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ILOCOS NORTE IRRIGATION PROJECT  
I N  
THE PHILIPPINES  
(PHASE II)  
APPENDIX

DECEMBER 1980

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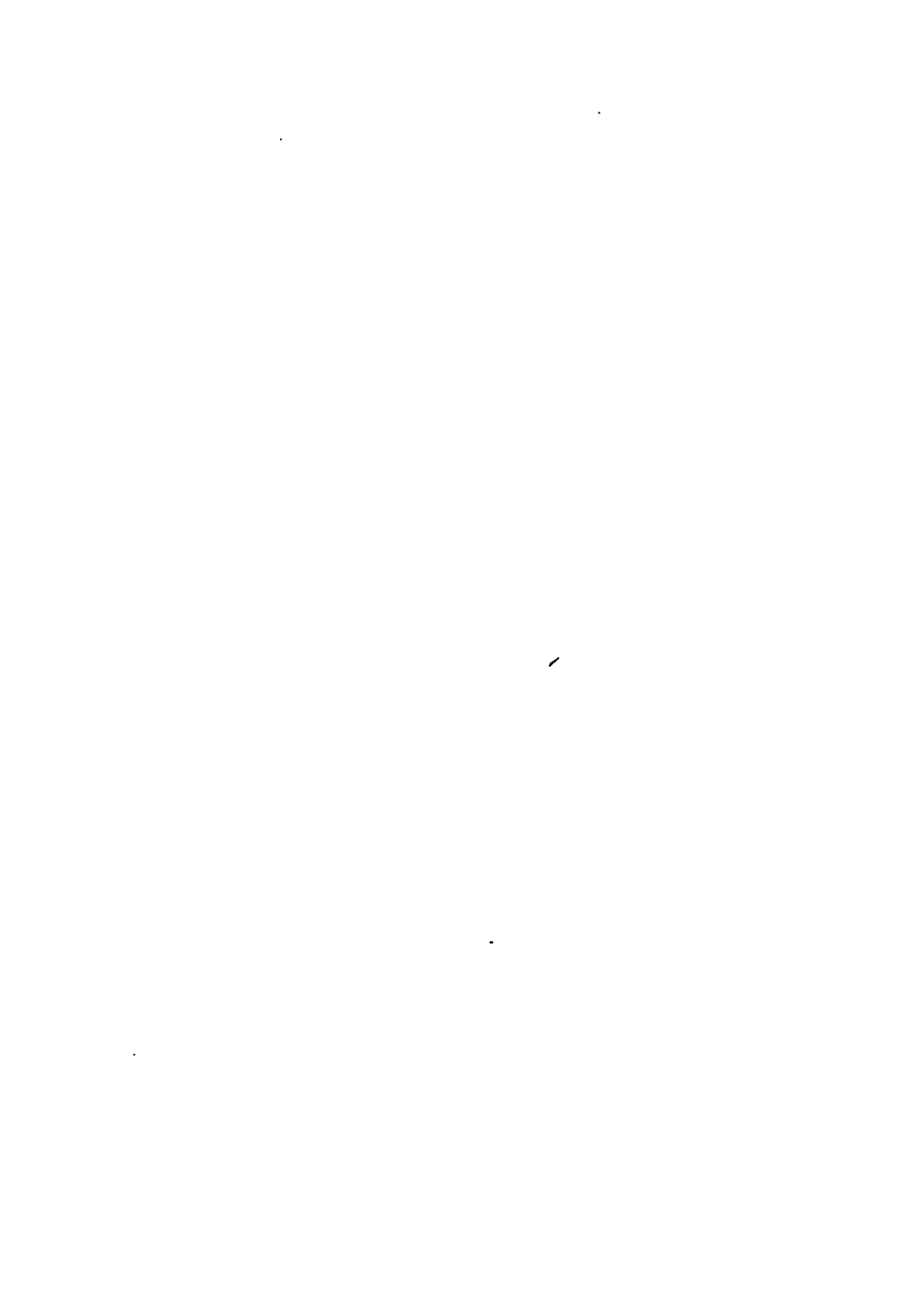
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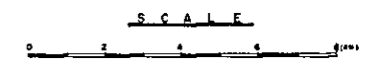
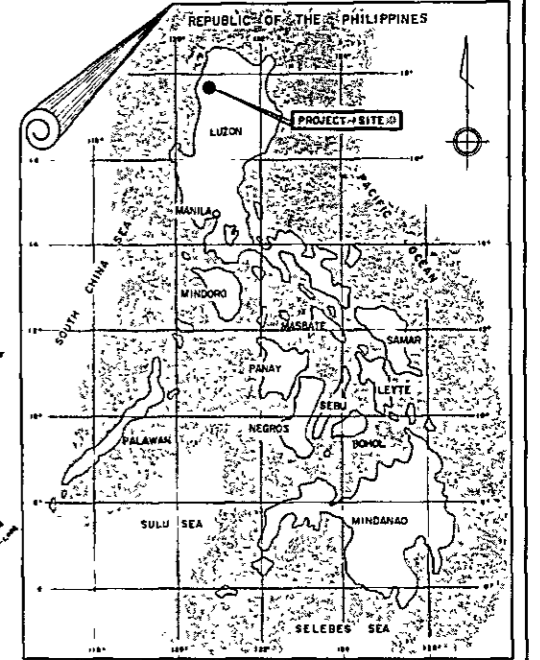
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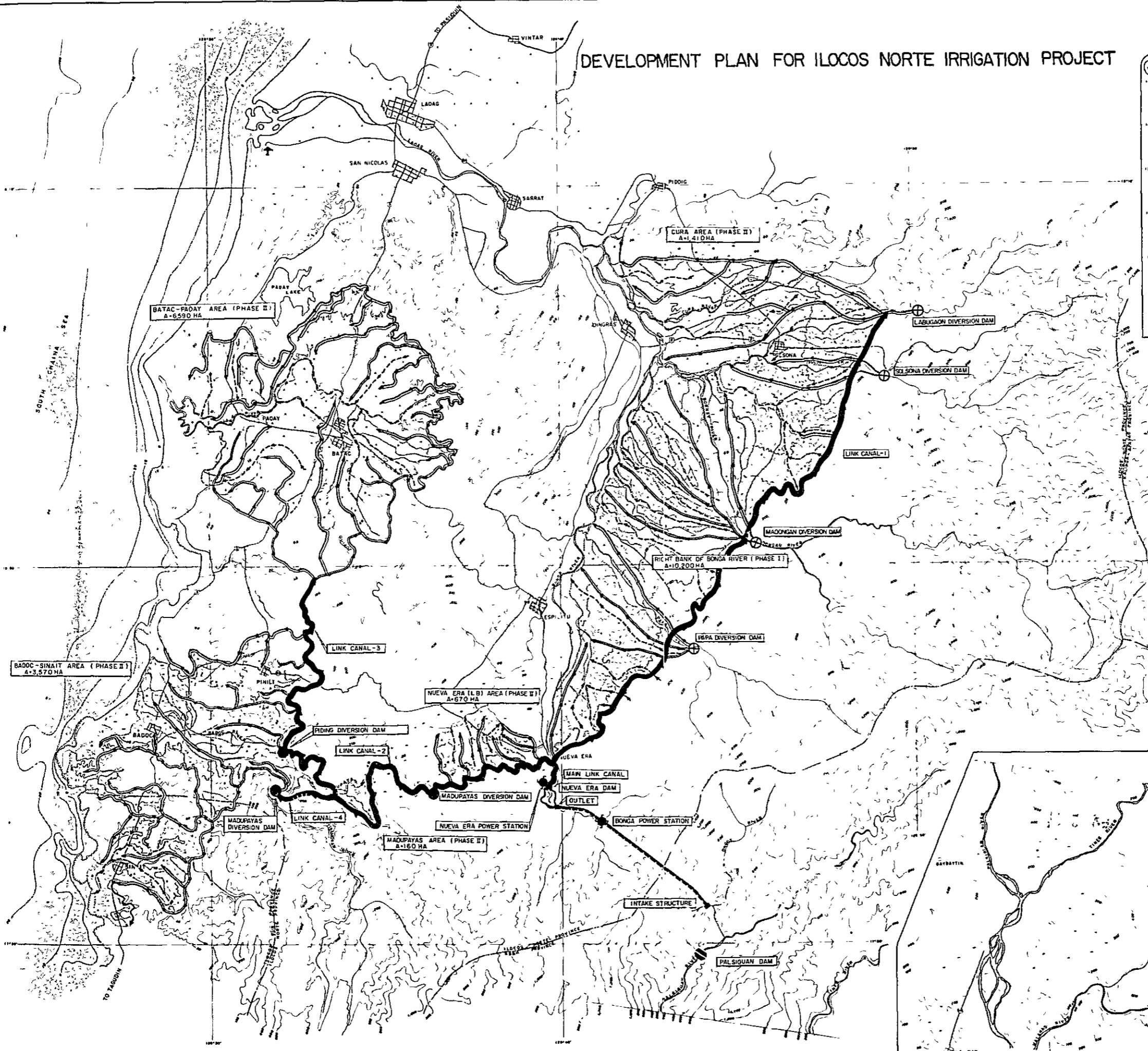


# DEVELOPMENT PLAN FOR ILOCOS NORTE IRRIGATION PROJECT



## LEGEND

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- NATIONAL AND PROVINCIAL ROADS
- RIVER AND RIVER WASHED AREA
- TOWN
- EXISTING 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)
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Data List Used for Feasibility Study<sup>1/</sup>

A. Climate and Hydrology

1. Meteorological 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.

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<sup>1/</sup>: 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

THE UNIVERSITY OF CHICAGO





Table 2A-3      Gross National Product  
- in million pesos -

	<u>1975</u>	<u>1976</u>	<u>1977</u>	<u>1978</u>
At current prices	114,265	132,712	152,693	171,940
At constant prices of 1972	68,530	72,718	77,279	81,961
	('76/'75)	('77/'76)	('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 -

	<u>At Constant Prices of 1972</u>			
	<u>1975</u>	<u>1976</u>	<u>1977</u>	<u>1978</u>
1. Agriculture, Fishery and Forestry	<u>18,218</u>	<u>19,671</u>	<u>20,646</u>	<u>21,633</u>
2. Industrial Sector	<u>22,690</u>	<u>24,904</u>	<u>26,821</u>	<u>28,546</u>
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	<u>27,453</u>	<u>28,387</u>	<u>30,017</u>	<u>31,914</u>
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	<u>68,361</u>	<u>72,962</u>	<u>77,484</u>	<u>82,093</u>

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

Industry	At Constant Prices of 1972			
	1975 <sup>r</sup>	1976 <sup>r</sup>	1977 <sup>p</sup>	1978 <sup>p</sup>
1. Agriculture, Fishery and Forestry	<u>26.6</u>	<u>27.0</u>	<u>26.6</u>	<u>26.4</u>
2. Industrial Sector	<u>33.2</u>	<u>34.1</u>	<u>34.6</u>	<u>34.8</u>
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	<u>40.2</u>	<u>38.9</u>	<u>38.7</u>	<u>38.9</u>
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	<u>100.0</u>	<u>100.0</u>	<u>100.0</u>	<u>100.0</u>

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 <sup>r</sup>	1976-1977 <sup>r</sup>	1977-1978 <sup>p</sup>
1. Agriculture, Fishery and Forestry	<u>8.0</u>	<u>5.0</u>	<u>4.8</u>
2. Industrial Sector	<u>9.6</u>	<u>7.7</u>	<u>6.4</u>
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	<u>5.5</u>	<u>5.7</u>	<u>6.3</u>
a. Transport, 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	<u>7.5</u>	<u>6.2</u>	<u>5.9</u>

