Irrigation
13. Communal Irrigation System along Palsiguan River
14. Phisical Soil Test for Planning Upland Crop Irrigation
15. Water Management of Selected Crops
16. Tide and Current Table, Philippines 1980

D. Agriculture and Soil

17. Regional Development Investigation Program, 1981 - 1985
18. The Philippines Virginia Tobacco Industry
19. UPLB - PVTA Annual Report
20. Comparative Input, Output and Financial Data for Cotton, Paddy, Burley and Tobacco, etc.

1/: Data listed in Phase I Feasibility Study Report, Appendix, 1978 are not included in this tabulation.

21. Annual Report (1977 - 1978) for PCC
22. Soil Report 59, Soil Survey of Ilocos Norte Province, Philippines
23. Fertilizer Recommendation for High Yielding Variety Rice and Others
24. Master List of Tobacco Farmer (Ilocos Norte)
25. Extractions From the 1971 Census of Agriculture, Ilocos Norte
26. Soil and Land Classification Survey (Palsiguan River Multi-Purpose Project)
27. Soil Map (Batac-Paoay Area, Badoc-Sinait Area and Nueva Era Area)
28. Present Land Use Map at Project Area
29. Land Classification Map of Project Area
30. Field and Laboratory Soil Characterization by the Nine Test Pit Sites
31. Laboratory Test Results of Palsiguan Project, Phase II Master Pit Samples

E. Layout of Facilities and Cost Estimate

32. Earthquake Data of Philippines prepared by PAGASA
33. Cost Estimate of Magat River Multi-Purpose Project
34. Cross Section Survey Map of Palsiguan Dam
35. Design Criteria for Irrigation Canals, Drainage Canals and Appurtenant Structures
36. Topographic Survey Map of Sample Area for Planning On-farm Facilities
37. Statistical Data of NPC Operating Plants
38. Financial Forecast Ilocos Norte Electric Cooperative Inc.
39. Single Line Diagram, Luzon Grid
40. Unit Cost of Labor and Material prepared by NIA
41. Estimation of Construction Unit Cost

F. Agricultural Economy

42. Five Year Regional Grain Industry Development Plan (1978 - 1982), Region I.
43. Statistic of Employment
44. Rules and Regulation of the NGA

45. Presidential Degree, No.175
46. Philippines Water Code
47. The Ilocos Norte Socio-economy
48. Fertilizer Recommendation
49. Restricted Pesticides in the Philippines
50. Masagana 99, Rice Culture, 16 Steps
51. Improved Cotton Republic Technology, 1979 - 1980
52. Masagana 99, Bulletin Volume 3, No.3
53. Implementing Guidelines of the Cotton
54. Supervised Credit Finance Program, 1979
55. Mongbean, Community Situation Report, 1979

CHAPTER II. ECONOMIC BACKGROUND

Table 2A-1 Philippines Population

- in thousands -

Year	Population
1948	19,234
1960	27,087
1970	36,684
1975	42,517

Source: Long-Term Philippine Development Plan up to the year 2000.

Table 2A-2 Employed Persons

- percent -

	1960 Oct.	1971 Nov.	1975 Aug.
Agriculture, forestry, hunting & fishing	61.1	50.4	53.5
Mining, manufacture, and electric etc.	15.4	15.7	15.2
Commerce, transport and service	22.8	33.9	31.0
Total	100.0	100.0	100.0

Source: Philippine Statistical Yearbook, 1977

Table 2A-3 Gross National Product

- in million pesos -

	1975	1976	1977	1978
At current prices	114,265	132,712	152,693	171,940
At constant prices of 1972	68,530	72,718 ('76/'75)	77,279 ('77/'76)	81,961 ('78/'77)
Annual growth rate		6.9%	6.3%	6.1%

Source: The National Income Accounts, CY 1975 - 77, CY 1976 - 78, NEDA.

Table 2A-4 Gross Domestic Product at Market Prices

- in million pesos -

	At Constant Prices of 1972			
	1975	1976	1977	1978
1. Agriculture, Fishery and Forestry	18,218	19,671	20,646	21,633
2. Industrial Sector	22,690	24,904	26,821	28,546
a. Mining and quarrying	1,445	1,491	1,742	1,777
b. Manufacturing	16,537	17,481	18,793	20,066
c. Construction	4,101	5,254	5,575	5,953
d. Electricity	607	678	711	750
3. Service Sector	27,453	28,387	30,017	31,914
a. Transport	3,277	3,875	4,050	4,276
b. Commerce	15,056	14,999	15,953	17,047
c. Services	9,120	9,513	10,014	10,591
Gross Domestic Product	68,361	72,962	77,484	82,093

Table 2A-5 Distribution of Gross Domestic Product by Industrial Origin, CY 1976 to 1978

- in percent -

Industry	At Constant Prices of 1972			
	1975[r]	1976[r]	1977[r]	1978[p]
1. Agriculture, Fishery and Forestry	26.6	27.0	26.6	26.4
2. Industrial Sector	33.2	34.1	34.6	34.8
a. Mining and quarrying	2.1	2.0	2.2	2.2
b. Manufacturing	24.2	24.0	24.3	24.4
c. Construction	6.0	7.2	7.2	7.3
d. Electricity, gas and water	0.9	0.9	0.9	0.9
3. Service Sector	40.2	38.9	38.7	38.9
a. Transport, communication and storage	4.8	5.3	5.2	5.2
b. Commerce	22.0	20.6	20.6	20.8
c. Services	13.0	13.0	12.9	12.9
Gross Domestic Product at Market Prices	100.0	100.0	100.0	100.0

r. Revised p. Preliminary

Note: Details may not add up to totals due to rounding.

Table 2A-6 Annual Growth Rates of Gross National Product, National Income and Gross Domestic Product by Industrial Origin, CY 1976 to 1978

- in percent -

Industry	At Constant Prices of 1972		
	1975-1976[r]	1976-1977[r]	1977-1978[p]
1. Agriculture, Fishery and Forestry	8.0	5.0	4.8
2. Industrial Sector	9.6	7.7	6.4
a. Mining and quarrying	3.2	16.8	2.0
b. Manufacturing	5.7	7.5	6.8
c. Construction	28.1	6.1	6.8
d. Electricity, gas and water	4.4	4.9	5.5
3. Service Sector	5.5	5.7	6.3
a. Trasnport, communication and storage	8.6	4.5	5.6
b. Commerce	4.6	6.4	6.9
c. Services	5.9	5.3	5.8
Gross Domestic Product at Market Prices	7.5	6.2	5.9

r. Revised p. Preliminary

Table 2A-7 Gross Value Added in Agriculture, Fishery and Forestry by Industry Group, CY 1976 to 1978

- million pesos -

Industry Group	At Current Prices			At Constant Prices of 1972		
	1976[r]	1977[r]	1978[p]	1976[r]	1977[r]	1978[p]
Agricultural crops	23,327	26,641	28,639	12,069	12,707	13,336
Palay	6,254	7,272	7,321	3,395	3,813	3,999
Corn	2,320	2,803	2,715	1,240	1,336	1,382
Coconut including copra	3,100	3,756	4,058	1,437	1,327	1,329
Sugarcane	2,548	2,118	1,990	1,640	1,344	1,175
Banana	2,239	2,624	3,200	1,402	1,733	2,053
Other crops	6,866	8,068	9,445	2,955	3,154	3,398
Livestock	2,860	2,052	3,320	1,740	1,808	1,871
Poultry	1,481	1,780	1,957	968	1,057	1,207
Fishery	6,368	7,474	8,473	3,300	3,491	3,655
Forestry	3,305	3,741	4,737	1,594	1,583	1,564
Gross Value Added in Agriculture, Fishery and Forestry	37,341	42,688	47,126	19,671	20,646	21,633

r. Revised p. Preliminary

Table 2A-8 Average Annual Total Income, by Region and by Area, December 1975

- pesos/family -

Region	Ave. Income from All Sources	Area	
		Rural	Urban
Philippines	5,456	7,934	4,355
Region I	4,824	6,766	4,395
II	4,999	6,853	4,763
III	5,016	6,494	4,417
IV	9,714	9,714	-
IV-A	5,039	6,623	4,420
V	3,937	5,244	3,669
VI	5,582	8,328	4,734
VII	5,110	7,141	4,379
VIII	4,848	5,929	4,622
IX-A	4,028	6,445	3,669
IX-B	5,236	6,665	4,985
X	3,652	5,634	3,213
XI	5,691	9,331	4,460
XII	4,674	6,050	4,432

Note : Per capita average income
Philippines: 894 Pesos, Region I: 778 Pesos
Region IV-A: 1,592 Pesos

Source: Special Release
Office of the Executive Director, NCSO

Table 2A-9 Trade Value (F.O.B. Price)
- million dollars -

	1972	1973	1974	1975	1976
Export	1,168.4	1,837.2	2,725.0	2,294.5	2,573.7
Inport	1,333.6	1,596.5	3,143.3	3,459.2	3,633.5
Balance	- 165.2	240.6	- 418.3	-1,164.7	-1,059.8

Source: Foreign Trade Statistics of the Philippines.

Table 2A-10 Exports Value
- million dollars -

	1975	1976
Sugar	580.7	429.2
Coconuts oil	230.3	298.7
Log	194.1	203.4
Copra	172.3	149.7
Banana	73.1	75.6
Gross Value	2,294.5	2,573.7

Table 2A-11 Investment Requirements, 1978 -82 and 1983 - 87
(In millions of pesos/US dollars at 1978 prices)

Item	1978	1979	1980	1981	1982	Total 1978-82	1987	Total 1983-87	Average Foreign Exchange Component
Grand Total[1/]	₱3,681	4,380	4,371	4,788	4,819	22,399	5,852	26,615	
I. Irrigation	₱2,019	2,229	2,515	2,545	2,554	11,862	2,557	12,740	45
II. Water Supply and Sewerage	1,168	1,651	1,691	1,693	1,690	7,893	2,056	9,541	40
1. MWSS[2/]	₱ 855	1,142	1,077	973	840	4,887	606	3,601	
2. Waterworks (LWUA)[3/]	153	250	300	350	400	1,453	550	2,400	46
3. Waterworks (MPW) [4/]	80	109	114	120	150	573	350	1,290	
4. Artesian Wells and Springs	80	150	200	250	300	980	550	2,250	
III. Flood Control	₱ 494	500	525	550	575	2,644	1,239	4,334	40
A. Metro Manila	199	172	155	162	111	799	41	378	
B. Provincial	295	328	370	388	464	1,845	1,198	3,956	
IV. Hydrologic Data System	₱ 2.5	2.7	3.5	2.0	2.0	12.7	2.2	11.0	

1/: Amount of hydrologic data system not included.
2/: MWSS: Metropolitan Water Works and Sewerage System
3/: LWUA: Local Water Utilities Administration
4/: MPW: Ministry of Public Works
Source: Five-year Philippine Development Plan, MPW 1978 - 1982.

Table 2A-12 Gross National Product, Population, and Per Capita GNP, 1977-82 and 1987

Item	Value (million pesos)							Annual Growth Rates (percent)					
	1977[e]	1978	1979	1980	1981	1982	1987	1977 1978	1978 1979	1979 1980	1980 1981	1981 1982	1982 1987
Gross National Product (in million pesos at constant prices of 1972)	77,804	83,250	89,494	96,206	103,902	112,214	164,879	7.0	7.5	7.5	8.0	8.0	8.0
Gross National Product (in million pesos at current prices)	152,029	174,076	200,198	230,317	266,093	207,578	633,795	14.5	15.0	15.0	15.5	15.6	15.6
Total Population[1/] (in thousands, medium assumption)	45,028	46,350	47,719	49,137	50,557	52,026	59,903	2.9	3.0	3.0	2.9	2.9	2.9
Per Capita GNP (in pesos at constant prices of 1972)	1,728	1,796	1,875	1,958	2,055	2,157	2,752	3.9	4.4	4.4	5.0	5.0	5.0
Per Capita GNP (in pesos at current prices)	3,376	3,756	4,195	4,687	5,263	5,912	10,580	11.3	11.7	11.7	12.3	12.3	12.3

e. Estimate

1/: Although the medium assumption is used, the target population level uses the low assumption.

Source: Five-year Philippine Development Plan, EPRS-NEDA., 1978 - 1982.

Table 2B-1 Annual Growth Rate of Population

	1960	1970	1975	Annual Growth Rate 1960 - 1970 (%)	Annual Growth Rate 1970 -1975 (%)
Ilocos Norte	287,333	343,427	371,724	1.8	1.6
Phase I					
Dingras	28,308	22,751	25,530	(-)2.2	2.3
Espiritu	9,972	11,671	12,434	1.6	1.3
Marcos		9,406	9,804		0.8
Nueva Era	2,803	3,413	3,608	2.0	1.1
Solsona	12,043	12,803	14,142	0.6	2.0
Sub-total	53,126	60,044 (50,638)	65,518 (55,714)	1.2	1.8
Phase II					
Badoc	12,210	19,000	20,805	4.6	1.8
Batac	27,139	33,114	35,230	2.0	1.1
Paoay	13,189	15,218	15,994	1.4	1.0
Pinili	10,472	12,211	12,741	1.5	0.9
Sub-total	63,010	79,543	84,770	2.4	1.3

Source: 1975 Integrated Census of the Population and its Economic Activities Ilocos Norte, NEDA

Table 2B-2 Land Use by Municipality, April 1971

Province, Municipality	No. of Farms (No.)	(%)	Arable Land (Ha.)	(%)	Permanent Crop Land (Ha.)	(%)	Permanent Medow and Pastures (Ha.)	(%)
Ilocos Norte	31,047	100.0	32,336	100.0	2,683	100.0	4,165	100.0
Phase I								
Dingras	2,689		3,100		536		71	
Espiritu	1,413		1,921		86		221	
Marcos	1,107		1,224		111		7	
Nueva Era	434		599		35		492	
Solsona	1,738		2,110		257		139	
Sob-total	7,381	23.8	8,954	27.7	1,025	38.2	930	22.3
Phase II								
Badoc	2,515		2,432		270		61	
Batac	2,851		3,055		117		21	
Paoay	1,118		1,244		207		150	
Pinili	1,703		1,812		187		43	6.6
Sub-total	8,187	26.4	8,543	26.4	781	29.1	275	
Phase I + Phase II	15,568	50.2	17,497	54.1	1,806	67.3	1,205	28.9

Source: Agricultural Census, 1971

Table 2B-3 Effective Crop Area, 1971

Province, Municipality	Palay (Ha.)	Palay (%)	Palay (10^3cavan)	Palay (%)	Tobacco (Ha.)	Tobacco (%)	Garlic (Ha.)	Garlic (%)	Mungbeans (Ha.)	Mungbeans (%)
Ilocos Norte	31,526		1,076		3,053		1,916		1,680	
Phase I										
Dingras	3,586		136		124		35		227	
Espiritu	1,726		46		170		1		34	
Marcos	1,229		41		34		1		107	
Nueva Era	591		15		8		0		21	
Solsona	2,039		77		2		0		310	
Sub-total	9,171	29.1	315	29.3	338	11.1	37	2.0	699	41.6
Phase II										
Badoc	2,171		66		252		880		137	
Batac	2,691		70		1,157		130		55	
Paoay	1,077		28		66		107		24	
Pinili	1,514		75		580		224		7	
Sub-total	7,461	23.7	239	22.2	2,015	66.0	1,341	70.0	223	13.3
Phase I + Phase II	16,632	52.8	554	51.5	2,353	77.1	1,378	72.0	922	54.9

