GOVERNMENT OF THE REPUBLIC OF HONDURAS

MINISTRY OF NATURAL RESOURCES

FEASIBILITY STUDY

ON

THE AGRICULTURAL DEVELOPMENT

IN THE [illegible] RIVER BASIN

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GOVERNMENT OF THE REPUBLIC OF HONDURAS

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FEASIBILITY STUDY ON THE AGRICULTURAL DEVELOPMENT IN THE CHOLUTECA RIVER BASIN

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METEOROLOGY AND HYDROLOGY

A METEOROLOGY AND HYDROLOGY

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A1. GENERAL CLIMATIC CONDITIONS

Honduras is situated from 13°N to 16°N bordered by the Atlantic Ocean in the north and by the Pacific Ocean in the south. The climate of Honduras is dominated by a tropical low pressure when prevailing the trade wind and by the Bermuda high pressure (Anticyclones of Bermuda). Due to the mountainous topography, the climate in the southern Pacific coastal areas is different from that in the northern Atlantic coastal areas especially in the annual rainfall pattern.

The Choluteca river basin is located in the southern part of Honduras under the tropical and semitropical zones. Its climate is characterized by small annual temperature variations and distinct dry and wet seasons. The dry season lasts from November to April when the weather is governed by the Bermuda high pressure area. During the west season between May to October a tropical low pressure area covers the Choluteca river basin. For about one month from mid July to mid August, however, the Bermuda high pressure prevails and brings little rainfalls.

In the Choluteca river basin the annual mean precipitation ranges from 1,000 mm to 2,000 mm, and the vegetation falls into the category of tropical dry woodland from the elevation 0 to 650 m where the annual mean temperature is over 24°C and into the category of semi-tropical humid woodland from the elevation 650 m to 1,500 m where the annual mean temperature is under 24°C, according to the Informe Oficial Misión 105 a Honduras OEA by Dr. L. R. Holdridge. The area above the elevation 1,500 m, occupying only a small percentage of the Choluteca river basin, is governed by the temperate humid climate with dry season.

The monthly and annual mean temperatures and precipitations at Tegucigalpa representing highland of the Choluteca basin, at Choluteca representing lowland of the Choluteca basin, and at San Pedro Sula representing the northern coastal area facing to the Atlantic Ocean are shown in the following table.

	Tegucigalpa		Choluteca		San Pedro Sula	
	Temperature (°C)	Precipitation (mm)	Temperature (°C)	Precipitation (mm)	Temperature (°C)	Precipitation (mm)
Jan.	18.7	10	28.9	1	23.1	71
Feb.	19.7	5	29.2	2	24.0	50
Mar.	20.9	8	30.6	13	26.0	53
Apr.	22.3	31	30.2	49	27.3	49
May	22.8	151	29.7	270	27.9	86
Jun.	22.4	158	27.9	364	27.9	158
Jul.	22.0	85	28.7	192	27.0	158
Aug.	22.2	89	28.5	239	27.2	115
Sep.	22.2	184	27.7	413	27.4	173
Oct.	21.1	138	27.6	350	25.8	174
Nov.	19.7	38	27.7	53	24.5	147
Dec.	18.8	12	28.7	5	23.2	121
Annual	21.1	909	28.8	1,951	25.9	1,355
Altitude	El.1007 m		El.48 m		El.76 m	

A2. METEOROLOGY

A2.1 Data Availability

The meteorological and pluviometric stations in and around the Choluteca basin are given in Table-A1 and the precipitation data available are shown in Fig.-A1. Most of the stations are operated under the control of the Servicios Hidrologicos y Climatologicos of the Ministry of Natural Resources and the Servicio Meteorologico Nacional of the Ministry of Transport, Communications and Public Works. The location of such stations is shown in Fig.-A2.

Meteorological stations are generally well equipped, e.g., the La Venta station is equipped with maximum and minimum thermometer, automatic temperature recorder, hygrometer, standard A-pan evaporation measurement apparatus, wind direction and wind speed meter, and rainfall gauge with automatic recorder. The current network of meteorological and pluviometric stations is considered to be dense enough to assess the meteorological condition of the Choluteca river basin.

A2.2 Temperature

Temperatures are almost constant throughout the year under the tropical or semi-tropical climate. The difference between highest monthly mean temperature and the lowest one is only 3 to 4°C. On the other hand, the daily temperature variation ranges 8 to 12°C.

The annual mean temperature depends on the altitude, and the temperature changes at the rate of 0.6 to 0.7°C per each 100 meters difference in altitude.

Monthly averages of daily mean, maximum and minimum temperatures at Tegucigalpa, La Venta, Paso La Ceiba and Choluteca Stations are shown in Table-A2.

A2.3 Relative Humidity

Annual mean relative humidity is 72% at Tegucigalpa and 65% at Choluteca. The lowest monthly values are 61% at Tegucigalpa in April and 50% at Choluteca in February. The highest values are 79% at Tegucigalpa in October and 81% at Choluteca in September.

The monthly mean relative humidities at Tegucigalpa, La Venta, Paso La Ceiba and Choluteca Stations are given in Table-A3.

A2.4 Direction and Velocity of Wind

The prevailing wind direction at Tegucigalpa is north in the dry season and north-east in the rainy season. The annual averaged daily maximum wind velocity is 15.7 km/hour ranging from 13.1 km/hour in September to 18.2 km/hour in January. The maximum recorded wind velocity during the years 1971 and 1972 is 103.0 km/hour. Wind data at Tegucigalpa is considered representative for the northern part of the Choluteca river basin.

At Choluteca, on the other hand, the prevailing wind direction is north to north-east in the dry season and east to south in the rainy season. The monthly averages of the daily maximum wind velocity varies from 9.9 km/hour in September to 20.5 km/hour in January, resulting in 14.5 km/hour in terms of annual average. The maximum wind velocity of 65 km/hour was recorded during the years of 1963 to 1965. The Choluteca wind data is considered representative for the southern part of the Choluteca river basin.

Wind data at Tegucigalpa and Choluteca Stations are given in Table-A4.

A2.5 Evaporation

Evaporation data were collected at Tegucigalpa, La Venta, Paso La Ceiba, Los Encuentros and Choluteca Stations. The monthly mean evaporations at these stations are given in Table-A5.

The high evaporations of 2,700 mm to 2,900 mm have been observed at Choluteca and Los Encuentros Stations due to high temperatures especially during the months of the dry season and to the low relative humidity during such dry months. On the other hand, the annual mean evaporations at Tegucigalpa, La Venta and Paso La Ceiba Stations located at higher altitudes are considerably lower ranging from 1,500 mm to 1,650 mm.

As for the annual variation of monthly evaporations, the maximum evaporation is observed in April or May and the minimum one is in October or November.

A2.6 Precipitations

Averaged annual precipitations in the Choluteca river basin are about 1,000 mm in the upstream basin, about 700 mm in the middle-stream basin and about 1,900 mm in the downstream basin, averaging in the annual basin precipitation of 1,013 mm.

More than 80% of the annual precipitation is concentrated in the rainy season from May to October, though a relatively dry period from mid July to mid August is included. Generally the most rainy month is June or September. Little rainfall occurs during the dry season especially in the lower Choluteca basin, where the precipitations during four months from December to March are 0 mm to 20 mm, accounting for only 0.4% of the annual precipitation.

Monthly and annual precipitation data are presented in the Table-A6.

A3. HYDROLOGY

A3.1 Runoff Analysis

A3.1.1 Data Availability

Runoff data in the main stem and tributaries of the Choluteca river are available at 12 stations shown in Table-A7 and Fig.-A3 and the duration of stream flow observation at each station is shown in Fig.-A4.

A3.1.2 Method of Runoff Measurement

Water levels are measured either by an automatic water level recorder or by a staff reading. In case of staff reading, water levels are measured three times a day, i.e. 6 a.m., 12 noon and 6 p.m. When a flood comes, water levels are measured every two hours from 6 a.m. to 6 p.m. This standard method of water level measurement would result in a smaller runoff than actual, because a typical rainfall during the rainy season begins in the afternoon and stops in mid night and therefore a water level at mid night if measured might be the largest.

Direct runoff measurement is made once a day at 6 a.m. if the water level is different from that of the previous day. The direct measurement data are statistically handled to establish a rating curve at each station. The established rating curve is reviewed at monthly intervals and maintained effective at all times.

A3.1.3 Approach to Runoff Analysis

The proposed San Fernando Damsite with the drainage area of 1,665 km^2 is located at about 2.5 kilometers downstream from the Hernando Lopez Station covering the drainage area of 1,565 km^2. On the other hand, the alternative Morolica Damsite with the drainage area of 6,187 km^2 is located at about 12 km upstream of the Los Encuentros Station covering the drainage area of 6,370 km^2.

Since the data reliability is considered comparatively high and also the duration of data availability is long at these stations, the runoff analysis is forcussed to complete the monthly discharges by estimating monthly discharges during the data missing periods at these two stations.

Monthly discharges at San Fernando Damsite could be estimated from the discharges at Hernando Lopez, and those at Morolica alternative damsite could be estimated from the discharges at Los Encuentros.

A3.1.4 Monthly Discharges at Hernando Lopez Station

Runoff data at Hernando Lopez Station are available since mid 1954 to date with interruptions from January 1960 to December 1963 and from October 1972 to April 1973.

The station was equipped with a Stevens water-level recorder until late 1972. Since then the water level measurements have been made by staff gauge readings. A gauge shelter was on the left bank of the river just upstream side of the road bridge on Juticalpa Road. Staff gauges are installed near the gauge shelter. The range of measurement is about 10 meters above the river bed.

It is to be noted that the station was submerged when extraordinary floods occurred, making it impossible to observe water levels in such periods. This may probably be the reason why the water level data were frequently missing during flood peak time in the past. It is, therefore, recommended to reconstruct a runoff gauge station equipped with a water level recorder at higher levels near the existing station.

In order to complete monthly discharge data since 1954 to date, discharges during the period when data are not available were estimated on monthly basis by means of a Tank Model Method. The results of the runoff simulation by the Tank Model Method are graphically shown in Fig.-A5. The monthly discharges completed from 1954 to date are shown in Table-A8.

The monthly discharges at San Fernando damsite are estimated by multiplying those at Hernando Lopez by the drainage area ratio of 1.064. The results are shown in Table-A9.

A3.1.5 Monthly Discharges at Los Encuentros

Runoff measurement at Los Encuentros station started in late 1956 and terminated in October 1973, with the interruption from January 1960

to June 1964. Since the station is important for water resources development planning in the lower Choluteca basin, it is recommended to re-establish the Los Encuentros station on soonest possible date.

Monthly discharges during the period when the runoff data are not available were estimated also by the Tank Model Method. Results of the runoff simulation are shown in Fig.-A6. Monthly discharges thus completed since 1956 to date are shown in Table-A10. The discharge volumes in Table-A10 include, in addition to the observed runoff, discharge volumes consumed for the irrigation of the San Juan de Flores area since 20 years ago when an intake weir was constructed on the Choluteca river near the village of San Juan de Flores. The monthly volumes taken at the intake weir are estimated as follows.

(Unit: 10^6 m^3)

J	F	M	A	M	J	J	A	S	O	N	D	Annual
0.7	0.5	0.8	1.1	0.4	0.2	0.2	0	0	0.1	0.6	0.8	5.4

Monthly discharges at Morolica alternative damsite are calculated from the Los Encuentros discharges according to the drainage area ratio of 0.971. The estimated monthly discharges are shown in Table-A11 since 1956 to date.

A3.1.6 Monthly Discharges at El Papalon Intake Weir Site

The drainage area of the Choluteca river at El Papalon intake weir site is 7,115 km^2 as shown below.

	Drainage Area
At Los Encuentros Station	6,370 km^2
At Poza Grande Station	353 km^2
Remaining Drainage Area	392 km^2
Drainage Area at El Papalon	7,115 km^2

Monthly discharges at El Papalon are estimated as a sum of the discharges at Los Encuentros, at Poza Grande and 1.1 times of Poza Grande discharge under the assumption that the specific discharge of the remaining

drainage area be the same as that of the Poza Grande drainage area, as far as the Poza Grande discharge data are available. The runoff data available at Poza Grande are shown in Table-A12. In case no data are available at Poza Grande, the discharges are estimated based on the Los Encuentros discharges and the drainage area ratio. Monthly discharge volumes at El Papalon are shown in Table-A13.

A3.1.7 Monthly Discharges at San Juan de Flores Irrigation Intake Site

Near the village of San Juan de Flores, there exists an intake weir for irrigation, constructed on the Choluteca river about 20 years ago. The San Juan de Flores area is scheduled to be developed mainly for the cultivation of sugar cane under irrigated farming. The drainage area of the Choluteca river at the intake weir site is 1,820 km^2. The nearest runoff measurement station is Paso La Ceiba Station with the drainage area of 1,743 km^2.

The observed runoff data at Paso La Ceiba are shown in Table-A14. These data, however, are not considered reliable because the ratio of monthly discharges at Paso La Ceiba to those at Hernando Lopez varies widely as shown in Table-A15, though the drainage areas of the two stations are almost the same.

Therefore, monthly discharges at San Juan de Flores intake weir site are estimated from those at Hernando Lopez by the drainage area ratio. The estimated monthly discharge volumes at San Juan de Flores site are shown in Table-A16.

A3.2 Assessment of Water Resources of the Choluteca River Basin

A3.2.1 Precipitations

Averaged annual precipitations are around 1,000 mm in the upstream basin, about 800 mm in the middle stream basin and about 1,900 mm in the downstream basin, averaging to be 1,013 mm for the whole of the Choluteca river basin of 7,580 km^2.

Rainfalls concentrates in the rainy season of about 5 months, from early May to mid July and from mid August to end October. In the dry season there is little rainfall, especially in the lower Choluteca basin.

A3.2.2 Runoff

Following the characteristics of the rainfall pattern, the discharge volume of the Choluteca river also concentrates in the rainy season. About 80 % of the annual discharge volume occurs during 5 months from June to October. The averaged annual discharge volumes are 399 million cubic meters at Hernando Lopez station, 1,251 million cubic meters at Los Encuentros station, and 1,948 million cubic meters for the whole of the Choluteca basin.

The runoff coefficient is calculated to be around 23 % to 25 %, which is considerably lower than the runoff coefficient of 44.3 % estimated for the neighbouring Nacaome basin.

The surface water hydrology of the Choluteca basin may be summarized in the following table. That of the Nacaome basin is also shown for reference.

	Choluteca basin			Nacaome basin
	H. Lopez	Los Encuentros	Whole basin	
Drainage area (km^2)	1,565	6,370	7,580	2,577
Annual average rainfall (mm)	1,033	851	1,013	1,686
Annual average				
discharge volume (MCM)	399	1,251	1,948	1,925
discharge (m^3/s)	12.6	39.6	61.7	61.0
Runoff coefficient (%)	24.7	23.1	25.4	44.3
Specific discharge per 100 km^2 (m^3/s)	0.81	0.62	0.81	2.37

A3.3 Probable Maximum Flood

A3.3.1 Probable Maximum Precipitation

A3.3.1.1 General Procedures

The probable maximum precipitation is derived from the following three steps:

(i) Selection of a heavy storm passed in or near the Choluteca basin in the past,

(ii) Depth-Area-Duration analysis (DAD analysis) of the selected heavy storm,

(iii) Transposition of the storm to the Choluteca basin with an adjustment on account of the difference of dew point temperatures.

A3.3.1.2 Selection of Heavy Storm

Of the heavy storms passed in the territory of Honduras, Hurricane "Fifi" is selected, because:

(i) "Fifi" is one of the largest hurricanes passed in Honduras in the past,

(ii) Precipitation data at the time of the "Fifi" are available to the extent that enables satisfactory DAD analysis.

The precipitation data presented in the Report entitled "ANALISIS PRELIMINAR DE LA PRECIPITACION PRODUCIDA POR EL HURACAN "FIFI" A SU PASO POR HONDURAS (Septiembre 16-20 de 1974)" published by SERVICIO METEOROLOGICO NACIONAL, are used in the present study.

A3.3.1.3 DAD Analysis

At the time of Hurricane "Fifi", the precipitation was heaviest near La Ceiba station of the northern part of Honduras. One-day precipitation exceeded 400 mm in the center of the storm. Isohyet curves are prepared for 1-day, 2-day and 3-day duration and these are shown in Fig.-A7. Table-A17 is prepared based on Fig.-A7.

Also isohyet curves are prepared for every 6-hour duration and Table-A18 summarizes the result of the DAD analysis.

Maximum depth-area-duration curves of the Hurricane "Fifi" are drawn as shown in Fig.-A8.

A3.3.1.4 Adjustment Factor

A dew point temperature can be calculated from atmospheric temperature and relative humidity data by the following equation developed by J. F. Bosen.

$$Td = T - \left\{(14.55 + 0.114T)X + \left[(2.5 + 0.007T)X\right]^3 + (15.9 + 0.117T)X^{14}\right\}$$

where, Td: Dew point temperature (^{o}C)

T : Atmospheric temperature (^{o}C)

X : 1-H/100, H: Relative humidity (%)

The storm center of the Hurricane "Fifi" was near La Ceiba station. Relative humidty data during "Fifi" are not available at La Ceiba station. Therefore averaged sea level dew point temperature at the station in September is used, which is 22.2^{o}C.

In case the probable maximum precipitation occurs in the Choluteca basin, data at Tegucigolpa station is considered to represent the drainage area of the San Fernando damsite and the average of the data at Tegucigalpa and Choluteca stations is considered to represent the drainage area of the Morolica alternative damsite. The maximum sea level dew point temperatures are 26.4^{o}C and 25.5^{o}C for the drainage areas of the San Fernando damsite and Morolica alternative damsite, respectively.

By use of Fig.-A9, which is quoted from FIGURE 2-17 in Page 37 of WEATHER AND HYDROLOGY, the following table is prepared.

	La Ceiba	San Fernando damsite	Morolica damsite
Sea level dew point temperature	22.2°C	26.4°C	25.5°C
Inflow barrier	0 m	1,122 m	1,122 m
Wp (1,000 mb to 200 mb)	63.5 mm	91.44 mm	84.58 mm
Wp (1,000 mb to Inf. barrier)	0 mm	25.40 mm	23.37 mm
Wp (Inf. barrier to 200 mb)	63.5 mm	66.04 mm	61.21 mm
Adjustment Factor	1.00	1.04	0.96

A3.3.1.5 Probable Maximum Precipitation

The probable maximum precipitations at each of the damsites can be calculated from DAD curves shown in Fig.-A8 and the adjustment factor determined in A3.3.1.4. The results are summarized below.

Precipitation in mm

Damsite	Duration in hours 6 hrs.	12 hrs.	18 hrs.	24 hrs.	48 hrs.	72 hrs.
San Fernando Drainage area 1,665 km^2	106	179	221	255	372	398
Adjustment (x 1.04)	110	186	230	265	387	414
Morolica Drainage area 6,187 km^2	62	110	146	177	262	296
Adjustment (x 0.96)	60	106	141	171	253	285

A3.3.2 Unit Hydrograph

A3.3.2.1 General

A unit hydrograph should be determined to compute probable maximum flood from the probable maximum precipitation.