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 <sup>r</sup>	1977 <sup>r</sup>	1978 <sup>p</sup>	1976 <sup>r</sup>	1977 <sup>r</sup>	1978 <sup>p</sup>
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	<u>2,860</u>	<u>2,052</u>	<u>3,320</u>	<u>1,740</u>	<u>1,808</u>	<u>1,871</u>
Poultry	<u>1,481</u>	<u>1,780</u>	<u>1,957</u>	<u>968</u>	<u>1,057</u>	<u>1,207</u>
Fishery	<u>6,368</u>	<u>7,474</u>	<u>8,473</u>	<u>3,300</u>	<u>3,491</u>	<u>3,655</u>
Forestry	<u>3,305</u>	<u>3,741</u>	<u>4,737</u>	<u>1,594</u>	<u>1,583</u>	<u>1,564</u>
Gross Value Added in Agriculture, Fishery and Forestry	<u>37,341</u>	<u>42,688</u>	<u>47,126</u>	<u>19,671</u>	<u>20,646</u>	<u>21,633</u>

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 <sup>1/</sup>	<u>₱3,681</u>	<u>4,380</u>	<u>4,371</u>	<u>4,788</u>	<u>4,819</u>	<u>22,399</u>	<u>5,852</u>	<u>26,615</u>	
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 <sup>2/</sup>	₱ 855	1,142	1,077	973	840	4,887	606	3,601	
2. Waterworks (LWUA) <sup>3/</sup>	153	250	300	350	400	1,453	550	2,400	46
3. Waterworks (MPW) <sup>4/</sup>	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	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 <sup>e</sup>	1978	1979	1980	1981	1982	1987	1977	1978	1979	1980	1981	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	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	15.6
Total Population <sup>1/</sup> (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	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	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	12.3

e. Estimate

<sup>1/</sup>: 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

	<u>1960</u>	<u>1970</u>	<u>1975</u>	Annual Growth Rate	
				<u>1960 - 1970 (%)</u>	<u>1970 - 1975 (%)</u>
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)	<u>1.2</u>	<u>1.8</u>
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	<u>2.4</u>	<u>1.3</u>

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 Meadow 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