Source: Agricultural Census, 1971

CHAPTER III. THE PROJECT AREA

FIGURE 3B-1 CLIMATIC MAP IN THE PHILIPPINES

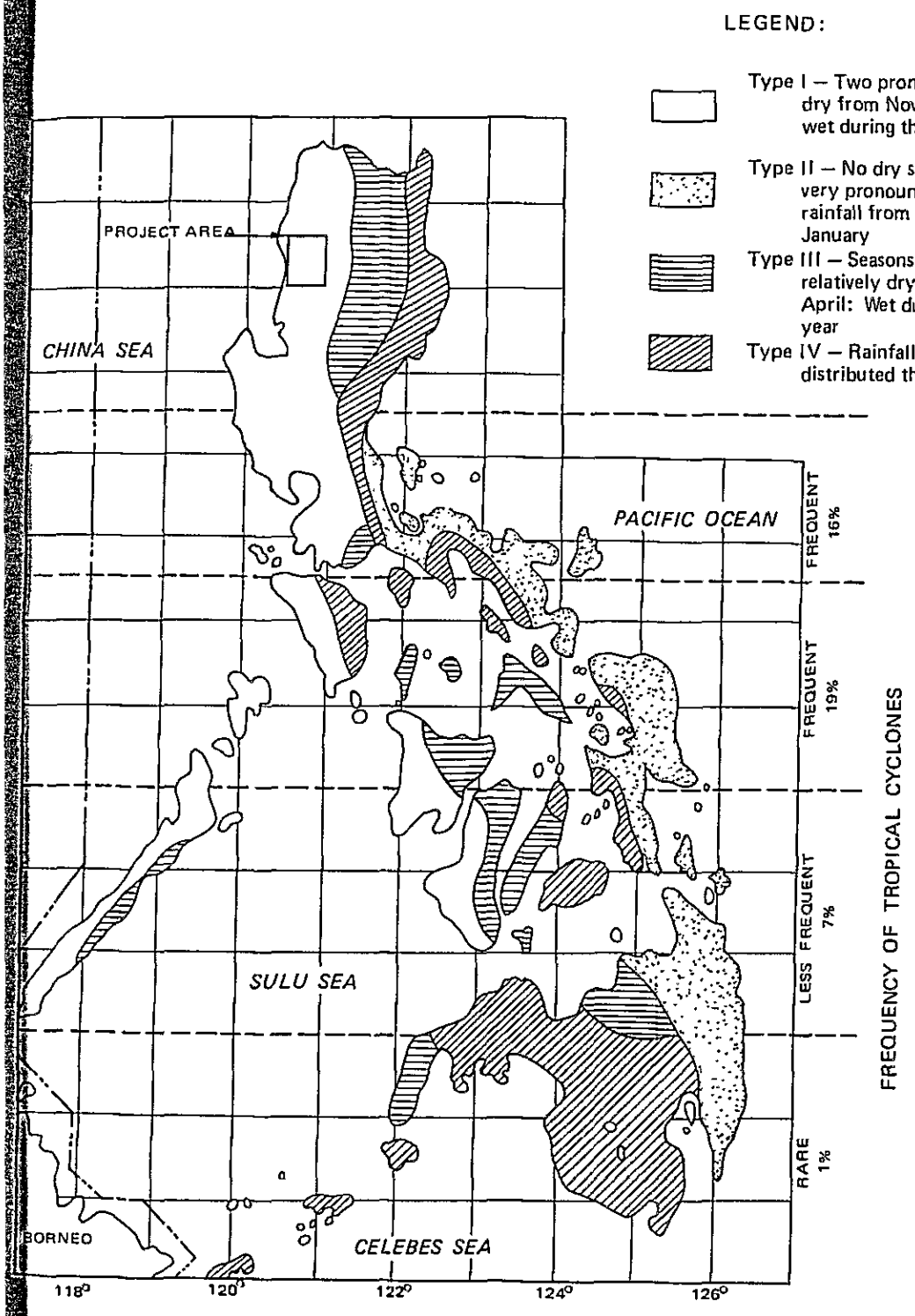


Table 3B-1 Monthly Rainfall at Laoag, Ilocos Norte [1/]

(Unit: mm)

Year	Dry Season				Wet Season						Dry Season		Total
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	
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
1978	0	0	0	51.6	119.0	429.2	227.8	443.7	259.1	107.2	41.5	0	1,679.1
1979	0	0	0	15.9	470.7	95.0	525.1	494.8	114.4	79.6	17.3	6.0	1,818.8
Mean	3.1	1.1	1.7	14.1	122.1	379.1	415.3	538.4	373.7	111.0	44.6	11.6	2,015.8
Percent	0.2	0.1	0.1	0.7	6.1	18.8	20.6	26.6	18.5	5.5	2.2	0.6	100

Note: 1/ Observations have been made at the Laoag Airport and records are compiled at PAGASA.
2/ No record
3/ Data were interporated by 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	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1949	23.9	25.1	26.4	28.0	29.3	28.9	28.0	27.6	27.2	27.2	26.5	25.7
1950	24.9	25.3	26.0	28.2	28.6	27.9	27.1	27.1	27.5	27.2	26.1	24.7
1951	24.6	24.7	26.3	28.3	28.4	27.8	27.5	27.4	27.4	27.4	27.6	26.2
1952	25.2	26.0	27.0	31.4	29.2	29.9	28.4	27.4	27.4	28.4	26.3	26.0
1953	24.8	25.8	27.1	28.1	28.6	28.6	27.7	27.5	27.2	27.7	27.0	26.4
1954	25.1	25.9	27.8	28.6	29.7	29.0	28.1	27.6	27.0	26.8	25.4	25.4
1955	24.7	24.4	25.5	28.0	29.0	28.1	27.5	27.1	27.9	27.2	26.6	23.5
1956	24.4	24.7	26.4	28.2	28.2	28.0	27.6	27.1	26.6	27.2	27.2	26.2
1957	25.0	24.3	26.8	28.2	28.5	28.0	26.8	27.6	27.0	27.4	25.2	25.5
1958	24.9	24.4	26.2	28.2	29.4	27.4	27.6	27.8	27.2	27.6	26.6	24.8
1959	23.5	25.7	27.0	27.8	29.0	29.0	27.8	27.2	27.4	26.8	26.4	26.2
1960	25.2	26.4	26.6	28.5	29.2	28.4	28.2	27.0	27.5	27.3	26.7	25.3
1961	23.3	24.3	26.5	23.1	28.9	27.9	26.4	26.9	26.7	26.8	26.2	25.2
1962	23.9	23.7	26.5	27.7	29.1	28.4	27.2	27.3	27.5	27.4	26.7	24.7
1963	22.5	23.8	24.8	26.5	28.8	27.2	27.2	28.2	27.6	27.1	26.7	25.7
1964	25.0	25.2	26.2	27.9	29.2	27.9	27.9	27.1	27.4	27.3	26.3	24.2
1965	23.9	24.9	25.7	27.7	28.5	27.4	27.4	27.6	27.3	27.1	27.0	25.4
1966	24.7	25.9	26.7	28.3	28.5	28.5	28.1	27.7	26.6	27.3	26.9	26.0
1967	24.4	24.4	26.0	27.4	28.4	27.2	27.9	27.2	27.0	26.4	26.2	24.0
1968	23.8	23.3	25.7	27.2	28.6	28.8	28.0	26.0	26.4	26.6	25.6	24.4
1969	24.8	24.4	26.7	28.1	29.3	28.9	27.9	27.6	27.4	27.0	26.3	25.8
1970	24.6	24.7	27.0	28.6	29.6	27.9	28.3	27.5	27.2	27.6	27.3	26.6
1971	23.6	25.2	25.8	27.5	29.0	28.0	27.5	27.6	27.4	27.0	26.2	26.0
1972	24.7	25.2	25.5	28.5	29.5	29.1	27.2	27.3	28.4	28.2	28.4	26.0
1973	25.0	26.3	26.9	29.2	30.0	29.0	28.0	27.4	28.1	27.6	26.9	25.1
1974	23.3	24.8	25.7	27.9	29.0	27.8	28.6	27.2	27.4	27.4	26.6	26.1
1975	25.4	25.4	27.3	29.1	30.2	28.7	28.5	27.1	28.5	28.2	26.5	24.8
1976	24.7	24.8	27.3	28.5	28.8	26.7	27.8	27.6	27.9	27.9	26.0	26.1
1977	25.7	25.0	26.5	29.0	30.4	30.1	26.7	27.8	27.3	27.8	26.5	25.2
1978	23.2	25.0	27.0	29.0	29.0	29.0	28.0	28.0	23.0	29.0	26.0	26.0
1979	24.8	25.0	27.0	29.0	29.0	29.0	29.0	27.0	28.0	27.0	27.0	25.0
Mean	24.4	25.0	26.4	28.1	29.1	29.2	27.7	27.4	27.2	27.4	26.5	25.4
Annual												27.0

Table 3B-3 Mean Monthly Relative Humidity at Laoag Station (Unit: %)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1949	72	70	68	70	71	78	84	85	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	77	72	7	76	71	81	76	87	84	84	79	77
1975	71	72	72	67	72	82	80	83	80	83	73	71
1976	65	66	70	71	82	80	83	84	86	80	73	74
1977	75	70	68	75	73	78	84	85	88	80	64	77
1978	69	75	72	73	73	80	81	86	84	78	70	64
1979	69	71	69	69	77	77	80	84	79	75	73	67
Mean	73	72	71	71	74	81	81	86	85	71	75	73
Annual												76

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

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1950	NNE	N	NW	NW	SW	SW	SW	SW	SW	NE	NW	NW
1951	NNE	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
1972	-1/	-	-	-	-	-	-	-	-	-	-	-
1973	-	-	-	-	-	-	-	-	-	-	-	-
1974	NNW	N	NNW	NNW	NNW	SSW	ENE	S	NNW	N	NNW	NNW
1975	N	E	N	NNE	E	S	SSW	S	NE	N	NNE	N
1976	E	NNE	N	NNW	N	SSW	N	S	SSW	E	-	N
1977	N	NNW	NNE	NNW	S	E	SW	S	S	N	N	NNE
1978	N	N	NWE	S	S	S	SW	S	ENE	ENE	N	N
1979	NNW	N	ESE	E	SW	S	SW	S	N	N	N	N

Note: 1/ No record

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

(Unig: km/hr)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1950	48	58	45	56	39	72	72	64	31	71	50	55
1951	45	51	48	40	64	64	117	64	105	45	55	53
1952	60	63	50	48	40	53	53	51	71	43	66	55
1953	51	64	47	51	50	87	72	77	51	32	108	58
1954	51	63	56	45	42	56	32	100	48	56	97	53
1955	48	51	48	48	48	48	42	48	64	43	56	45
1956	47	56	48	74	34	47	48	80	55	61	72	55
1957	56	55	48	51	51	80	77	58	80	50	58	50
1958	56	64	58	48	51	48	60	47	45	53	58	50
1959	64	56	58	60	43	48	47	64	48	56	80	58
1960	64	56	51	51	43	56	58	79	48	60	53	68
1961	64	56	53	55	53	42	64	66	48	48	64	64
1962	58	64	60	63	51	55	80	105	60	61	51	80
1963	48	61	53	63	42	90	63	40	72	53	64	51
1964	42	56	56	27	42	48	32	126	90	52	50	58
1965	53	45	60	37	50	71	145	63	64	37	65	60
1966	56	51	63	58	74	71	40	77	63	71	71	60
1967	63	77	63	88	74	106	76	63	53	121	66	63
1968	56	60	53	56	64	63	88	88	137	47	60	48
1969	48	51	50	42	60	60	100	63	77	53	56	63
1970	53	48	58	66	51	64	61	63	34	48	58	60
1971	56	60	61	61	58	56	88	66	77	66	53	66
1972	57	48	48	41	37	67	65	54	48	43	44	44
1973	52	48	43	41	44	54	78	41	37	111	70	67
1974	52	56	59	52	46	52	52	72	56	118	118	59
1975	56	54	41	52	56	52	39	56	48	46	56	59
1976	56	43	48	57	63	74	48	52	59	52	52	54
1977	59	56	59	48	44	33	83	56	63	52	56	48
1978	48	59	52	63	41	41	48	48	48	64	59	59
1979	44	59	41	41	41	22	74	74	33	52	63	44
Mean	52	56	53	53	50	59	64	67	60	59	64	57

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	162.8	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
1978	138.9	144.2	220.1	202.5	203.8	166.5	155.0	145.4	148.5	153.5	147.8	147.3	1,973.5
1979	147.3	140.3	196.9	205.5	181.4	171.0	179.8	162.8	154.5	161.2	160.5	151.9	2,013.1
Mean	154.9	159.1	201.6	208.8	205.0	166.2	160.0	146.0	144.8	159.5	148.2	143.6	1,997.7

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 Adjusted Total Monthly 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	189.0	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
1978	177.8	151.4	224.5	194.4	199.7	194.8	162.8	181.8	175.2	205.7	181.8	212.1	2,262.0
1979	188.5	147.3	200.8	197.3	177.8	200.1	188.8	203.5	182.3	216.0	197.4	218.7	2,318.5
Mean	198.4	167.0	205.6	200.6	201.3	194.4	168.1	182.5	170.9	213.7	182.3	206.8	2,291.6