A unit hydrograph occurring from a unit effective rainfall can be determined by two factors, Tp and Tk, if the following equation is applied.

$$Qp = \frac{0.2778\ ARo}{0.3Tp + Tk}$$

where, Qp: Peak discharge in m^3/s
A : Basin area in km^2
Ro: Unit effective rainfall in mm
Tp: Time to peak in hours
Tk: Time of recession in hours

A unit hydrograph or the values of Tp and Tk, must be determined by a trial and error method so that calculated flood hydrographs may conform to the observed ones to the maximum extent.

Data specifically collected for a unit hydrograph study are shown in Table-A19.

A3.3.2.2 Unit Hydrograph at Hernando Lopez

The following four flocds are selected to determine a unit hydrograph.

Flood No.	Date of Flood Peak	Peak Flood Discharge (m^3/s)	Runoff Coefficient (%)	Base Flow (m^3/s)
1	May 31, 1968	543	20.6	61
2	Sep. 30, 1969	562	29.7	46
3	Sep. 29, 1970	648	47.1	80
4	Oct. 21, 1971	564	27.1	52

Basin rainfalls are calculated from the following 6 station data by the Thiessen method.

Station	Thiessen Coefficient
Tegucigalpa	0.384
Zambrano	0.300
La Venta	0.123
Paso La Ceiba	0.022
Maraita	0.022
Ojojona	0.149

Hourly rainfall data corresponding to the selected floods are used as far as available, but when hourly data are not available 6-hr rainfall data at Tegucigalpa is assumed to represent the rainfall pattern of the other stations. Under such assumption as stated above, basin rainfalls are prepared at every 6 hour duration for the selected floods. Rainfalls at 6 hour duration are not sufficient to simulate a flood hydrograph at Hernando Lopez where the drainage area is 1,565 km^2. To find 2 hour rainfall, the available hourly rainfall data were studied and the study concluded that about 75 % of the 6-hr rainfall could be concentrated within 2-hr duration as shown in Fig.-A10.

Two kinds of rainfall loss are considered to determine effective rainfall. These are an initial loss in mm, and infiltration and evapotranspiration loss in mm/6 hours. These two loss values have been determined so that a calculated flood volume may equal to the observed flood volume and also that a calculated flood hydrograph may conform to the observed ones.

Calculated flood hydrographs are shown in Figs-A11(1) to A11(4) with observed ones for comparison purpose. The Tp and Tk values of unit hydrograph are determined to be 9.0 hours and 6.0 hours, respectively.

Basin rainfalls and effective rainfalls corresponding to the selected floods are shown in Table-A20.

A3.3.2.3 Unit Hydrograph at Los Encuentros

The following two floods are selected to determine a unit hydrograph at Los Encuentros station.

Flood No.	Date of Flood Peak	Peak Flood Discharge (m^3/s)	Runoff Coefficient (%)	Base Flow (m^3/s)
1	Sep. 30, 1969	578	36.5	134
2	Sep. 29, 1970	654	59.2	202

Basin rainfalls are calculated by Thiessen method from the following 9 station data.

Station	Thiessen Coefficient
Tegucigalpa	0.141
Zambrano	0.071
La Venta	0.054
Paso La Ceiba	0.124
Maraita	0.124
Yuscaran	0.140
Oropoli	0.195
Texiguat	0.106
Los Encuentros	0.045

To prepare 6-hour basin rainfall, rainfalls at Texiguat and Los Encuentros are assumed to be represented by the Choluteca rainfall pattern, and those at the other stations are assumed to be represented by the Tegucigalpa rainfall pattern insofar as the hourly rainfall data are not available.

Because of the large drainage area of 6,370 km^2 at Los Encuentros station, 2-hour rainfalls are not considered necessary.

The same procedures are used as in the determination of a unit hydrograph at Hernando Lopez station, and, as the result, a unit hydrograph with Tp = 15 hours and Tk = 24 hours is determined for Los Encuentros station.

The basin rainfalls and the effective rainfalls are shown in Table-A21. Computed flood hydrographs are compared with observed ones in Fig.-A12(1) and (2).

A3.3.2.4 Unit Hydrographs at Proposed Damsites

Based on the comparison of drainage areas at the proposed damsites and at the two gauging stations where unit hydrographs have been determined, unit hydrographs or the Tp and Tk values at San Fernando and Morolica damsites are determined as follows.

	Drainage Area (km^2)	Tp (hrs)	Tk (hrs)
Runoff measurement station			
Hernando Lopez	1,565	9.0	6.0
Los Encuentros	6,370	15.0	24.0
Proposed damsite			
San Fernando	1,665	9.0	6.5
Morolica	6,187	14.5	22.0

A3.3.3 Probable Maximum Flood

A3.3.3.1 Rainfall Loss

The initial losses and the infiltration and evapotranspiration losses of rainfall for the studied six floods are averaged to be 4 mm and 10 mm/6 hrs, respectively.

For the calculation of probable maximum flood, initial loss is not taken into account because initial loss does not affect much a flood hydrograph occurring from such an enormous rainfall as the probable maximum rainfall. The infiltration and evapotranspiration loss of 10 mm/6 hrs is considered in the estimation of a probable maximum flood.

A3.3.3.2 Rainfall Pattern

The probable maximum 24-hour basin rainfall at the proposed damsites has been distributed for every 6-hour duration by the DAD analysis as stated in A3.3.1.5. The second largest 24-hour basin rainfall is also

distributed in 6-hour duration based on the actual rainfall pattern of the Hurricane "Fifi". The rainfall in the third day is not taken into account because it hardly affects a peak discharge and a volume of floods.

Basin rainfalls and effective rainfalls for every 6-hour duration are prepared as follows, so as to produce a largest peak discharge of flood.

PROBABLE MAXIMUM PRECIPITATION (mm)

Damsite	Time Duration (Hours)							
	0-6	6-12	12-18	18-24	24-30	30-36	36-42	42-48
(Precipitation)								
San Fernando	11.6	14.8	59.0	36.6	44.0	110.0	76.0	35.0
Morolica	7.8	9.9	39.7	24.6	35.0	60.0	46.0	30.0
(Effective Precipitation)								
San Fernando	1.6	4.8	49.0	26.6	34.0	100.0	66.0	25.0
Morolica	-	-	29.7	14.6	25.0	50.0	36.0	20.0

A3.3.3.3 Base Flow

For San Fernando damsite, a base flow of 60 m^3/s is considered, which is an average base flow of the studied four floods at Hernando Lopez station. A base flow for Morolica damsite is assumed to be 168 m^3/s, which is an average of the base flows studied at Los Encuentros station.

A3.3.3.4 Probable Maximum Flood

The effective probable maximum precipitations are converted to a probable maximum flood through the determined unit hydrograph, as summarized below.

Damsite	Peak Flood Discharges (m^3/s)	Flood Volume (MCM)	Specific Discharge ($m^3/s/km^2$)
San Fernando	5,280	511	3.17
Morolica	6,390	1,035	1.02

The probable maximum flood is shown in Fig.-A13 for both San Fernando and Morolica damsites.

A 3.4 Probable Flood Study

A3.4.1 Observed Peak Flood Discharges

Flood discharge data are available at Hernando Lopez station for 18 years from 1954 to 1959 and from 1964 to 1975, and at Los Encuentros station for 12 years from 1958 to 1959 and from 1964 to 1973. The annual maximum peak flood discharges are shown in Table-A22. The maximum recorded flood discharges are 962 m^3/s and 1,227 m^3/s at San Fernando and Moralica damsites, respectively.

These flood data, however, are not utilized for the estimation of probable floods because of the following reasons.

(i) Except for the water level measurement by an automatic recorder, water levels and consequently discharges have been measured only during the daytime from 6 a.m. to 6 p.m.

(ii) Water level measurements were often suspended during an extraordinary flood time maybe due to a difficult access to a gauging site. As a typical example, no water level measurement was effectuated at the runoff measurement stations in the Choluteca basin during the Hurricane "Fifi" extraordinary flood time except a temporary gauge at the Choluteca bridge site near Choluteca city. According to the "ANALISIS DE LAS CONDICIONES CLIMATICAS Y DE LOS RECURSOS HIDRAULICOS" prepared in July 1975 by PROGRAMA DE CATASTRO NACIONAL, a peak flood discharge and a flood volume during 5 days from 18 to 22 of September 1974 are estimated to be 3,969 m^3/s and 464 million cubic meters, respectively, at the Choluteca bridge site with the drainage area of 6,964 km^2.

On the other hand, rainfall data are available for sufficient length of time and are considered more reliable. Therefore, probable floods are estimated from a probable rainfall study.

A3.4.2 Rainfall Probability Study

A3.4.2.1 General

Since the unit hydrographs are determined for the proposed damsite, probable floods can be computed if probable basin rainfalls are determined.

Nine years of reliable basin rainfall can be prepared by the Thiessen method from the rainfall data at several stations in the Choluteca basin. Since point rainfall data at Tegucigalpa station are available for as long as 38 years, the correlation between basin rainfalls and rainfalls at Tegucigalpa has been studied to expand 9 years of basin rainfalls. The correlation, however, is not satisfactory.

A3.4.2.2 Probable Basin Rainfall

Probable basin rainfall is estimated based on 9 years of data. The annual maximum 1-day and 2-day basin rainfalls are shown in Table-A23, for both San Fernando and Morolica damsites. The annual maximum 1-day and 2-day point rainfalls at Tegucigalpa station are also shown in the same table for reference.

The annual maximum basin rainfalls are plotted on a log-normal sheet as shown in Fig.-A14, and probable basin rainfalls are estimated as shown in Table-A24.

A3.4.2.3 Rainfall Pattern and Rainfall Loss

Based on the rainfall patterns causing the floods studied for the estimation of a unit hydrograph, a typical basin rainfall distribution is estimated as follows.

Time duration (Hours)	Percent of daily rainfall (%)
18 - 24	57.6
0 - 6	34.1
6 - 12	7.1
12 - 18	1.2

Rainfall loss is assumed to be 10 mm/6 hrs for an infiltration and evapotranspiration loss for both San Fernando and Morolica damsites, and for initial loss to be 10 mm and 5 mm for San Fernando and Moralica damsites, respectively.

A3.4.2.4 Probable Floods

Probable floods are computed from probable effective basin rainfalls by means of the unit hydrograph method. The probable effective basin rainfalls are shown in Table-A25 and A26, and the computed probable floods are shown below.

Return Period (Year)	San Fernando damsite		Morolica damsite	
	Peak flow (m^3/s)	Volume (MCM)	Peak flow (m^3/s)	Volume (MCM)
2	342	21	408	29
5	644	45	917	114
10	845	60	1.286	169
20	1.035	77	1.611	227
50	1.287	99	2.062	314
100	1.488	115	2.394	373
200	1.662	132	2.723	432
1.000	2.121	168	3.475	573

Probable flood hydrographs for San Fernando damsite and Morolica damsite are shown in Fig.-A15 and Fig.-A16, respectively.

A3.5 Reservoir Evaporation

A3.5.1 Evaporation from San Fernando Reservoir

Of the several meteoroligical stations where evaporation data are available, data at La Venta station are selected for the estimation of evaporation from San Fernando reservoir, because the station is located close to the reservoir area.

Monthly reservoir evaporation is estimated by multiplying a conversion factor of 0.7 to the Standard A-pan evaporation data at La Venta station. The estimated averaged monthly reservoir evaporations are shown in Table A-27.

A3.5.2 Evaporation from Morolica Reservoir

Near the Morolica reservoir area, there are no meteorological stations. The Morolica reservoir evaporation is estimated from evaporation data at Tegucigalpa, La Venta, Paso La Ceiba, Los Encuentros and Choluteca stations.

The mean annual evaporations at the abovementioned 5 stations are as follows.

Station	Mean Annual Evaporation	Altitude
Tegucigalpa	1,515 mm	E/. 960 m
La Venta	1,523 mm	E/. 890 m
Paso La Ceiba	1,597 mm	E/. 630 m
Los Encuentros	2,892 mm	E/. 100 m
Choluteca	2,656 mm	E/. 48 m

The annual evaporations of the first three stations are almost the same, but differ greatly from those at the remaining two stations. The difference is considered as the result of the difference in altitude which generally causes a difference in temperature.

Therefore, the evaporation at Morolica damsite, which is located at the elevation of about 240 meters, is estimated by calculating the weighted average of the evaporation data at the first three stations and those at the remaining two stations by altitudes. The procedure and the results of reservoir evaporation estimate are shown in Table-A28.

A3.6 Sediment Problem

No sediment data are available in the Choluteca river basin except IECO's measurement for a limited time in 1967. Since the data on sediment loads are indispensable for a proper planning and design of dam and reservoir schemes, it is recommended to commence sediment load measurement at both Hernando Lopez and Los Encuentros stations.

There are no reliable sediment data on any major river system in Honduras. No dam and reservoir projects of a considerable size have yet been realized. However, feasibility studies for several dam and reservoir projects have been conducted, in which sediment loads are estimated mostly based on direct sediment measurement for a limited time. Sediment loads estimated in the past feasibility studies are shown in Table-A29.

Table-A29 indicates that the IECO's estimate is the largest of all. Therefore the sediment volume estimated by IECO is taken for the present study. The annual sediment volume is thus estimated to be 1,100,000 m^3 at San Fernando damsite. The annual sediment volume at Morolica damsite is calculated to be 3,200,000 m^3, as a sediment volume is considered proportional to the annual runoff volume.

Since an effective life of a dam and reservoir is set at 50 years, the sediment volumes during the life are 55 million cubic meters and 160 million cubic meters for San Fernando and Morolica damsites, respectively.

A3.7 Tailwater Level

No rating curve is available in San Fernando damsite or in Morolica damsite.

A tailwater level at San Fernando damsite is assumed to be the same as estimated by TECO and a tailwater level at Morolica damsite is assumed based on river flow calculation and a rating curve at Los Encuentros station.

The assumed tailwater curves for San Fernando and Morolica damsites are shown in Fig.-A17 and Fig.-A18, respectively.

These assumptions are considered to be satisfactory in the feasibility study level, but in the next stage of detailed engineering, the tailwater curves should be confirmed by the direct runoff measurement.

TABLE-A1: METEOROLOGICAL AND PLUVIOMETRIC STATIONS IN AND AROUND THE CHOLUTECA BASIN

Station	Latitude North	Longitude West	Altitude m a.s.l.
Choluteca	13°18'	87°12'	48
El Corpus	13°17'	87°02'	370
El Picacho	14°02'30"	87°11'30"	1,373
El Sauce	13°55'	87°13'	1,318
El Triunfo	13°07'30"	86°59'30"	100
El Zamorano	14°00'	87°02'	793
Guacerique	14°02'30"	87°11'30"	1,007
Guinope	13°53'	86°56'10"	1,315
Hacienda Las Canadas	14°09'	87°03'	1,250
Hacienda San Isidro	13°52'	86°34'	750
La Venta	14°18'50"	87°10'15"	890
Liure	13°32'	87°05'	230
Los Encuentros	13°28'08"	87°05'29"	100
Maraita	13°53'00"	87°02'25"	940
Marcovia	13°17'10"	87°18'50"	10
Monjaras	13°12'	87°23'	3
Moroceli	14°08'	86°53'	616
Namasigue	13°12'	87°09'	40
Nueva Armenia	13°45'20"	87°09'50"	620
Nuevo Rosario	14°13'	87°05'	1,177
Ojojona	13°56'00"	87°17'50"	1,380
Oropoli	13°49'15"	86°49'15"	480
Paso La Ceiba	14°15'00"	87°00'50"	630
Pespire	13°34'	87°22'	60
Potrerillos	14°00'00"	86°46'00"	747
Sabanagrande	13°49'	87°16'	1,020
San Antonio de Flores	13°43'15"	86°53'00"	790
San Lucas	13°44'25"	86°57'20"	1,270
Soledad	13°35'	87°07'	330
Tegucigalpa	14°05'35"	87°12'15"	960
Texiguat	13°38'50"	87°01'30"	320
Yuscaran	13°56'35"	86°51'10"	950
Yusguare	13°18'	87°06'	50
Zambrano	14°16'45"	87°24'27"	1,360

TABLE-A2 : MONTHLY AVERAGES OF DAILY MAXIMUM, MEAN AND MINIMUM TEMPERATURES IN DEGREE CENTIGRADE

	J	F	M	A	M	J	J	A	S	O	N	D	Annual
Tegucigalpa Station (El. 1,007 m)													
Max.	25.3	27.1	29.2	30.2	29.9	28.3	27.6	28.4	28.5	27.1	25.7	25.1	27.7
Mean	19.4	20.5	21.9	23.1	23.3	22.8	22.3	22.6	22.6	21.9	20.4	19.6	21.7
Min.	13.9	14.0	14.7	16.5	17.8	18.2	17.6	17.3	17.4	17.3	15.6	14.6	16.2
Based on 28 years of data from 1948 to 1975													
La Venta Station (El. 890 m)													
Max.	25.2	26.6	29.6	31.4	30.7	28.9	27.6	28.5	28.4	27.0	25.6	24.8	27.9
Mean	19.8	20.6	23.4	26.1	24.9	23.8	23.1	23.0	23.0	22.1	21.0	19.7	22.5
Min.	12.3	11.6	12.8	15.2	16.4	16.9	15.9	16.6	17.0	16.8	16.2	13.9	15.1
Based on 5 years of data from 1972 to 1976													
Paso La Ceiba Station (El. 630 m)													
Max.	28.2	29.8	32.1	33.1	32.7	30.5	30.0	30.4	30.4	29.6	28.5	27.8	30.3
Mean	23.1	24.1	26.4	27.6	27.3	25.6	25.1	25.2	25.2	24.4	23.9	22.5	25.0
Min.	16.6	16.3	18.1	19.7	21.3	20.6	19.4	19.3	19.3	19.6	18.5	16.4	18.8
Based on 5 years of data from 1972 to 1976													
Choluteca Station (El. 47.5 m)													
Max.	34.6	35.5	37.3	37.3	35.6	32.7	33.7	33.4	32.6	32.4	32.9	34.3	34.4
Mean	28.3	28.5	29.6	30.0	28.8	27.3	28.2	27.7	26.8	26.6	27.2	27.9	28.1
Min.	23.1	23.0	23.4	24.3	23.6	23.4	24.0	23.6	22.6	22.7	22.4	23.0	23.3
Based on 15 years of data from 1961 to 1975													

TABLE-A3 MONTHLY MEAN RELATIVE HUMIDITY IN PERCENT

J	F	M	A	M	J	J	A	S	O	N	D	Annual
Tegucigalpa Station (El. 1,007 m)												
72	67	62	61	68	77	75	74	78	79	78	76	72
Based on 27 years of data from 1946 to 1972												
La Venta Station (El. 890 m)												
73	65	60	54	63	70	71	72	75	78	79	76	70
Based on 5 years of data from 1972 to 1976												
Paso La Ceiba Station (El. 630 m)												
72	70	65	63	66	75	72	73	73	77	74	76	71
Based on 5 years of data from 1972 to 1976												
Choluteca Station (El. 47.5 m)												
51	50	52	54	70	79	68	72	81	79	67	55	65
Based on 14 years of data from 1963 to 1976												