CHAPTER II. THE PROJECT AREA

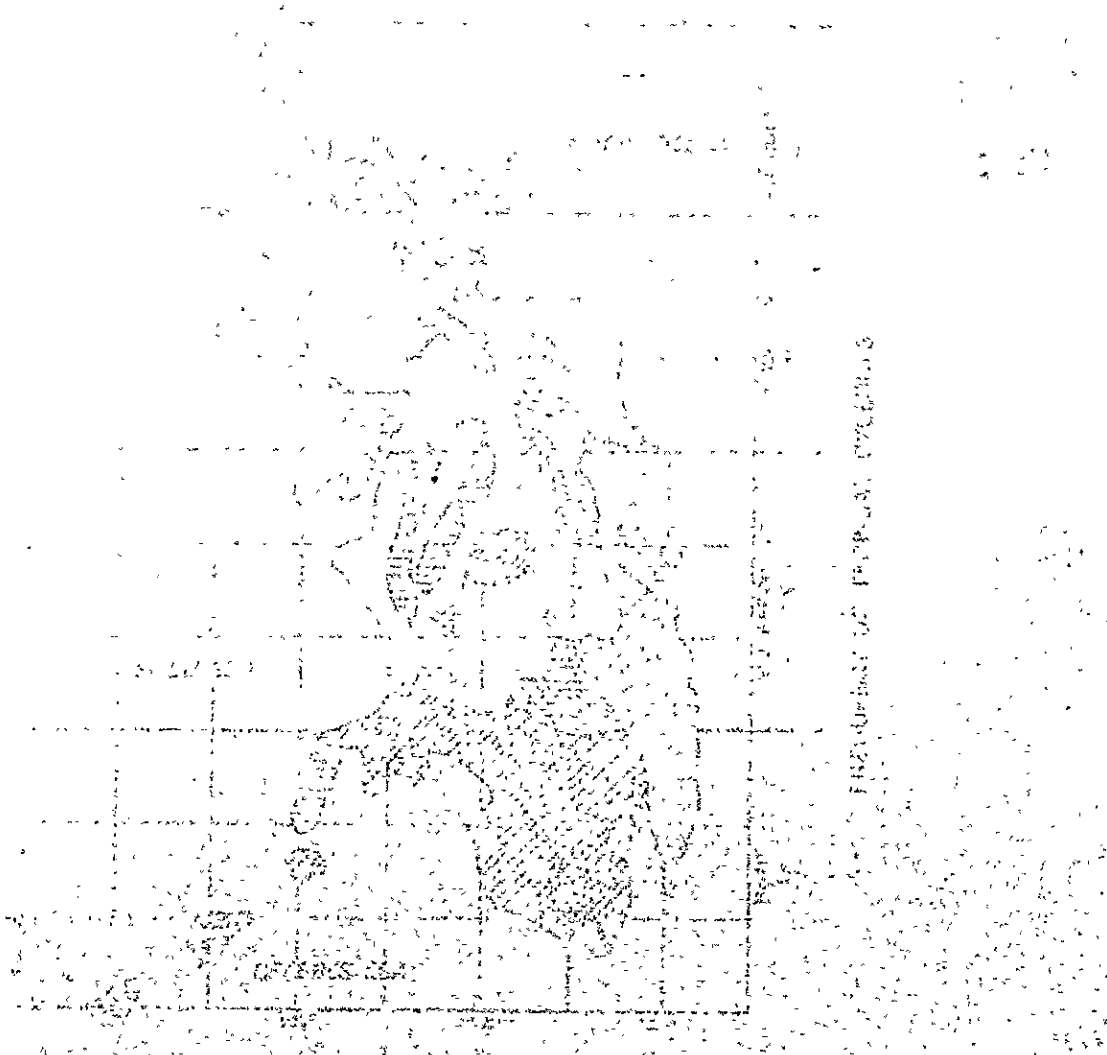
1970

1. The project area is located in the northern part of the state of...

2. The project area is located in the northern part of the state of...

CHAPTER III. THE PROJECT AREA

1. The project area is located in the northern part of the state of...



MAP OF THE PROJECT AREA

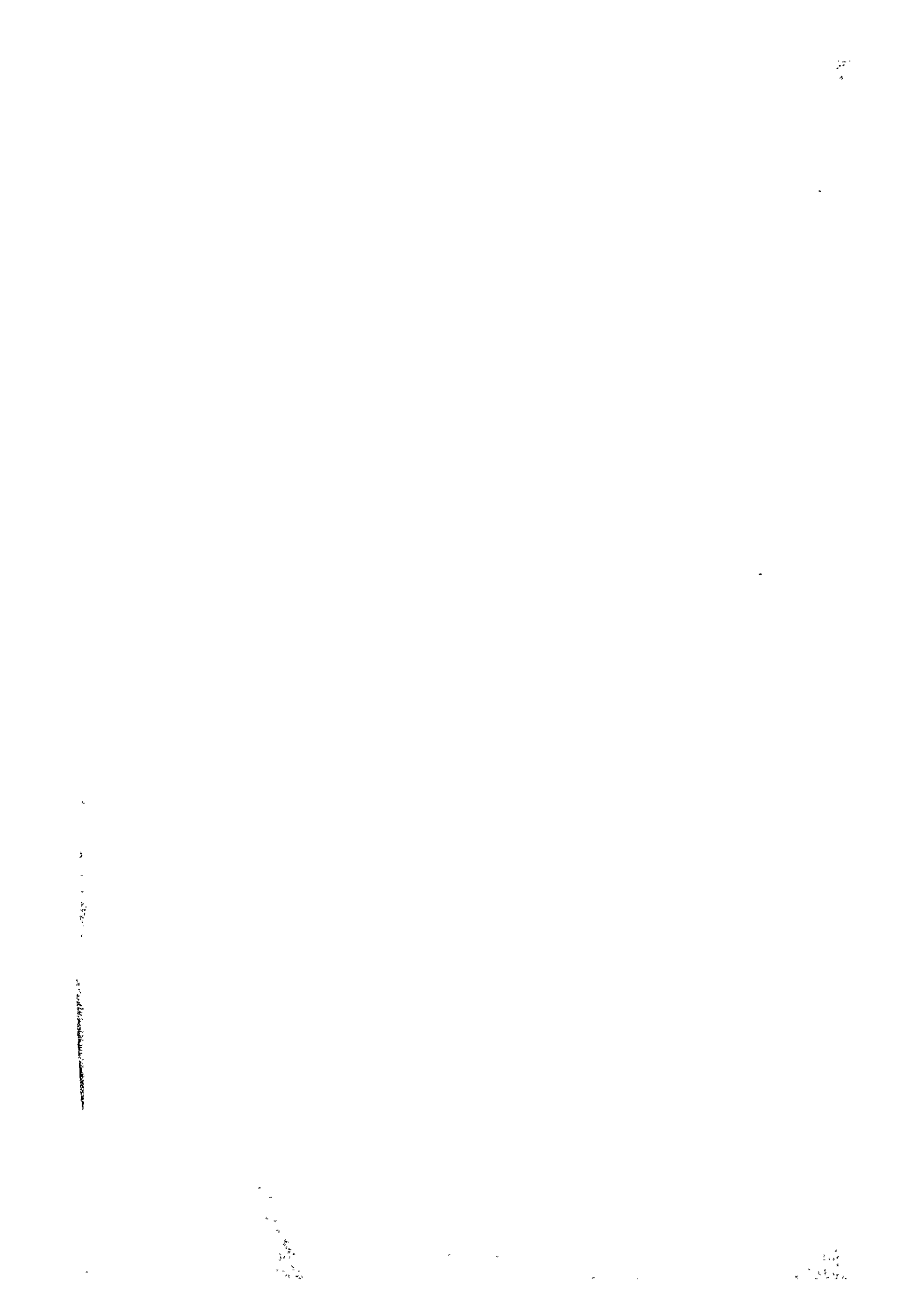


FIGURE 3B-1 CLIMATIC MAP IN THE PHILIPPINES

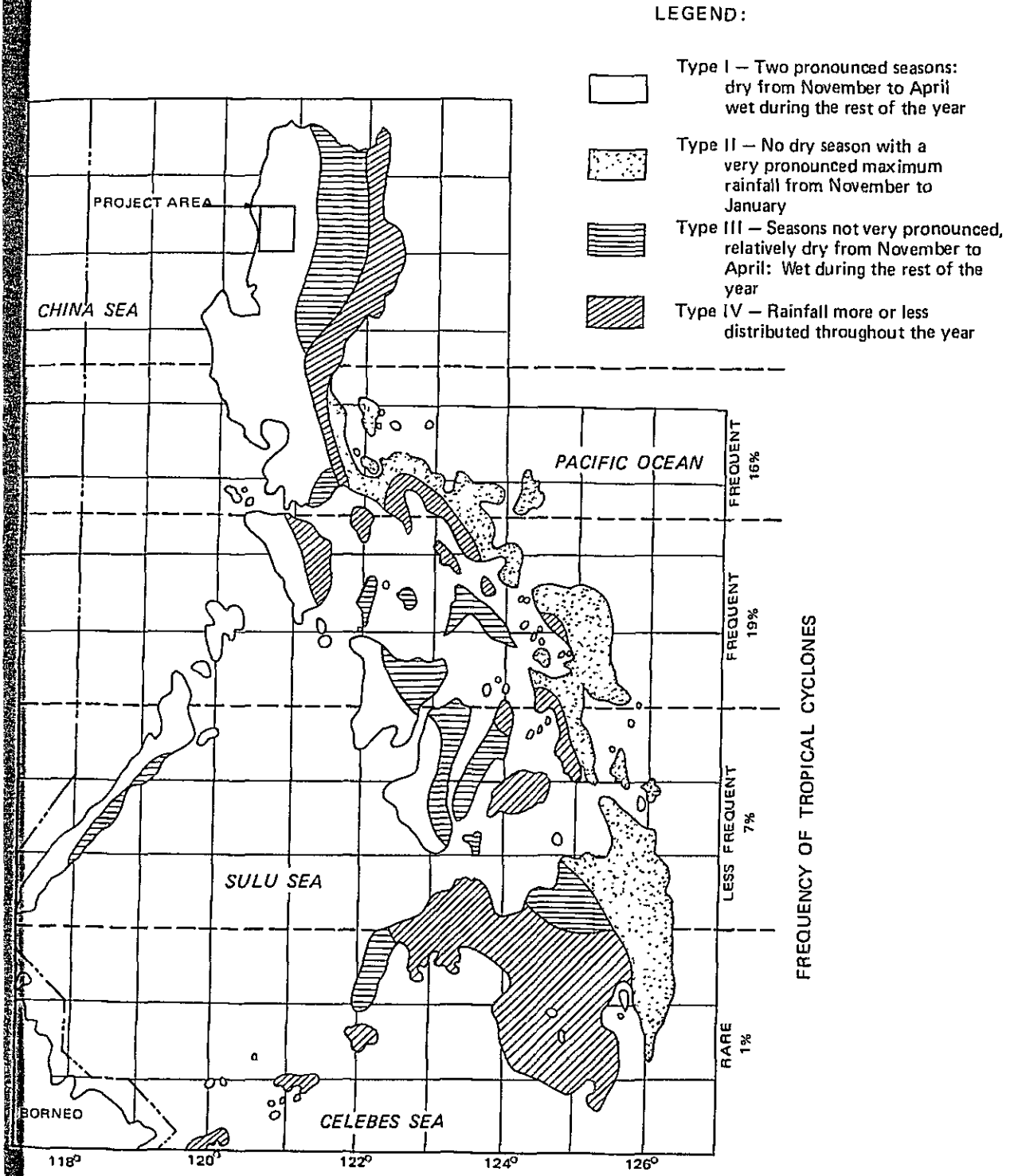


Table 3B-1 Monthly Rainfall at Laoag, Ilocos Norte <sup>1/</sup>

(Unit: mm)

Year	Dry Season				Wet Season				Dry Season		Total		
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.		Nov.	Dec.
1949	<sup>2/</sup>	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 <sup>3/</sup>	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
<u>Mean</u>	<u>3.1</u>	<u>1.1</u>	<u>1.7</u>	<u>14.1</u>	<u>122.1</u>	<u>379.1</u>	<u>415.3</u>	<u>538.4</u>	<u>373.7</u>	<u>111.0</u>	<u>44.6</u>	<u>11.6</u>	<u>2,015.8</u>
<u>Percent</u>	<u>0.2</u>	<u>0.1</u>	<u>0.1</u>	<u>0.7</u>	<u>6.1</u>	<u>18.8</u>	<u>20.6</u>	<u>26.6</u>	<u>18.5</u>	<u>5.5</u>	<u>2.2</u>	<u>0.6</u>	<u>100</u>

Note: <sup>1/</sup> Observations have been made at the Laoag Airport and records are compiled at PAGASA.<sup>2/</sup> No record<sup>3/</sup> Data were interpolated by applying monthly mean ratio to Vigan, Ilocos sur.







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	N	N	NNW	S	S	SSW	WSW	N	NNW	N
1961	N	N	N	N	NNW	SW	SW	SSW	SSW	N	N	N
1962	N	N	N	NW	N	SW	S	SSW	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	NNW	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

Year	(Unig: km/hr)											
	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

(Unit: mm/month)													
<u>Vigan, Ilocos Sur (Observed Open-pan Evaporation) (A)</u>													
<u>Year</u>	<u>Jan.</u>	<u>Feb.</u>	<u>Mar.</u>	<u>Apr.</u>	<u>May</u>	<u>Jun.</u>	<u>Jul.</u>	<u>Aug.</u>	<u>Sep.</u>	<u>Oct.</u>	<u>Nov.</u>	<u>Dec.</u>	<u>Total</u>
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	<u>160.2</u>	<u>172.9</u>	<u>212.2</u>	<u>212.7</u>	<u>201.7</u>	<u>162.0</u>	<u>158.7</u>	<u>132.3</u>	<u>136.6</u>	<u>145.2</u>	<u>142.3</u>	<u>137.5</u>	<u>1,974.3</u>
<u>Laoag, Ilocos Norte (Observed Open-pan Evaporation) (B)</u>													
<u>Year</u>	<u>Jan.</u>	<u>Feb.</u>	<u>Mar.</u>	<u>Apr.</u>	<u>May</u>	<u>Jun.</u>	<u>Jul.</u>	<u>Aug.</u>	<u>Sep.</u>	<u>Oct.</u>	<u>Nov.</u>	<u>Dec.</u>	<u>Total</u>
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	<u>204.6</u>	<u>182.2</u>	<u>216.0</u>	<u>204.2</u>	<u>198.5</u>	<u>190.2</u>	<u>166.6</u>	<u>165.4</u>	<u>161.8</u>	<u>195.0</u>	<u>175.3</u>	<u>198.3</u>	<u>2,258.1</u>
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	<u>198.4</u>	<u>167.0</u>	<u>205.6</u>	<u>200.6</u>	<u>201.3</u>	<u>194.4</u>	<u>168.1</u>	<u>182.5</u>	<u>170.9</u>	<u>213.7</u>	<u>182.3</u>	<u>206.8</u>	<u>2,291.6</u>

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

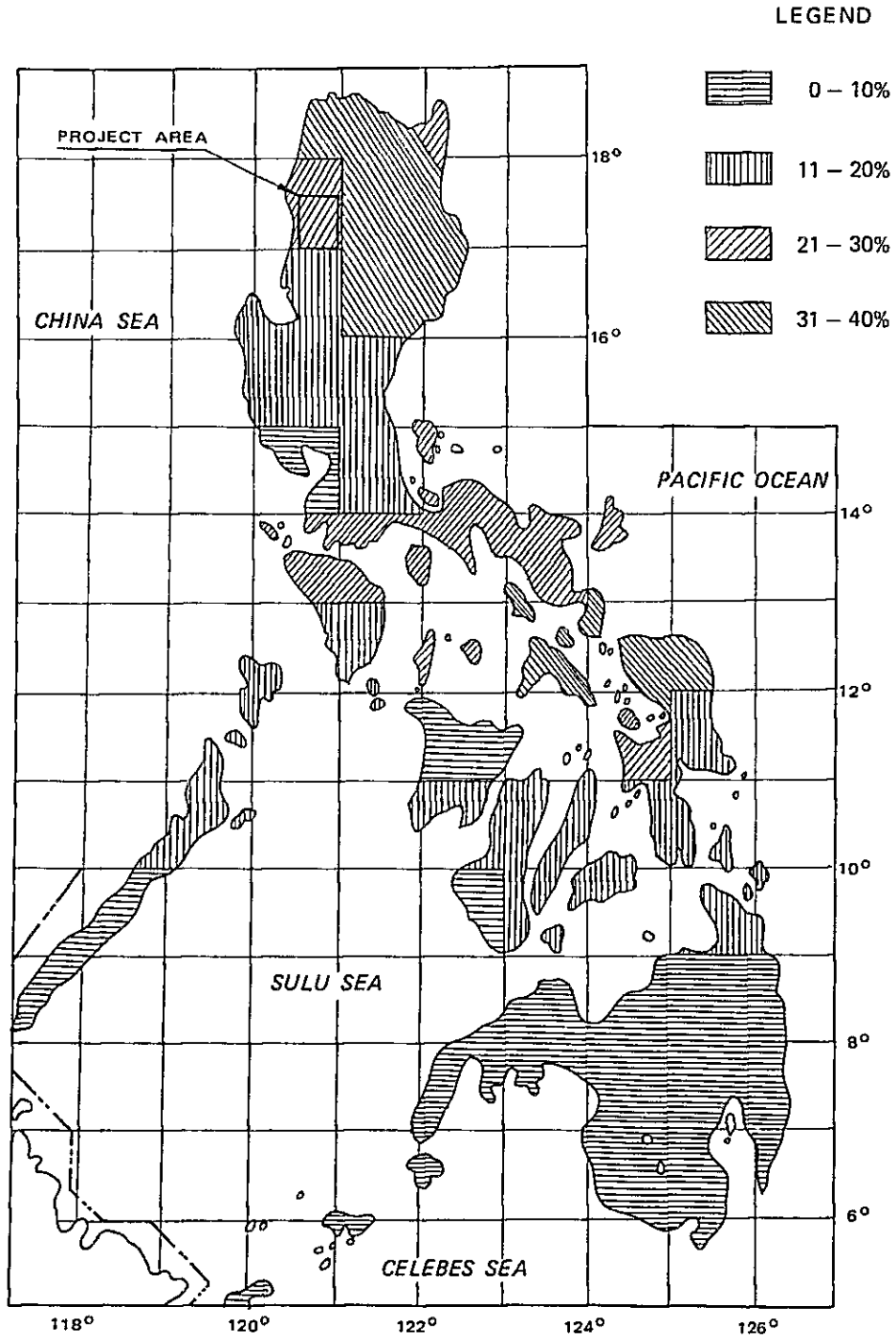


Table 3B-9 Status of Hydro-Meteorological Observation Relevant to the Project

<u>Item</u>	<u>Station</u>	<u>Location</u>	<u>Recorder</u>	<u>Installed Date</u>	<u>Agency</u>	<u>Available Period</u>	<u>Note</u>
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