FIGURE 3B-2 MEAN PERCENTAGE FREQUENCIES OF TROPICAL CYCLONE PASSAGE IN THE PHILIPPINES

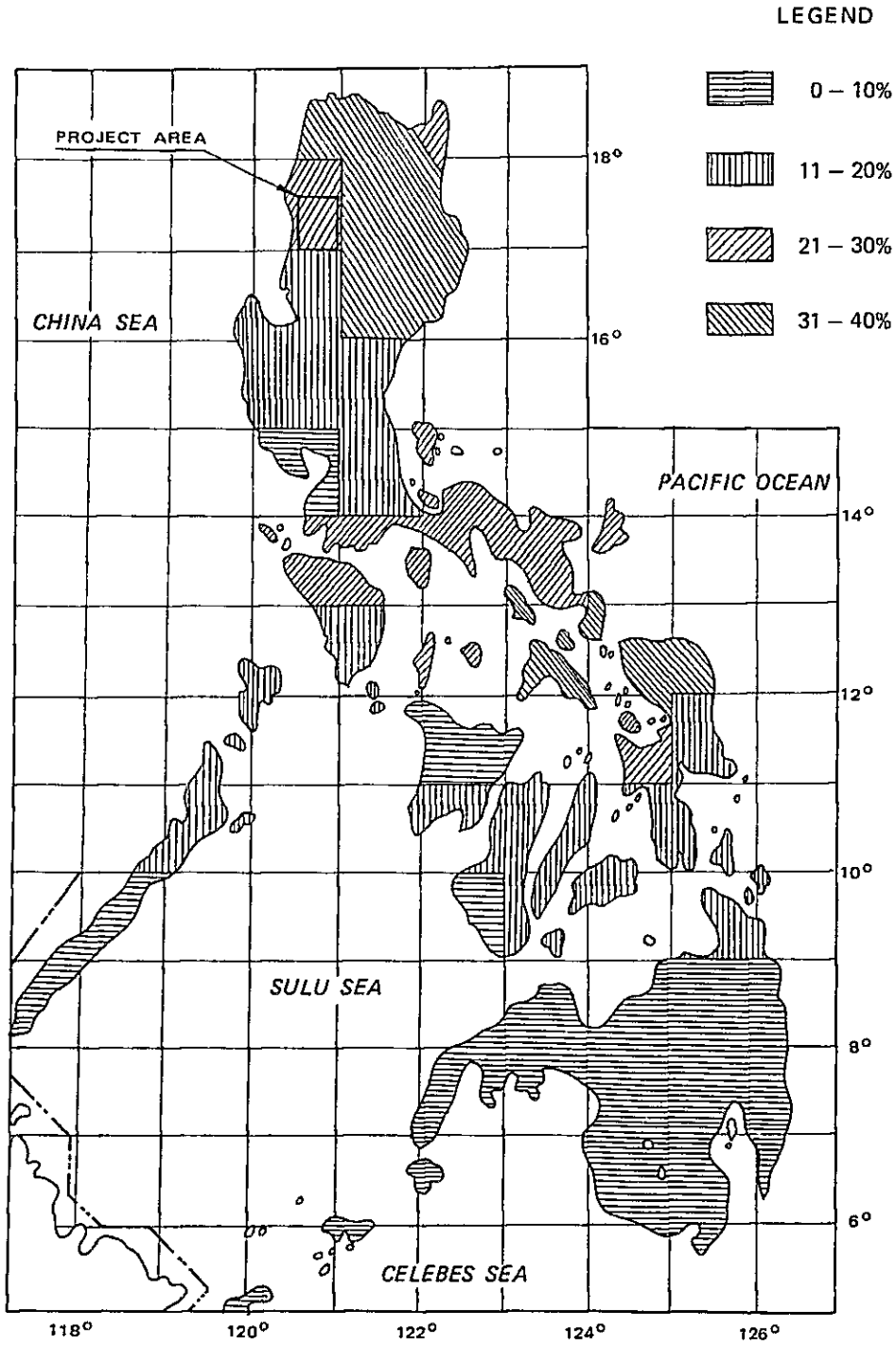


Table 3B-9 Status of Hydro-Meteorological Observation Relevant to the Project

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	MPW & 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	MPW & NIA	1946-present	-do-
	Solsona	Manalpac, Solsona	-do-	Sept. 1976	NIA	1976-present	-do-
	Madongan	San Marcelino, Padong, Dingras	Automatic	July 11, 1978	NIA	1978-present	Newly installed Station
	Palsiguan	Baybayation	-do-	July 28, 1978	NIA	1978-present	-do-
	Badoc	Badoc, Ilocos Norte	-do-	June 21, 1978	NIA	1978-present	-do-
Evaporation							
	Lumbad	Lumbad, Dingras	-do-	July 5, 1978	NIA	1978	-do-
	Alabaan	Alabaan, Dingras	-do-	June 22, 1978	NIA	1978	-do-
	Badoc	Badoc, Ilocos Norte	-do-	June 21, 1978	NIA	1978	-do-
River-stage							
	Labugaon	Maananteng, Solsona	Staff Gauge	Aug. 9, 1978	NIA	1978	No cable way
	Solsona	Manalpac, Solsona	Automatic	June 20, 1978	NIA	1978	Newly installed Station
	-do-	-do-	Staff Gauge	Apr. 1, 1946	MPW	1946-present	
	Madongan	San Marcelino, Padong, Dingras	Automatic	July 24, 1978	NIA	1978	Newly installed Station
	Bangay	Bangay, Dingras	Staff Gauge		MPW	1946-1976	
	Pablacion	Pablacion, Laoag City	-do-		MPW	1959-1974	
	Madupayas	Balbaldez, Badoc	-do-	Nov. 4, 1978	NIA	1978-present	Newly installed Station
	Tibangran	Balbaldez, Badoc	-do-	Oct. 1, 1978	NIA	1978-present	-do-
	Palsiguan	Baybayatin, Lagayan, Abra	Automatic	July 28, 1978	NIA	1978-present	-do-

FIGURE 3B-3 LOCATION OF HYDRO-METEOROLOGICAL STATIONS

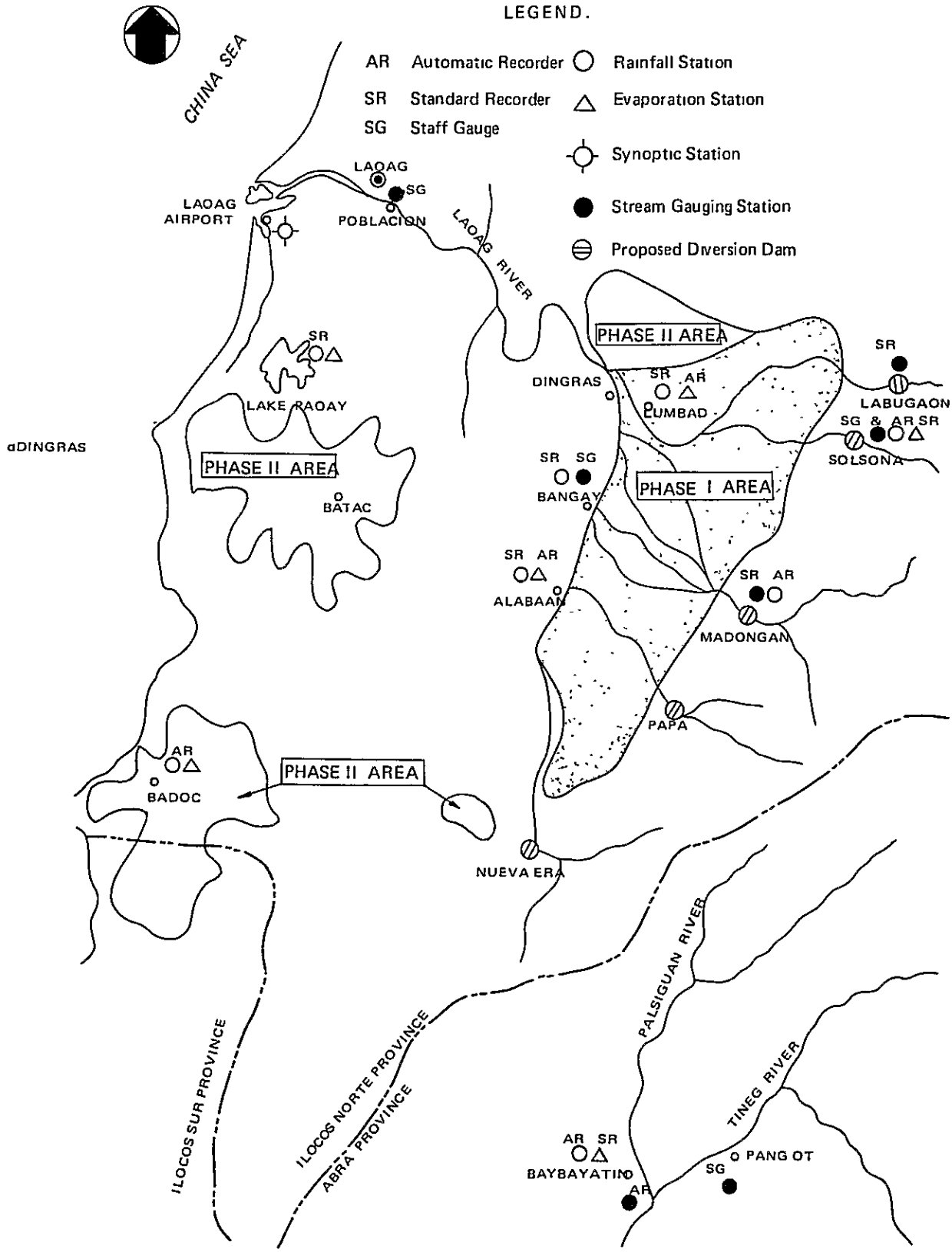


Table 3B-10 Monthly Run-off of the Labugaon River
(Labugaon Diversion Dam Site: C.A. = 100.5 sq.km)

(Unit: MCM)

Year	Dry Season Jan.	Feb.	Mar.	Apr.	Wet Season May	June	July	Aug.	Sept.	Oct.	Dry Season Nov.	Dec.	Total	
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	(171.21)[1/]
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	(285.61)
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	(289.46)
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	(238.88)
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	(411.57)
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	(237.48)
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	(291.92)
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	(317.68)
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	(227.92)
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	(190.00)
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	

Note: 1/ Figures in bracket show annual run-off in each water year, May to April.

Table 3B-11 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	June	July	Aug.	Sept.	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	(134.60)[1/]
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	(224.49)
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	(231.67)
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	(187.75)
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	(333.53)
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	(186.67)
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	(229.48)
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	(249.72)
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	(179.18)
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	(149.34)
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	

Note: 1/ Figures in bracket show annual run-off in each water year, May to April.

Table 3B-12 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	June	July	Aug.	Sept.	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	(183.19)1/
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	(306.10)
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	(397.11)
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	(320.81)
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	(459.31)
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	(261.65)
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	(311.77)
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	(397.70)
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	(240.77)
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	(246.12)
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	

Note: 1/ Figures in bracket show annual run-off in each water year, May to April.

Table 3B-13 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	June	July	Aug.	Sept.	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	(87.59)[1/]
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	(142.64)
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	(150.72)
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	(122.16)
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	(210.50)
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	(121.46)
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	(149.11)
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	(162.48)
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	(116.56)
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	(97.19)
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	

Note: 1/ Figures in bracket show annual run-off in each water year, May to April.

Table 3B-14 Monthly Run-off of the Bonga River
(Bonga Afterbay Dam Site: C.A. = 52.4 sq.km)

(Unit: MCM)

Year	Dry Season Jan.	Feb.	Mar.	Apr.	Wet Season May	June	July	Aug.	Sept.	Oct.	Dry Season Nov.	Dec.	Total	
1960	6.42	6.28	2.36	1.66	2.89	11.72	9.65	25.46	10.25	12.86	4.33	4.43	98.31	(89.35)1/
1961	3.48	1.62	1.61	1.05	5.23	9.47	41.61	30.46	24.43	17.81	6.73	5.17	148.67	(149.03)
1962	3.50	2.12	1.17	1.33	2.85	14.60	33.13	31.95	32.04	16.44	8.18	5.56	152.87	(153.78)
1963	3.69	3.02	1.20	1.12	1.03	24.37	25.25	19.37	26.40	8.50	4.19	5.88	124.02	(124.62)
1964	3.18	2.91	2.05	1.49	8.62	25.32	14.56	40.65	45.60	17.50	25.08	21.59	208.55	(214.76)
1965	7.75	3.46	1.71	2.92	8.70	33.59	22.57	15.35	20.15	9.56	5.00	4.54	135.30	(123.90)
1966	2.07	1.24	0.66	0.47	8.97	11.72	10.07	33.65	22.45	5.97	22.11	9.27	128.65	(152.32)
1967	12.17	7.29	4.92	4.03	3.95	22.00	63.47	12.68	12.57	13.97	12.36	11.62	180.75	(165.75)
1968	6.34	2.90	1.46	2.41	6.84	20.71	25.80	23.40	20.10	7.92	4.11	3.95	125.94	(118.94)
1969	2.71	1.55	0.89	0.96	3.56	10.20	20.18	8.34	17.39	14.36	7.63	5.61	93.38	(99.14)
1970	2.92	2.21	2.75	3.99	8.38	10.45	6.86	9.65	10.08	8.54	11.51	11.76	89.10	(-)
Mean	4.93	3.15	1.89	1.95	5.55	17.65	24.83	22.81	21.95	12.13	10.11	8.13	135.08	

Note: 1/ Figures in backet show annual run-off in each water year, May to April.

Table 3B-15 Monthly Run-off of the Madupayas River
(Madupayas Diversion Dam Site: C.A. = 24.3 sq.km)

(Unit: MCM)

Year	Dry Season				Wet Season						Dry Season		Total 1/
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	
1960	0	0	0	0	0.40	3.24	2.67	7.04	2.83	3.61	0.60	0	20.39
1961	0	0	0	0	0.72	2.62	11.51	8.43	6.75	4.93	0.93	0	35.89
1962	0	0	0	0	0.39	4.04	9.16	8.84	8.86	4.55	1.13	0	36.97
1963	0	0	0	0	0.14	6.74	6.99	5.36	7.30	2.35	0.58	0	29.46
1964	0	0	0	0	1.19	8.84	4.03	11.24	12.61	4.84	3.47	0	46.22
1965	0	0	0	0	1.20	9.29	6.24	4.25	5.57	2.64	0.69	0	29.88
1966	0	0	0	0	1.24	3.24	2.79	9.31	6.21	1.65	3.06	0	27.50
1967	0	0	0	0	0.55	6.08	17.56	3.51	3.48	3.86	1.71	0	36.75
1968	0	0	0	0	0.95	5.73	7.13	6.47	5.56	2.19	0.57	0	28.60
1969	0	0	0	0	0.49	2.82	5.58	2.31	4.81	3.97	1.05	0	21.03
1970	0	0	0	0	1.16	2.89	1.90	2.67	2.79	2.36	1.59	0	15.36
Mean	0	0	0	0	0.77	5.05	6.87	6.31	6.07	3.36	1.40	0	29.82

Note: 1/ Figures in each water year (May to April) are equal to figures in each calendar year.

Table 3B-16 Monthly Run-off of the Madupayas River
(Existing Piding Weir: C.A. = 50.5 sq.km)

(Unit: MCM)

Year	Dry Season				Wet Season						Dry Season		Total[1/]
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	
1960	0	0	0	0	0.83	6.73	5.55	14.63	5.88	7.50	1.25	0	42.37
1961	0	0	0	0	1.50	5.44	23.92	17.52	14.03	10.25	1.93	0	74.59
1962	0	0	0	0	0.81	8.40	19.04	18.37	18.41	9.46	2.35	0	76.84
1963	0	0	0	0	0.29	14.61	14.53	11.14	15.17	4.88	1.21	0	61.83
1964	0	0	0	0	2.47	18.37	8.38	23.36	26.21	10.06	7.21	0	96.06
1965	0	0	0	0	2.50	19.31	12.97	8.83	11.58	5.49	1.43	0	62.11
1966	0	0	0	0	2.58	6.73	5.80	19.35	12.91	3.43	6.36	0	57.16
1967	0	0	0	0	1.14	12.64	36.49	7.29	7.23	8.02	3.55	0	76.36
1968	0	0	0	0	1.97	11.91	14.82	13.45	11.55	4.55	1.18	0	59.43
1969	0	0	0	0	1.02	5.86	11.60	4.80	10.00	8.25	2.18	0	43.71
1970	0	0	0	0	2.41	6.01	3.95	5.55	5.80	4.90	3.30	0	31.92
Mean	0	0	0	0	1.59	10.49	14.28	13.12	12.62	6.98	2.90	0	62.03

Note: 1/ Figures in each water year (May to April) are equal to figures in calendar year.

Table 3B-17 Monthly Run-off of the Tibangran River
(Tibangran Diversion Dam Site: C.A. = 72.7 sq.km)

(Unit: MCM)

Year	Dry Season				Wet Season						Dry Season		Total[1/]
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	
1960	0	0	0	0	1.20	9.69	7.99	21.06	8.47	10.80	1.80	0	61.01
1961	0	0	0	0	2.15	7.84	34.44	25.22	20.20	14.75	2.78	0	107.38
1962	0	0	0	0	1.17	12.09	27.41	26.45	26.51	13.61	3.38	0	110.62
1963	0	0	0	0	0.42	20.17	20.91	16.04	21.84	7.03	1.74	0	88.15
1964	0	0	0	0	3.56	26.45	12.06	33.63	37.73	14.48	10.38	0	138.29
1965	0	0	0	0	3.59	27.80	18.67	12.72	16.67	7.90	2.06	0	89.41
1966	0	0	0	0	3.71	9.69	8.35	27.86	18.58	4.94	9.16	0	82.29
1967	0	0	0	0	1.65	18.19	52.54	10.50	10.41	11.55	5.12	0	109.96
1968	0	0	0	0	2.84	17.14	21.33	19.36	16.64	6.55	1.71	0	85.57
1969	0	0	0	0	1.47	8.44	16.70	6.91	14.39	11.88	3.14	0	62.93
1970	0	0	0	0	3.47	8.65	5.68	7.99	8.35	7.06	4.76	0	45.96
Mean	0	0	0	0	2.28	15.10	20.55	18.89	18.16	10.05	4.18	0	89.23

Note: 1/ Figures in each water year (May to April) are equal to figures in each calendar year.