TABLE-A4 PREVAILING DIRECTION AND MONTHLY MEAN VELOCITY OF WIND

	J	F	M	A	M	J	J	A	S	O	N	D	Annual
Tegucigalpa Station (El. 1,007 m)													
1.	N	N	N	NE	NE	NE	N	NNE	ENE	N	N	N	
2.	18.2	17.7	17.1	16.5	14.5	13.6	14.4	14.3	13.1	14.6	17.2	17.4	15.7
Based on 25 years of data from 1950 to 1974													
Choluteca Station (El. 47.5 m)													
1.	NNE	NNE	NNE	N	SSE	ENE	NE	E	S	ESE	ESE	NNE	
2.	20.5	19.7	15.8	14.5	11.2	11.2	14.2	12.1	9.9	11.2	14.9	19.3	14.5
Based on 12 years of data from 1963 to 1974													

Note: 1. Prevailing wind direction

2. Monthly average of daily maximum wind velocity in km/hour

TABLE-A5 MONTHLY EVAPORATIONS IN MM

	J	F	M	A	M	J	J	A	S	O	N	D	Annual
Tegucigalpa /1	125	148	197	189	159	121	133	135	114	107	107	115	1,650
La Venta /2	92	121	179	185	169	129	119	126	130	108	82	83	1,523
Paso La Ceiba /3	111	131	185	189	172	130	126	129	122	111	93	99	1,598
Los Encuentros /4	269	263	313	255	331	227	213	230	188	171	190	242	2,892
Choluteca /5	290	289	314	282	187	170	200	169	148	160	195	252	2,656

/1 Based on 12 years of records

/2 Based on 15 years of records

/3 Based on 6 years of records

/4 Based on 4 years of records

/5 Based on 7 years of records

Table-A6 (1) MONTHLY AND ANNUAL PRECIPITATIONS IN MM AT CHOLUTECA

Year	J	F	M	A	M	J	J	A	S	O	N	D	Annual
1943	0	0	0	50	287	241	168	464	379	764	19	5	2,376
1944	0	0	2	8	118	421	305	282	534	98	4	0	1,772
1945	0	0	0	2	243	325	202	239	409	350	49	4	1,823
1951	0	0	5	8	325	282	317	261	346	243	38	4	1,829
1952	0	0	4	124	215	580	137	248	336	396	34	0	2,074
1953	0	0	0	56	704	276	96	215	528	240	0	11	2,126
1954	0	0	16	75	304	559	147	239	409	350	49	4	2,157
1955	0	0	23	15	201	259	687	381	646	757	38	4	3,011
1956	0	0	0	50	406	295	116	278	459	409	16	0	2,029
1957	0	23	38	86	305	335	203	81	371	193	20	0	1,655
1958	0	8	56	145	432	462	158	83	566	292	48	15	2,220
1959	0	0	16	50	186	207	23	135	233	444	12	0	1,306
1960	1	0	0	46	326	453	205	356	272	514	42	0	2,215
1961	0	1	1	1	4	381	136	67	346	211	134	25	1,307
1962	0	0	20	65	206	474	202	206	379	353	49	4	1,958
1963	0	0	0	50	277	381	188	206	308	214	203	0	1,827
1964	0	15	1	72	113	492	268	242	433	188	14	8	1,846
1965	0	0	0	0	224	432	137	239	550	350	49	4	1,985
1966	0	0	3	35	298	651	201	93	398	296	7	11	1,993
1967	0	1	54	67	7	314	98	182	283	122	10	5	1,143
1968	0	0	0	13	504	584	77	131	571	483	54	1	2,418
1969	12	0	33	129	299	439	199	465	444	602	73	0	2,695
1970	0	0	0	71	265	201	469	430	488	281	79	2	2,286
1971	1	2	0	1	358	178	110	307	413	341	132	1	1,844
1972	0	0	97	30	320	224	194	180	131	261	55	0	1,492
1973	0	0	3	2	233	274	262	450	564	551	8	34	2,386
1974	0	0	0	0	211	370	29	168	520	117	44	1	1,460
1975	1	0	4	0	311	140	213	184	529	403	201	0	1,986
1976	0	0	0	172	134	337	32	76	125	339	41	0	1,256
1977	0	0	0										
Mean	1	2	13	49	270	364	192	239	413	350	53	5	1,951

Table-A6 (2) MONTHLY AND ANNUAL PRECIPITATIONS IN MM AT EL CORPUS

Year	J	F	M	A	M	J	J	A	S	O	N	D	Annual
1973	-	-	-	-	-	25	33	502	773	965	31	4	-
1974	0	0	3	21	420	711	127	476	975	308	0	0	3,022
1975	3	0	6	17	721	423	239	733	1,197	955	321	0	4,615
1976	0	0	0	142	499	1,164	204	63	622	917	83	0	3,694
1977	-	0	0	163									-
Mean	1	0	2	81	547	581	151	444	892	786	109	1	3,595

Table-A6 (3) MONTHLY AND ANNUAL PRECIPITATIONS IN MM AT EL PICACHO

Year	J	F	M	A	M	J	J	A	S	O	N	D	Annual
1943	-	-	-	-	-	-	-	-	301	294	6	40	-
1944	18	3	0	28	110	284	84	132	204	39	39	31	972
1945	12	3	3	1	196	-	-	36	74	67	5	0	-
1946	1	0	0	15	70	85	13	65	117	88	46	12	498
1947	8	3	19	0	44	130	150	188	173	152	103	28	998
1948	5	0	50	7	100	149	95	37	59	94	54	27	677
1949	70	6	0	2	45	216	78	51	211	217	76	34	1,007
1950	-	-	7	13	48	185	152	92	180	269	127	66	1,139
1951*	420	50	20	0	0	0	0	0	0	0	0	0	490
1957	-	-	-	0	154	160	77	41	233	82	29	47	-
1958	8	2	-	-	-	40	163	72	70	-	56	28	-
1959	64	4	2	35	403	107	42	116	107	105	83	42	1,110
1960	25	4	16	87	256	147	75	137	159	169	110	42	1,227
1961	48	15	27	0	71	126	96	83	137	110	139	23	875
1962	35	2	1	45	109	130	61	-	88	122	27	10	-
1963	10	8	-	-	-	-	104						-
Mean	25	4	11	18	134	147	92	88	151	139	64	31	904

* Data for 1951 are incredible.

Table-A6 (4) MONTHLY AND ANNUAL PRECIPITATIONS IN MM AT EL SAUCE

Year	J	F	M	A	M	J	J	A	S	O	N	D	Annual
1956	-	-	-	-	-	-	-	-	275	75	17	13	-
1957	16	1	1	82	175	254	64	45	570	97	19	19	1,343
1958	10	0	8	21	354	277	143	33	118	106	15	5	1,090
1959	20	2	2	28	185	124	25	116	82	232	24	7	845
1960	8	1	48	41	178	331	62	184	326	267	59	18	1,522
1961	19	23	24	3	108	178	144	96	171	119	142	0	1,028
1962	3	4	0	25	128	252	55	162	234	193	12	0	1,067
1963	26	2	0	0	83	236	81	53	135	139	139	0	895
1964	2	4	0	7	151	362	131	85	172	110	16	9	1,049
1965	3	0	0	32	228	192	20	45	448	136	24	9	1,137
1966	4	4	27	18	240	241	127	60	282	116	12	5	1,136
1967	22	1	29	96	6	288	46	41	259	56	14	5	863
1968	13	0	0	8	384	325	47	113	240	178	38	15	1,361
1969	31	16	21	15	117	508	65	300	367	372	27	10	1,849
1970	8	0	2	45	166	79	151	219	336	98	49	14	1,167
1971	6	10	8	3	214	67	41	220	214	228	67	14	1,092
1972	0	9	0	38	432	319	68	16	74	105	47	0	1,108
1973	4	0	0	17	154	209	117	170	204	272	38	0	1,185
1974	7	0	16	14	224	230	30	139	542	52	15	23	1,292
1975	18	-	-	0	209	22	71	82	315	230	126	13	-
Mean	12	4	10	26	197	237	78	115	268	159	69	9	1,184

Table-A6 (5) MONTHLY AND ANNUAL PRECIPITATIONS IN MM AT EL TRIUNFO

Year	J	F	M	A	M	J	J	A	S	O	N	D	Annual
1956	-	-	-	-	-	-	81	79	182	364	-	-	-
1958	-	0	4	46	317	551	150	111	446	264	18	-	-
1959	0	13	0	0	264	202	20	152	288	-	-	-	-
1972	-	-	-	-	-	320	46	88	254	187	88	18	-
1973	0	0	0	0	185	381	367	468	484	641	44	0	2,570
1974	0	0	0	2	345	309	53	209	625	252	22	0	1,817
1975	5	0	8	0	349	121	141	345	792	536	167	0	2,464
1976	0	0	0	29	436	733	55	29	193	449	97	0	2,021
Mean	1	2	2	13	316	374	114	185	408	385	73	4	1,877

Table-A6 (6): MONTHLY AND ANNUAL PRECIPITATIONS IN MM AT EL ZAMORANO

Year	J	F	M	A	M	J	J	A	S	O	N	D	Annual
1944	9	6	0	22	86	425	180	204	183	42	38	5	1,199
1945	14	6	11	18	175	241	79	198	337	145	62	24	1,309
1946	19	50	7	4	110	107	87	132	207	150	56	12	942
1947	21	13	7	3	28	163	221	159	149	195	118	35	1,111
1948	13	10	14	7	164	364	184	77	193	176	42	13	1,247
1949	11	7	0	2	43	262	113	56	216	256	35	19	1,021
1950	43	0	6	0	41	311	182	128	144	308	56	0	1,219
1951	0	0	0	4	99	277	125	51	209	87	18	9	879
1952	10	4	68	51	144	506	159	125	186	92	53	2	1,399
1953	0	10	1	15	127	84	60	133	276	179	3	27	914
1954	10	5	6	22	176	407	147	187	251	182	3	6	1,403
1955	0	5	6	45	70	101	393	331	324	352	45	17	1,688
1956	2	9	24	25	160	233	142	55	212	78	58	15	1,013
1957	25	0	0	83	254	257	112	102	218	72	40	9	1,172
1958	0	0	0	41	361	283	319	116	185	0	0	0	1,305
1959	-	26	1	-	126	142	57	123	39	141	4	0	659
1960	43	0	0	187	344	221	95	211	193	202	87	14	1,597
1961	22	21	3	15	22	237	192	93	96	100	66	28	894
1962	7	0	0	7	15	236	134	80	100	95	28	0	700
1963	26	12	16	11	47	139	174	106	121	197	103	0	952
1964	5	12	0	59	92	268	173	182	215	59	62	8	1,138
1965	6	26	6	21	212	190	127	93	191	-	42	15	929
1966	-	-	-	49	-	206	167	129	189	187	20	9	-
1972	13	3	2	1	168	103	99	102	91	100	35	20	737
1973	22	5	8	7	137	128	66	134	138	342	44	61	1,092
Mean	14	10	7	29	133	236	151	132	187	156	45	14	1,114

Table-A6 (7) MONTHLY AND ANNUAL PRECIPITATIONS IN MM AT GUACERIQUE

Year	J	F	M	A	M	J	J	A	S	O	N	D	Annual
1944	-	-	-	-	-	569	113	282	314	41	30	19	-
1945	4	0	5	0	234	196	95	97	334	182	53	8	1,208
1946	15	9	7	13	213	142	45	77	271	118	81	26	1,017
1947	11	17	9	0	0	210	235	362	168	95	69	12	1,188
1948	5	3	18	23	137	47	66	60	124	41	40	4	568
1949	-	-	-	-	81	254	107	108	186	156	57	15	-
1950	9	0	4	1	107	360	94	222	152	319	75	11	1,354
1964	12	0	0	0	131	415	249	0	177	115	36	0	1,135
1965	0	0	12	30	271	147	74	79	272	153	26	0	1,064
Mean	8	4	8	10	147	260	120	76	222	136	52	11	1,054

Table-A6 (8) MONTHLY AND ANNUAL PRECIPITATIONS IN MM AT GUINOPE

Year	J	F	M	A	M	J	J	A	S	O	N	D	Annual
1966	-	-	-	-	-	-	68	175	220	370	48	61	-
1967	35	22	52	95	10	300	185	172	300	100	0	0	1,271
1968	0	10	2	0	333	705	59	128	424	213	43	16	1,933
1969	21	20	20	0	321	637	107	611	377	473	138	0	2,725
1970	30	0	0	0	130	186	238	133	-	205	5	40	-
1971	0	0	0	0	210	78	75	284	261	258	47	25	1,238
1972	1	0	0	0	245	15	88	91	107	109	9	2	667
1973	0	0	0	1	183	205	176	193	140	261	3	0	1,162
1974	21	0	1	0	322	180	80	87	312	126	3	2	1,134
1975	10	13	0	0	180	12	96	140	323	293	71	9	1,147
1976	12	0	0	3	77	312	38	64	61	208	39	4	818
1977	0	7	0	28	249								
Mean	16	7	7	12	205	263	110	189	253	238	37	14	1,351

Table-A6 (9) MONTHLY AND ANNUAL PRECIPITATIONS IN MM AT HACIENDA LAS CANADAS

Year	J	F	M	A	M	J	J	A	S	O	N	D	Annual
1958	45	20	9	14	288	199	299	186	249	175	71	31	1,585
1959	92	40	18	125	299	138	108	288	213	462	80	36	1,898
1960	47	9	13	96	319	521	393	408	424	400	134	72	2,834
1961	83	118	30	50	112	338	333	129	184	110	156	39	1,681
1962	49	8	3	43	204	222	186	194	220	230	154	11	1,522
1963	27	23	17	16	271	269	11	228	213	286	208	8	1,577
1964	10	10	2	39	136	415	261	98	249	147	62	49	1,477
1965	20	23	5	6	224	136	160	113	268	241	133	17	1,345
1966	21	16	210	30	304	302	357	200	238	-	-	-	-
1967	35	17	21	151	17	73	37	47	92	62	23	18	592
1968	24	7	8	15	115	114	46	41	107	53	35	17	582
1969	13	0	0	16	38	110	57	84	79	82	16	4	499
1970	0	0	0	24	64	120	26	89	167	77	44	16	627
1971	10	6	0	0	18	53	77	109	100	82	45	9	509
1972	2	0	0	0	59	43	30	41	54	71	16	7	323
1973	0	0	0	18	23	40	93	107	109	118	16	27	551
1974	27	0	0	0	43	115	54	92	127	99	52	23	632
1975	13	9	5	0	33	15	27	42	-	-	-	-	
Mean	29	17	19	36	143	179	142	139	182	168	78	24	1,156

Remarks: The annual precipitations before the interruption in late 1966 are apparently larger than those recorded after 1967. Date at this station are therefore not reliable.

Table-A6.(10) MONTHLY AND ANNUAL PRECIPITATIONS IN MM AT HACIENDA SAN ISIDRO

Year	J	F	M	A	M	J	J	A	S	O	N	D	Annual
1958	-	-	-	-	-	-	-	33	75	158	38	-	-
1959	22	-	28	11	66	153	120	107	74	137	25	0	-
1960	36	7	66	91	117	215	234	142	83	100	79	15	1,184
1961	35	36	0	18	31	203	240	125	134	293	115	50	1,280
1962	37	-	0	47	81	283	190	143	152	182	29	14	-
1963	33	13	15	80	51	191	158	107	169	256	143	22	1,237
1964	8	8	2	8	37	442	193	104	101	159	62	29	1,153
1965	13	7	9	0	69	83	106	177	203	110	28	18	823
1966	8	5	33	40	156	212	135	146	166	-	-	-	-
1967	59	3	14	29	17	144	171	95	200	73	90	23	919
1968	28	12	5	2	354	292	119	142	197	136	62	27	1,376
1969	19	0	22	87	92	393	128	171	185	218	72	33	1,420
1970	20	0	0	68	191	113	215	183	-	89	55	44	-
1971	0	-	0	95	93	73	124	116	165	241	21	51	-
1972	27	10	-	-	210	86	81	145	79	74	62	26	-
Mean	27	9	15	44	120	206	158	129	142	159	63	27	1,099

Table-A6 (11) MONTHLY AND ANNUAL PRECIPITATIONS IN MM AT LA VENTA

Year	J	F	M	A	M	J	J	A	S	O	N	D	Annual
1955	0	23	4	32	78	99	331	137	153	276	65	29	1,229
1956	10	20	1	92	131	188	122	72	184	82	31	50	983
1957	18	41	42	31	196	215	86	55	182	116	10	30	1,022
1958	6	1	55	0	205	211	194	88	139	106	24	11	1,040
1959	44	0	1	32	196	36	46	93	42	98	88	19	695
1964	-	-	-	-	80	288	136	98	218	93	53	66	-
1965	12	7	0	19	65	153	88	50	184	133	128	131	970
1966	42	23	65	10	242	167	155	88	230	134	13	14	1,184
1967	48	19	45	69	30	125	93	49	181	141	17	25	842
1968	9	5	4	48	310	234	60	109	264	273	92	28	1,436
1969	13	5	35	16	238	275	146	295	279	346	101	34	1,783
1970	12	7	0	0	138	60	148	142	240	213	70	31	1,061
1971	12	30	3	1	166	64	92	172	112	227	79	31	989
1972	12	21	6	10	112	200	65	43	115	164	51	13	812
1973	5	6	0	12	-	87	104	120	156	334	50	86	-
1974	11	9	2	13	146	127	83	99	161	151	42	29	873
1975	43	8	15	0	94	40	89	82	411	228	244	25	1,279
1976	22	3	1	49	41	318	52	62	9	419	36	44	1,056
Mean	19	13	16	26	139	160	116	103	176	196	66	37	1,067

Table-A6 (12) MONTHLY AND ANNUAL PRECIPITATIONS IN MM AT LIURE

Year	J	F	M	A	M	J	J	A	S	O	N	D	Annual
1968	-	-	-	0	366	354	46	128	260	189	28	0	-
1969	0	0	6	48	203	235	130	-	271	279	6	0	-
1970	0	0	0	11	-	-	-	-	-	-	-	-	-
1971	-	-	-	-	-	-	-	-	-	-	-	-	-
1972	0	0	5	7	211	304	44	76	21	84	14	0	766
1973	0	0	0	0	174	122	136	393	90	343	0	0	1,258
1974	0	0	0	0	32	19	3	15	41	5	0	0	115
1975	0	1	0	0	29	8	13	9	37	30	13	0	140
1976	0	0	0	5	10	35	3	1	63	220	22	0	359
1977	0	0	0	0									-
Mean	0	0	1	8	146	154	54	104	112	164	12	0	755

Table-A6 (13) MONTHLY AND ANNUAL PRECIPITATIONS IN MM AT LOS ENCUENTROS

Year	J	F	M	A	M	J	J	A	S	O	N	D	Annual
1958	-	-	-	-	-	-	-	49	145	108	20	4	-
1960	0	-	-	-	-	-	-	-	-	-	-	-	-
1964	-	-	-	-	-	-	-	110	306	-	0	0	-
1965	1	0	0	0	259	119	11	6	301	218	0	0	915
1966	0	7	0	1	446	438	164	32	168	230	15	0	1,501
1967	0	0	40	37	2	292	44	96	284	31	3	0	829
1968	0	0	0	10	423	376	68	69	309	208	20	0	1,483
1969	6	1	24	35	341	290	129	197	292	318	2	9	1,644
1970	0	0	4	27	276	101	197	278	431	189	69	0	1,572
1971	0	0	0	0	236	60	34	278	297	256	21	0	1,182
1972	0	0	0	0	125	247	33	99	35	131	20	0	690
1973	0	0	0	0	168	200	109	277	269	374	5	0	1,402
1974	0	0	0	0	386	190	12	112	443	11	0	0	1,154
1975	0	0	19	5	262	58	79	103	345	173	164	0	1,208
1976	0	0	0	11	129	337	43	30	114	297	20	0	981
Mean	1	1	7	11	254	226	77	124	267	196	26	1	1,191