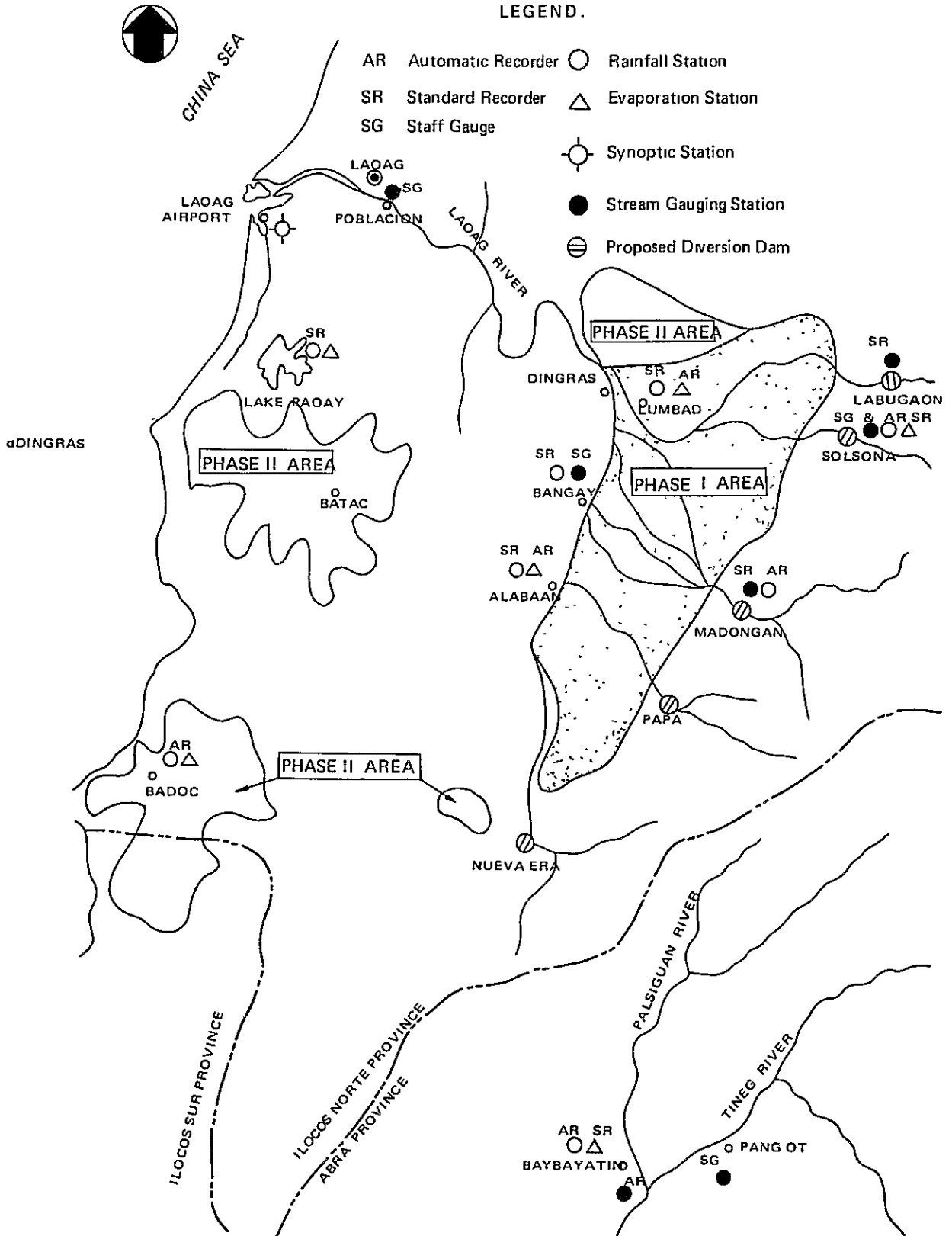


Table 3B-10 Monthly Run-off of the Labugaon River  
(Labugaon Diversion Dam Site: C.A. = 100.5 sq.km)

(Unit: MCM)

Year	Dry Season			Wet Season					Dry Season			Total	
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	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 (171.21) <u>1/</u>
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)

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) <u>1/</u>
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

(Unit: MCM)

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)

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) L/
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: L/ 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)

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) <u>L/</u>
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

(Unit: MCM)

Note: L/ 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			Wet Season				Dry Season			Total		
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.		Nov.	Dec.
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) <u>L/</u>
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	<u>4.93</u>	<u>3.15</u>	<u>1.89</u>	<u>1.95</u>	<u>5.55</u>	<u>17.65</u>	<u>24.83</u>	<u>22.81</u>	<u>21.95</u>	<u>12.13</u>	<u>10.11</u>	<u>8.13</u>	<u>135.08</u>

Note: L/ Figures in bracket 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 <sup>1/</sup>	
	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: <sup>1/</sup> 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 <sup>1/</sup>		
	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
<u>Mean</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>1.59</u>	<u>10.49</u>	<u>14.28</u>	<u>13.12</u>	<u>12.62</u>	<u>6.98</u>	<u>2.90</u>	<u>0</u>	<u>62.03</u>

Note: <sup>1/</sup> 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 <sup>1/</sup>		
	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: <sup>1/</sup> 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<sup>1/</sup>  
(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) <sup>2/</sup>
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: <sup>1/</sup> Compensation water for downstream of the proposed dam site is not considered in this run-off amount.

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

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

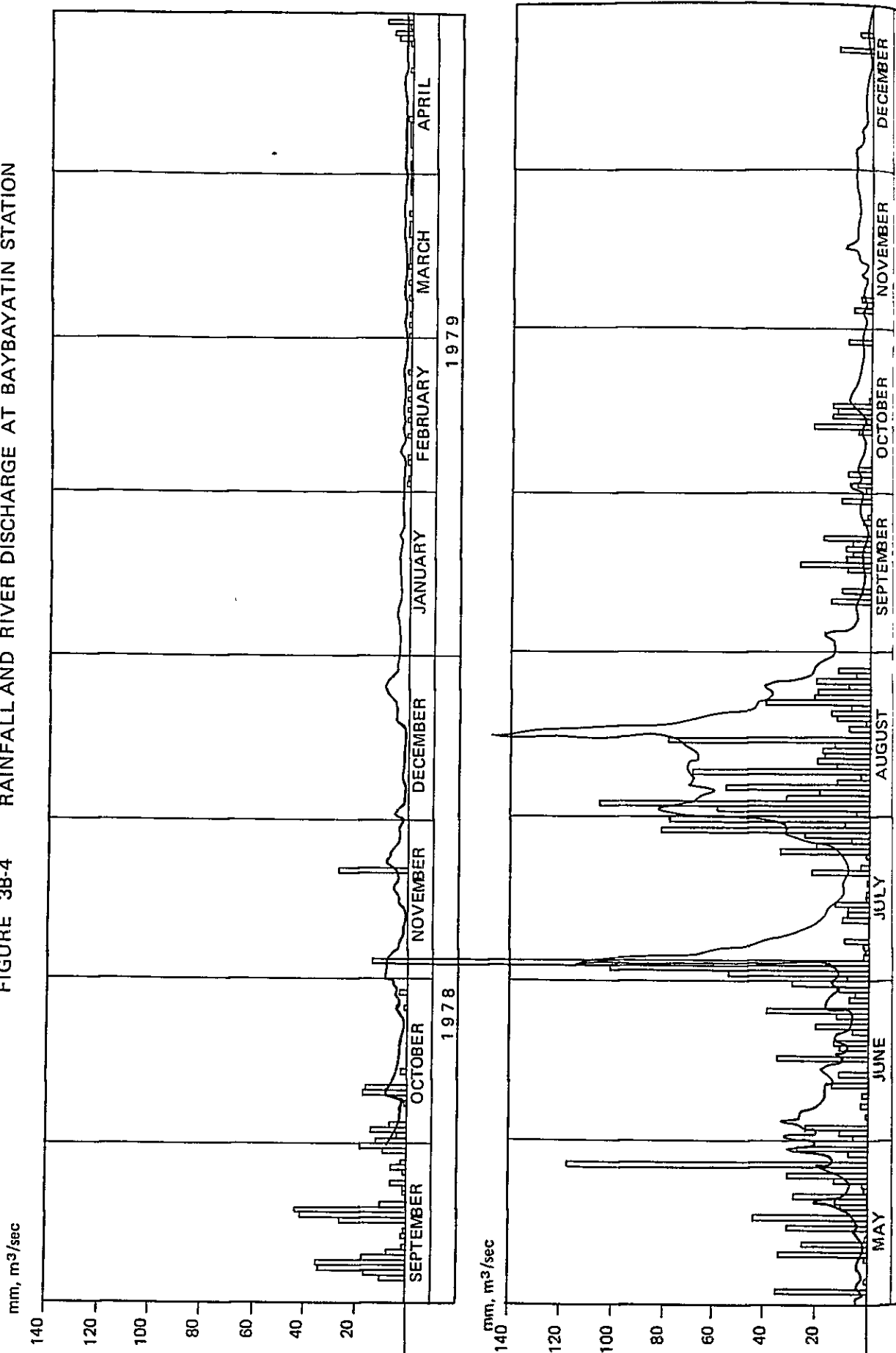


Table 3B-19 Flood Peak and Flood-Frequency Analysis by Hazen Method  
in Tineg River

<u>Year</u>	<u>Flood Peak</u>		<u>Order</u>	<u>Flood-Frequency Analysis</u>		
	<u>Qp</u> <sup>1/</sup> (cu.m/sec)	<u>Date</u>		<u>2i-1/2N</u> <sup>2/</sup>	<u>Year</u>	<u>Qp</u> (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: <sup>1/</sup> Qp stands for flood peak observed at Pang-Ot Station.