Table 3B-18 Monthly Run-off of the Palsiguan River[1/]
(Palsiguan Dam Site: C.A. = 153.0 sq.km)

(Unit: MCM)

Year	Dry Season				Wet Season						Dry Season		Total	
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.		
1960	27.3	24.6	17.0	13.0	13.3	19.8	15.7	97.2	42.0	51.0	17.2	18.2	356.3	(313.6)[2/]
1961	16.1	5.9	9.9	7.3	14.8	21.7	112.3	65.8	65.0	40.8	19.5	17.6	396.7	(394.3)
1962	12.9	10.1	7.5	6.3	8.8	27.0	80.3	76.9	69.4	49.2	20.1	20.5	389.0	(390.4)
1963	12.2	11.0	8.7	6.3	6.2	42.2	58.9	42.5	65.4	28.7	19.0	25.1	326.2	(375.7)
1964	29.2	23.4	22.5	12.6	14.5	25.4	18.7	76.9	75.1	40.5	50.4	55.4	444.6	(415.1)
1965	26.9	16.5	8.7	6.1	8.8	49.2	58.1	36.2	27.7	19.8	14.8	12.9	285.7	(255.7)
1966	9.4	6.7	6.5	5.6	18.0	17.6	16.3	55.5	39.4	14.1	32.6	24.1	245.8	(281.6)
1967	25.4	13.0	8.7	16.9	6.9	44.1	38.4	41.3	72.7	53.3	15.1	10.5	346.3	(299.7)
1968	8.5	3.9	2.9	2.1	3.0	6.8	63.4	66.3	91.4	60.0	21.9	21.0	351.2	(365.7)
1969	12.4	7.7	6.3	5.5	8.1	45.6	99.3	59.4	57.3	51.5	16.6	14.9	384.6	(408.9)
1970	16.0	12.3	13.9	14.0	21.3	33.5	34.1	52.2	90.7	38.5	25.1	19.7	371.3	
Mean	17.8	12.3	11.6	8.7	11.2	30.3	54.1	60.9	63.3	40.7	23.0	21.8	354.3	

Note: 1/ Compensation water for downstream of the proposed dam site is not considered in this run-off amount.

2/ Figures in bracket show annual run-off in each water year, May to April.

FIGURE 3B-4 RAINFALL AND RIVER DISCHARGE AT BAYBAYATIN STATION

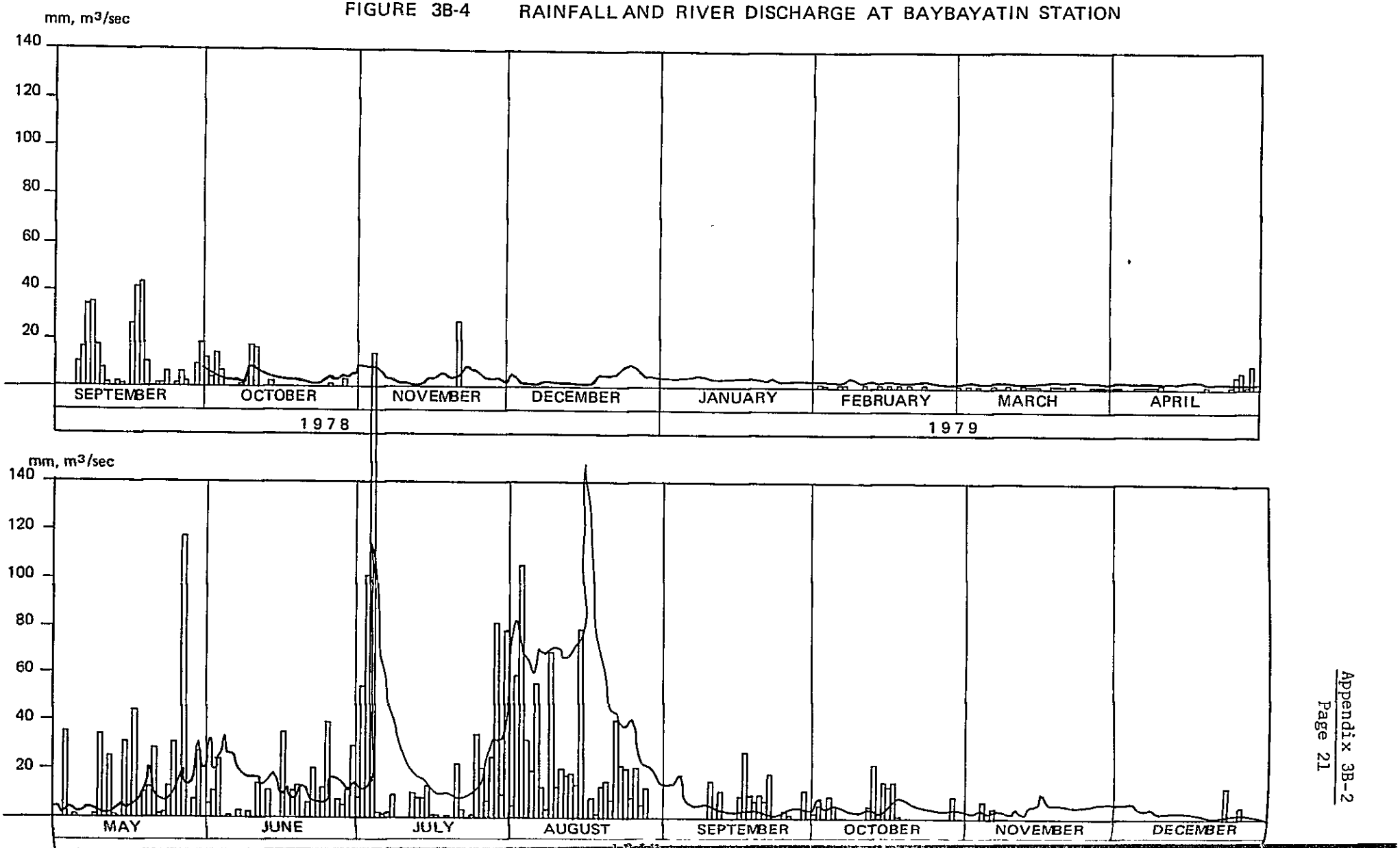


Table 3B-19 Flood Peak and Flood-Frequency Analysis by Hazen Method in Tineg River

Flood Peak				Flood-Frequency Analysis		
Year	Qp[1] (cu.m/sec)	Date	Order	2i-1/2N[2]	Year	Qp (cu.m/sec)
1959	787.0	11/18	1	0.03	1967	3,951.0
1960	826.0	8/21	2	0.08	1977	2,580.0
1961	1,532.5	7/14	3	0.13	1968	2,070.0
1962	1,376.0	7/22	4	0.18	1969	1,950.0
1963	550.9	7/21	5	0.23	1964	1,860.0
1964	1,860.0	9/9	6	0.29	1971	1,620.0
1965	451.0	7/14	7	0.34	1961	1,532.5
1966	514.6	8/16	8	0.39	1976	1,530.0
1967	3,951.0	6/28	9	0.45	1972	1,470.0
1968	2,070.0	9/29	10	0.50	1962	1,376.0
1969	1,950.0	7/22	11	0.55	1973	1,206.0
1970	685.0	9/8	12	0.61	1960	826.0
1971	1,620.0	7/21	13	0.66	1959	787.0
1972	1,470.0	7/28	14	0.71	1970	685.0
1973	1,206.0	10/16	15	0.76	1974	615.0
1974	615.0	11/8	16	0.82	1963	550.9
1975	510.0	8/15	17	0.87	1966	514.6
1976	1,530.0	6/30	18	0.92	1975	510.0
1977	2,580.0	7/26	19	0.97	1965	451.0

Note: 1/ Qp stands for flood peak observed at Pang-Ot Station.

2/ i: order N: number of samples

FIGURE 3B-5 CATCHMENT AREA-SPECIFIC DISCHARGE RELATION

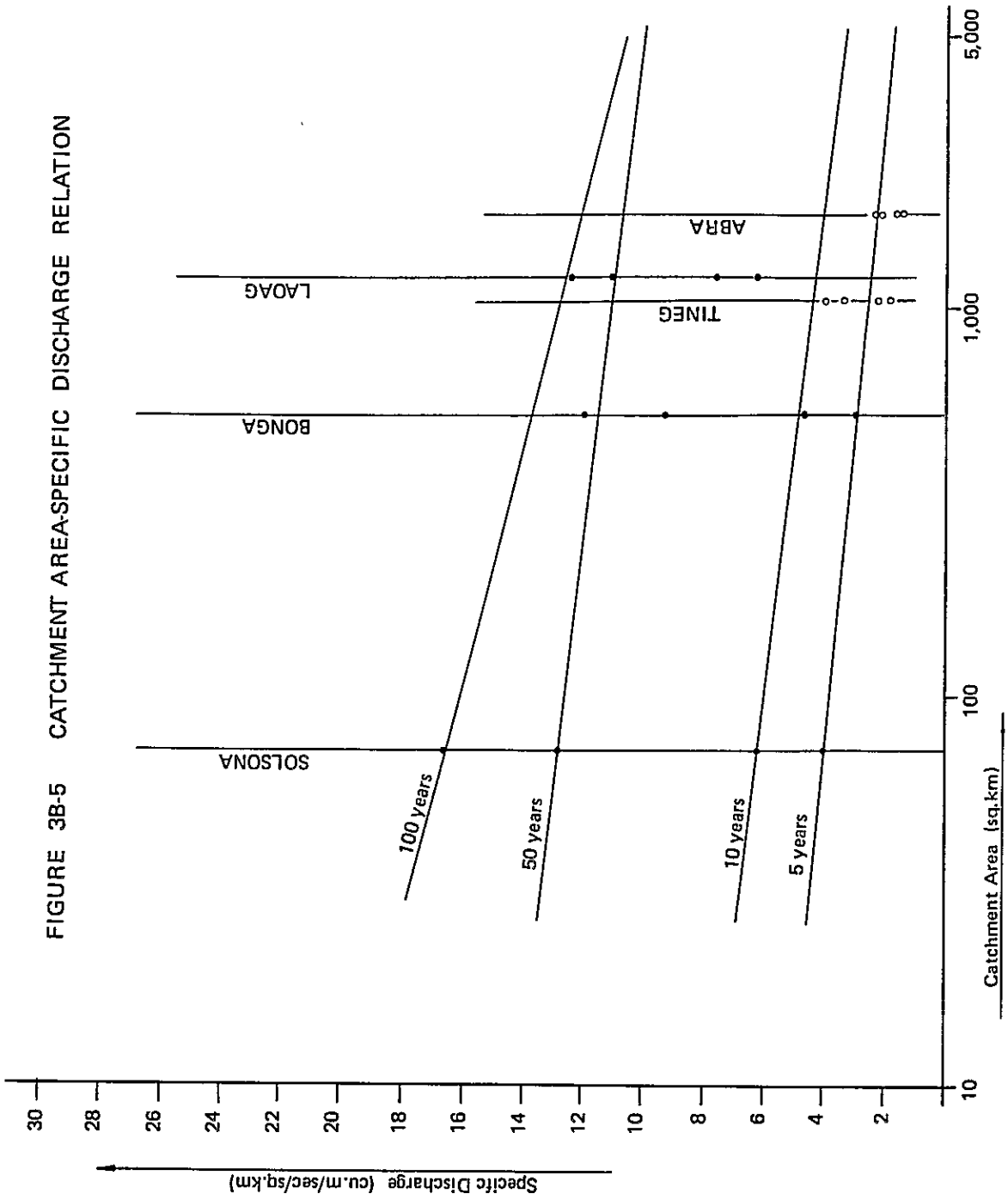


FIGURE 3B-6 DESIGN FLOOD OF DAM SPILLWAY (FILL TYPE)
IN LUZON ISLAND ONLY

	NAME OF DAM		
1	ANTIPAS	18	O'DONNELL
2	BALINTINGON	19	PAPAYA
3	BALOG-BALOG	20	PILA
4	BANGAT	21	SALAPANGAN
5	BAYABAS	22	TIBU
6	CAMILING	23	UPPER AMBAYOAN
7	GARLANG	24	AMBUKLAO
8	GUMAIN	25	ANGAT
9	KALAANAN	26	BINGA
10	KATGIPSIPAN	27	PANTABANGAN
11	LOWER CABU	28	MAGAT
12	LUBAS		
13	LUBINGAN		
14	MAASIM		
15	MARIMCA		
16	MARINGALO		
17	MORIONES		

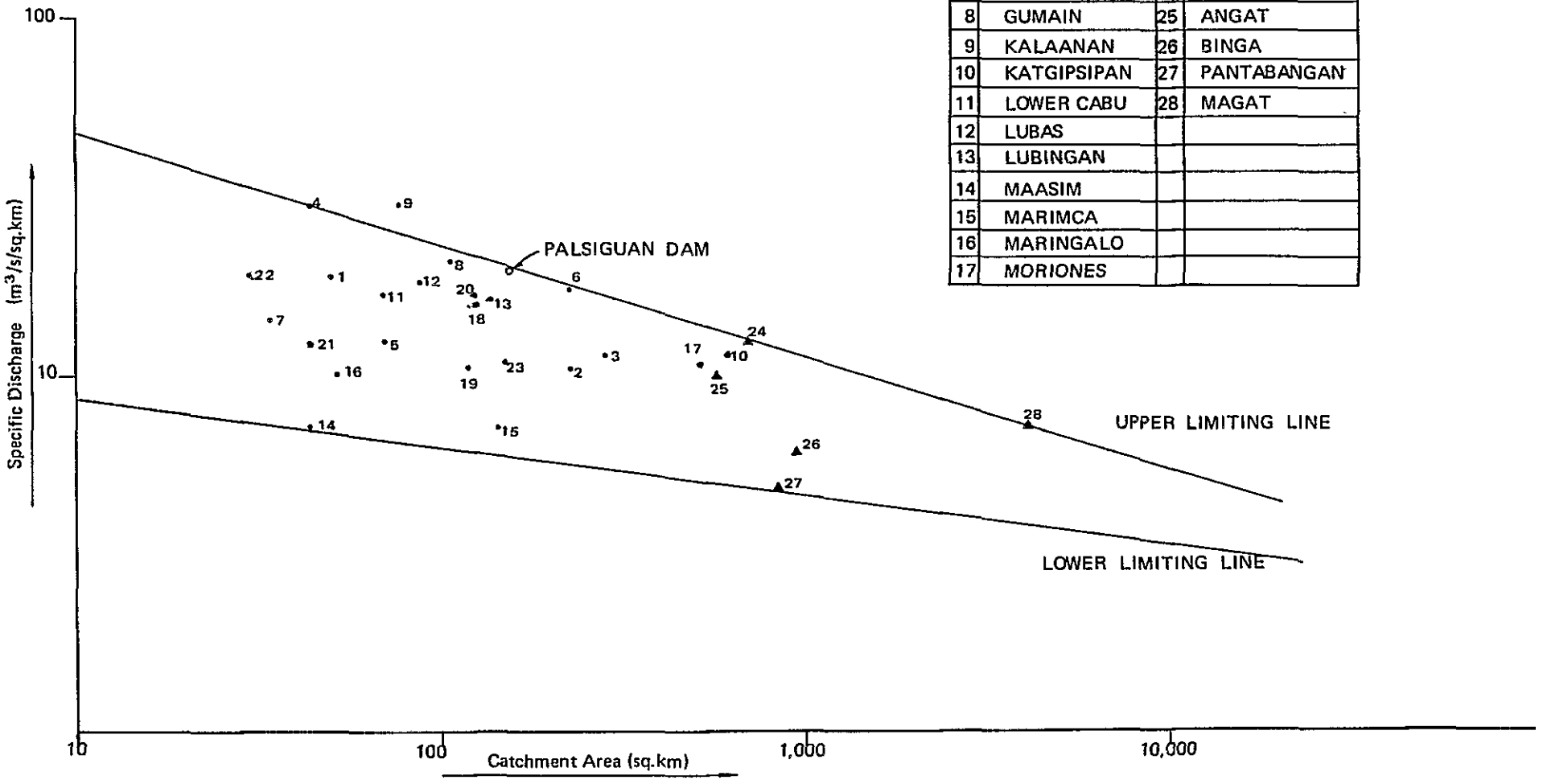


Table 3B-20 Overlapping Moving Average of Annual Rainfall
(Laoag Station Unit: mm)

Year	1 year	3 years	5 years	10 years
1951	2,341	-	-	-
1952	1,519	2,081	-	-
1953	2,382	1,879	1,836	-
1954	1,737	1,773	1,739	-
1955	1,199	1,597	1,845	1,791
1956	1,856	1,702	1,737	1,881
1957	2,051	1,916	1,678	1,990
1958	1,841	1,778	1,746	1,979
1959	1,442	1,608	2,024	2,014
1960	1,541	2,076	2,136	2,083
1961	3,245	2,465	2,222	2,070
1962	2,609	2,709	2,350	2,152
1963	2,271	2,322	2,420	2,184
1964	2,085	2,082	2,116	2,460
1965	1,890	1,900	2,169	2,347
1966	1,725	2,163	2,147	2,221
1967	2,874	2,253	2,282	2,183
1968	2,160	2,598	2,274	2,128
1969	2,759	2,258	2,326	2,186
1970	1,854	2,199	2,196	2,161
1971	1,984	2,021	2,110	2,105
1972	2,224	1,979	2,091	2,021
1973	1,728	2,205	2,047	1,972
1974	2,664	2,009	1,883	1,878
1975	1,636	1,821	1,885	-
1976	1,163	1,610	1,835	-
1977	2,033	1,625	1,666	-
1978	1,679	1,844	-	-
k979	1,819	-	-	-

Table 3B-21 Comparison of Annual Rainfall among Each Station

(Unit: mm)

Year	Laoag R.	Estimated Palsiguan R.	Langangilang
1951	2,341	2,847	-
1952	1,519	1,978	-
1953	2,382	2,920	-
1954	1,737	2,238	-
1955	1,199	1,664	-
1956	1,856	2,402	-
1957	2,051	2,703	3,660
1958	1,841	2,263	3,758
1959	1,442	1,873	3,084
1960	1,541	1,970	2,664
1961	3,245	3,807	3,113
1962	2,609	3,005	3,493
1963	2,271	2,766	3,766
1964	2,085	2,586	3,011
1965	1,890	2,332	3,610
1966	1,725	2,245	3,227
1967	2,874	3,400	3,950
1968	2,160	2,463	3,245
1969	2,759	3,262	2,808
1970	1,854	2,335	3,451
1971	1,984	2,451	4,118
1972	2,224	2,705	2,572
1973	1,728	2,236	2,755
1974	2,664	3,219	-
1975	1,636	2,074	1,654
1976	1,163	1,574	-
1977	2,033	2,506	-
1978	1,679	2,099	-
1979	1,819	2,658 1/	-
Mean	2,016	2,499	3,216

Note: 1/ Actually observed data.