Table-A6 (14): MONTHLY AND ANNUAL PRECIPITATIONS IN MM AT MARAITA

Year	J	F	M	A	M	J	J	A	S	O	N	D	Annual
1965	15	19	14	35	149	91	44	48	240	111	31	28	825
1966	15	17	44	42	246	170	128	102	127	134	7	3	1,035
1967	8	1	22	46	1	166	46	26	196	38	9	3	562
1968	13	1	1	1	204	169	41	59	141	67	28	11	736
1969	33	5	6	17	114	232	56	156	140	188	19	11	1,007
1970	5	2	1	15	44	40	55	35	62	32	18	15	324
1971	4	7	1	1	29	26	55	54	85	25	13	13	313
1972	6	2	1	0	73	81	21	37	30	41	5	4	301
1973	6	0	0	3	105	90	93	83	102	195	19	2	698
1974	16	1	1	2	152	45	12	10	51	10	1	3	304
1975	4	1	2	0	23	3	14	14	39	30	11	1	142
1976	0	0	1	1	108	395	44	77	90	200	28	12	956
Mean	10	5	8	14	104	126	51	58	109	89	16	9	599

Table A6 (15) MONTHLY AND ANNUAL PRECIPITATIONS IN MM AT MARCOVIA

Year	J	F	M	A	M	J	J	A	S	O	N	D	Annual
1966	-	-	-	-	-	-	-	40	133	135	2	1	-
1967	0	2	19	20	2	168	34	42	148	47	9	0	491
1968	0	0	0	21	146	179	36	66	148	138	62	1	796
1969	5	0	7	-	31	41	154	426	441	277	25	0	-
1970	-	-	1	11	185	255	366	439	380	224	64	0	-
1971	0	0	0	0	308	166	105	353	272	414	88	0	1,706
1972	1	0	2	26	318	229	193	126	236	171	57	0	1,359
1973	0	0	0	50	194	265	245	446	608	503	15	0	2,326
1974	0	0	0	0	277	497	130	503	1,135	314	2	0	2,858
1975	1	0	5	0	186	104	164	395	558	276	354	0	2,043
Mean	1	0	4	16	183	212	159	284	406	250	68	0	1,583

Table-A6 (16) MONTHLY AND ANNUAL PRECIPITATIONS IN MM AT MONJARAS

Year	J	F	M	A	M	J	J	A	S	O	N	D	Annual
1973	-	-	-	-	91	375	309	591	481	555	17	0	-
1974	0	0	0	0	196	479	145	231	844	149	0	0	2,044
1975	5	0	1	9	256	223	127	274	633	245	264	0	2,037
1976	0	0	0	16	114	507	85	79	181	323	34	0	1,339
1977	0	0											
Mean	1	0	0	8	164	396	189	294	535	318	79	0	1,984

Table-A6 (17) MONTHLY AND ANNUAL PRECIPITATIONS IN MM AT MOROCELI

Year	J	F	M	A	M	J	J	A	S	O	N	D	Annual
1955	-	-	-	-	-	-	-	52	195	396	81	24	-
1956	1	3	0	-	120	251	88	54	91	46	56	3	-
1957	12	0	15	13	386	-	-	-	216	15	4	2	-
1958	1	0	13	-	340	244	307	73	110	238	31	-	-
1959	0	0	0	0	9	262	8	477	23	64	3	0	845
1960	3	-	3	14	34	58	56	243	402	486	98	1	-
1961	0	0	0	1	3	255	142	165	190	97	110	2	966
1962	2	0	0	44	14	39	51	67	110	66	6	2	401
1963	0	0	0	3	4	45	41	43	43	32	19	2	231
1964	1	1	0	2	11	21	57	19	19	24	2	1	158
1965	0	0	1	1	18	41	24	10	25	20	7	1	147
1966	1	1	2	4	24	413	48	17	44	-	-	-	-
Mean	2	1	3	9	88	163	81	58	122	135	38	3	703

Table-A6 (18) MONTHLY AND ANNUAL PRECIPITATIONS IN MM AT NAMASIGUE

Year	J	F	M	A	M	J	J	A	S	O	N	D	Annual
1973	-	-	-	-	23	468	217	456	431	925	11	0	-
1974	0	0	0	0	380	398	109	176	627	132	5	-	-
1975	1	0	3	0	306	149	158	337	644	437	263	0	2,298
1976	0	0	0	140	228	544	28	136	340	630	31	0	2,077
1977	0	0	0										
Mean	0	0	1	47	234	390	128	276	511	531	78	0	2,196

Table-A6-(19) MONTHLY AND ANNUAL PRECIPITATIONS IN MM AT NUEVA ARMENIA

Year	J	F	M	A	M	J	J	A	S	O	N	D	Annual
1966	-	-	-	-	-	-	-	149	221	168	2	5	-
1967	0	3	25	43	0	102	96	79	175	84	0	0	607
1968	0	0	0	10	135	193	99	69	198	117	63	0	884
1969	25	1	8	1	50	108	49	128	109	112	1	1	593
1970	0	0	0	0	36	32	63	76	81	86	11	0	385
1971	0	0	1	0	67	36	73	226	228	181	31	1	844
1972	0	0	8	8	235	45	30	13	18	87	15	0	459
1973	0	0	0	8	147	114	97	213	324	269	13	0	1,185
1974	7	0	0	0	190	252	45	69	491	137	3	2	1,189
1975	4	0	0	19	348	166	51	209	445	173	0	0	1,411
1976	0	0	0	124	237	376	19	35	88	318	41	0	1,238
1977	0	0	0										-
Mean	3	0	4	21	145	142	62	115	216	150	16	1	875

Table A6 (20) MONTHLY AND ANNUAL PRECIPITATIONS
(continued) IN MM AT NUEVO ROSARIO

Year	J	F	M	A	M	J	J	A	S	O	N	D	Annual
1936	38	13	41	10	405	239	234	155	140	304	164	50	1,791
1937	64	10	15	56	239	147	126	89	380	358	36	64	1,584
1938	20	28	5	28	86	152	64	257	315	154	46	50	1,204
1939	38	15	15	4	152	132	137	95	206	81	38	126	1,040
1940	38	6	19	19	160	287	159	66	311	222	91	83	1,462
1941	20	10	13	109	284	109	168	104	190	171	122	62	1,364
1942	32	3	8	19	343	221	160	130	260	211	57	77	1,520
1943	41	32	25	57	91	132	114	37	109	272	89	64	1,063
1944	32	13	8	30	81	354	119	208	235	41	97	27	1,245
1945	61	6	15	30	244	208	108	135	226	160	119	18	1,331
1946	38	33	14	3	61	130	121	142	191	75	94	51	951
1947	48	38	8	3	20	130	241	173	178	84	142	70	1,134
1948	43	33	6	24	171	190	211	117	211	171	64	38	1,280
1949	18	19	0	13	95	226	102	103	179	218	38	79	1,090
1950	125	15	19	6	104	405	203	180	169	276	125	22	1,649
1951	38	13	3	28	211	307	199	202	211	180	66	27	1,485
1952	33	28	53	140	199	483	253	123	199	130	79	52	1,772
1955	-	40	16	37	122	153	464	189	308	472	173	68	-
1956	30	40	19	42	251	297	232	106	230	148	122	96	1,611
1957	63	23	25	6	212	274	182	138	264	110	34	85	1,416
1958	51	12	35	21	379	250	279	149	120	170	71	28	1,565
1959	91	7	19	60	227	73	114	151	119	221	80	60	1,222
1960	38	12	14	103	223	369	122	165	195	210	91	53	1,585
1961	87	93	30	25	69	197	123	108	106	135	123	59	1,156
1962	60	9	3	46	223	65	82	105	126	276	11	28	1,033
1963	12	9	8	6	40	55	29	89	193	267	229	63	1,000
1964	28	24	1	7	73	368	227	93	197	119	51	45	1,235
1965	25	16	5	14	218	297	167	107	221	333	70	78	1,551

Table-A6 (20) MONTHLY AND ANNUAL PRECIPITATIONS IN MM AT NUEVO ROSARIO (Continued)

Year	J	F	M	A	M	J	J	A	S	O	N	D	Annual
1966	63	25	82	25	231	227	178	123	193	184	54	44	1,428
1967	76	20	54	156	36	209	193	75	168	79	59	25	1,150
1968	0	49	11	26	400	309	145	138	232	224	92	64	1,690
1969	99	25	19	5	301	314	162	327	248	291	135	66	1,992
1970	54	15	2	101	142	256	242	137	336	107	111	76	1,579
1971	21	43	3	7	174	104	122	141	192	304	35	56	1,202
1972	61	20	2	7	151	85	185	178	142	191	75	33	1,130
1973	18	5	6	48	114	249	162	182	191	459	52	28	1,514
Mean	46	22	17	37	181	225	170	139	205	206	87	56	1,391

Table-A6 (21) MONTHLY AND ANNUAL PRECIPITATIONS IN MM AT OJOJONA

Year	J	F	M	A	M	J	J	A	S	O	N	D	Annual
1966											3	5	
1967	9	7	22	136	16	295	50	34	327	82	8	13	999
1968	15	0	0	31	225	376	40	148	339	128	28	13	1,343
1969	36	28	53	31	178	495	111	401	502	422	32	5	2,294
1970	5	2	0	85	132	146	259	188	406	136	27	16	1,402
1971	27	8	0	59	285	74	47	257	348	181	63	15	1,364
1972	4	3	10	61	301	241	40	13	43	45	-	8	-
1973	0	0	0	60	269	199	109	226	225	-	3	0	-
1974	0	0	0	0	92	97	59	-	-	36	0	0	-
1975	0	0	0	0	295	53	121	44	387	113	91	0	1,104
1976	0	0	0	21	121	379	71	31	168	311	50	5	1,157
1977	-	0	0										
Mean	10	4	8	48	191	237	91	149	305	162	31	7	1,243

Table A6 (22) MONTHLY AND ANNUAL PRECIPITATIONS IN MM AT OROPOLI

Year	J	F	M	A	M	J	J	A	S	O	N	D	Annual
1966	-	-	-	-	-	-	29	58	118	102	11	3	-
1967	0	0	3	25	3	83	51	40	101	21	16	4	347
1968	0	3	0	1	112	59	35	66	130	59	26	3	494
1969	30	0	7	0	63	166	28	123	94	102	6	0	619
1970	0	0	9	10	68	31	96	-	93	46	24	11	-
1971	2	0	0	0	77	37	23	82	81	65	11	0	378
1972	5	0	0	0	47	40	34	25	-	-	-	-	-
1973	-	0	0	0	70	92	74	54	100	244	12	0	646
1974	7	0	0	0	172	105	96	69	143	93	11	0	696
1975	14	5	4	0	102	31	65	56	282	135	236	0	930
1976	0	0	0	112	153	229	56	52	70	156	28	1	857
1977	0	0	0	11									
Mean	6	1	2	14	87	87	53	63	121	102	38	2	576

Table-A6 (23) MONTHLY AND ANNUAL PRECIPITATIONS IN MM AT PASO LA CEIBA

Year	J	F	M	A	M	J	J	A	S	O	N	D	Annual
1965	-	-	-	-	43	148	70	165	204	174	30	55	-
1966*	0.0	0.0	1.5	2.5	30.0	12.5	22.5	15.0	14.5	21.5	4.5	1.5	126.0
1967*	1.5	1.0	1.5	9.0	5.0	17.0	11.5	6.0	21.0	6.0	2.5	3.0	85.0
1968*	0.5	2.5	0.0	0.0	38.5	13.0	9.8	15.1	30.6	16.5	11.2	3.6	141.3
1969	5	0	1	1	26	85	89	30	218	268	59	13	794
1970	10	2	0	35	178	160	210	103	174	82	31	44	1,029
1971	18	5	0	3	95	80	95	192	123	171	49	18	849
1972	10	2	0	1	134	132	59	92	44	27	26	6	533
1973	9	0	0	38	158	134	140	121	71	237	19	11	938
1974	12	1	6	7	152	89	69	128	218	145	35	17	879
1975	30	7	11	0	58	-	-	-	-	-	-	124	-
1976	9	4	4	19	60	301	75	65	38				
Mean	13	3	3	13	100	141	101	112	136	158	36	36	852

* Records during these three years appear too low. When supposed that these data are in the unit of inches, the results of 3,200 mm, 2,159 mm and 3,589 mm look too large. Therefore data for this period are not considered reliable.

Table-A6 (24) MONTHLY AND ANNUAL PRECIPITATIONS IN MM AT PESPIRE

Year	J	F	M	A	M	J	J	A	S	O	N	D	Annual
1943	-	-	-	-	148	209	80	278	546	350	0	0	-
1944	0	0	0	0	225	447	117	271	389	87	17	0	1,553
1945	0	0	14	26	-	-	-	-	-	-	-	-	-
1946	0	0	0	0	229	23	10	125	68	69	0	0	524
1947	0	28	14	0	208	42	12	21	40	23	7	-	-
1966	0	0	0	43	620	342	265	85	384	257	-	-	-
1967	0	9	66	47	9	345	73	157	350	101	80	0	-
1968	0	0	0	0	276	469	128	117	411	304	191	0	1,896
1969	12	0	13	0	501	518	139	514	396	505	56	0	2,654
1970	0	0	0	27	298	159	370	377	489	229	39	12	2,000
1971	0	1	1	31	329	89	97	354	310	562	112	0	1,886
1972	0	0	0	16	334	250	110	98	181	328	146	0	1,463
1973	0	0	0	1	158	382	194	415	345	606	84	0	2,185
1974	1	0	1	9	298	318	51	145	631	-	0	0	-
1975	9	-	2	2	320	155	139	240	157	156	142	1	-
1976	0	0	0	54	174	414	35	64	165	333	20	0	1,259
1977	0	0	0	24									
Mean	1	3	7	18	275	277	121	217	317	279	64	1	1,580

Table A6 (25) MONTHLY AND ANNUAL PRECIPITATIONS IN MM AT POTRERILLOS

Year	J	F	M	A	M	J	J	A	S	O	N	D	Annual
1966	-	-	-	-	-	-	32	91	193	233	15	27	-
1967	5	5	6	27	5	113	86	61	147	168	22	11	656
1968	14	10	1	3	268	182	69	101	203	178	113	19	1,161
1969	77	7	23	28	181	320	118	184	238	297	40	25	1,538
1970	8	4	1	5	180	106	176	82	237	146	54	26	1,025
1971	13	10	2	0	161	45	80	112	138	229	41	23	854
1972	7	4	0	0	90	71	49	63	60	48	30	5	427
1973	1	0	0	34	108	200	73	151	83	375	75	2	1,102
1974	17	4	0	2	161	96	69	46	200	130	15	18	758
1975	24	12	3	0	110	18	55	103	278	313	128	4	1,048
1976	20	0	1	7	81	327	33	56	42	227	35	15	844
1977	4	-	0	39									
Mean	17	6	3	13	135	148	76	95	165	213	52	16	939

Table-A6 (26) MONTHLY AND ANNUAL PRECIPITATIONS IN MM, AT SABANAGRANDE

Year	J	F	M	A	M	J	J	A	S	O	N	D	Annual
1956	2	3	0	27	187	220	65	34	385	96	26	3	1,048
1957	2	2	4	14	235	181	10	18	239	165	2	0	872
1958	8	9	30	12	-	151	116	32	209	138	19	0	-
1959	6	1	0	26	149	178	32	54	143	192	3	10	794
1960	10	1	9	6	6	73	28	105	75	87	16	0	416
1961	0	10	23	4	80	55	52	63	76	104	35	1	503
1962	0	0	10	43	87	52	16	-	-	-	-	-	-
1963	-	-	-	-	66	301	165	56	101	165	150	0	-
1964	6	0	0	69	170	388	144	193	251	186	3	1	1,411
1965	1	1	1	0	96	61	4	1	447	156	9	0	777
1966	0	0	53	52	349	450	180	103	415	245	7	5	1,859
1967	1	17	27	170	36	432	36	92	408	69	5	1	1,294
1968	1	1	0	76	477	605	89	76	331	294	45	1	1,996
1969	33	0	7	75	357	1	134	121	577	582	28	1	1,916
1970	1	13	0	56	297	62	157	536	495	279	29	2	1,927
1971	2	3	25	27	310	20	83	278	417	256	54	1	1,476
1972	0	0	2	44	426	364	10	13	75	130	12	0	1,076
1973	0	0	0	15	311	248	139	321	277	480	3	0	1,791
1974	-	-	-	-	-	-	-	-	-	-	-	-	-
1975	1	0	3	28	164	79	68	140	445	262	116	0	1,306
Mean	4	3	11	42	211	206	80	124	298	216	31	1	1,227

Table-A6 (27) MONTHLY AND ANNUAL PRECIPITATIONS
IN MM AT SAN ANTONIO DE FLORES

Year	J	F	M	A	M	J	J	A	S	O	N	D	Annual
1956	13	12	11	10	161	228	63	33	303	32	20	23	909
1957	20	7	2	103	313	151	73	119	135	177	33	-	-
1958	-	-	0	0	357	321	177	242	70	81	-	-	-
1966	-	-	-	-	-	-	74	169	196	210	29	6	-
1967	19	3	7	174	7	138	81	82	135	46	31	9	812
1968	15	2	4	0	73	152	90	82	-	-	-	-	-
1969	-	8	3	4	82	55	70	154	101	154	20	35	-
1970	13	-	3	50	191	-	262	166	305	148	28	26	-
1971	9	10	4	0	264	131	90	247	143	174	60	30	1,162
1972	7	3	1	2	133	156	64	63	61	144	24	14	672
1973	9	0	0	46	149	226	175	210	192	478	27	1	1,513
1974	29	3	4	7	321	168	153	168	420	53	10	7	1,343
1975	39	22	1	5	160	53	114	192	371	219	97	15	1,288
1976	16	3	5	27	156	240	76	62	132	214	67	7	1,005
1977	1	1	0	31									
Mean	16	6	3	33	182	168	112	142	197	164	37	16	1,076

Table-A6 (28) MONTHLY AND ANNUAL PRECIPITATIONS IN MM AT SAN LUCAS

Year	J	F	M	A	M	J	J	A	S	O	N	D	Annual
1966	-	-	-	-	-	-	-	67	123	108	28	5	-
1967	10	4	32	96	1	197	67	45	148	42	40	6	688
1968	14	3	1	0	209	355	64	46	118	180	11	4	1,005
1969	52	0	16	55	154	248	73	140	141	157	12	6	1,054
1970	8	0	8	25	43	212	179	217	391	456	41	83	1,663
1971	41	1	0	0	212	60	142	429	453	475	40	28	1,881
1972	15	4	0	0	21	26	48	70	60	87	28	15	374
1973	9	1	1	65	167	269	173	312	307	526	32	2	1,864
1974	47	0	8	0	565	234	74	125	439	71	5	4	1,572
1975	26	2	5	0	28	9	12	158	429	249	126	14	1,058
1976	14	0	9	24	208	298	55	64	94	197	47	10	1,020
1977	0	0	0	32									
Mean	21	1	7	27	161	191	89	152	246	232	37	16	1,180