<sup>2/</sup> i: order      N: number of samples

FIGURE 3B-5 CATCHMENT AREA-SPECIFIC DISCHARGE RELATION

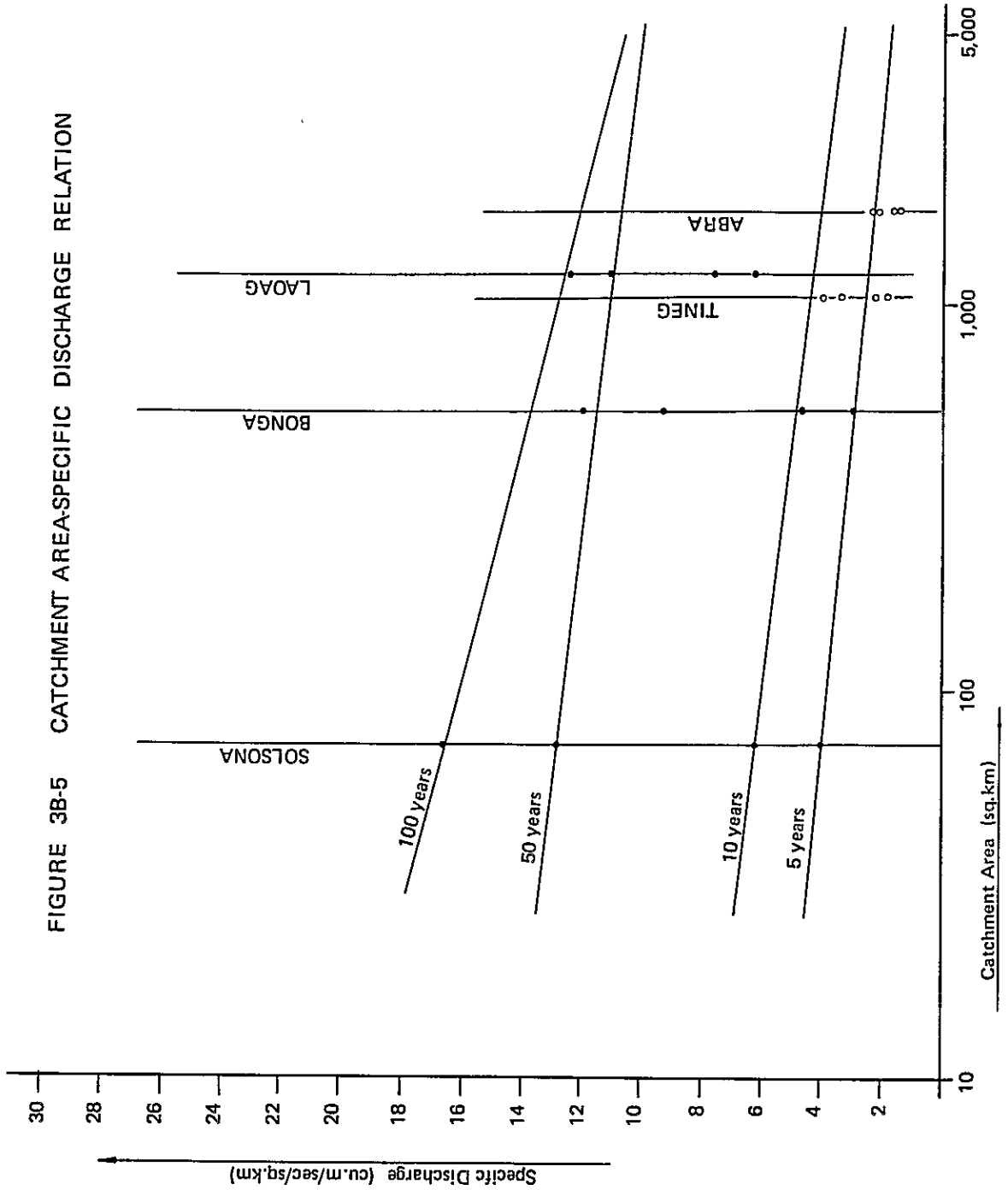


FIGURE 3B-6 DESIGN FLOOD OF DAM SPILLWAY (FILL TYPE)  
IN LUZON ISLAND ONLY

	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	

● PROPOSED DAM  
▲ EXISTING DAM

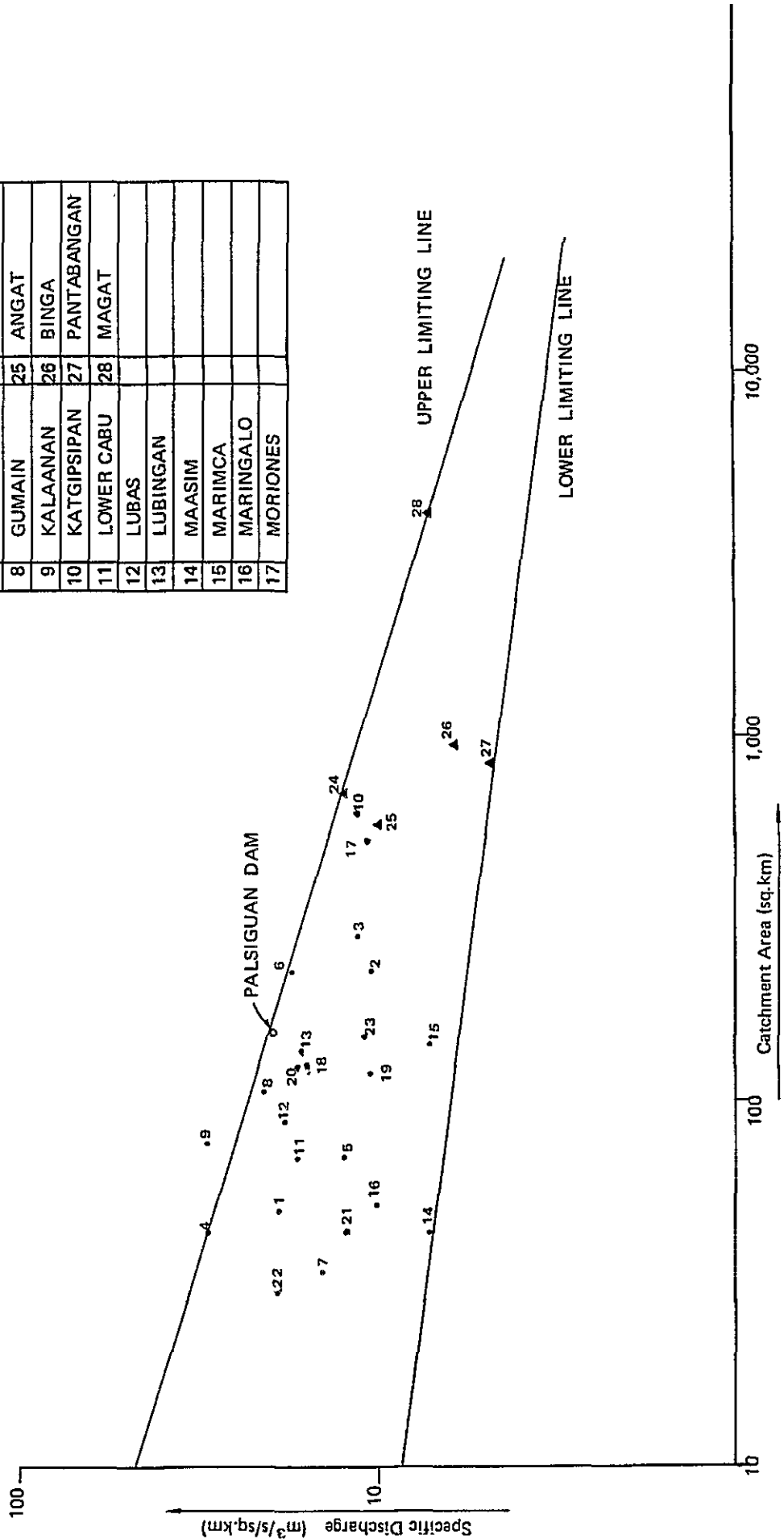


Table 3B-20 Overlapping Moving Average of Annual Rainfall  
(Laoag Station Unit: mm)

<u>Year</u>	<u>1 year</u>	<u>3 years</u>	<u>5 years</u>	<u>10 years</u>
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	-	-
1979	1,819	-	-	-

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

(Unit: mm)

<u>Year</u>	<u>Laoag R.</u>	<u>Estimated Palsiguan R.</u>	<u>Langangilang</u>
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 <sup>1/</sup>	-
<u>Mean</u>	<u>2,016</u>	<u>2,499</u>	<u>3,216</u>

Note: <sup>1/</sup> Actually observed data.



Table 3B-22 Maximum Consecutive Rainfall and  
Successive No Rainfall Day<sup>1/</sup>

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: <sup>1/</sup> 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;

<u>Location</u>	<u>Hole Number</u>	<u>Depth</u>	<u>Remarks</u>
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	<u>7 holes</u>	<u>540 m</u>	

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;

<u>Location</u>	<u>Line Number</u>	<u>Length</u>
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	<u>7 lines</u>	<u>5,550 m</u>

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;

<u>Borrow Area</u>	<u>Test Pit Number</u>	<u>Depth</u>
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	<u>15 test pits</u>	<u>68.4</u>

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;

<u>Test Items</u>	<u>Borrow Area and the Number of Samples</u>
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 ( $\phi = 10\text{cm}$ )	Polot 12, Manaois 1
( $\phi = 15\text{cm}$ )	Polot 3
Permeability test ( $\phi = 10\text{cm}$ )	Polot 3, Manaois 1
( $\phi = 15\text{cm}$ )	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;

<u>Test Item</u>	<u>Quantity</u>
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;

<u>Drilling Point</u>	<u>Hole Number</u>	<u>Hole Depth</u>	<u>Remarks</u>
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	<u>6 holes</u>	<u>204.6 m</u>	

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;

<u>Location</u>	<u>Line Number</u>	<u>Length of Line</u>
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	<u>2,500 m</u>

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;

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

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;

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

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

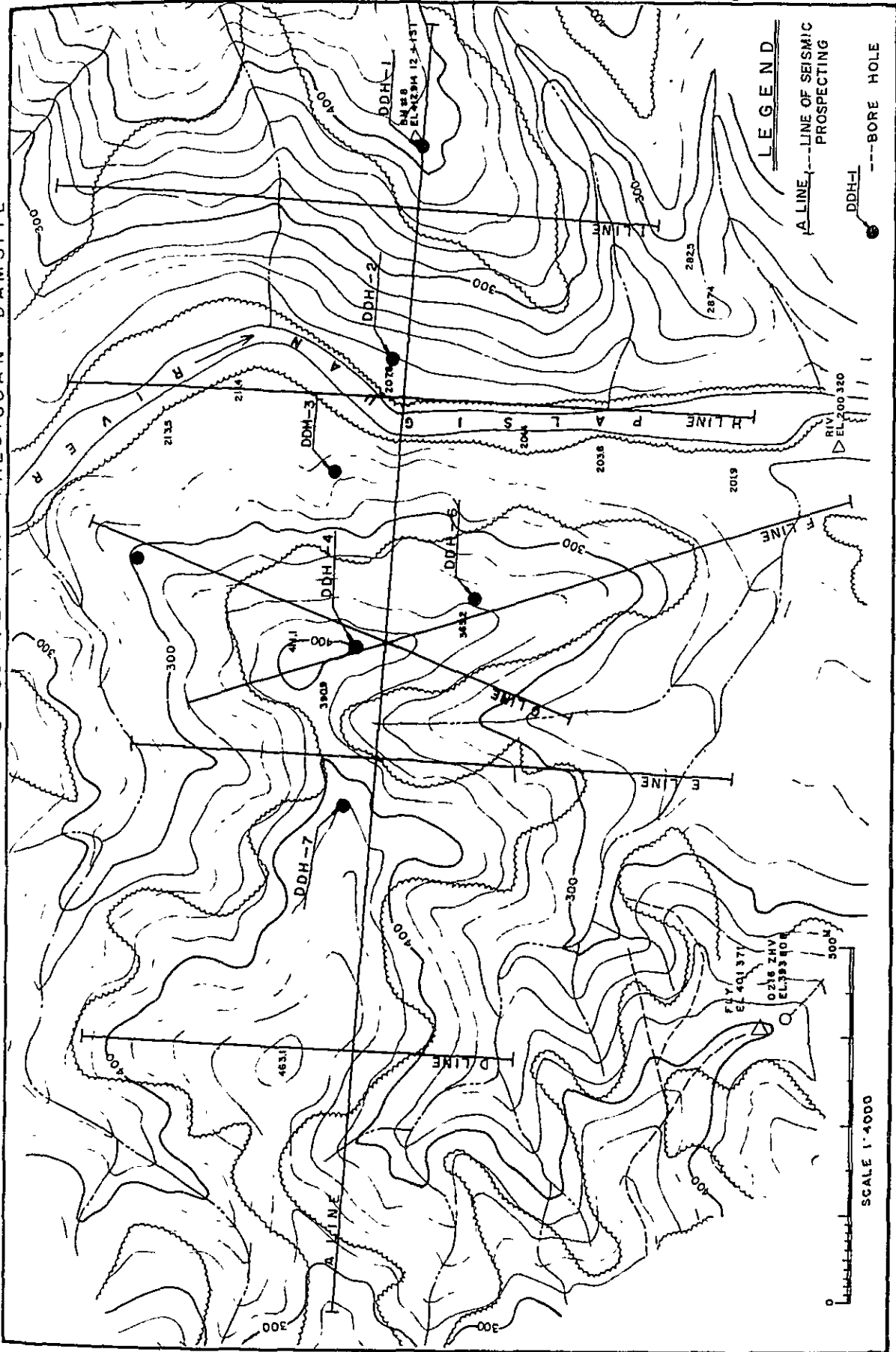




FIGURE 3B-8 BORE-HOLE LOG AT PALSIGUAN DAM SITE

BOREHOLE LOG													
PROJECT		ILOCOS NORTI IRRIGATION PROJECT						SITE		PALSIGUAN DAM			
HOLE NO.	ELEVATION		ANGLE		VERTICAL		MACHINE		BEGUN	6/28/79	SITE ENGINEER		
	DEPTH	100.00 M	BIT		PUMP		COMPLETED	8/3/78	FOREMAN				
	DIAMETER	NQ.8Q	GW LEVEL	NO WATER	ENGINE		DAYS REQUIRED	37	DRILLER				
DATE	ELEVATION	DEPTH	THICKNESS	LOG	TERMINOLOGY	COLOR	MAX. CORE NO. OF CORE	RECOVERY (%)	DRILL SPEED (h/m)	PERMEABILITY K in CGS/ LUDEON	DESCRIPTIONS		
							20 40 60 80	20 40 60 80	1 2 3	10 <sup>-5</sup> 10 <sup>-4</sup>			
	0.00				TOP SOIL						0.00M-1.00M-soil boring		
	1.00	1.00			OVER BURDEN						1.00M-1.45M-conducted penetration test.(9-8-1) sandy clay brownish fine to medium grains 1.45M-2.45M-was hard boring 2.45M-2.90M-again conducted penetration test (11-10-13) same as in 1.00M-1.45M 2.90M-5.25M-sludge recovery. 5.25M-36.00M-BASALT core recovered are mostly broken due to intensive jointings which exhibits subrounded to sharp in edges. Epidote/chlorite are also noted especially along the broken surface. Along the joint plane noted iron stains and qtz/calc. light gray in color and fine grain. Moderately hard to hard when applied by hammer blows. Massive and hard. Sludge recovered at sections (15.00-16.00) (11.00-12.30) (12.50-15.00) (17.00-18.00) (18.00-19.00)		
	1.25				MODERATLY WEATH RED BASALT								