Table 3B-22 Maximum Consecutive Rainfall and Successive No Rainfall Day1/

Year	Maximum Consecutive Rainfall							Successive no Rainfall Day
	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	95
1952	254.0	257.6	257.9	264.0	312.7	321.1	333.5	81
1953	392.4	515.6	515.6	515.6	516.1	516.1	516.1	42
1954	170.9	268.4	268.4	294.9	300.5	318.5	319.5	40
1955	71.9	81.5	127.5	142.5	163.6	199.2	219.8	86
1956	173.7	320.0	381.2	388.3	412.0	435.2	441.0	55
1957	186.2	371.4	426.8	450.7	511.7	539.4	551.1	134
1958	127.0	237.5	321.6	366.0	391.9	409.4	422.6	109
1959	250.7	337.6	345.5	349.8	366.8	374.7	380.5	72
1960	122.2	183.9	200.4	250.4	287.5	343.1	363.4	79
1961	494.8	670.8	785.1	810.5	821.2	895.1	1,009.4	83
1962	409.2	491.3	672.1	778.0	879.1	893.3	901.4	88
1963	294.9	471.7	629.4	736.3	842.5	931.9	934.4	86
1964	162.9	221.3	268.6	268.6	301.8	405.0	407.5	56
1965	280.6	304.5	317.3	320.1	320.4	320.4	338.7	115
1966	136.2	229.2	261.2	273.9	295.5	306.7	324.6	84
1967	510.3	557.2	557.5	576.0	584.1	584.4	587.0	97
1968	248.5	308.2	337.1	384.9	404.5	434.5	454.1	101
1969	323.6	482.1	526.6	629.1	718.0	803.3	879.8	69
1970	93.5	165.6	228.6	271.6	318.0	362.8	394.1	85
1971	225.2	393.3	472.1	474.6	474.6	476.4	483.9	73
1972	249.7	358.7	438.7	557.0	615.2	666.8	716.9	56
1973	320.6	496.4	516.8	524.0	527.1	544.1	561.9	101
1974	176.5	274.7	359.3	382.9	394.6	431.4	498.3	111
1975	125.7	221.5	262.4	275.1	330.8	371.7	448.3	115
1976	128.4	219.1	228.2	231.6	234.7	236.3	237.1	117
1977	243.0	396.2	428.5	463.0	495.3	509.3	516.9	81
1978	157.0	195.2	240.4	278.6	279.7	284.6	322.8	111
1979	183.4	226.3	258.7	274.2	310.0	343.1	354.7	93

Note: 1/ Data are based on Laoag Station.

Geological Investigation and Analysis of the Proposed Dam Site

A. Geological Condition of the Proposed Dam Site

1. Palsiguan Dam Site
   a) Drilling of Bore-holes
   b) Seismic Prospecting
   c) Test Pitting
   d) Embankment Material Tests

2. Nueva Era Dam Site
   a) Drilling of Bore-holes
   b) Seismic Prospecting

3. Madupayas Diversion Dam Site
   a) Drilling of Bore-holes

4. Tibangran Diversion Dam Site
   a) Drilling of Bore-holes

B. Technical Support

1) General Geology

2) Geology of Dam Site
   a) General Geology
   b) Foundation Treatment
   c) Surveys and Tests on Embankment Materials

3) Nueva Era Dam Site
   a) General Geology
   b) Foundation Treatment

4) Madupayas Diversion Dam Site

5) Tibangran Diversion Dam Site

A. Geological Condition of the Proposed Dam Site

The following geological study has been conducted for the proposed dam sites in Palsiguan, Borga, Madupayas and Tibangran up to the present.

Palsiguan dam site:

- ° Drilling of bore-holes upon the proposed dam axes;
- ° Seismic prospecting at the dam site;
- ° Test pitting in the proposed borrow area; and,
- ° Embankment material test.

Nueva Era dam site:

- ° Drilling of bore-holes upon the proposed dam axis; and,
- ° Seismic prospecting at the dam site.

Madupayas diversion dam site:

- ° Drilling of bore-holes upon the proposed dam axis.

Tibangran diversion dam site:

- ° Drilling of bore-holes upon the proposed dam axis.

The geological surveys so far performed are summarized below;

1. Palsiguan Dam Site

a) Drilling of Bore-holes

NIA drilled seven bore-holes at Palsiguan dam site as tabulated below;

Location	Hole Number	Depth	Remarks
Left abutment	DDH-1	100 m	Vertical
Left abutment	DDH-2	65	-do-
Right abutment	DDH-3	65	-do-
Right abutment	DDH-4	100	-do-
Diversion tunnel route	DDH-5	40	-do-
Spillway	DDH-6	70	-do-
Saddle of the right bank	DDH-7	100	-do-
Total	7 holes	540 m	

The location of bore-holes and their geological log are indicated in Figure 3B-7 and 3B-8, Appendix 3B-3.

b) Seismic Prospecting

NIA performed the seismic prospecting for seven lines as follows;

Location	Line Number	Length
Dam axis	A line	1,450 m
Quarry	D	500
Saddle of right bank	E	700
Spillway	F	800
Diversion tunnel	G	600
River bed	H	800
Left abutment	I	700
Total	7 lines	5,550 m

The location of each line and its velocity profile are indicated in Figure 3B-7 to Figure 3B-15, Appendix 3B-3.

c) Test Pitting

NIA performed the test pitting at 15 points as follows;

Borrow Area	Test Pit Number	Depth
Kiwas area	KTP-1	2.0 m
Polot area	TP-1	4.6
Polot area	TP-2	4.0
Polot area	TP-3	4.3
Polot area	TP-4	5.3
Polot area	TP-5	4.9
Polot area	TP-6	5.1
Polot area	TP-7	5.0
Polot area	TP-8	5.0
Polot area	TP-9	4.2
Polot area	TP-10	4.0
Manaois area	MTP-1	5.0
Manaois area	MTP-2	4.9
Manaois area	MTP-3	5.1
Manaois area	MTP-4	5.0
Total	15 test pits	68.4

The location of each test pit and its geological log are indicated in Figures 3B-16 and 3B-21, Appendix 3B-3.

d) Embankment Material Tests

1) Impermeable Material Tests

NIA conducted the physical and mechanical tests of embankment materials sampled in Polot, Manaois and Kiwas areas as follows;

Test Items	Borrow Area and the Number of Samples
Moisture content test	Polot 10, Manaois 2, Kiwas 1
Specific gravity test	Polot 10, Manaois 2, Kiwas 1
Liquid limit test	Polot 10, Manaois 2
Plastic limit test	Polot 10, Manaois 2
Grain size analysis	Polot 10, Manaois 2, Kiwas 1
Compaction test (ϕ = 10cm)	Polot 12, Manaois 1
(ϕ = 15cm)	Polot 3
Permeability test (ϕ = 10cm)	Polot 3, Manaois 1
(ϕ = 15cm)	Polot 3
Triaxial compression test	Polot 2, Manaois 2

The test results are shown in Table 3B-23, Appendix 3B-3.

2) Rock Materials

NIA conducted the rock test of boring cores sampled at the proposed dam site in the preliminary survey as follows;

Test Item	Quantity
Compressive strength test	6
Specific gravity test	6
Absorption test	6
Soundness test	6

The test results are indicated in Table 3B-24, Appendix 3B-3.

2. Nueva Era Dam Site

a) Drilling of Bore-hole

NIA drilled the six bore-holes as tabulated below;

Drilling Point	Hole Number	Hole Depth	Remarks
Left abutment	DDH-1	30.0 m	Vertical
River bed	DDH-2	30.0	-do-
River bed	DDH-3	30.5	-do-
Right abutment	DDH-4	31.6	-do-
Right abutment	DDH-5	32.5	-do-
Left abutment	DDH-6	50.0	-do-
Total	6 holes	204.6 m	

The location of bore-holes and their geological logs are shown in Figures 3B-22 and 3B-23, Appendix 3B-3.

b) Seismic Prospecting

NIA performed the seismic prospecting for nine lines of which detail is tabulated below;

Location	Line Number	Length of Line
Dam axis	No.1	400 m
Downstream of the dam axis	No.2	400
Left bank of the river bed	No.3	300
Right bank of the river bed	No.4	300
Left abutment	No.5	200
Right abutment	No.6	200
Left abutment	No.7	100
Right abutment	No.8	200
Upstream of the dam axis	No.9	400
Total	9 Lines	2,500 m

The location of each seismic prospecting line and its velocity profile are indicated in Figures 3B-22 to Figure 3B-31, Appendix 3B-3.

3. Madupayas Diversion Dam Site

a) Drilling of Bore-holes

NIA drilled three bore-holes as follows;

Location	Hole Number	Depth (m)
Dam axis	DDH-1	21.6
Dam axis	DDH-2	25.5
Dam axis	DDH-3	21.0
Total	3 holes	68.1

The location of each bore-hole and its geological log are indicated in Figures 3B-32 and Figure 3B-33, Appendix 3B-3.

4. Tibangran Diversion Dam Site

a) Drilling of Bore-holes

NIA drilled three bore-holes as follows;

Location	Hole Number	Depth (m)
Dam axis	DDH-2	17.0
Dam axis	DDH-3	37.0
Dam axis	DDH-4	47.0
Total	3 holes	101.0

The location of each bore-hole and its geological log are shown in Figures 3B-32 and Figure 3B-34, Appendix 3B-3.

FIGURE 3B-7 LOCATION MAP OF GEOLOGICAL SURVEY AT PALSIGUAN DAMSITE

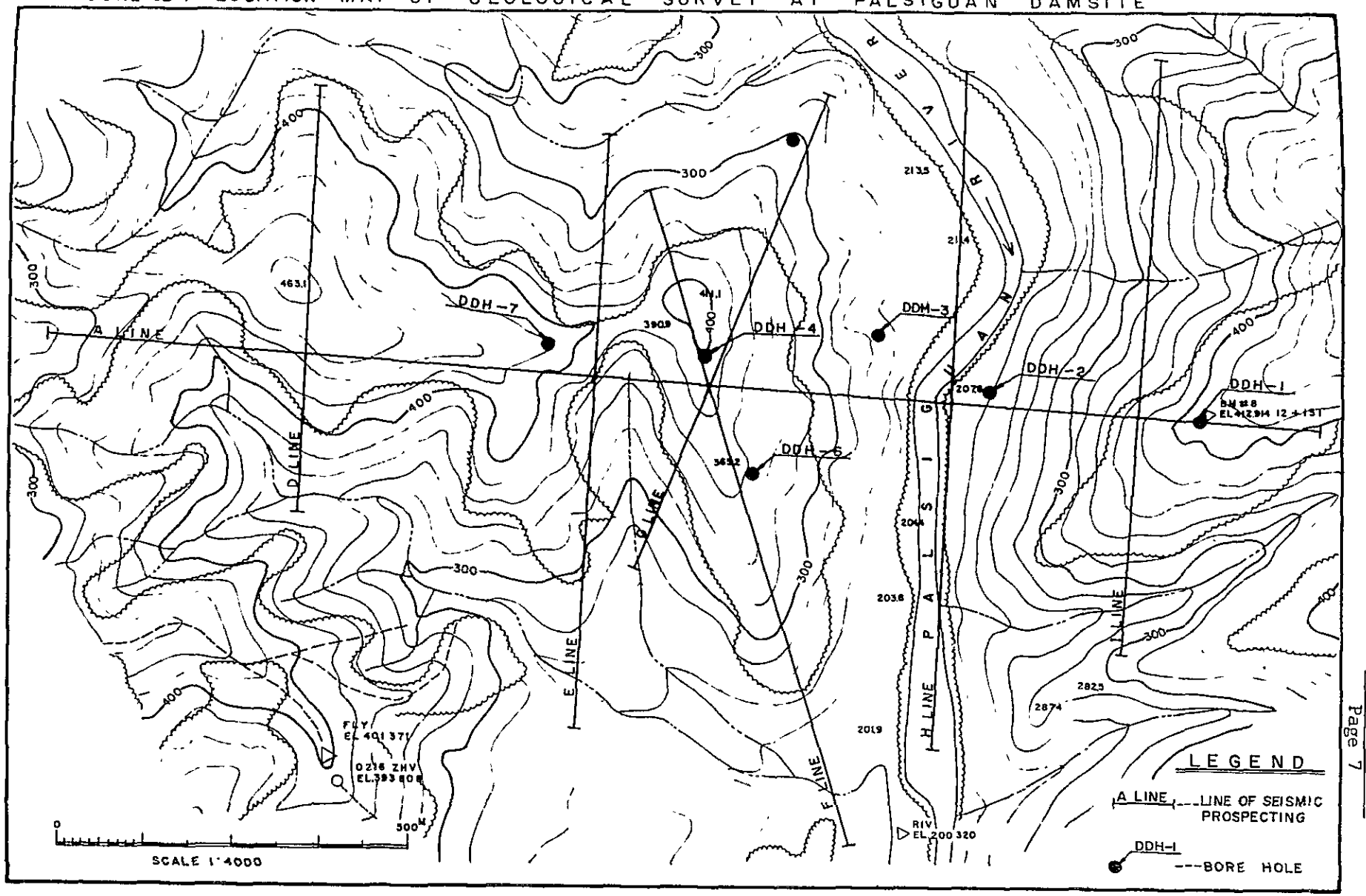
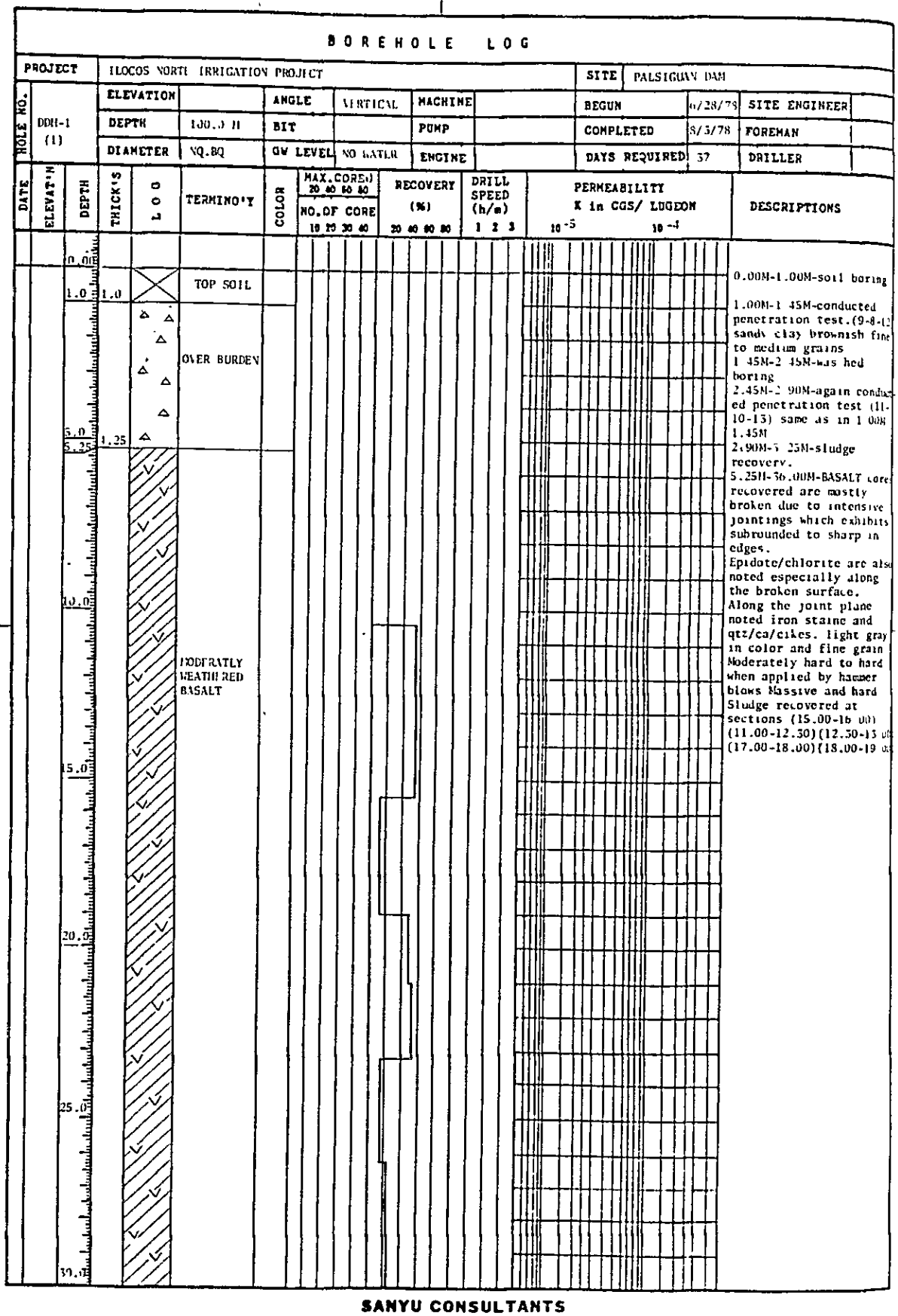