Table-A6 (29): MONTHLY AND ANNUAL PRECIPITATIONS IN MM AT SOLEDAD

Year	J	F	M	A	M	J	J	A	S	O	N	D	Annual
1968	–	–	–	–	309	280	21	23	540	32	3	0	1,208
1969	0	0	0	3	144	77	4	22	28	28	1	0	307
1970	0	0	0	0	16	2	26	17	29	18	5	0	113
1971	0	0	0	0	30	1	5	26	18	21	2	0	103
1972	0	0	0	0	24	18	3	4	8	10	0	0	67
1973	0	0	0	0	15	18	15	31	32	475	0	0	586
1974	0	0	0	0	28	23	4	10	50	5	0	0	120
1975	0	0											
Mean	0	0	0	1	81	60	11	19	101	84	2	0	359

Table-A6 (30) MONTHLY AND ANNUAL PRECIPITATIONS IN MM AT TEGUCIGALPA

Year	J	F	M	A	M	J	J	A	S	O	N	D	Annual
1938	13	18	5	15	55	53	32	86	181	125	91	5	679
1939	14	10	5	2	160	141	63	67	271	74	0	0	807
1940	0	0	3	1	126	171	33	52	224	187	25	41	863
1941	4	8	5	50	56	3	40	91	207	208	153	47	872
1942	45	12	9	12	309	176	80	112	233	83	41	32	1,144
1943	19	5	16	46	80	27	95	42	201	409	39	53	1,032
1944	3	6	0	6	197	311	68	130	170	37	28	6	962
1945	64	27	14	5	275	208	77	139	232	278	71	3	1,393
1946	26	4	2	7	159	95	48	93	235	114	34	12	829
1947	9	6	42	0	130	164	186	239	134	114	56	16	1,096
1948	5	0	50	7	100	185	95	37	63	99	54	28	723
1949	6	7	0	2	44	218	76	77	40	218	85	34	807
1950	9	6	11	2	103	76	45	75	63	167	24	0	633
1951	6	0	0	8	96	146	43	115	241	78	18	2	752
1952	4	1	49	132	168	355	112	35	190	80	26	4	1,152
1953	2	2	0	77	170	90	75	39	277	81	7	8	827
1954	9	5	2	16	208	330	71	61	337	125	5	5	1,173
1955	0	11	2	6	65	95	275	268	263	201	25	10	1,278
1956	2	6	0	8	135	177	75	63	132	39	41	10	689
1957	5	0	2	34	162	140	90	61	215	39	13	18	777
1958	5	0	2	7	222	201	169	62	77	213	12	2	971
1959	21	0	5	72	294	146	31	126	103	107	42	3	944
1960	28	0	11	37	143	174	65	143	137	191	27	5	961
1961	14	10	9	37	67	149	114	57	155	69	84	8	773
1962	10	1	0	142	149	190	63	135	161	202	6	1	1,064
1963	5	7	2	13	160	148	163	67	118	97	101	1	882
1964	1	2	3	1	111	255	168	70	176	63	39	3	892
1965	2	6	0	25	157	90	35	39	262	113	20	16	765

Table-A6 (30) MONTHLY AND ANNUAL PRECIPITATIONS IN MM AT TEGUCIGALPA (Continued)

Year	J	F	M	A	M	J	J	A	S	O	N	D	Annual
1966	2	4	35	33	268	181	132	50	136	186	14	5	1,047
1967	12	4	15	104	55	144	61	35	155	40	8	6	640
1968	3	5	0	3	300	243	26	82	237	87	29	13	1,025
1969	17	2	19	27	177	266	53	168	262	178	22	5	1,197
1970	9	1	0	90	113	67	143	101	293	109	53	22	1,001
1971	5	5	0	10	151	38	39	129	159	174	33	7	750
1972	4	4	0	15	136	101	33	21	39	58	26	15	452
1973	6	1	1	86	135	137	91	104	227	262	20	13	1,083
1974	1	2	0	2	121	169	82	77	201	104	6	2	858
1975	11	2	4	1	189	10	141	84	341	196	77	0	1,075
1976	3	0	0	25	127	296	29	38	33	161	24	19	755
1977	0	8	0	58									
Mean	10	5	8	31	151	158	85	89	184	138	38	12	909

Table-A6 (31) MONTHLY AND ANNUAL PRECIPITATIONS IN MM AT TEXIGUAT

Year	J	F	M	A	M	J	J	A	S	O	N	D	Annual
1965	0	0	0	0	40	31	26	14	100	44	7	0	262
1966	0	0	0	5	54	62	36	30	71	46	3	1	308
1967	0	0	33	84	7	76	20	5	124	49	6	0	404
1968	0	0	0	0	137	109	13	15	123	94	4	0	495
1969	4	0	15	18	103	85	42	121	137	180	7	0	612
1970	0	0	0	20	81	17	98	73	121	46	9	0	465
1971	0	0	0	0	5	12	27	24	40	35	24	0	167
1972	0	0	0	0	34	32	5	4	18	20	8	0	121
1973	0	0	0	10	32	40	30	28	39	64	0	1	234
1974	1	0	0	0	45	32	10	30	449	74	0	0	641
1975	0	2	0	3	261	53	102	87	255	150	104	0	1,017
1976	0	0	0	27	189	409	15	33	56	316	6	0	1,066
1977	0	0	0	22									-
Mean	0	0	4	15	82	80	35	39	128	93	15	0	491

Table-A6 (32) MONTHLY AND ANNUAL PRECIPITATIONS IN MM AT YUSCARAN

Year	J	F	M	A	M	J	J	A	S	O	N	D	Annual
1945	41	64	-	-	263	673	147	241	434	-	-	-	-
1951	-	-	2	19	83	248	143	80	219	171	27	6	-
1952	9	22	40	58	144	532	155	187	173	207	35	5	1,567
1953	27	9	0	13	100	166	149	100	339	148	15	40	1,106
1954	2	19	8	8	274	442	108	136	306	228	4	3	1,538
1955	1	13	8	29	56	70	276	183	301	726	25	20	1,708
1956	-	13	10	1	124	330	218	41	201	109	41	19	1,107
1957	6	-	6	24	4	50	68	79	213	136	38	4	628
1965	24	29	22	50	198	123	61	66	316	149	44	40	1,122
1966	24	26	61	59	324	225	170	149	202	306	36	22	1,604
1967	15	13	74	76	3	151	132	136	294	90	19	25	1,028
1968	6	18	4	5	275	182	137	213	249	294	74	27	1,434
1969	77	13	28	26	166	413	178	373	294	264	73	27	1,932
1970	8	8	17	10	150	135	243	179	309	246	57	49	1,411
1971	26	15	2	21	215	78	114	280	167	285	38	35	1,276
1972	19	8	2	0	148	74	109	97	53	47	9	6	572
1973	3	2	1	88	161	269	175	181	210	454	80	4	1,628
1974	55	16	7	10	335	170	147	174	382	157	26	7	1,486
1975	59	31	2	0	67	26	113	142	444	393	27	0	1,304
1976	29	0	0	26	48	400	91	71	104	189	54	9	1,021
1977	2	5	0	44									
Mean	23	17	15	28	156	239	147	155	261	242	38	18	1,339

Table-A6 (33) : MONTHLY AND ANNUAL PRECIPITATIONS IN MM AT YUSGUARE

Year	J	F	M	A	M	J	J	A	S	O	N	D	Annual
1973	-	-	-	-	-	252	149	386	497	772	7	31	-
1974	0	0	4	1	383	229	132	80	528	146	0	-	-
1975	-	-	-	-	-	259	154	271	571	369	138	0	-
1976	0	0	0	199	144	565	119	81	275	464	15	0	1,862
1977	0	0											
Mean	0	0	2	100	264	326	139	205	936	438	40	10	2,460

Table-A6 (34) MONTHLY AND ANNUAL PRECIPITATIONS IN MM AT ZAMBRANO

Year	J	F	M	A	M	J	J	A	S	O	N	D	Annual
1955	0	11	3	27	100	126	229	102	137	442	36	43	1,257
1956	4	0	0	0	125	281	51	47	97	-	17	26	-
1957	26	8	5	11	241	207	89	50	152	85	10	6	890
1958	8	0	1	4	313	213	148	39	161	88	12	4	991
1968	10	5	5	19	395	387	24	70	223	234	54	13	1,429
1969	38	17	12	20	260	382	83	253	200	278	58	10	1,611
1970	1	7	0	107	178	64	307	157	307	137	59	49	1,373
1971	5	11	6	12	174	70	88	213	163	122	37	13	914
1972	14	9	1	37	134	94	30	45	111	120	27	6	628
1973	4	4	1	76	160	222	94	82	152	198	29	3	1,025
1974	9	8	2	3	406	176	54	81	249	277	11	8	1,284
1975	23	1	0	11	89	27	115	49	456	263	130	3	1,167
1976	13	0	0	47	103	461	62	49	34	305	17	17	1,108
Mean	12	6	3	29	206	208	106	95	188	212	38	15	1,118

Table-A7 RUNOFF GAUGE STATIONS IN THE CHOLUTECA BASIN

Station	River	Longitude West	Latitude North	Drainage Area (km^2)
Concepción	Choluteca	87°15'	14°00'	145.7
Las Calabazas	Choluteca	87°13'	14°00'	219.6
El Incienso	Tatumbla	87°10'	14°02'	61.4
El Aguacate	Sabacuante	87°10'	14°01'	80.3
El Batallon	Guacerique	87°16'	14°04'	192.0
Sitio de Presa	El Hombre	87°21'	14°14'	334.2
Hernando Lopez	Choluteca	87°11'	14°17'	1,564.6
Paso La Ceiba	Choluteca	87°08'	14°15'	1,742.5
Puente Ojo de Agua	Choluteca	86°52'	14°05'	2,270.0
Los Encuentros	Choluteca	87°05'	13°28'	6,370.0
Poza Grande	Orocuina	87°06'	13°25'	353.1
Puente Choluteca	Choluteca	87°12'	13°19'	6,964.0

Table A8 DISCHARGE VOLUME OF CHOLUTECA RIVER AT HERNANDO LOPEZ

C.A. = 1,565 km^2 (MCM)

	J	F	M	A	M	J	J	A	S	O	N	D	Total
1954								36.3	195	162	19.2	7.9	-
55	6.5	5.8	5.7	5.4	5.0	7.0	120	67.5	129	231	55.1	19.7	657.7
56	11.4	8.0	5.6	5.3	14.3	88.7	48.6	15.4	39.4	36.2	14.7	12.7	300.3
57	12.5	7.6	5.5	5.1	28.1	75.5	18.4	19.4	50.5	40.8	10.5	9.5	283.4
58	5.7	3.8	3.7	3.0	62.4	135	61.5	32.0	25.4	62.8	10.0	7.5	412.8
59	7.7	5.5	4.5	3.9	23.9	36.1	12.4	23.3	18.9	54.7	16.6	10.5	218.0
1960*	5.0	3.7	3.3	3.1	13.7	104	19.1	39.7	88.1	123	17.5	10.3	430.5
61*	9.8	7.9	6.9	5.4	5.5	23.6	30.2	15.6	39.3	31.0	28.9	11.5	215.6
62*	10.9	7.1	5.6	5.3	21.1	64.1	17.5	32.1	69.3	129	12.2	10.8	385.0
63*	8.1	5.6	4.9	4.5	4.4	25.1	30.1	12.3	30.7	45.9	42.4	6.2	220.2
64	5.1*	3.7*	3.5*	3.1*	2.9*	85.2	104	15.1	54.7	70.1	7.1	5.8	360.3
65	2.6	2.8	1.8	1.5	21.4	43.0	16.5	11.5	247	78.2	35.3	12.5	474.1
66	7.4	4.5	4.6	4.4	48.3	80.5	74.1	26.3	39.1	63.0	12.7	7.9	372.8
67	6.8	5.2	4.5	10.4	3.5	13.3	14.2	9.4	32.8	33.0	10.0	5.7	148.8
68	4.5	2.7	1.9	1.8	51.8	160	27.6	21.9	86.6	64.2	37.6	11.9	472.5
69	9.6	3.9	3.0	1.9	16.8	204	72.4	130	181	203	38.5	21.3	885.4
1970	9.7	6.2	3.9	8.1	15.4	19.9	50.6	91.2	176	75.6	28.5	14.5	499.6
71	6.8	4.6	3.2	2.8	23.5	16.7	16.1	40.8	102	96.0	18.5	7.8	338.8
72	5.5	3.2	2.2	2.4	13.9	37.7	7.7	8.4	9.7	8.5*	4.3*	3.3*	106.8
73	3.2*	2.8*	3.0*	2.8*	17.3	45.5	43.1	29.2	88.9	175	40.4	9.8	461.0
74	6.0	5.1	4.5	3.2	86.9*	41.7	19.3	8.4	104.7*	39.9	12.0	9.9	341.6
75	9.1	6.5	4.9	3.6	14.3	8.0	16.5*	5.2*	220.2*	154	176**	12.6	630.9
76	8.5	6.0	5.1	4.9									-
Mean	7.4	5.1	4.1	4.1	23.6	62.6	39.1	31.4	92.2	89.8	29.4	10.4	399.2

* Discharge estimated by rainfall-runoff studies

** Discharge estimated by direct observation data for 26 days

Table-A9 DISCHARGE VOLUME OF CHOLUTECA RIVER AT SAN FERNANDO DAMSITE

C.A. = 1,665 km^2 (MCM)

	J	F	M	A	M	J	J	A	S	O	N	D	Total
1954								38.6	207	172	20.4	8.4	-
55	6.9	6.2	6.1	5.7	5.3	7.4	128	71.8	137	246	58.6	21.0	700.0
56	12.1	8.5	6.0	5.6	15.2	94.4	51.7	16.4	41.9	38.5	15.6	13.5	319.4
57	13.3	8.1	5.9	5.4	29.9	80.3	19.6	20.6	53.7	43.4	11.2	10.1	301.5
58	6.1	4.0	3.9	3.2	66.4	144	65.4	34.0	27.0	66.8	10.6	8.0	439.4
59	8.2	5.9	4.8	4.1	25.4	38.4	13.2	24.8	20.1	58.2	17.7	11.2	232.0
1960	5.3	3.9	3.5	3.3	14.6	111	20.3	42.2	93.7	131	18.6	11.0	458.4
61	10.4	8.4	7.3	5.7	5.9	25.1	32.1	16.6	41.8	33.0	30.7	12.2	229.2
62	11.6	7.6	6.0	5.6	22.4	68.2	18.6	34.2	73.7	137	13.0	11.5	409.4
63	8.6	6.0	5.2	4.8	4.7	26.7	32.0	13.1	32.7	48.8	45.1	6.6	234.3
64	5.4	3.9	3.7	3.3	3.1	90.6	111	16.1	58.2	74.6	7.6	6.2	383.7
65	2.8	3.0	1.9	1.6	22.8	45.7	17.6	12.2	263	83.2	37.6	13.3	504.7
66	7.9	4.8	4.9	4.7	51.4	85.6	78.8	28.0	41.6	67.0	13.5	8.4	396.6
67	7.2	5.5	4.8	11.1	3.7	14.1	15.1	10.0	34.9	35.1	10.6	6.1	158.2
68	4.8	2.9	2.0	1.9	55.1	170	29.4	23.3	92.1	68.3	40.0	12.7	502.5
69	10.2	4.1	3.2	2.0	17.9	217	77.0	138	193	216	41.0	22.7	942.1
1970	10.3	6.6	4.1	8.6	16.4	21.2	53.8	97.0	187	80.4	30.3	15.4	531.1
71	7.2	4.9	3.4	3.0	25.0	17.8	17.1	43.4	109	102	19.7	8.3	360.8
72	5.9	3.4	2.3	2.6	14.8	40.1	8.2	8.9	10.3	9.0	5.0	3.5	114.0
73	3.4	3.0	3.2	3.0	18.4	48.4	45.9	31.1	94.6	186	43.0	10.4	490.4
74	6.4	5.4	4.8	3.4	92.5	44.4	20.5	8.9	111.4	42.4	12.8	10.5	363.4
75	9.7	6.9	5.2	3.8	15.2	8.5	17.6	5.5	234.3	164	187	13.4	671.1
76	9.0	6.4	5.4	5.2									-
Mean	7.9	5.4	4.4	4.4	25.1	66.6	41.6	33.4	98.1	95.6	31.3	11.1	424.9

Note: Discharge computed by multiplying discharge at Hernando Lopez by 1.064, the drainage area ratio

Table-A10: DISCHARGE VOLUME OF CHOLUTECA RIVER AT LOS ENCUENTROS

C.A.= 6,370 km^2 (MCM)

	J	F	M	A	M	J	J	A	S	O	N	D	Total
1956											59.5	32.2	-
57	43.5	29.5	22.2	19.2	144.5	224.7	44.3	61.0	219.5	198.9	39.5	27.6	1074.4
58	18.4	10.7	9.6	8.7	165.8	370.2	248.7	124.2	81.8	223.9	42.6	22.4	1327.0
59	18.8	12.2	8.0	5.6	41.2	71.2	19.5	45.2	42.1	205.8	38.7	15.7	524.0
1960*	14.1	7.4	5.5	5.5	97.4	237.9	124.7	193.4	232.9	310.6	96.6	35.1	1361.1
61*	30.4	24.4	19.2	15.2	13.4	146.9	156.6	80.6	128.6	146.4	74.8	30.6	888.1
62*	26.4	17.6	11.8	10.2	68.9	159.3	90.2	85.4	141.0	192.7	31.0	22.4	856.9
63*	19.5	12.0	10.9	10.3	9.2	87.6	94.4	50.2	120.8	208.2	156.4	27.1	806.5
64	19.3*	12.2*	11.9*	10.9*	9.6*	335.4*	246.6*	74.5	166.7	292.2	41.3	27.2	1247.8
65	12.1	5.3	5.1	4.4	84.2	133.7	54.6	50.9	368.1	281.3	94.7	36.7	1131.1
66	23.3	14.3	12.7	17.1	138.6	394.2	286.8	128.0	175.0	393.8	65.9	35.9	1685.6
67	26.8	19.8	17.0	36.1	14.7	89.6	56.4	48.7	153.4	111.3	39.5	22.6	635.9
68	20.1	12.8	8.6	8.6	145.0	560.1	108.4	74.5	329.2	209.9	118.0	45.8	1740.0
69	39.0	16.7	14.7	12.7	51.8	580.8	206.2	471.4	534.0	784.9	154.8	44.2	2911.2
1970	17.9	9.5	6.9	7.8	34.1	32.1	137.3	218.3	436.8	329.5	107.6	45.0	1382.8
71	29.1	17.7	12.9	10.1	71.6	52.8	32.9	111.4	318.8	353.6	68.5	31.9	1111.3
72	21.6	14.1	9.8	8.7	50.0	134.5	23.0	28.4	28.8	32.8	20.4	12.0	384.1
73	9.1	5.5	4.2	5.6	33.6	89.4	97.2	72.6	240.3	592.0	170.3*	35.7*	1355.5
74*	18.6	9.0	7.1	6.4	238.9	205.2	103.3	105.4	507.8	334.6	74.1	21.8	1632.2
75*	12.5	6.9	6.7	6.7	27.9	8.8	33.9	51.1	592.1	544.1	375.6	73.8	1740.1
76*	24.8	13.8	8.6	7.3									-
Mean	22.3	13.6	10.7	10.9	75.8	206.0	113.9	109.2	253.6	307.7	94.5	32.3	1250.5