BOREHOLE LOG														
PROJECT		ILOCOS NORTE IRRIGATION PROJECT										SITE		PALSIGUAN DAM
HOLE NO.	DATE	ELEVATION		ANGLE		MACHINE		BEGUN		SITE ENGINEER				
		DDH-1 (3)												
		DEPTH	DIAMETER	BIT	GW LEVEL	PUMP	ENGINE	COMPLETED	FOREMAN	DRILLER				
DATE	ELEVATION	DEPTH	THICK'S	LOG	TERMINO'Y	COLOR	MAX. CORE (cm)	NO. OF CORE	RECOVERY (%)	DRILL SPEED (m/m)	PERMEABILITY K in CGS/ LUZEON		DESCRIPTIONS	
							20 40 60 80	10 20 30 40	20 40 60 80	1 2 3	10 <sup>-5</sup>	10 <sup>-4</sup>		
		60.0												
		55.0			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												
		75												
		80.0												
		81.6	45.6										77.00-81.50M-on this section noted abundant presence of iron stains and epidote/chlorite.	
		85.0			DACITE								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.	
		88.5	6.95											
		90.0			BASALT									

BOREHOLE LOG															
PROJECT ILOCOS NORTE IRRIGATION PROJECT											SITE PALSIGUAN DAM				
HOLE NO.	ELEVATION		ANGLE		MACHINE			SEGUN		SITE ENGINEER					
	DEPTH		BIT		PUMP			COMPLETED		FOREMAN					
	DIAMETER		GW LEVEL		ENGINE			DAYS REQUIRED		DRILLER					
DATE	ELEVATION	DEPTH	THICKNESS	LOG	TERMINOLOGY	COLOR	MAX. CORE NO. (20 40 60 80)	RECOVERY (%)	DRILL SPEED (m/m)	PERMEABILITY K in CGS/ LUDEON		DESCRIPTIONS			
									10-5	10-1					
							10 20 30 40	20 40 60 80	1 2 3						
	90											88.55M-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	✓												

BOREHOLE LOG																			
PROJECT										SITE									
ILOCOS NORTE IRRIGATION PROJECT										PALSIGUAN DAM									
HOLE NO.	ELEVATION		ANGLE	VERTICAL	MACHINE	BEGUN		SITE ENGINEER											
	DDH-2 (1)					5/5/78													
	DEPTH		BIT		PUMP	COMPLETED		FOREMAN											
	DIAMETER		OW LEVEL		ENGINE	DAYS REQUIRED		DRILLER											
DATE	ELEVATION	DEPTH	THICKNESS	L O D	TERMINOLOGY	COLOR	R.Q.D.				RECOVERY (%)			DRILL SPEED (h/m)			PERMEABILITY		DESCRIPTIONS
							20	40	60	80	20	40	60	80	1	2	3	10 <sup>-5</sup>	
	0.0																		0.00-2.00M OVER BURDEN Recovered as sludge grayish in color. Admixture of soil and brecciated fragments of stone.
	2.0	2.00			OVER BURDEN														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				DACITE														
	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				BASALT														
	15.7	2.7			BASALT														
	20.0				DACITE														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.
	25.0				DACITE														
	30.0				DACITE														

BOREHOLE LOG																				
PROJECT ILOCOS NORTE IRRIGATION PROJECT										SITE PALSIGUAN DAM										
HOLE NO.	ELEVATION		ANGLE		MACHINE			BEGUN		SITE ENGINEER										
	DEPTH		BIT		PUMP			COMPLETED		FOREMAN										
	DIAMETER		GW LEVEL		ENGINE			DAYS REQUIRED		DRILLER										
DATE	ELEVATION	DEPTH	TRICK'S	LOG	TERMINO'Y	COLOR	R.Q.D				RECOVERY (%)			DRILL SPEED (h/m)			PERMEABILITY K in CGS/ LUDEON		DESCRIPTIONS	
							20	40	60	80	30	60	90	80	1	2	3	10 <sup>-5</sup>		10 <sup>-4</sup>
	30.0																			Sheared zone at Sections 22.00-24.00M and 34.35-35.85M. Presence of crush angular fragments of dacite.
	35.0				DACITE															Suspected fault at elevation 31.20-34.35M, very low percentage core recovery;
	37.0	21.3			BASALT															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 chloritized. Broken core at section 39.47-39.87M
	39.8																			
	40.0	2.87			DACITE															39.87-42.95M Dacite. Dark gray. Hard and massive. Fresh joint/ Fracture plane filled with calcite veinlets.
	42.95	3.08																		
	45.0				BASALT															41.90-42.95M Basalt Dark gray hard and massive Presence of quartz/calcite along cavities.
	48.0	5.05																		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 44.12-44.42M Core partially soft to friable at elev. 42.95-44.78M.
	50.0				DACITE															A brecciated zone at section 45.50-46.64M Presence of crush angular fragments with some powdery materials.
	55.0																			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.
	60.0																			

BOREHOLE LOG																				
PROJECT		ILOCOS NORTH IRRIGATION PROJECT						SITE		PALSIGUAN DAM										
MOLE NO.	DDH-2 (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	TERMINO'Y	COLOR	R.Q.D				RECOVERY (%)		DRILL SPEED (h/m)		PERMEABILITY K in CGS/ LUDEDON		DESCRIPTIONS			
							20	40	60	80	20	40	60	80	1	2		3	10 <sup>-5</sup>	10 <sup>-4</sup>
		60.15		^ ^ ^ ^ ^ ^	DACITE															Broken Core at sections 48.00-48.80m, 49.67-50.57 50.40-41.18m, 53.00-53.40 55.00-55.50m; 56.85-55.20 57.25-58.40m, 58.50-60.00 60.40-61.10m, 62.00-62.50 and 62.60-63.80m,
		65																		

BOREHOLE LOG																			
PROJECT		ILOCOS NORTE (IRRIGATION PROJECT)						SITE		FALSIGUAN DAN									
HOLE NO.	DATE	ELEVATION		ANGLE	VERTICAL	MACHINE		BEGUN	8/9/78	SITE ENGINEER									
		DEPTH		BIT		PUMP		COMPLETED	8/21/78	FOREMAN									
		DIAMETER		AQ, BQ	GW LEVEL	ENGINE		DAYS REQUIRED	23	DRILLER									
		THICK'S	LOG	TERMINO'Y	COLOR	MAX. CORE)			RECOVERY			DRILL SPEED			PERMEABILITY		DESCRIPTIONS		
						20	40	60	80	%			h/m			K in CGS/ LUDDON			
						10	20	30	40	20	40	60	80	1	2	3		10 <sup>-5</sup>	10 <sup>-4</sup>
																			0.00-1.00M-wash boring
				OVER BUDEN															1.00-1.45M-penetration test (8-17-26) Flows sandy clay.
																			1.45-14.5M-sludge recovery medium grain dark brown in color.
				MODERATELY WEATHERED BASALT															
				SLIGHTLY WEATHERED BASALT															
																			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 sample exhibits angular edges slightly weathered.



B O R E H O L E   L O G															
PROJECT										SITE					
ILOCOS NORTE IRRIGATION PROJECT										PALSIGUAN DAM					
HOLE NO.	ELEVATION		ANGLE		MACHINE		BEGUN		SITE ENGINEER						
	DDH-3 (2)														
	DEPTH		BIT		PUMP		COMPLETED		FOREMAN						
DIAMETER		GW LEVEL		ENGINE		DAYS REQUIRED		DRILLER							
DATE	ELEVATION	DEPTH	THICK'S	LOG	TERMINO'Y	COLOR	MAX. CORE NO. OF CORE	RECOVERY (%)	DRILL SPEED (h/m)	PERMEABILITY		DESCRIPTIONS			
							20 40 60 80	20 40 60 80	1 2 3	10 <sup>-5</sup>	10 <sup>-4</sup>				
	35	19.4			SLIGHTLY WEATHERED BASALT										
	35														
	40														
	45				BASALT										
	50														
	55														
	50														

35.90-47.05M-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 penetrat deeper solid cores recovered that joints noted to be dipping 45° to 65° light gray in color slightly weathered to fresh.

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.



BOREHOLE LOG																			
PROJECT		ILOCOS NORTE IRRIGATION PROJECT						SITE		PALSIGUAN DAM									
HOLE NO.	DATE	ELEVATION		ANGLE	VERTICAL	MACHINE		BEGUN	3/17/78	SITE ENGINEER									
		DEPTH		BIT		PUMP		COMPLETED	5/29/78	FOREMAN									
		DIAMETER		NQ, BQ	GW LEVEL	NO WATER	ENGINE		DAYS REQUIRED	74	DRILLER								
		THICK'S	LOG	TERMINO'Y	COLOR	R.O.D			RECOVERY (%)	DRILL SPEED (h/m)			PERMEABILITY K in CGS/ LUQUEM		DESCRIPTIONS				
						20	40	60	80	20	40	60	80	1		2	3	10 <sup>-5</sup>	10 <sup>-4</sup>
		0.0																	0.0-2.0M OVER BURDEN
		2.0	2.0	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															5.50-17.50M DACITE porphyritic hard and massive. Grayish in color. Fracture/joint plane rusty and calcitic
		5.50	2.7																
		10.0		SLIGHTLY WEATHERED DACITE															
		15.0																	
		17.50	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 48.30-49.80m, 52.00-66.10m 68.00-70.00m.
		20.0																	
		25.0																	
		30.0																	

BOREHOLE LOG																				
PROJECT ILOCOS NORTE IRRIGATION PROJECT										SITE PALSIGUAN DAM										
HOLE NO.	ELEVATION		ANGLE		MACHINE		BEGUN		SITE ENGINEER											
	DEPTH		BIT		PUMP		COMPLETED		FOREMAN											
	DIAMETER		GW LEVEL		ENGINE		DAYS REQUIRED		DRILLER											
DATE	ELEVATION	DEPTH	THICK'S	LOG	TERMINO'Y	COLOR	R.Q.D				RECOVERY (%)			DRILL SPEED (h/m)			PERMEABILITY K in CGS/ LUQUEM		DESCRIPTIONS	
							20	40	60	80	30	40	60	80	1	2	3	10 <sup>-5</sup>		10 <sup>-1</sup>
	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															
	45.0		^																	
	50.0		^																	
	55.0		^																	
	60.0		^																	

BOREHOLE LOG													
PROJECT										SITE			
ILOCOS NORTE IRRIGATION PROJECT										PALSICUAN DAN			
HOLE NO.	ELEVATION		ANGLE	MACHINE		BEGUN		SITE ENGINEER					
	DDH-4 (3)		DEPTH	BIT	PUMP		COMPLETED		FOREMAN				
	DIAMETER		GV LEVEL	ENGINE		DAYS REQUIRED		DRILLER					
DATE	ELEVATION	DEPTH	TRICK'S	LOG	TERMINO'Y	COLOR	R.Q.D.	RECOVERY (%)	DRILL SPEED (h/m)	PERMEABILITY K in CGS/ LUDEOM		DESCRIPTIONS	
							20 40 60 80	20 40 60 80	1 2 3	10 <sup>-5</sup>	10 <sup>-4</sup>		
	80.00	0.00											
	85.00	5.00											
	70.00	15.00			DACITE								At elev. 70.20m down to 70.60 meters a suspected fault noted presence of clayey fragments probably gauge?
	75.00	10.00											77.00- 83.00m Dacite hard and massive pyritic greenish in color fresh broken and fragmented At elev. 83.00-85.00m basaltic andesite rock noted. Hard an massive
	80.00	5.00											
	85.00	10.00											
	90.00	15.00											