FIGURE 3B - 8 BORE-HOLE LOG AT PALSIGUAN DAM SITE



SANYU CONSULTANTS

BOREHOLE LOG

PROJECT	ILOCOS NORTE IRRIGATION PROJECT			SITE	PALSIGUAN DAM		
HOLE NO.	ELEVATION	ANGLE	MACHINE	BEGUN		SITE ENGINEER	
DH(-1 (2)	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^{-1}	DESCRIPTIONS
		30									
					MODERATLY WEATHERED BASALT						
		35.0									
		36.0	30.75								
		40.0									
					SLIGHTLY WEATHERED BASALT						44.00M-51.25M-BASALT cores recovered were reduced to BQ size. cobbles and pebbles sizes with subrounded to sharp in edges Other observation same as in previous run.
		45.0									
		50.0									51.25M-61.65M-BASALT Broken cores with sharp edges of pebble and cobbles sizes solid cores recovered are less than 10.00cm still abundant present of iron stains with some epidote/chlorite and qtz/calcite. Moderately hard when break by hammer blows. Hard and massive, fine grain, slightly weathered.
		55.0									
		60.0									

SANYU CONSULTANTS

BOREHOLE LOG

PROJECT	ILOCOS NORTE IRRIGATION PROJECT				SITE	PALSIGUAN DAM	
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 85) / 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
		60.0									
		65.0			SLIGHTLY WEATHERED BASALT						61.45M-81.60M-BASALT Dark gray in color fine grain solid cores recovered less than 10.00cm white broken cores exhibit subrounded and angular edges. Iron stains and epidote/ chlorite are also noted but few joints dipping 45° to 25° but few Massive and Hard, slightly weathered.
		70.0									
		75.0									77.00-81.50M-on this section noted abundant presence of iron stains and epidote/chlorite.
		80.0									
		81.6	45.6								81.60M-88.55M-DACITE Cores recovered are mostly less than 10.00cm Medium grain, Massive and solid, broken cores also noted w/ sharp edges abundant presence of epidote/ chlorite.
		85.0			DACITE						
		88.55	6.95								
		90.0			BASALT						

SANYU CONSULTANTS

BOREHOLE LOG

PROJECT	ILOCOS NORTE IRRIGATION PROJECT			SITE	PALSIGUAN DAM		
HOLE NO. DDH-1 (4)	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 ... 10-1)	DESCRIPTIONS
		90.0									88.35M-100.00M-BASALT Dark gray in color still abundant presence of iron stains but less epidote/ chlorite. Hard and Massive fine grain Joints orienting 60° or less broken cores also present with sharp edges but mostly solid cores.
		95.0			BASALT						
		100									

SANYU CONSULTANTS

BOREHOLE LOG

PROJECT	ILOCOS NORTE IRRIGATION PROJECT					SITE	PALSIGUAN DAM		
HOLE NO.	DDH-2 (1)	ELEVATION		ANGLE	VERTICAL	MACHINE		BEGUN	3/5/78	SITE ENGINEER	
		DEPTH	65.0 M	BIT		PUMP		COMPLETED	3/26/78	FOREMAN	
		DIAMETER	NQ, BQ	GW LEVEL	21.0 M	ENGINE		DAYS REQUIRED	22	DRILLER	

DATE	ELEVAT'N	DEPTH	THICK'S	LOG	TERMINO'Y	COLOR	R.Q.D. 20 40 60 80	RECOVERY (%) 20 40 60 80	DRILL SPEED (h/m) 1 2 3	PERMEABILITY K in CGS/ LUGEON 10^{-5} 10^{-4}	DESCRIPTIONS
		0.0									
			2.00		OVER BURDEN						0.00-2.00M OVER BURDEN Recovered as sludge grayish in color. Admixture of soil and brecciated fragments of stone.
		2.0									2.00-13.00M Dacite Porphyritic, light gray Hard and massive, fresh Moderately to highly fractured Fracture/joint plane pyritic Irregular Fracture. Core generally broken at sections 2.00-4.35M, 5-1.00M, 7.25-10.00M, and 12.30-13,00M.
		5.0									
					DACITE						
		10.0									
		13.0	11.0								
					BASALT						13.00-15.77M Basalt porphyritic dark gray to black fresh. Hard and massive. Fracture plane calcitic oriented 50°-60° from the core axis longest core recovered = 60 cm Average length of core = 23 cm
		15.0									
		15.7	2.7								15.77-37.00M Dacite porphyritic. Hard and massive. Moderately to highly fractured pyritic along joint/fracture plane. Core generally broken at sections 17.00-18.82M, 20.00-21.00M, 21.42-22.00M, 23.00-24.30M, 24.00-25.15M, 26.20-26.50M, 26.80-27.00M.
		20.0									
					DACITE						
		25.0									
		30.0									

SANYU CONSULTANTS

BOREHOLE LOG

PROJECT	ILOCOS NORTE IRRIGATION PROJECT			SITE	PALSIGUAN DAM		
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	R.Q.D (20 40 60 80)	RECOVERY (%) (20 40 60 80)	DRILL SPEED (h/m) (1 2 3)	PERMEABILITY K in CGS/ LUGEON (10^{-5} ... 10^{-1})	DESCRIPTIONS
		30.0									Sheared zone at Sections 22.00-24 00M and 34 35-35 85M. Presence of crust angular fragments of dacite.
											Suspected fault at elevation 31.20-34.35M, very low percentage core recovery;
		35.0			DACITE						
		37 0	21 3								37 00-39.87M Basalt Dark gray to black. Hard and massive. Fresh Calcite veinlets ranges from 5mm to paper thin. Partially pyritic fracture/joint plane calcitic and chlonitized. Broken core at section 39.47-39.87M
		39.8			BASALT						
		40.0	2.87								39.87-42.95M Dacite. Dark gray. Hard and massive. Fresh joint/ Fracture plane filled with calcite veinlets.
		42.9	3.08		DACITE						
											41 90-42 95M Basalt Dark grav hard and massive Presence of quartz/calcite along cavities.
		45.0			BASALT						42.95-48.00M Basalt: Pyritic dark grayish hard and massive fracture plane calcitic, calcite veinlets oriented at vertical degree from the core axis Broken core at section 44.42-44 42M Core partially soft to friable at elev. 42.95-43.78M.
		48.0	5.03								
		50.0			DACITE						A brecciated zone at section 45.50-46.64M Presence of crush angular fragments with some powdery materials. 48.00-65.00M Dacite· pyritic dark gr Hard and massive fresh., Moderately fractured fracture plane calcitic oriented 45°-50° from the core axis. Core generally chloritized at sections 52.40-55.00M.
		55.0									
		60.0									

SANYU CONSULTANTS

BOREHOLE LOG

PROJECT	ILOCOS NORTE IRRIGATION PROJECT				SITE	PALSIGUAN DAM	
HOLE NO. DDH-2 (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	R.Q.D 20 40 60 80	RECOVERY (%) 20 40 60 80	DRILL SPEED (h/m) 1 2 3	PERMEABILITY K in CGS/ LUGEON 10-5 — 10-4	DESCRIPTIONS
		60.10									
					DACITE						Broken Core at sections 48 00-48 80m,49.67-50 37 50.40-41 18m,53.00-53 30 55.00-55.50m;56.85-58 20 57.25-58.40m,58 50-60 00 60.40-61 10m,62 00-62 50 and 62,60-63.80m,
		65.0									

SANYU CONSULTANTS

BOREHOLE LOG

PROJECT	ILOCOS NORTE IRRIGATION PROJECT					SITE	PALSIGUAN DAM		
HOLE NO.	ELEVATION		ANGLE	VERTICAL	MACHINE		BEGUN	8/9/78	SITE ENGINEER	
DDH-3 (1)	DEPTH	65.0 M	BIT		PUMP		COMPLETED	8/21/78	FOREMAN	
	DIAMETER	NQ,BQ	GW LEVEL		ENGINE		DAYS REQUIRED	25	DRILLER	

DATE	ELEVAT'N	DEPTH	THICK'S	LOG	TERMINO'Y	COLOR	MAX.CORE(s) 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
		0.0									0.00-1.00M-wash boring
		2.0	2.0		OVER BUDEN						1.00-1.45M-penetration test (8-17-26) Flows sandy clay.
		5.0			MODERATELY WEATHERED BASALT						1.45-14.5M-sludge recovery medium grain dark brown in color.
		10									
		14.5	12.5								
		15									14.50-33.90M-BASALT core samples recovered are mostly cobble and pebble sizes with sub-rounded in shape, light gray in color, fine grain abundant presence of iron stains with some presence of epidote/chlorite, especially along the joint planes joints orienting high angle about 75°. Moderately hard to hard. Some broken samples exhibits angular edges slightly weathered.
		20			SLIGHTLY WEATHERED BASALT						
		25									
		30.6									

SANYU CONSULTANTS

BOREHOLE LOG

PROJECT	ILOCOS NORTE IRRIGATION PROJECT			SITE	PALSIGUAN DAM		
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 (%) (20 40 60 80)	DRILL SPEED (h/m) (1 2 3)	PERMEABILITY K in CGS/ LUGEON (10^{-5} – 10^{-4})	DESCRIPTIONS
		30									
					SLIGHTLY WEATHERED BASALT						
		33.9	19.4								33.90-47.05M-BASALT core samples recovered are pebble sizes less percentage of iron stains as in previous run. sub-rounded to angular in shape. Hard and Massive that moderately breaks by hammer blows. As penetrate deeper solid cores recovered that joints noted to be dipping 45° to 65° light gray in color slightly weathered to fresh.
		35.0									
		40.0									
		45.0			BASALT						
		50.0									47.65-65.00M-BASALT dark gray in color. fine grain still rusty especially along the joint planes. cores are mostly solid with R.Q.D. Joints dipping 45° to 70°. Hard and solid that moderately breaks by hammer blows epidote/chlorite are also noted especially along broken surfaces fresh.
		55.0									
		60.0									

SANYU CONSULTANTS

BOREHOLE LOG

PROJECT	ILOCOS NORTE IRRIGATION PROJECT				SITE	PALSIGUAN DAM	
HOLE NO. DDH-3 (3)	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 (%) (20 40 60 80)	DRILL SPEED (h/m) (1 2 3)	PERMEABILITY K in CGS/ LUGEON (10-5 ~ 10-4)	DESCRIPTIONS
		60.0			BASALT						
		65.0									

SANYU CONSULTANTS

BOREHOLE LOG

PROJECT	ILOCOS NORTE IRRIGATION PROJECT					SITE	PALSIGUAN DAM		
HOLE NO.	ELEVATION		ANGLE	VERTICAL	MACHINE		BEGUN	3/17/78	SITE ENGINEER
DDH-4 (1)	DEPTH	100.0 M	BIT		PUMP		COMPLETED	5/29/78	FOREMAN
	DIAMETER	NQ,BQ	GW LEVEL	NO WATER	ENGINE		DAYS REQUIRED	74	DRILLER

DATE	ELEVATION	DEPTH	THICKNESS	LOG	TERMINOLOGY	COLOR	R.Q.D (20 40 60 80)	RECOVERY (%) (20 40 60 80)	DRILL SPEED (h/m) (1 2 3)	PERMEABILITY K in CGS/ LUGEON (10^{-5} – 10^{-4})	DESCRIPTIONS
		0.0									
		2.0	2.0		OVER BURDEN						0.0-2.0M OVER BURDEN 0.0-2.00m Top Soil with few appearance of rock fragments brownish in color
		2.8	0.8		MODERATELY WEATHERED DACITE						2.00-5.50M Majority of rock fragments. Fragments ranges in size from 3-5 cm in diameter angular fresh but very slight iron stain noted grayish in color.
		5.0			SLIGHTLY WEATHERED DACITE						
		5.50	2.7								5.50-17.50M DACITE porphyritic hard and massive. Grayish in color Fracture/joint plane rusty and calcitic
		10.0			SLIGHTLY WEATHERED DACITE						
		15.0									
		17.5	12.0								17.50-77.0M DACITE Core recovered generally in fair condition. Broken and fragmented throughout the bottom of the hole Basaltic andesite noted at elev 5.50-34.50m, 51.40-61.10m (dark grayish in color hard and massive porphyritic in character Core generally broken and fragmented at sections 5.50-24.50m,25.00-34.00m 34.50-39.80m,41.20-46.40m 48.80-49.80m,52.00-66.10m 68.00-70.00m.
		20.0									
		25.0			DACITE						
		30.0									