*: Discharge estimated by rainfall-runoff studies

Table-A11 DISCHARGE VOLUME OF CHOLUTECA RIVER AT MOROLICA DAMSITE
C.A. = 6,187 km^2 (MCM)

	J	F	M	A	M	J	J	A	S	O	N	D	Total
1956											57.8	31.3	-
57	42.3	28.7	21.6	18.6	140.3	218.2	43.0	59.2	213.2	193.2	38.4	26.8	1043.5
58	17.9	10.4	9.3	8.5	161.0	359.6	241.6	120.6	79.5	217.5	41.4	21.8	1289.1
59	18.3	11.8	7.8	5.4	40.0	69.2	18.9	43.9	40.9	199.9	37.6	15.2	508.9
1960	13.7	7.2	5.3	5.3	94.6	231.1	121.1	187.8	226.2	301.7	93.8	34.1	1321.9
61	29.5	23.7	18.6	14.8	13.0	142.7	152.1	78.3	124.9	142.2	92.1	29.7	862.6
62	25.6	17.1	11.5	9.9	66.9	154.7	87.6	82.9	136.9	187.2	30.1	21.8	832.2
63	18.9	11.7	10.6	10.0	8.9	85.1	91.7	48.8	117.3	202.2	151.9	26.3	783.4
64	18.7	11.8	11.6	10.6	9.3	325.8	239.5	72.4	161.9	283.8	40.1	26.4	1211.9
65	11.8	5.1	5.0	4.3	81.8	129.9	53.0	49.4	357.5	273.2	92.0	35.6	1098.6
66	22.6	13.9	12.3	16.6	134.6	382.9	278.6	124.3	170.0	382.5	64.0	34.9	1637.2
67	26.0	19.2	16.5	35.1	14.3	87.0	54.8	47.3	149.0	108.1	38.4	22.0	617.7
68	19.5	12.4	8.4	8.4	140.8	544.0	105.3	72.4	319.7	300.0	114.6	44.5	1690.0
69	37.9	16.2	14.3	12.3	50.3	564.1	200.3	457.9	518.7	762.4	150.4	42.9	2827.7
1970	17.4	9.2	6.7	7.6	33.1	31.2	133.4	212.0	424.3	320.0	104.5	43.7	1343.1
71	28.3	17.2	12.5	9.8	69.5	51.3	32.0	108.2	309.6	343.4	66.5	31.0	1079.3
72	21.0	13.7	9.5	8.5	48.6	130.6	22.3	27.6	28.0	31.9	19.8	11.7	373.2
73	8.8	5.3	4.1	5.4	32.6	86.8	94.4	70.5	233.4	575.0	165.4	34.7	1316.4
74	18.1	8.7	6.9	6.2	232.0	199.3	100.3	102.4	493.2	325.0	72.0	21.2	1585.3
75	12.1	6.7	6.5	6.5	27.1	8.5	32.9	49.6	575.1	528.5	364.8	71.7	1690.0
76	24.1	13.4	8.4	7.1									-
Mean	21.7	13.2	10.4	10.6	73.6	200.1	110.6	106.1	246.3	298.9	91.8	31.4	1214.7

Note: Discharge computed by multiplying discharge at Los Encuentros by 0.971, the drainage area ratio

Table-A12 : DISCHARGE VOLUME OF OROCUINA RIVER AT POZA GRANDE

C.A. = 353 km^2 (MCM)

	J	F	M	A	M	J	J	A	S	O	N	D	Total
1956											2.3	1.8	-
57	0.3	0.1	0.1	0.9	1.1	1.6	0.8	0.7	8.8	1.2	0.6	0.4	16.6
58	0.5	0.3	0.4	0.3	2.6	6.3	1.6	0.9	1.7	3.1	0.7	0.5	18.9
59	1.6	1.2	1.0	1.0	4.1	5.7	1.3	2.1	2.1	16.6	2.3	1.2	40.2
60													
65											0.8	0.3	-
66					27.3	42.6	15.5	3.0	12.6	15.9	1.6	1.5	-
67	1.2	0.6	0.6	0.8	0.4	9.7	1.9	0.4	12.2	6.4	1.2	0.7	36.1
68	0.5	0.4	0.3	0.2	7.1	29.3	0.7	0.1	17.2	25.6	3.0	0.7	85.1
69	0.9	0.1	0.1	0.1	4.5	38.7	4.7	42.2	58.1	55.9	21.2	4.6	231.1
70	4.1	1.6	1.2	1.1	2.0	2.4	2.2	30.6	52.6	34.2	8.2	2.9	143.1
71	2.0	1.9	2.1	1.7									

Table-A13 DISCHARGE VOLUME OF CHOLUTECA RIVER AT EL PAPALÓN

C.A. = 7,115 km^2 (MCM)

	J	F	M	A	M	J	J	A	S	O	N	D	Total
1956											64.4*	36.0*	-
57*	44.1	29.7	22.4	21.1	146.8	228.1	46.0	62.5	238.1	201.4	40.8	28.4	1,109.4
58*	19.5	11.3	10.4	9.3	171.3	383.5	252.1	126.1	85.4	230.4	44.1	23.5	1,366.9
59*	22.2	14.7	10.1	7.7	49.9	83.2	22.2	49.6	46.5	240.8	43.6	18.2	608.7
1960	15.7	8.3	6.1	6.1	108.8	265.7	139.3	216.0	260.1	346.9	107.9	39.2	1,520.1
61	34.0	27.3	21.4	17.0	15.0	164.1	174.9	90.0	143.6	163.5	105.9	34.2	990.9
62	29.5	19.7	13.2	11.4	77.0	177.9	100.7	95.4	157.5	215.2	34.6	25.0	957.1
63	21.8	13.4	12.2	11.5	10.3	97.8	105.4	56.1	134.9	232.5	174.7	30.3	900.9
64	21.6	13.6	13.3	12.2	10.7	374.6	275.4	83.2	186.2	326.4	46.1	30.4	1,393.7
65	13.5	5.9	5.7	4.9	94.0	149.3	61.0	56.9	411.2	314.2	96.4*	37.3*	1,250.3
66	26.0	16.0	14.2	19.1	196.2*	484.1*	319.5*	134.3*	201.6*	427.4*	69.3*	39.1*	1,946.8
67*	29.3	21.1	18.3	37.8	15.5	110.1	60.4	49.5	179.1	124.8	42.0	24.1	712.0
68*	21.2	13.6	9.2	9.0	160.0	621.9	109.9	74.7	365.5	362.9	124.3	47.3	1,919.5
69*	40.9	16.9	14.9	12.9	61.3	662.5	216.1	560.5	656.6	902.9	199.5	53.9	3,398.9
1970*	26.6	12.9	9.4	10.1	38.3	37.2	141.9	282.9	547.8	401.7	124.9	51.1	1,684.8
71	33.3*	21.7*	17.3*	13.7*	80.0	59.0	36.7	124.4	356.1	395.0	76.5	35.6	1,249.9
72	24.1	15.7	10.9	9.7	55.8	150.2	25.7	31.7	32.2	36.6	22.8	13.4	428.8
73	10.2	6.1	4.7	6.3	37.5	99.9	108.6	81.1	268.4	661.2	190.2	39.9	1,514.1
74	20.8	10.1	7.9	7.1	266.8	229.2	115.4	117.7	567.2	373.7	82.8	24.3	1,823.0
75	14.0	7.7	7.5	7.5	31.2	9.8	37.9	57.1	661.3	607.7	419.5	82.4	1,943.6
76	27.7	15.4	9.6	8.2									-
Mean	24.8	15.1	11.9	12.1	85.6	231.0	123.6	123.7	289.4	345.5	105.5	35.7	1,403.9

* Discharge estimated based on discharge at Los Encuentros and at Poza Grande.

Others computed by multiplying discharge at Los Encuentros by 1.117, drainage area ratio

Table-A14 . DISCHARGE VOLUME OF CHOLUTECA RIVER AT PASO LA CEIBA

C.A. = 1,743 km^2 (MCM)

	J	F	M	A	M	J	J	A	S	O	N	D	Total
1956					20.0	107.3	60.3	21.3	79.1	41.8	21.5	20.8	-
57	14.5	7.6	4.9	3.7	30.0	86.8	16.3	20.1	53.9	54.4	16.4	19.5	328.1
58	4.4	2.9	3.0	1.9	76.6	161.2	92.9	41.2	29.5	87.6	9.1	5.9	516.2
59	6.9	4.5	3.2	3.3	37.5	76.5	11.4	19.6	14.5	69.1	18.8	15.6	280.9
1964						112.2	127.0	30.0	87.9	101.8	14.9	13.8	-
65	9.2	5.2	4.0	3.5	27.1	58.1	26.0	19.0	197.6	110.9	63.8	28.4	552.8
66	11.3	6.1	6.4	6.3	88.6	163.5	130.3	30.9	55.2	106.6	15.5	10.5	631.2
67	9.1	7.4	6.8	14.4	2.9	58.2	16.7	10.4	38.1	40.6	11.2	5.7	221.5
68	5.0	3.4	1.5	1.5	84.2	253.4	92.7	32.8	105.4	90.9	51.6	11.0	733.4
69	7.7	2.1	19.4	3.4	23.0	241.8	88.1	155.3	215.1	241.3	48.5	28.4	1074.1
70	14.7	10.2	7.8	12.6	16.6	21.4	56.2	92.2	166.6	83.8	45.9	22.3	550.3
71	14.7	10.2	8.9	12.2	44.1	32.4	26.1	48.9	102.5	102.8	84.3	12.4	499.5
72	8.4	6.4	5.4	5.7	16.8	44.2	12.6	13.9	14.6				-
73					23.6	56.8	53.8	37.5	80.9	168.0	31.5	11.9	-
74	7.4	6.6	6.1	5.5	36.3*	63.8*	30.6*	13.0*	81.5*	77.7*	15.2*	8.6*	352.3
75*	8.4	5.5	3.6	2.4	7.3	8.0	5.9	5.4	213.6	189.2	152.0	14.9	616.2
76*	6.9	4.3	3.5	3.3									
Mean	9.2	5.9	6.0	5.7	35.6	96.6	52.9	37.0	85.5	103.4	40.0	15.3	493.1

* Discharges not yet registered in Servicios Hydrologicos y Climatologicos, estimated from water level data and tentative rating curve

Table-A15 RATIOS OF DISCHARGE VOLUMES AT PASO LA CEIBA TO THOSE AT HERNANDO LOPEZ

Ratio of Drainage Area 1,743/1,565 = 1.114

	J	F	M	A	M	J	J	A	S	O	N	D	Total
1956	-	-	-	-	1.40	1.21	1.24	1.38	2.01	1.15	1.46	1.64	-
57	1.16	1.00	0.89	0.73	1.07	1.15	0.89	1.04	1.07	1.33	1.56	2.05	1.16
58	0.77	0.76	0.81	0.63	1.23	1.19	1.51	1.29	1.16	1.39	0.91	0.79	1.25
59	0.90	0.82	0.71	0.85	1.57	2.12	0.92	0.84	0.77	1.26	1.13	1.49	1.29
1964	-	-	-	-	-	1.32	1.22	1.99	1.61	1.45	2.10	2.38	-
65	3.54	1.86	2.22	2.33	1.27	1.35	1.58	1.65	0.80	1.42	1.81	2.27	1.17
66	1.53	1.36	1.39	1.43	1.83	2.03	1.76	1.17	1.41	1.69	1.22	1.33	1.69
67	1.34	1.42	1.51	1.38	0.83	4.38	1.18	1.11	1.16	1.23	1.12	1.00	1.49
68	1.11	1.26	0.79	0.83	1.63	1.69	3.36	1.50	1.22	1.42	1.37	0.92	1.55
69	0.80	0.54	6.47	1.79	1.37	1.19	1.22	1.19	1.19	1.19	1.26	1.33	1.21
70	1.52	1.65	2.00	1.56	1.08	1.08	1.11	1.01	0.95	1.11	1.61	1.54	1.10
71	2.16	2.22	2.78	4.36	1.88	1.94	1.62	1.20	1.00	1.07	4.56	1.59	1.47
72	1.53	2.00	2.45	2.38	1.21	1.17	1.64	1.65	1.51	-	-	-	-
73	-	-	-	-	1.36	1.25	1.25	1.28	0.91	0.96	0.78	1.21	-
74	1.23	1.29	1.36	1.72	-	1.53	1.59	1.55	-	1.95	1.27	0.87	-
75	0.92	0.85	0.73	0.67	0.51	1.00	-	-	-	1.23	-	1.18	-
76	0.81	0.72	0.69	0.67									

Table-A16 DISCHARGE VOLUME OF CHOLUTECA RIVER AT SAN JUAN DE FLORES

C.A. = 1,820 km^2 (MCM)

	J	F	M	A	M	J	J	A	S	O	N	D	Total
1954								42.3	227.0	188.6	22.3	9.2	-
55	7.6	6.8	6.6	6.3	5.8	8.1	139.7	78.6	150.2	268.9	64.1	22.9	765.6
56	13.3	9.3	6.5	6.2	16.6	103.2	56.6	17.9	45.9	42.1	17.1	14.8	349.5
57	14.6	8.8	6.4	5.9	32.7	87.9	21.4	22.6	58.8	47.5	12.2	11.1	329.9
58	6.6	4.4	4.3	3.5	72.6	157.1	71.6	37.2	29.6	73.1	11.6	8.7	480.3
59	9.0	6.4	5.2	4.5	27.8	42.0	14.4	27.1	22.0	63.7	19.3	12.2	253.6
1960	5.8	4.3	3.8	3.6	15.9	121.1	22.2	46.2	102.5	143.2	20.4	12.0	501.0
61	11.4	9.2	8.0	6.3	6.4	27.5	35.2	18.2	45.7	36.1	33.6	13.4	251.0
62	12.7	8.3	6.5	6.2	24.6	74.6	20.4	37.4	80.7	150.2	14.2	12.6	448.4
63	9.4	6.5	5.7	5.2	5.1	29.2	35.0	14.3	35.7	53.4	49.4	7.2	256.1
64	5.9	4.3	4.1	3.6	3.4	99.2	121.1	17.6	63.7	81.6	8.3	6.8	419.6
65	3.0	3.3	2.1	1.7	24.9	50.1	19.2	13.4	287.5	91.0	41.1	14.6	551.9
66	8.6	5.2	5.4	5.1	56.2	93.7	86.3	30.6	45.5	73.3	14.8	9.2	433.9
67	7.9	6.1	5.2	12.1	4.1	15.5	16.5	10.9	38.2	38.4	11.6	6.6	173.1
68	5.2	3.1	2.2	2.1	60.3	186.2	32.1	25.5	100.8	74.7	43.8	13.9	549.9
69	11.2	4.5	3.5	2.2	19.6	237.5	84.3	151.3	210.7	236.3	44.8	24.8	1030.7
1970	11.3	7.2	4.5	9.4	17.9	23.2	58.9	106.2	204.9	88.0	33.2	16.9	581.6
71	7.9	5.4	3.7	3.3	27.4	19.4	18.7	47.5	118.7	111.7	21.5	9.1	394.3
72	6.4	3.7	2.6	2.8	16.2	43.8	9.0	9.8	11.3	9.9	5.0	3.8	124.3
73	3.7	3.3	3.5	3.3	20.1	52.9	50.1	34.0	103.4	203.7	47.0	11.4	536.4
74	7.0	5.9	5.2	3.7	101.0	48.5	22.5	9.8	121.8	46.4	14.0	11.5	397.3
75	10.6	7.6	5.7	4.2	16.6	9.3	19.2	6.0	256.1	179.3	204.9	14.7	734.2
76	9.9	7.0	5.9	5.7									
Mean	8.6	5.9	4.8	4.8	27.5	72.8	45.5	36.5	107.3	104.5	34.2	12.1	464.5

Note: Since discharge data at Paso La Ceiba are doubtful, discharge estimated by multiplying discharge at Hernando Lopez by 1.164, drainage area ratio

Table-A17 AREA-DEPTH CALCULATION FOR FIXED DURATION OF RAINFALL

Isohyet (mm)	Area between isohyet (km^2)	Accumulated area (km^2)	Mean depth (mm)	Volume between isohyet (mm-km^2)	Accumulated volume (mm-km^2)	Average depth (mm)
For 1-day duration						
420	10	10	420	4,200	4,200	420
400	30	40	407	12,200	16,400	410
350	69	109	375	25,875	42,275	388
300	160	269	325	52,000	94,275	350
250	328	597	275	90,200	184,475	309
200	1,144	1,741	225	257,400	441,875	254
150	1,423	3,164	175	249,025	690,900	218
For 2-day duration						
480	0					
450	189	189	465	87,885	87,885	465
400	348	537	425	147,900	235,785	439
350	408	945	375	153,000	388,785	411
300	587	1,532	325	190,775	579,560	378
250	956	2,488	275	262,900	842,460	339
For 3-day duration						
488	0					
450	398	398	469	186,662	186,662	469
400	269	667	425	114,325	300,987	451
350	547	1,214	375	205,125	506,112	417
300	886	2,100	325	287,950	794,062	378
250	1,104	3,204	275	303,600	1,097,662	343

Table-A18 RESULT OF DAD ANALYSIS

(Depth in mm)

Area (km^2)	Duration 6-hr	12-hr	18-hr	24-hr	Area (km^2)	Duration 48-hr	Area (km^2)	Duration 72-hr
10	206	355	390	420	189	465	398	469
40	201	347	381	410	537	439	667	451
109	169	305	352	388	945	411	1,214	417
269	146	268	317	350	1,532	378	2,100	378
597	127	234	279	309	2,488	339	3,204	343
1,741	98	174	216	254				
3,164	83	146	183	218				

Table-A19 DATA COLLECTED FOR FLOOD STUDY

Station	Period
1. Hourly rainfall data	
La Venta	Sep. 26 - Oct. 8, 1970
"	Oct. 20 - Nov. 4, 1973
Choluteca	May 27 - Jun. 2, 1968
"	Jun. 24 - Jul. 3, 1969
"	Sep. 26 - Oct. 4, 1969
"	Oct. 18 - Oct. 24, 1971
Tegucigalpa	Oct. 17 - Oct. 19, 1966
"	Sep. 17 - Sep. 24, 1974
Paso La Ceiba	Oct. 18 - Oct. 25, 1971
"	Oct. 20 - Nov. 4, 1973
"	Sep. 18 - Sep. 24, 1974
El Zamorano	Oct. 20 - Nov. 4, 1973
"	Sep. 18 - Sep. 24, 1974
2. Hourly water level data	
Hernardo Lopez and Los Encuentros	May 27 - Jun. 2, 1968
"	Sep. 26 - Oct. 4, 1969
"	Sep. 26 - Oct. 8, 1970
"	Oct. 18 - Oct. 24, 1971