BOREHOLE LOG																		
PROJECT										SITE								
ILOCOS NORTE IRRIGATION PROJECT										PALSIGUAN DAM								
HOLE NO.	ELEVATION		ANGLE	VERTICAL	MACHINE	BEGUN		SITE ENGINEER										
	DDH-5 (1)		40.0 M	BIT	PUMP	6/10/78												
	DEPTH		40.0 M	ENGINE	COMPLETED		6/20/78		FOREMAN									
DIAMETER		70, 80	GW LEVEL	34.0 M	DAYS REQUIRED		21		DRILLER									
DATE	ELEVATION	DEPTH	THICKNESS	L.O.D.	TERMINOLOGY	COLOR	NO. OF CORE				RECOVERY (%)		DRILL SPEED (h/m)			PERMEABILITY K in CGS/ LUDEM		DESCRIPTIONS
							20	40	60	80	20	40	60	80	1	2	3	
	0.0				TOP SOIL													0.8-1.00m: Pebbles, Cobbles of andesitic/basaltic rocks. Angular with slight iron stain noted along its surface. Slightly weathered
	0.8																	
	5.0				MODERATELY WEATHERED DACITE													4.00-5.10m: Sandy Formation Recovered as sludge, light gray fine to medium coarse grained. 5.10-9.00m: Pebbles, Cobbles of andesitic rocks. Fragments range from 2-3 cm in diameter. Subrounded to angular with slight iron staining along surfaces. 9.00-12.00m: Sandy Formation Recovered as sludge. Medium coarse grained. Brownish in color. 12.00-13.80m: Pebbles, Cobbles. Fragments ranges from 2-6cm in diameters. Angular. 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 rock. Fragments ranges from 2-4 cm in diameter. Subrounded 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, hard and massive. Grayish in color. Chloritized along surfaces. Fracture/joint plane filled with calcite ranges from 5mm to paper thin. Fracture joint plane calcitic with slight iron noted. Slightly weathered to fresh. Core broken and fragmented 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																	
	25.2				SLIGHTLY WEATHERED DACITE													
	30.0																	

BOREHOLE LOG																		
PROJECT		ILOCOS NORTE IRRIGATION PROJECT								SITE		PALSIGUAN DAM						
DATE	HOLE NO.	ELEVATION		ANGLE		MACHINE		BEGUN		SITE ENGINEER								
		DEPTH		BIT		PUMP		COMPLETED		FOREMAN								
		DIAMETER		GW LEVEL		ENGINE		DAYS REQUIRED		DRILLER								
ELEVATION	DEPTH	THICK'S	LOG	TERMINO'Y	COLOR	R.Q.D				RECOVERY (%)			DRILL SPEED (R/m)		PERMEABILITY K in CGS/ LUOEDM		DESCRIPTIONS	
						20	40	60	80	20	40	60	80	1	2	3		10
	30																	
	31	7.5																31.0-40:DACITE Hard and massive, Fresh. Core recovered in fair condition.
	35				DACITE													
	40																	



BOREHOLE LOG																				
PROJECT		ILOCOS NORTE IRRIGATION PROJECT.								SITE		PALSIGUAN DAM								
HOLE NO.	DATE	ELEVAT. M	DEPTH	THICK'S	L O O	TERMINO'Y	COLOR	MAX. CORE D			RECOVERY			DRILL SPEED			PERMEABILITY		DESCRIPTIONS	
								NO. OF CORE			NO. OF CORE			h/m			K in CGS/ LUQEDN			
								20	40	80	20	40	80	1	2	3	10 <sup>-3</sup>	10 <sup>-3</sup>		
DH-6 (1)			0.0			OVER BURDEN													1.00-1.20M-penetration test (11-28-22)	
			2.0	2.0		EXTREMELY WEATHERED BASALT													Clayey silt, whitish gray made up of pebble and cobble sizes of basaltic dacitic rock subrounded to rounded in shape notes when wet easily formed however when dry easily turn into grains	
			4.0	2.0		MODERATELY 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.	
			7.70	3.7															4.00-7.70M-Sludges recovery fine grain light gray to grayish in color	
			15.0			SLIGHTLY WEATHERED DACITE														7.70-23.40M-DACITE Cores samples recovered are subrounded to angular 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 prebably qtz. slightly weathered light gray to gray in color mostly pebble sizes. Noted iron stains on the joint surfaces.
			20.0	12.3		DACITE														
			23.0	3.4		BASALT														23.40-23.97m-BASALT Angular in shape fine grain and mostly pebble sizes Along joint planes noted iron stains and qtz. hard and gray in color
			25.0	0.5		DACITE														
			30.0																	

BOREHOLE LOG																			
PROJECT		ILOCOS NORTIC IRRIGATION PROJECT										SITE			PALISGUAN DAM				
DATE	HOLE NO.	ELEVATION		ANGLE		MACHINE			BEGUN		SITE ENGINEER								
		DEPTH		BIT		PUMP			COMPLETED		FOREMAN								
		DIAMETER		GW LEVEL		ENGINE			DAYS REQUIRED		DRILLER								
ELEVATION	DEPTH	THICK'S	LOG	TERMINO'Y	COLOR	MAX. CORE NO. OF CORE				RECOVERY (%)		DRILL SPEED (h/m)			PERMEABILITY K in CGS/ LUDEON		DESCRIPTIONS		
						10	20	30	40	20	40	60	80	1	2	3		10 <sup>-1</sup>	10 <sup>-3</sup>
	30																		
	31	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	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		>>>																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		>>>	BASALT															
	55		>>>																
	60		>>>																



BOREHOLE LOG																	
PROJECT										SITE							
HOCOS NORH IRRIGATION PROJCT										PALSIGUAN DAM							
DATE	HOLE NO.	ELEVATION		ANGLE	VERTICAL	MACHINE	BEGUN		SITE ENGINEER								
		DDH-7 (1)					5/20/78										
		DEPTH	100.0 M	BIT		PUMP	COMPLETED		FOREMAN								
		DIAMETER	NO. BQ	GW LEVEL	92.15 V	ENGINE	DAYS REQUIRED		DRILLER								
ELEVATION	DEPTH	THICKNESS	LOG	TERMINOLOGY	COLOR	MAX. CORE			RECOVERY (%)			DRILL SPEED (h/m)			PERMEABILITY K in CGS/ LUCEOM		DESCRIPTIONS
						20	40	80	20	40	80	1	2	3	10 <sup>-4</sup>	10 <sup>-5</sup>	
NO. OF CORE	18	20	30	40	20	40	80	20	40	80	1	2	3				
	0.0			OVER BURDEN													0.000-1.5m Overburden
	1.5	1.5															0.0-1.00m Recovered as sludge Brownish in color
	5.0			EXTREMELY WEATHERED DACITE													1.00-1.50m Clayey Silty Soil with rock fragments
	10.0	8.5															1.50-10.00m Pebbles, cobbles and scattered boulders with silty clayey fragments
	15.0																Partially soft and extremely weathered. Brownish in color.
	20.0			MODERATELY WEATHERED DACITE													10.00-16.00m Recovered as sludge Fine to medium coarse grained Brownish to grayish in color.
	25.0																10.00-23.35m Gravels, cobbles, pebbles with scattered boulders slightly weathered grayish in color
	30.0																23.35-26.40m Recovered as sludge coarse grained Grayish in color
	35.0																26.40-30.20m Gravels, cobbles of dacitic rocks

B O R E H O L E   L O G																				
PROJECT		TLOCOS NORTH IRRIGATION PROJECT										SITE								
DDH-7 (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				RECOVERY (%)				DRILL SPEED (h/m)			PERMEABILITY K in CGS/ LUDEON		DESCRIPTIONS
							20	40	60	80	20	40	60	80	1	2	3	10 <sup>-1</sup>	10 <sup>-3</sup>	
		30.00																		30.20-34.00m Recovered as sludge. Coarse grained. Grayish in color
		35.00	25.00		MODERATELY WEATHERED DACITE															35.00-100.00m Hard rock Dacite basaltic in some section porphyritic and partially amygdaloid pyritic, dark grayish in color Hard and massive, chloritised along surfaces. Fracture/joint plane filled with calcite ranges from 5mm to paper thin. Fracture/joint plane rusty and calcitic. Weathery varies from slightly weathered to fresh. Core recovered generally in fair condition. Broken and fragmented throughout the bottom of the hole
		40.00																		Core generally broken at sections 35.00-44.50m 40.00-57.00m:60.00-68.00m 68.00-68.40m:69.00-71.00m 71.00-71.40m:72.40-73.00m 73.00-74.00m:74.00-74.50m 80.00-81.50m:83.40-86.70m 86.75-87.55m:90.00-95.00m and 98.00-99.00 meters
		50.00			SLIGHTLY WEATHERED DACITE															
		55.00																		
		60.00																		

BOREHOLE LOG																		
PROJECT		ILOCOS NORTE IRRIGATION PROJECT								SITE								
DDH-7 (3)		ELEVATION	ANGLE	MACHINE	BEGUN	SITE ENGINEER												
		DEPTH	BIT	PUMP	COMPLETED	FOREMAN												
		DIAMETER	GW LEVEL	ENGINE	DAYS REQUIRED	DRILLER												
DATE	HOLE NO.	ELEVATION	DEPTH	THICK'S	L.O.O.	TERMINO'Y	COLOR	R.Q.D			RECOVERY (%)	DRILL SPEED (h/m)			PERMEABILITY K in COS/ LUJEDON		DESCRIPTIONS	
								20	40	60		80	30	60	90	1		2
		60.03																
		65.03				SLIGHTLY WEATHERED DACITE												
		70.03																
		74.03	39.0															
		75.03				DACITE												
		80.03																
		85.03																
		90.03																

BOREHOLE LOG																				
PROJECT										SITE		PALSIGUAN DAM								
HOLE NO.	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.				RECOVERY (%)		DRILL SPEED (ft/m)		PERMEABILITY K in CGS/ LUZEON		DESCRIPTIONS			
							20	40	60	80	20	40	60	80	1	2		3	10 <sup>-1</sup>	10 <sup>-3</sup>
	90																			
	95		^		DACITE															
	100		^																	





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

LINE A-A'