SANYU CONSULTANTS

BOREHOLE LOG

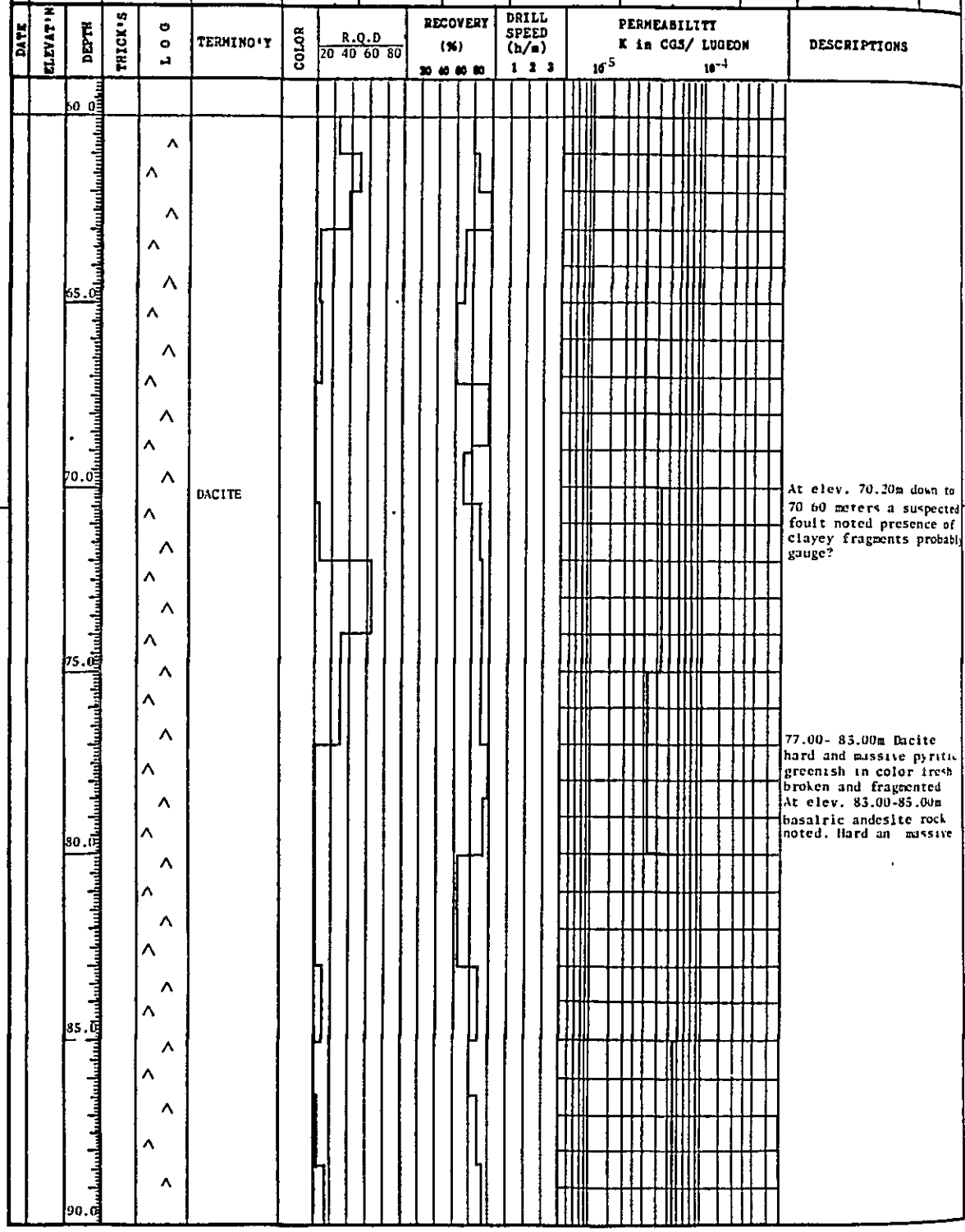
PROJECT	ILOCOS NORTE IRRIGATION PROJECT			SITE	PALSIGUAN DAM		
HOLE NO. DDH-3 (2)	ELEVATION	ANGLE	MACHINE	BEGUN		SITE ENGINEER	
	DEPTH	BIT	PUMP	COMPLETED		FOREMAN	
	DIAMETER	GW LEVEL	ENGINE	DAYS REQUIRED		DRILLER	

DATE	ELEVATION	DEPTH	THICKNESS	LOG	TERMINOLOGY	COLOR	R.Q.D (20 40 60 80)	RECOVERY (%) (20 40 60 80)	DRILL SPEED (h/m) (1 2 3)	PERMEABILITY K in CGS/ LUGEON (10^{-5} – 10^{-4})	DESCRIPTIONS
		30									At elevation 29.40 down to 34.50 meters. Core generally chloritized with some calcite. Iron staining along fracture/ joint plane from 33.75m down to 34.50m is noted.
		35.0									At elevation 34.50m down to 46.00 meters, moderately fractured andesite rock, noted Fracture/joint plane calcitic and rusty irregular fracturing.
		40.0			DACITE						
		45									
		50									
		55.0									
		60.0									

SANYU CONSULTANTS

BOREHOLE LOG

PROJECT	ILOCOS NORTE IRRIGATION PROJECT				SITE	PALSIGUAN DAM	
HOLE NO.	DDH-4 (3)	ELEVATION	ANGLE	MACHINE	BEGUN		SITE ENGINEER
		DEPTH	BIT	PUMP	COMPLETED		FOREMAN
		DIAMETER	GW LEVEL	ENGINE	DAYS REQUIRED		DRILLER



SANYU CONSULTANTS

BOREHOLE LOG

PROJECT	ILOCOS NORTE IRRIGATION PROJECT			SITE	PALSIGUAN DAM		
HOLE NO. DPH-4 (-1)	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	R.Q.D 20 40 60 80	RECOVERY (%) 20 40 60 80	DRILL SPEED (h/m) 1 2 3	PERMEABILITY K in CGS/ LUGEON 10^{-5} 10^{-4}	DESCRIPTIONS
		90.00									
					DACITE						85-100 meters-DACITE porphyritic and partially vesicular slightly weathered to fresh fracture/joint with calcite ranges from 8mm to paper thin.Fracture plane rusty and calcitic In some sections fracture joint plane filled with generals probably iron ore? especially at elev. 97.00-99.00m. Core generally broken at sections 85.40-86.00m, 95.00-97.00m, 97 00-99.00 m and 99 00-99.50 meters
		95.00									
		100									

SANYU CONSULTANTS

BOREHOLE LOG

PROJECT	ILOCOS NORTE IRRIGATION PROJECT					SITE	PALSIGUAN DAM		
HOLE NO.	ELEVATION		ANGLE	VERTICAL	MACHINE		BEGUN	5/10/78	SITE ENGINEER	
DDH-5 (1)	DEPTH	40.0 M	BIT		PUMP		COMPLETED	5/20/78	FOREMAN	
	DIAMETER	NQ,BQ	GW LEVEL	34.0 M	ENGINE		DAYS REQUIRED	21	DRILLER	

DATE	ELEVATION	DEPTH	THICKNESS	LOG	TERMINOLOGY	COLOR	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^{-4} – 10^{-3})	DESCRIPTIONS
		0.0									
		0.8			TOP SOIL						0.8-4.00m:Pebbles,Cobble of andesitic/basaltic rocks. Angular with slig iron stain noted along its surface. Slightly weathered
		5.0			MODERATELY WEATHERED DACITE						4.00-5.10m:Sandy Formati Recovered as sludge, light gray fine to medi coarse grained. 5.10-9.00m:Pebbles,Cobbl of andesitic rocks. Fragments range from 2- cm in diometer. Subrounde to angular with slight iron staining along surfaces. 9.00-12.00m.Sandy Formati Recovered as sludge Medium coarse grained. Brownish in color. 12.00-13.80m:Pebbles,Cob Fragments ranges from 2-6cm in diometers Angula Slightly weathered. 13.80-17.65m.Sandy Formation. Recovered as sludge coarse grained grading to fine grained Brownish in color. 17.65-19.00m:Pebbles, Cobbles of dioritic roc Fragments ranges from 2- cm in diometer. Subrounde ed and angular. 19.00-20.55m:Sandy Formation. Recovered as sludge. Fine grained Grayish in color. 20.55-21.20m:Pebbles, Cobbles of andesitic rock Angular. 21.20-23.50m:Sandy Formation. Recovered as sludge. Fine grained Grayish in color. 23.50-31.0m DACITE porphyritic pyritic, har and massive. Grayish in color. Chloritized along surfaces. Fracture/joint plane filled with calcite ranges from 5mm to paper thin. Fracture joint plan calcitic with slight iron noted. Slightly weatherd to fresh. Core broken and fragment ed at elev.23.50m down to 33.00 meters 22.25-31.0m· Sheared zone
		10.0									
		13.8									
		15.0			MODERATELY WEATHERED DIORITE						
		20.0	6.2								
		23.5	3.5		MODERATELY WEATHERED DACITE						
		25.0									
		25.25			SLIGHTLY WEATHERED DACITE						
		30.0									

SANYU CONSULTANTS

BOREHOLE LOG

PROJECT	ILOCOS NORTE IRRIGATION PROJECT			SITE	PALSIGUAN DAM		
HOLE NO. DDH-5 (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	R.Q.D 20 40 60 80	RECOVERY (%)	DRILL SPEED (h/m) 1 2 3	PERMEABILITY K in CGS/ LUGEON 10	DESCRIPTIONS
		30.0									
		31.0	7.5								31.0-40:DACITE Hard and massive, Fresh. Core recovered in fair condition.
		35.0			DACITE						
		40.0									

SANYU CONSULTANTS

BOREHOLE LOG

PROJECT	ILOCOS NORTE IRRIGATION PROJECT.					SITE	PALSIGUAN DAM		
HOLE NO.	DDH-6 (1)	ELEVATION		ANGLE	VERTICAL	MACHINE		BEGUN	7/13/78	SITE ENGINEER	
		DEPTH	70 0 M	BIT		PUMP		COMPLETED	7/31/78	FOREMAN	
		DIAMETER	NQ,BQ	GW LEVEL	NO WATER	ENGINE		DAYS REQUIRED	19	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^{-4} 10^{-3}	DESCRIPTIONS
		0.0									
		2.0	2.0		OVER BURDEN						1.00-1 20M-penetration test (11-28-22) Clayey silt, whitish gr made up of pebble and cobble sizes of basalti dacitic rock subrounded to rounded in shape note when wet easily formed however when dry easily turn into grains
		4.0	2.0		EXTREMELY WEATHERED BASALT						2 00-4.00M-BASALT Cores recovered mostly broken which exhibits pebble and cobble sizes with subrounded in shape gray in color and fine grain. Moderately hard but break at moderate hammer blows.
		5 0			MODERATELY WEATHERED BASALT						4.00-7.70M-Sludges recovery fine grain ligh gray to grayish in color
		7.70	3 7								7.70-23.40M-DACITE Cores samples recovered are subrounded to angula in shape. Medium hard to hard fine grain grainish gray in color and solid cores recovered are mostly less than 10.0 cm. White spots or in veinlet forms are noted especially on the surface or broken surface prebabbly qtz. slightly weathered light gray to gray in color mostly pebble sizes. Noted iro stains on the joint surfaces.
		10 0			SLIGHTLY WEATHERED DACITE						
		15.0									
		20.0	12.3		DACITE						
		23	3.4								23.40-23.97m-BASALT Angular in shape fine gr and mostly pebble sizes Along joint planes noted iron stains and qtz. Hard and gray in color
		23.9	0.5		BASALT						
		25			DACITE						
		50.0									

SANYU CONSULTANTS

BOREHOLE LOG

PROJECT	ILOCOS NORTE IRRIGATION PROJECT				SITE	PALSIGUAN DAM	
HOLE NO.	DDH-6 (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 m					10 20 30 40	20 40 60 80	1 2 3	10^{-4} 10^{-3}	
		31 m	7.1		DACITE						23.97-31.00m-DACITE Along joint/fracture planes noted abundant presence of iron stains solid and hard Other observation same as in section 7.70-28.40m.
		35.0	4.0		BASALT						31.00-35.00m-BASALT Highly iron stained especially along joint planes few qtz. noted. Joints orienting from 45°to 70° Other description same as in section 23.40-23.97m.
		40.0			DACITE						35.00-41.55m-DACITE Same as in section 23.97-31.00m.
		41.55	6.55								41.55-44.50m-BASALT Core samples recovered are mostly solid less than 10.00cm. fine grain gray in color. Massive and hard that difficult to destroy by hammer blows.
		45 m									44.50-66.30m-BASALT Mostly pebble sizes of angular shape. Moderately hard that moderately breaks at hammer blows fine grain, gray in color heavily fractured due to intensive jointings.
		50.0			BASALT						
		55.0									
		60 m									

SANYU CONSULTANTS

BOREHOLE LOG

PROJECT	ILOCOS NORTE IRRIGATION PROJECT				SITE		
HOLE NO. DDH-6 (3)	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 cm/sec	DESCRIPTIONS
		60.0									
		65.0			BASALT						
		24.7									
		65.1			DACITE						66.30-70.15m: Dacite Mostly pebble sizes of angular shape. Heavily fractured due to intensi jointings greenish gray in color epidote/chlori at the surface are also noted.
		70.0									

SANYU CONSULTANTS

BOREHOLE LOG

PROJECT	ILOCOS NORTE IRRIGATION PROJECT					SITE	PALSIGUAN DAM		
HOLE NO.	ELEVATION		ANGLE	VERTICAL	MACHINE		BEGUN	5/20/78	SITE ENGINEER	
DDH-7 (1)	DEPTH	100.0 M	BIT		PUMP		COMPLETED		FOREMAN	
	DIAMETER	NQ.BQ	GW LEVEL	92.15 M	ENGINE		DAYS REQUIRED		DRILLER	

DATE	ELEVATION	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 COS/ LUGEON (10^{-4} – 10^{-3})	DESCRIPTIONS
		0.0									
		1.5	1.5		OVER BURDEN						0.000-1.5m Overburden 0.0-1.00m Recovered as sludge Brownish in color 1.00-1.50m Clayey Silty Soil with rock fragments 1.50-10.00m Pebbles, cobbles and scattered boulders with silty clayey fragments Partially soft and extremely weathered. Brownish in color.
		5.0			EXTREMELY WEATHERED DACITE						
		10.00	8.5								10.00-16.00m Recovered as sludge Fine to medium coarse grained Brownish to grayish in color. 10.00-23.35m Gravels, cobbles, pebbles with scattered boulders slightly weathered grayish in color
		15.0			MODERATELY WEATHERED DACITE						
		20.00									
		25.0									23.35-26.40m Recovered as sludge coarse grained Grayish in color 26.40-30.20m Gravels, cobbles of dacitic rocks
		30.									