Table-A20 BASIN RAINFALL AND EFFECTIVE RAINFALL FOR SELECTED FLOODS AT HERNANDO LOPEZ

Date	Hours	Basin Rainfall (mm)	Effective Rainfall (mm)	Remarks
Flood No. 1 (May 30 - 31, 1968)				
30	18 - 24	29.9	12.05	Initial loss 0.75 mm
31	0 - 6	10.5	-	
	6 - 12	1.8	-	Loss 17.1 mm/6 hrs
	12 - 18	20.6	3.50	
	18 - 24	6.3	-	Runoff coefficient 20.6%
	Total	75.5	15.55	
Flood No. 2 (Sep. 29 - 30, 1969)				
29	18 - 24	32.5	12.90	Initial loss 6.44 mm
30	0 - 6	16.8	3.64	
	6 - 12	6.3	-	Loss 13.16 mm
	12 - 18	0.1	-	Runoff coefficient 29.7%
	Total	55.7	16.54	
Flood No. 3 (Sep. 28 - 30, 1970)				
28	18 - 24	20.2	6.29	Initial loss 8.11 mm
29	0 - 6	19.2	13.40	
	6 - 12	0.1	-	Loss 5.8 mm/6 hrs
	12 - 18	-	-	Runoff coefficient 47.1%
	18 - 24	10.6	4.80	
30	0 - 6	1.9	-	
	Total	52.0	24.49	
Flood No. 4 (Oct 20 - 21, 1971)				
20	18 - 24	33.3	12.01	Initial loss 6.49 mm
21	0 - 6	11.0	-	
	Total	44.3	12.01	Loss 14.8 mm/6 hrs
				Runoff coefficient 27.1%

Table-A21 BASIN RAINFALL AND EFFECTIVE RAINFALL FOR SELECTED FLOODS AT LOS ENCUENTROS

Date	Hours	Basin Rainfall (mm)	Effective Rainfall (mm)	Remarks
Flood No. 1 (Sep. 29 - 30, 1969)				
29	18 - 24	15.72	7.19	Initial loss 2.99 mm
30	0 - 6	8.40	2.86	Loss 5.54 mm/6 hrs
	6 - 12	3.12	-	Runoff coefficient
	12 - 18	0.30	-	36.5%
	Total	27.54	10.05	
Flood No. 2 (Sep. 28 - 30, 1970)				
28	18 - 24	4.98	3.21	Initial loss 0 mm
29	0 - 6	7.44	5.67	Loss 1.77 mm/6 hrs
	6 - 12	0.42	-	
	12 - 18	0.42	-	Runoff coefficient
	18 - 24	4.26	2.47	59.2%
30	0 - 6	1.68	-	
	Total	19.20	11.37	

Table-A22 OBSERVED PEAK FLOOD DISCHARGES

Year	Hernando Lopez (D.A. = 1,565 km^2)			Los Encuentros (D.A. = 6,370 km^2)		
	Date	Peak Discharge (m^3/s)	Order	Date	Peak Discharge (m^3/s)	Order
1954	Sep. 27	652	4	-	-	-
55	Oct. 26	247	10	-	-	-
56	Jun. 18	156	11	-	-	-
57	Oct. 1	116	15	-	-	-
58	Jun. 7	482	7	May 25	547	4
59	Jun. 1	106	16	Oct. 6	169	12
1964	Jul. 25	149	12	Sep. 30	386	9
65	Sep. 26	962	1	Sep. 26	1,227	1
66	Jul. 11	120	13	Oct. 18	480	8
67	Sep. 21	61	18	Jun. 20	252	10
68	May 31	543	5	Sep. 22	505	7
69	Sep. 30	654	3	Jun. 29	525	6
70	Sep. 29	750	2	Sep. 29	654	3
71	Oct. 21	498	6	Oct. 21	540	5
72	Jun. 11	79	17	Jun. 8	194	11
73	Oct. 26	395	9	Oct. 26	686	2
74	Jun. 21	119	14	-	-	-
75	Oct. 19	397	8	-	-	-

Table-A23 ANNUAL MAXIMUM BASIN RAINFALL (mm)

Year	San Fernando damsite	Morolica damsite	Tegusigalpa point rainfall
1-day Rainfall			
1968	60.7	33.0	83.3
69	37.9	21.3	44.9
70	38.7	19.8	65.2
71	31.6	25.2	46.7
72	38.8	22.6	34.3
73	60.0	36.5	60.5
74	55.5	50.8	66.7
75	48.5	37.9	86.0
76	48.4	54.0	44.5
2-day Rainfall			
1968	99.0	59.8	111.6
69	48.3	37.1	65.1
70	65.8	37.2	81.8
71	49.0	39.6	68.3
72	48.1	30.4	48.0
73	70.0	51.8	69.9
74	76.3	73.1	88.7
75	61.2	53.5	100.5
76	91.1	85.2	59.8

Table-A24 PROBABLE BASIN RAINFALL (mm)

Return Period (Years)	San Fernando damsite	Morolica damsite
1-day Rainfall		
2	44.5	32.5
5	56.5	44.5
10	64.5	52.5
20	72.0	60.0
50	82.0	70.0
100	90.0	77.5
200	97.0	85.0
1.000	115.0	102.0
2-day Rainfall		
2	65.5	50.0
5	82.5	68.0
10	94.0	79.5
20	105.0	91.0
50	119.5	107.0
100	130.0	118.0
200	141.0	129.0
1.000	164.5	155.0

Table-A25 (1) PROBABLE BASIN RAINFALL FOR SAN FERNANDO DAMSITE

Return Period (Year)	Duration of Time (Hour) 0-6	6-12	12-18	18-24	24-30	30-36	36-42	42-48
2	25.6	15.2	3.2	0.5	12.1	7.2	1.5	0.3
5	32.5	19.3	4.0	0.7	15.0	8.9	1.8	0.3
10	37.2	21.9	4.6	0.8	17.0	10.1	2.1	0.4
20	41.5	24.5	5.1	0.9	19.0	11.3	2.3	0.4
50	47.2	28.0	5.8	1.0	21.6	12.8	2.7	0.5
100	51.8	30.7	6.4	1.1	23.0	13.6	2.8	0.5
200	55.9	33.0	6.9	1.2	25.3	15.0	3.1	0.5
1.000	66.2	39.3	8.1	1.4	28.5	16.9	3.5	0.6

Table-A25 (2) PROBABLE EFFECTIVE RAINFALL FOR SAN FERNANDO DAMSITE

Return Period (Year)	Duration of Time (Hour) 0-6	6-12	12-18	18-24	24-30	30-36	36-42	42-48
2	5.6	5.2	-	-	2.1	-	-	-
5	12.5	9.3	-	-	5.0	-	-	-
10	17.2	11.9	-	-	7.0	0.1	-	-
20	21.5	14.5	-	-	9.0	1.3	-	-
50	27.2	18.0	-	-	11.6	2.8	-	-
100	31.8	20.7	-	-	13.0	3.6	-	-
200	35.8	23.0	-	-	15.3	5.0	-	-
1.000	46.2	29.3	-	-	18.5	6.9	-	-

Note: Initial Loss: 10 mm

Infiltration and Evapotranspiration Loss: 10 mm/6 hrs.

Table-A26(1) PROBABLE BASIN RAINFALL FOR MOROLICA DAMSITE

Return Period (Year)	Duration of Time (Hour) 0-6	6-12	12-18	18-24	24-30	30-36	36-42	42-48
2	18.7	11.1	2.3	0.4	10.1	6.0	1.2	0.2
5	25.6	15.2	3.2	0.5	13.5	8.0	1.7	0.3
10	30.2	17.9	3.8	0.6	15.6	9.2	1.9	0.3
20	34.6	20.4	4.3	0.7	17.9	10.6	2.2	0.4
50	40.3	23.9	5.0	0.8	21.3	12.6	2.6	0.4
100	44.6	26.5	5.5	0.9	23.3	13.8	2.9	0.5
200	49.0	28.9	6.1	1.0	25.3	15.0	3.1	0.5
1.000	58.8	34.7	7.3	1.2	30.5	18.1	3.8	0.6

Table-A26 (2) PROBABLE EFFECTIVE RAINFALL FOR MOROLICA DAMSITE

Return Period (Year)	Duration of Time (Hour) 0-6	6-12	12-18	18-24	24-30	30-36	36-42	42-48
2	3.7	1.1	-	-	0.1	-	-	-
5	10.6	5.2	-	-	3.5	-	-	-
10	15.2	7.9	-	-	5.6	-	-	-
20	19.6	10.4	-	-	7.9	0.6	-	-
50	25.3	13.9	-	-	11.3	2.6	-	-
100	29.6	16.5	-	-	13.3	3.8	-	-
200	34.0	18.9	-	-	15.3	5.0	-	-
1.000	43.8	24.7	-	-	20.5	8.1	-	-

Note: Initial Loss : 5 mm

Infiltration and Evapotranspiration Loss 10 mm/6 hrs.

Table-A27 RESERVOIR EVAPORATION AT SAN FERNANDO DAMSITE

Month	A-pan Evaporation at La Venta (mm)	Reservoir Evaporation at San Fernando (mm)
Jan.	92	64
Feb.	121	85
Mar.	179	125
Apr.	185	130
May	169	118
Jun.	129	90
Jul.	119	83
Aug.	126	88
Sep.	130	91
Oct.	108	76
Nov.	82	57
Dec.	83	58
Annual	1,523	1,065

Table-A28 RESERVOIR EVAPORATION AT MOROLICA DAMSITE

Month	Averaged A-pan Evaporation of Higher Stations /1 (mm) (1)	Lower Stations /2 (mm) (2)	Evaporation at Morolica /3 (mm) (3)	Reservoir Evaporation /1 at Morolica (mm) (4)
Jan.	109	279	242	169
Feb.	133	276	245	172
Mar.	187	314	286	200
Apr.	188	269	251	176
May	167	259	239	167
Jun.	127	199	183	128
Jul.	126	207	189	132
Aug.	130	200	185	130
Sep.	122	168	158	111
Oct.	109	166	153	107
Nov.	94	193	171	120
Dec.	99	247	214	150
Annual	1,591	2,777	2,516	1,762

/1 : Average of the Tegucigalpa, La Venta and Paso La Ceiba data, averaged altitude El. 827 m.

/2 : Average of the Los Encuentros and Choluteca data, averaged altitude El. 74 m.

/3 : $(1)\times\frac{240-74}{827-74}+(2)\times\frac{827-240}{827-74}$, El. 240 m at Morolica

/4 : (3)x 0.7 (Conversion Factor)

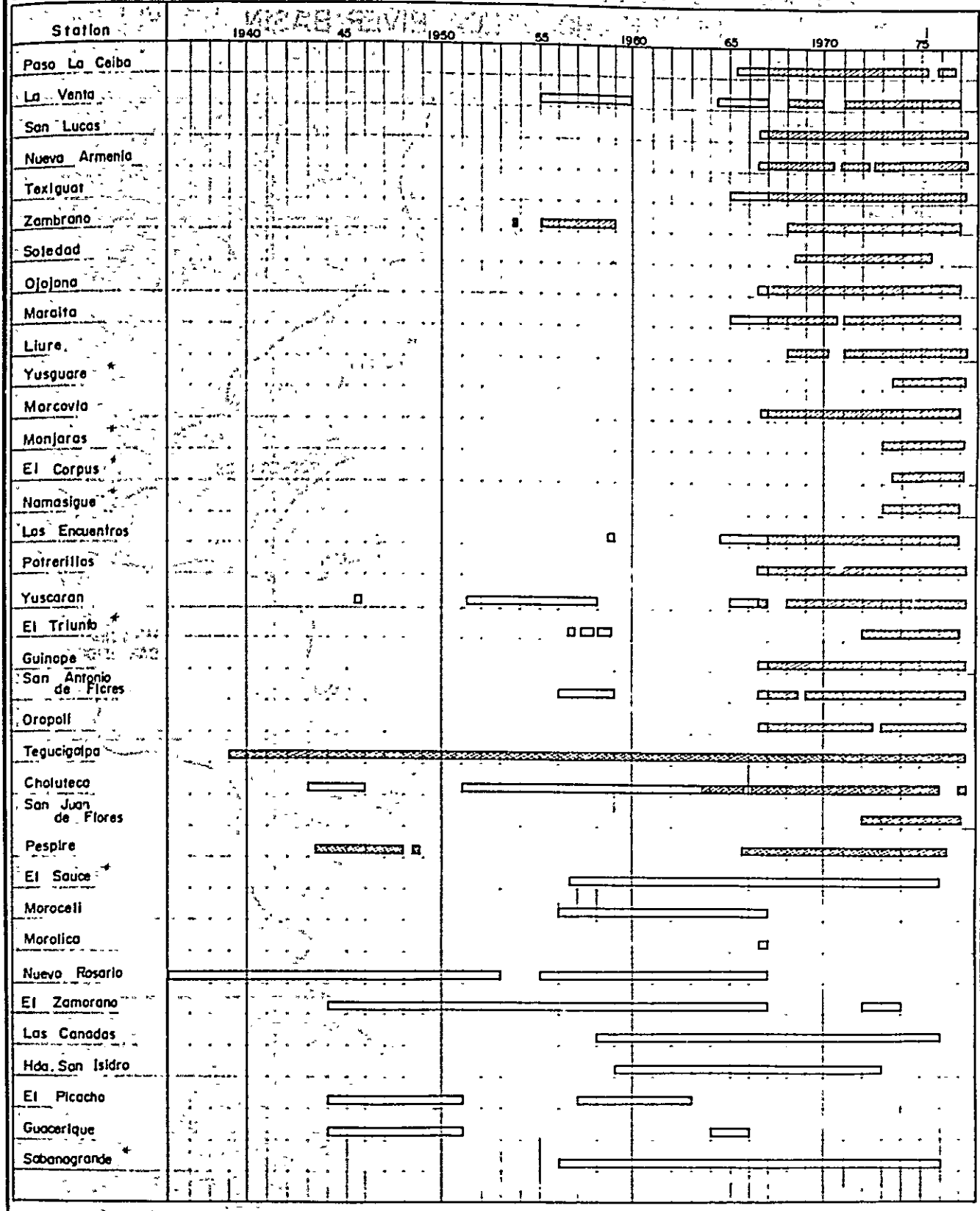
Table-A29 SEDIMENT VOLUME ESTIMATED IN PAST FEASIBILITY STUDIES IN HONDURAS

Name of Project	Nacaome Irrigation Project	El Cajon Hydropower Project	Choluteca Irrigation Project
Organization concerned	MRN /1	ENEE /2	MRN /1
Consultant	Motor Columbus	Motor Columbus	IECO
Studied Year	1972	1974	1968
Annual average discharge volume	$1,102 \times 10^6$ m^3	$4,400 \times 10^6$ m^3	416×10^6 m^3
Estimated annual sediment volume	$0.69\text{-}1.37 \times 10^6$ m^3	4.9×10^6 m^3	1.1×10^6 m^3
Drainage area	1,836 km^2	8,300 km^2	1,665 km^2
Annual sediment per km^2 of drainage area	380 - 750 m^3	590 m^3	660 m^3
Annual sediment volume per 10^6 m^3 of discharge	630 - 1,240 m^3	1,110 m^3	2,640 m^3

/1 : Ministry of Natural Resources

/2 : National Company of Electric Energy

Fig.-A1 AVAILABLE RAINFALL DATA



NOTE :

- Daily data collected
- 6-hr data collected
- Monthly data collected

* Stations located out of the Choluteca river basin

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Fig.-A2 LOCATION OF CLIMATOLOGICAL STATIONS IN THE CHOLUTECA RIVER BASIN