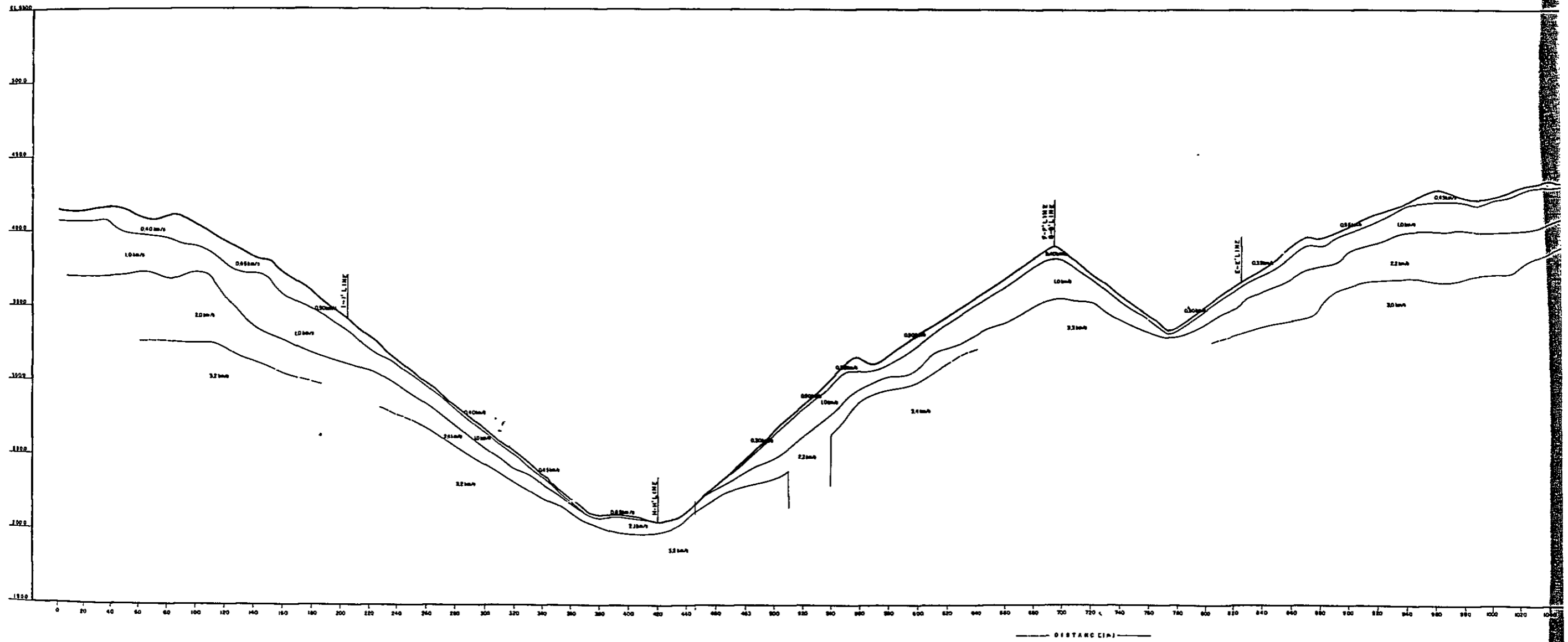
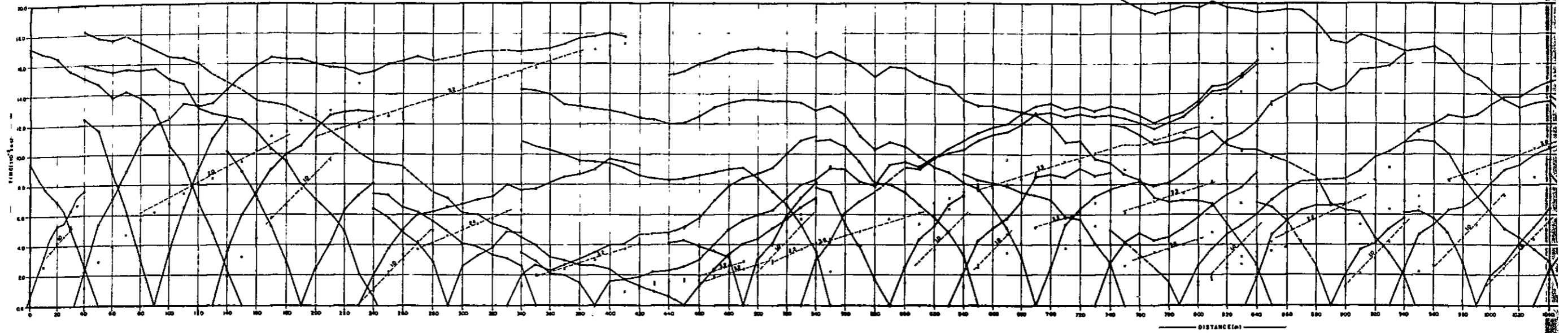
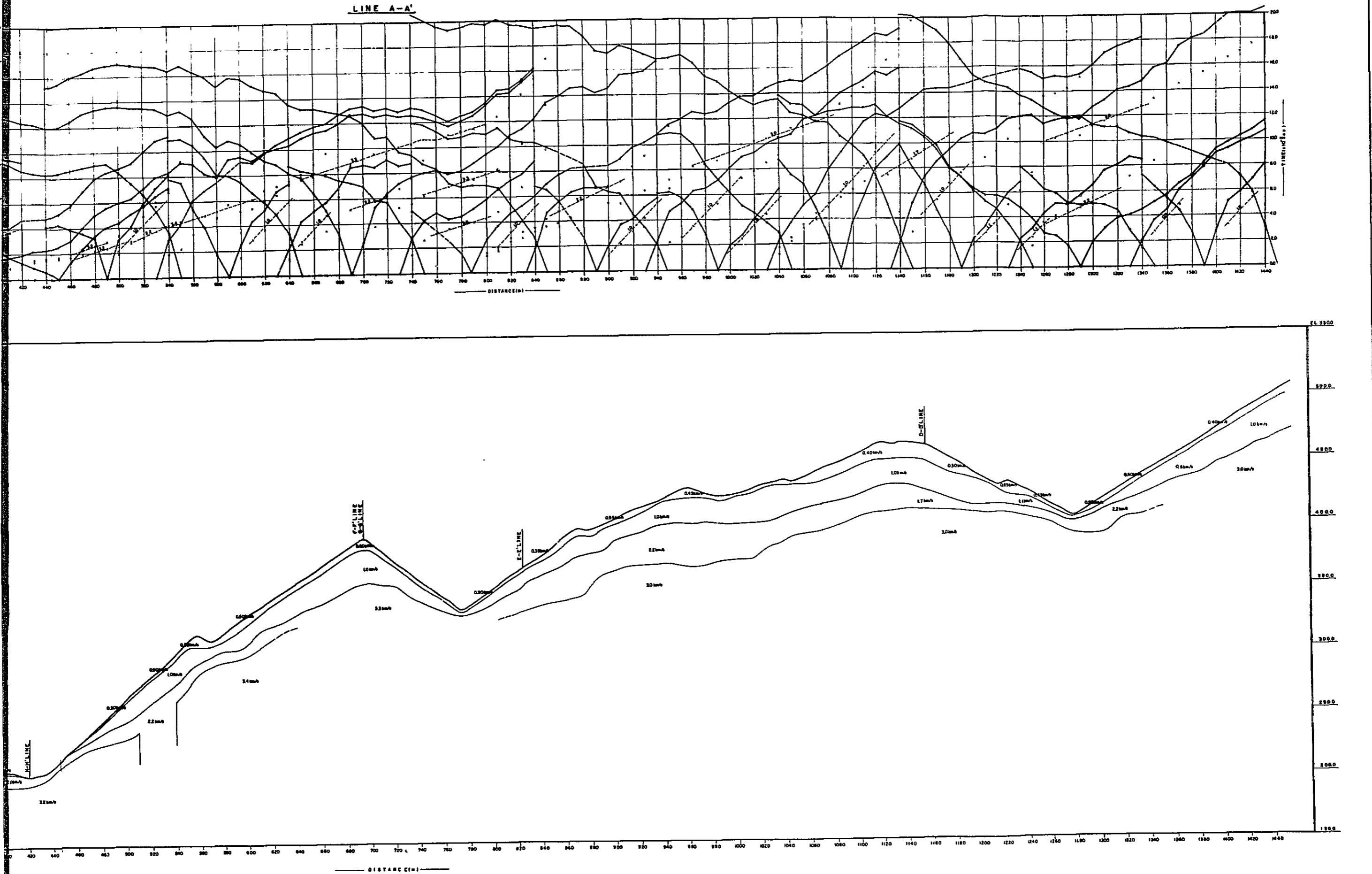
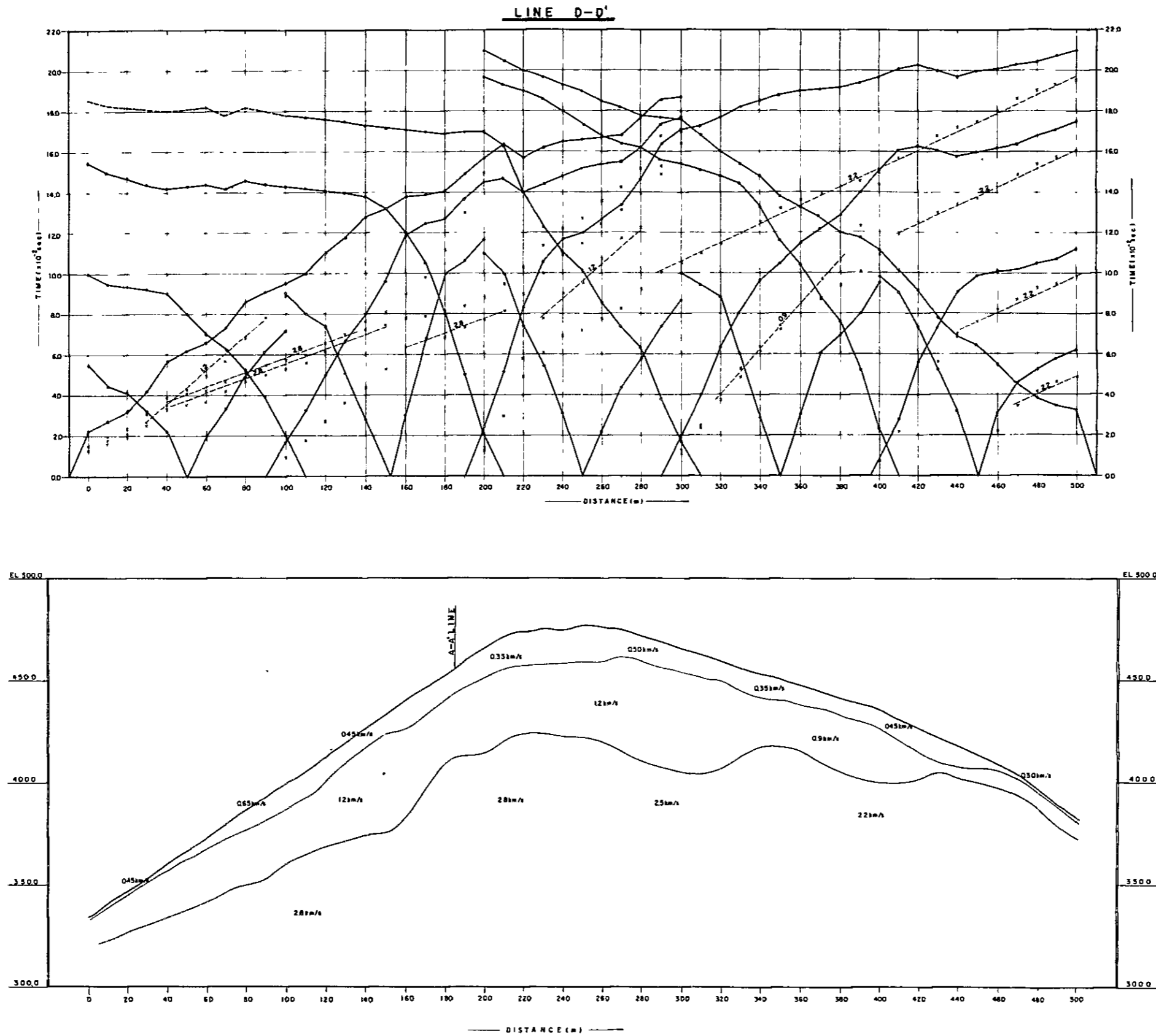


FIGURE 3B-9 TRAVEL TIME CURVE  
AND VELOCITY PROFILE  
(PALSIGUAN DAMSITE)



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



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