SANYU CONSULTANTS

BOREHOLE LOG

PROJECT	ILOCOS NORTE IRRIGATION PROJECT				SITE	PALSIGUAN DAM	
HOLE NO.	DDH-7 (2)	ELEVATION		ANGLE		MACHINE	
		DEPTH		BIT		PUMP	
		DIAMETER		GW LEVEL		ENGINE	

BEGUN		SITE ENGINEER	
COMPLETED		FOREMAN	
DAYS REQUIRED		DRILLER	

DATE	ELEVAT'N	DEPTH	THICK'S	LOG	TERMINO'Y	COLOR	R.Q.D 20 40 60 80	RECOVERY (%) 20 40 60 80	DRILL SPEED (h/m) 1 2 3	PERMEABILITY K in CGS/ LUGEON 10^{-1} – 10^{-3}	DESCRIPTIONS
		30.0									30.20-34.00m Recovered as sludge. Coarse grained. Grayish in color
					MODERATELY WEATHERED DACITE						
		35.0	25.0								35.00-100.00m Hard rock Dacite basaltic in some section porphyritic and partially amygdaloid pyritic, dark grayish in color Hard and massive, chlorotied along surfaces. Fracture/joint plane filled with calcite ranges from 5mm to paper thin. Fracture/joint plane rusty and calcitic heathery varies from slightly weathered to fresh. Core recovered generally in fair condition. Broken and fragmented throughout the bottom of the hole Core generally broken at sections 33.00-44.50m 40.00-57.00m:60.00-68.00 68.00-68.40m·69.00-71.00 71.00-71.40m:72.40-73.00 73.00-74.00m:74.00-74.80 80.00-81.50m:83.40-86.70 86.75-87.55m:90.00-95.00 and 98.00-99.00 meters
		40.0									
		45.0			SLIGHTLY WEATHERED DACITE						
		50.0									
		55.0									
		60.0									

SANYU CONSULTANTS

BOREHOLE LOG

PROJECT	ILOCOS NORTE IRRIGATION PROJECT				SITE	PALSIGUAN DAM	
HOLE NO. DDH-7 (3)	ELEVATION	ANGLE	MACHINE		BEGUN		SITE ENGINEER
	DEPTH	BIT	PUMP		COMPLETED		FOREMAN
	DIAMETER	GW LEVEL	ENGINE		DAYS REQUIRED		DRILLER

DATE	ELEVATION	DEPTH	THICK'S	LOG	TERMINOLOGY	COLOR	R.Q.D 20 40 60 80	RECOVERY (%) 20 40 60 80	DRILL SPEED (h/m) 1 2 3	PERMEABILITY K in COS/ LUGEON 10^{-4} — 10^{-3}	DESCRIPTIONS
		50.0									
		65.0			SLIGHTLY WEATHERED DACITE					CAVED IN	
		70.0									
		74.0	39.0								
		75.0			DACITE						
		80.0									
		85.0								CAVED IN	
		90.0									

SANYU CONSULTANTS

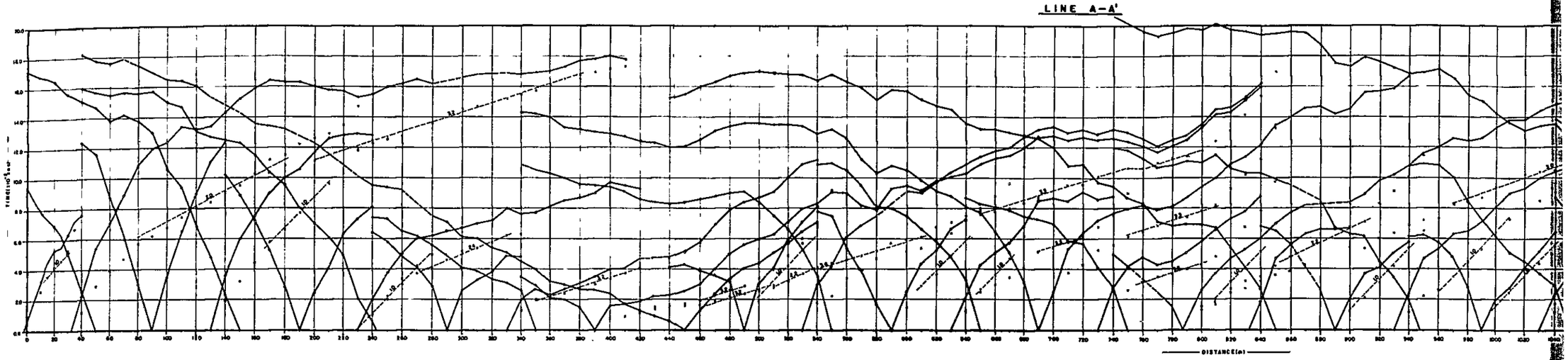
BOREHOLE LOG

PROJECT	ILOCOS NORTE IRRIGATION PROJECT				SITE	PALSIGUAN DAM	
HOLE NO. DNI-7 (4)	ELEVATION		ANGLE		MACHINE	BEGUN	SITE ENGINEER
	DEPTH		BIT		PUMP	COMPLETED	FOREMAN
	DIAMETER		OW LEVEL		ENGINE	DAYS REQUIRED	DRILLER

DATE	ELEVAT'N	DEPTH	THICK'S	LOG	TERMINO'Y	COLOR	R.Q.D 20 40 60 80	RECOVERY (%) 20 40 60 80	DRILL SPEED (h/m) 1 2 3	PERMEABILITY K in CGS/ LUGEON 10^{-4} — 10^{-3}	DESCRIPTIONS
		90.0									
		95.0			DACITE					CAVED IN	
		100									

SANYU CONSULTANTS

FIGURE 38-9 TRAVEL TIME CURVE
AND VELOCITY PROFILE
(PALSIGUAN DAMSITE)



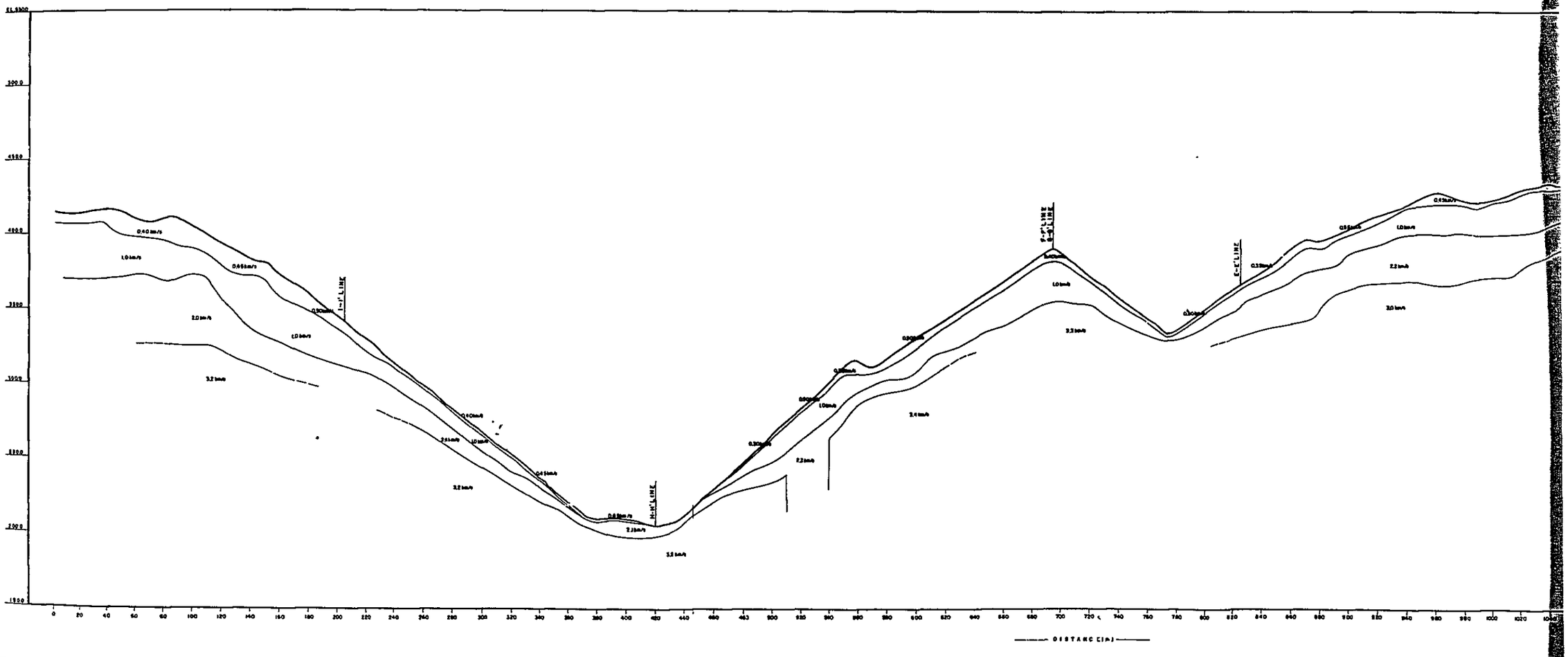
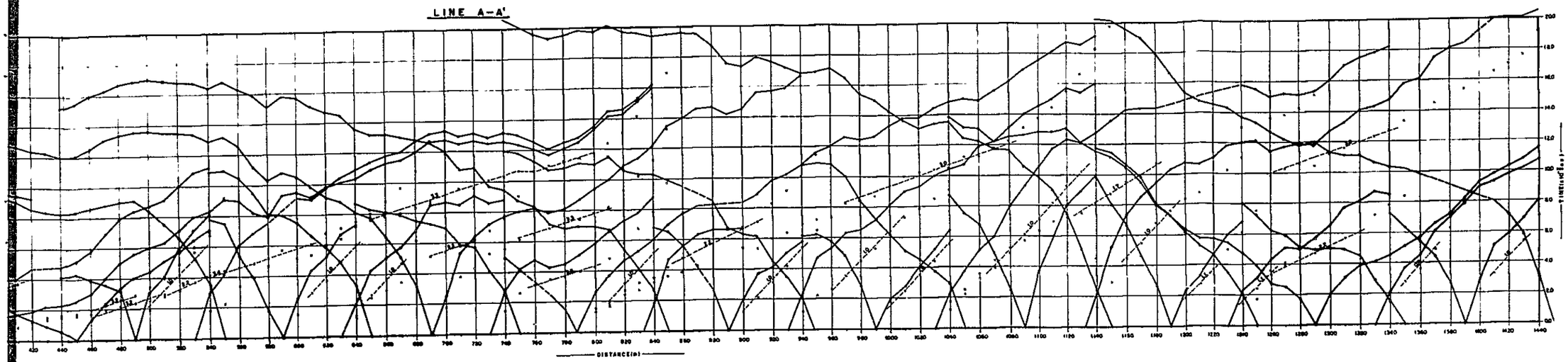


FIGURE 3B-9 TRAVEL TIME CURVE
AND VELOCITY PROFILE
(PALSIGUAN DAMSITE)



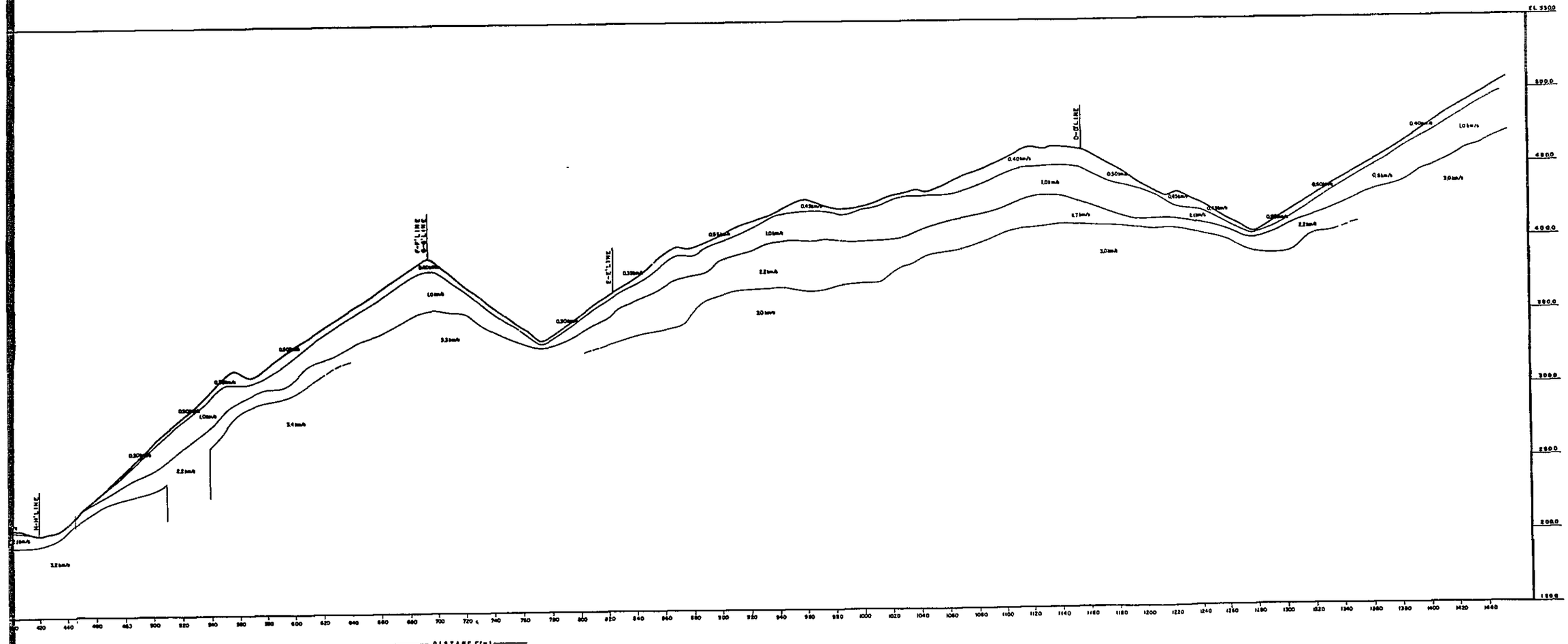


FIGURE 3B-10 TRAVEL TIME CURVE AND VELOCITY PROFILE (PALSIGUAN DAMSITE)

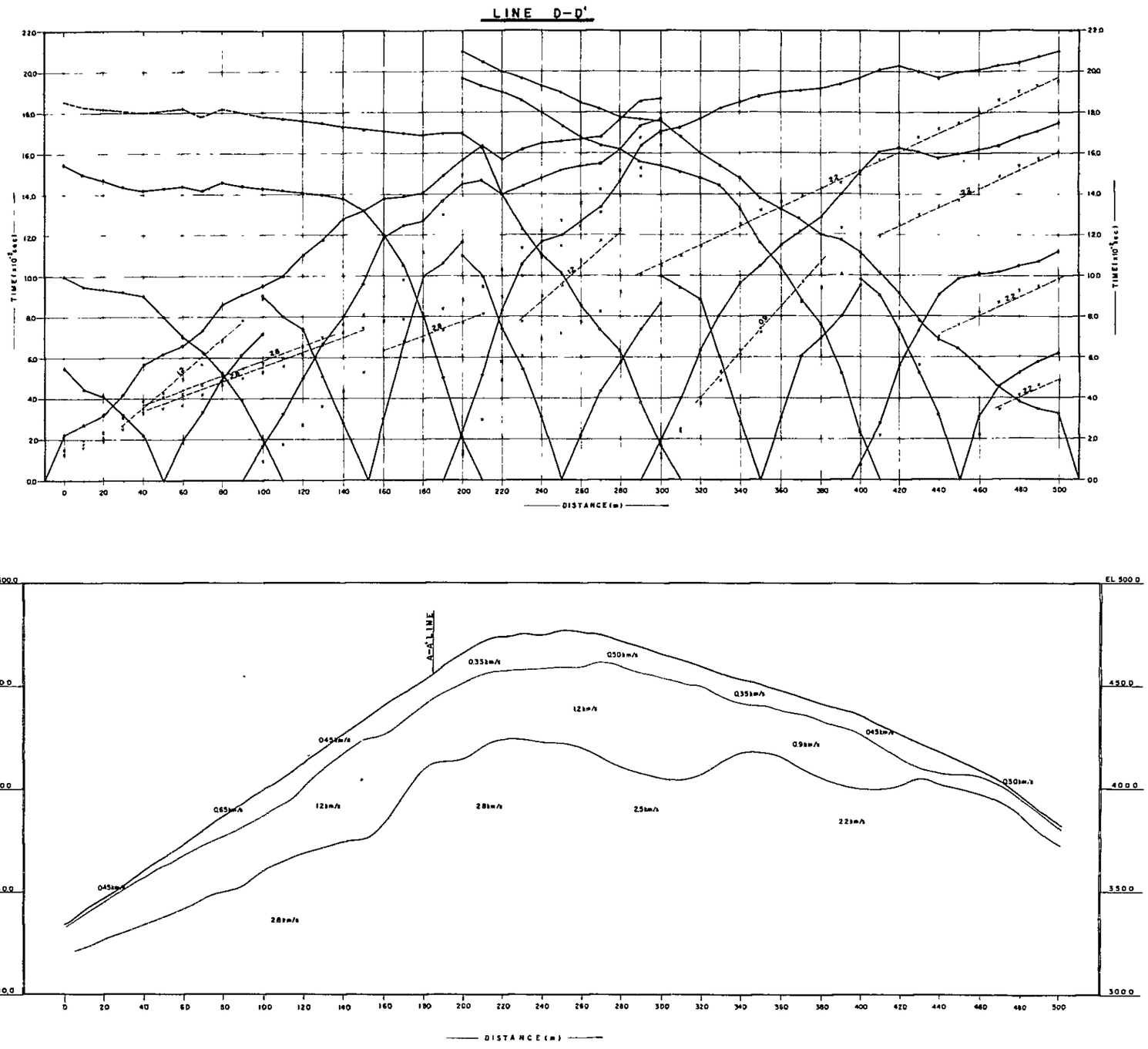


FIGURE 3B-11 TRAVEL TIME CURVE AND VELOCITY PROFILE (PALSIGUAN DAMSITE)