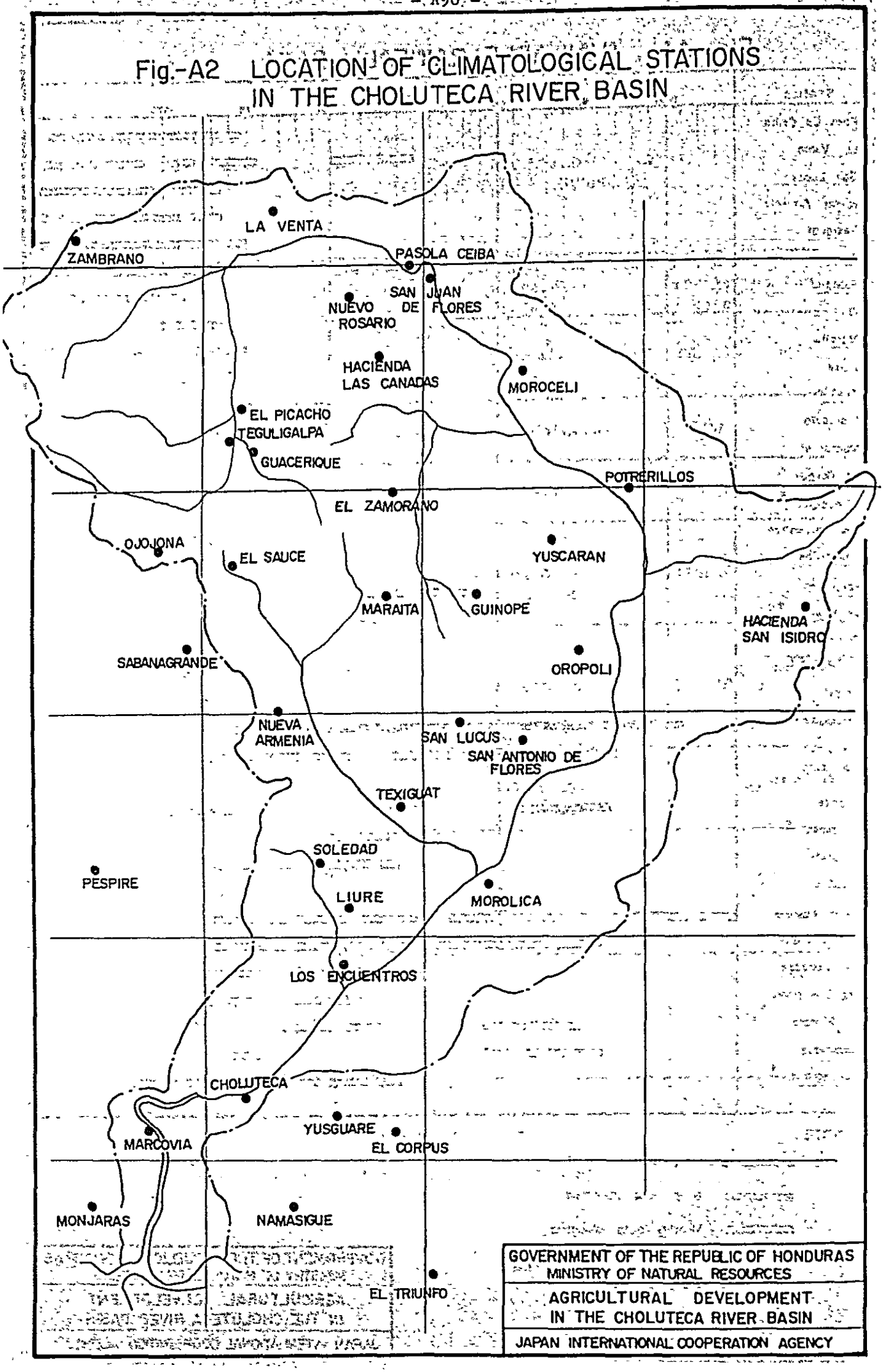

Fig.-A3 LOCATION OF DISCHARGE GAUGING STATIONS IN THE CHOLUTECA RIVER BASIN

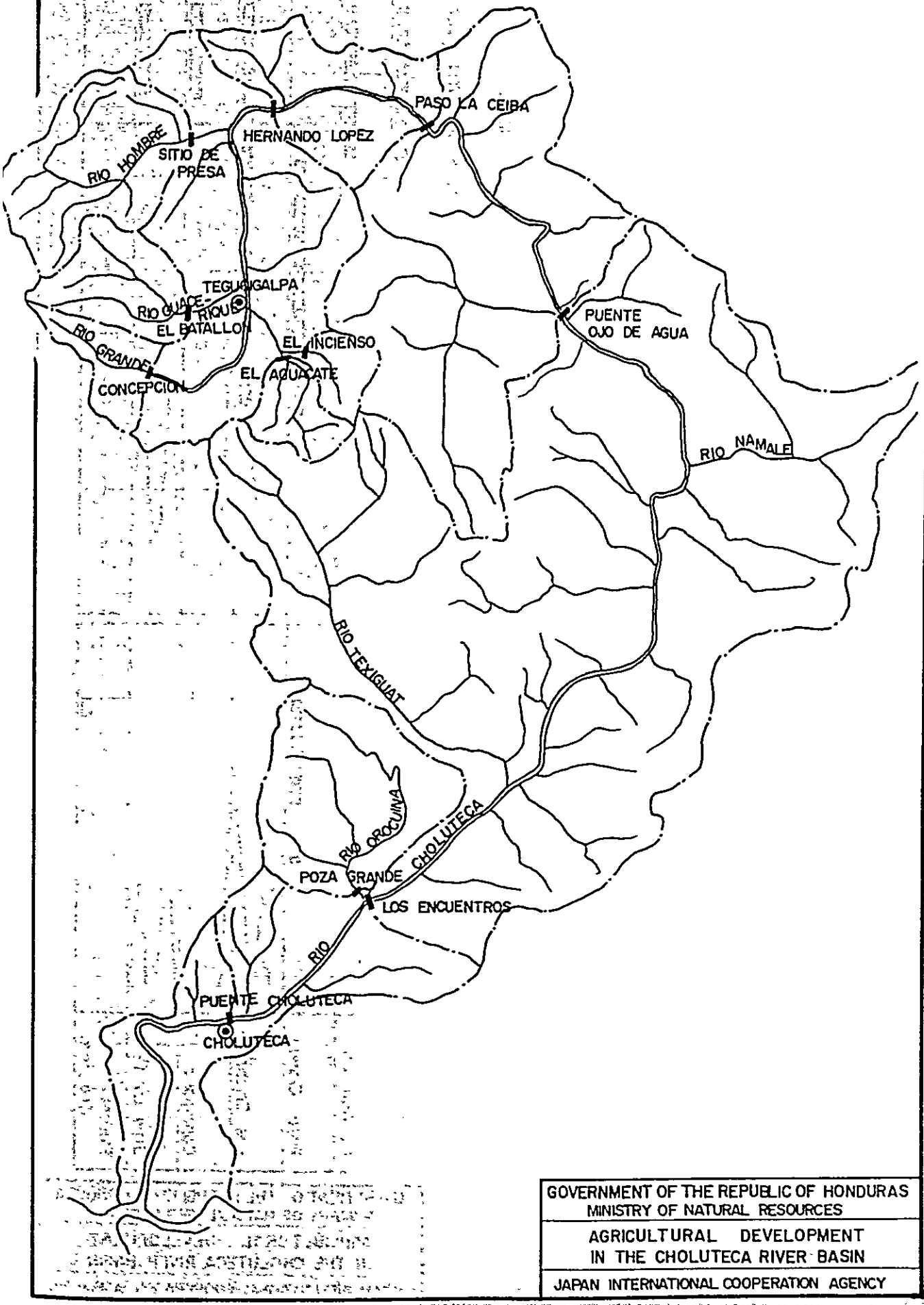

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Fig.- A4 AVAILABLE DAILY DISCHARGE DATA IN THE CHOLUTECA RIVER BASIN

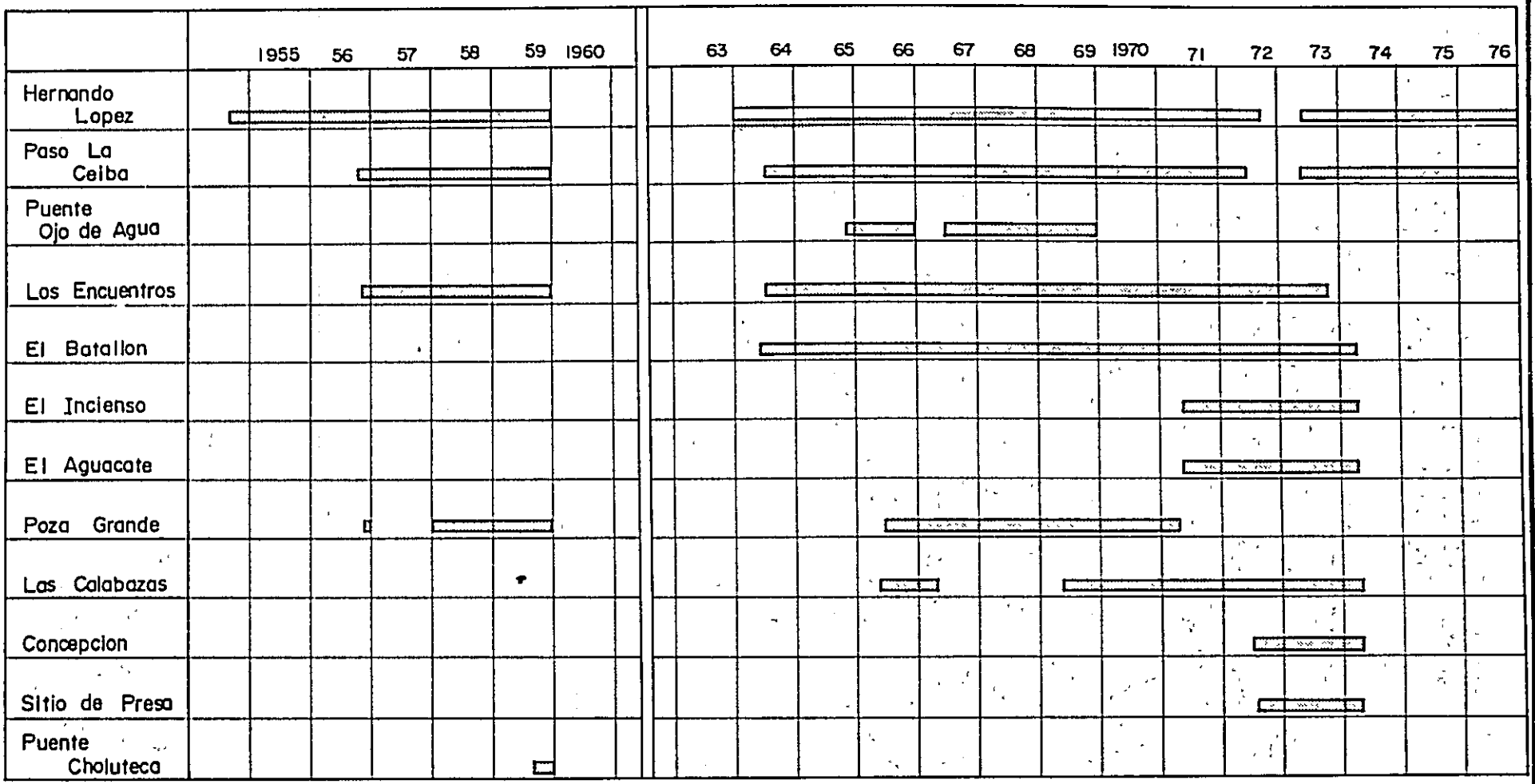

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Fig. - A6 COMPUTED AND OBSERVED MONTHLY DISCHARGES AT LOS ENCUENTROS

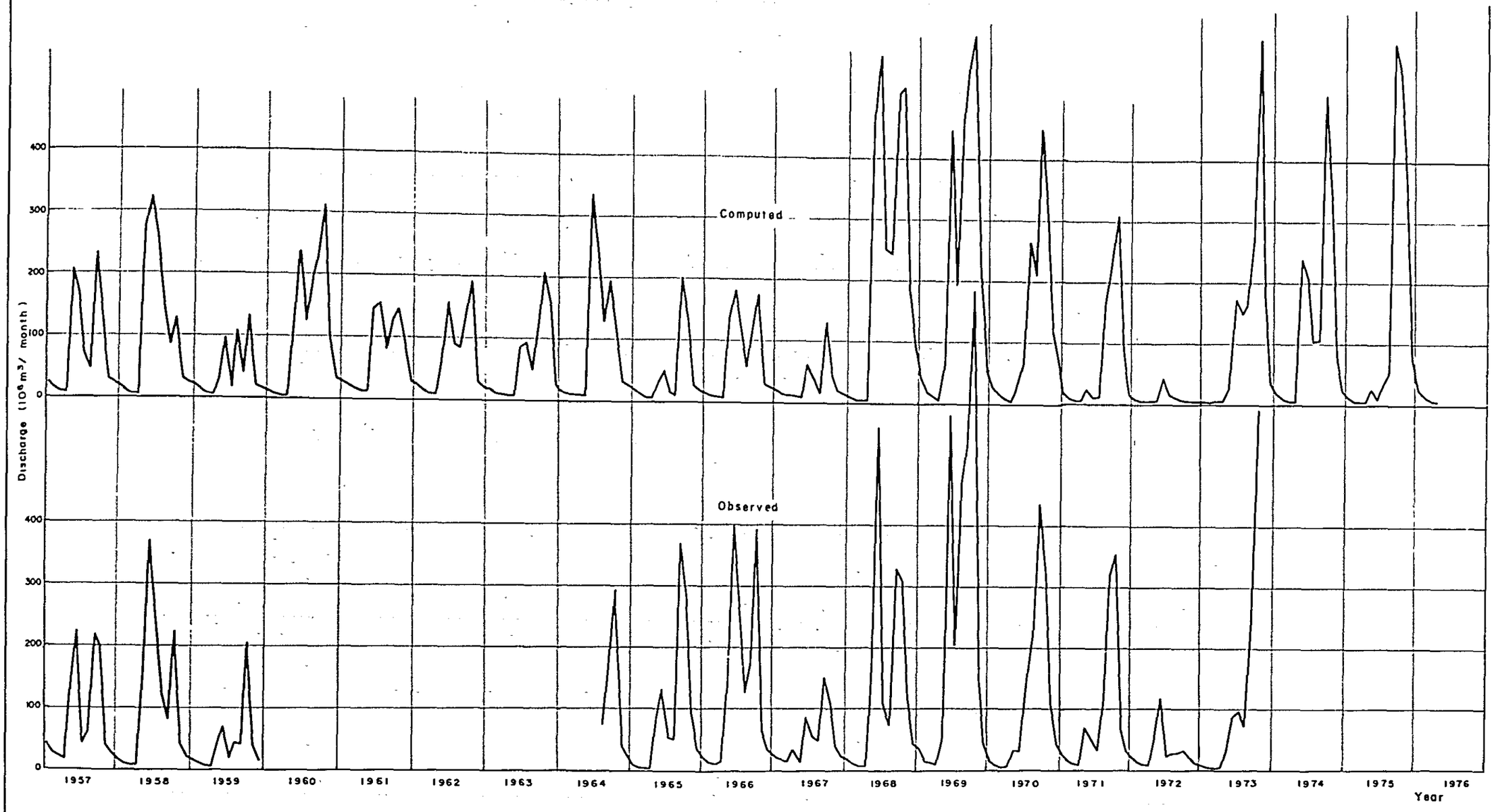

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Fig. - A5 COMPUTED AND OBSERVED MONTHLY DISCHARGES AT HERNANDO LOPEZ

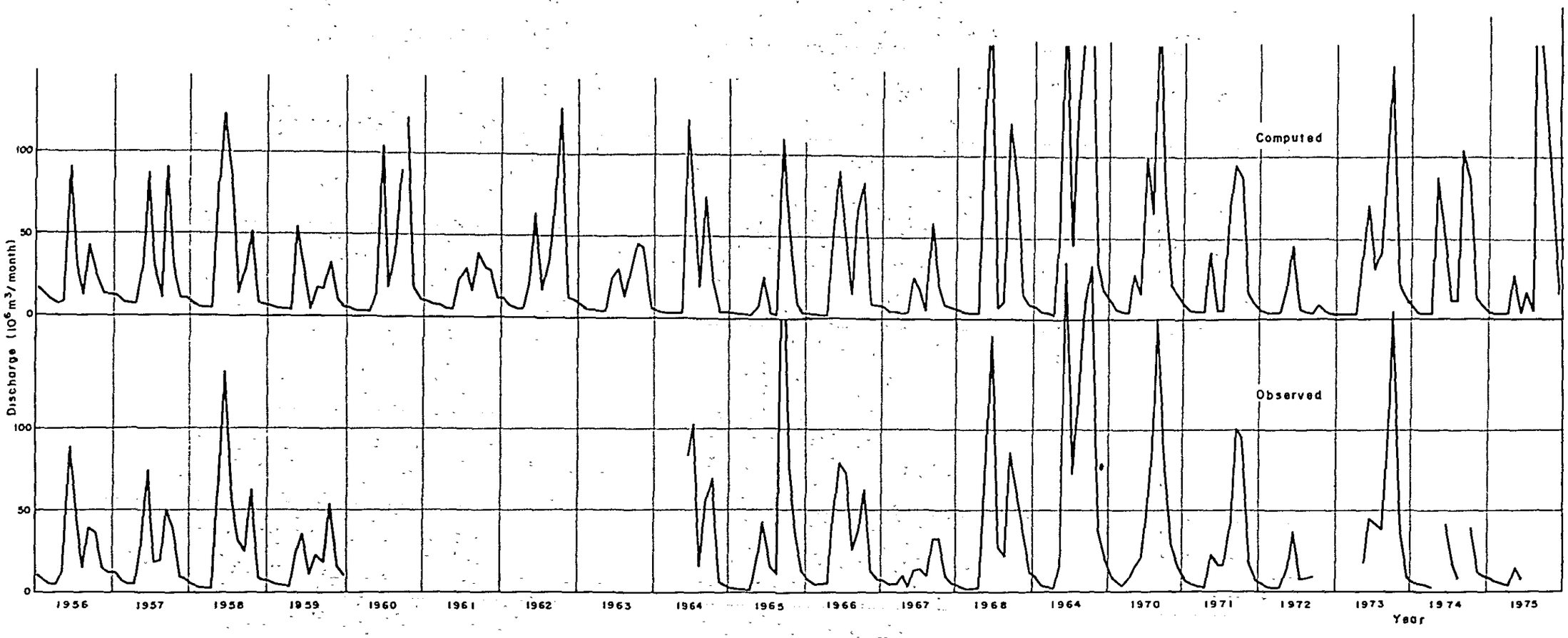

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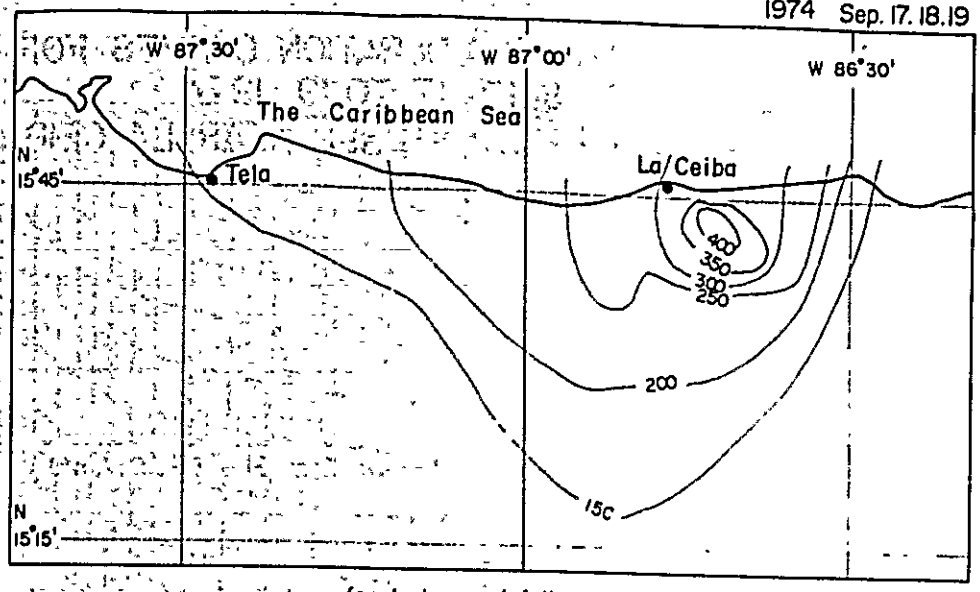
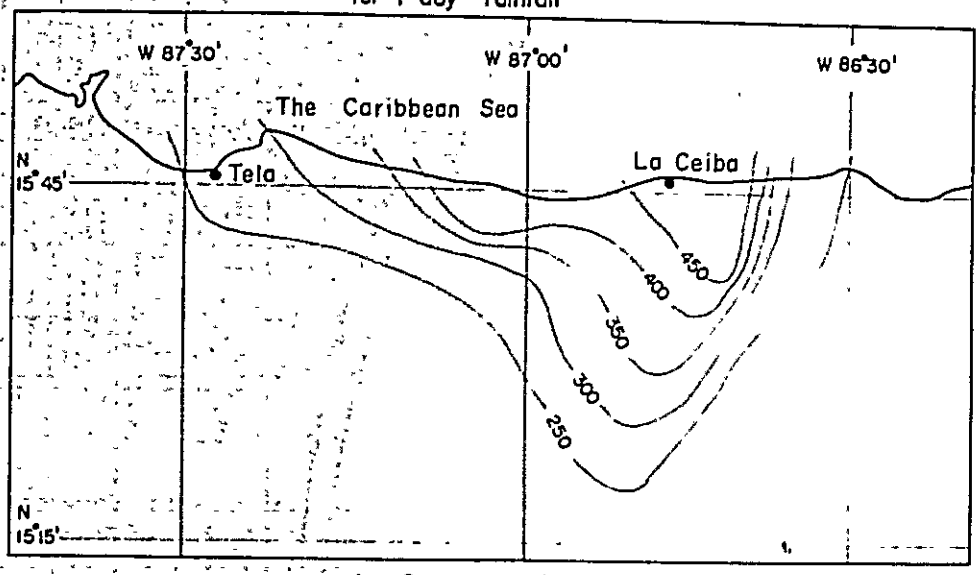
Fig.-A7 ISOHYET CURVES AT HARRICANE FIFI

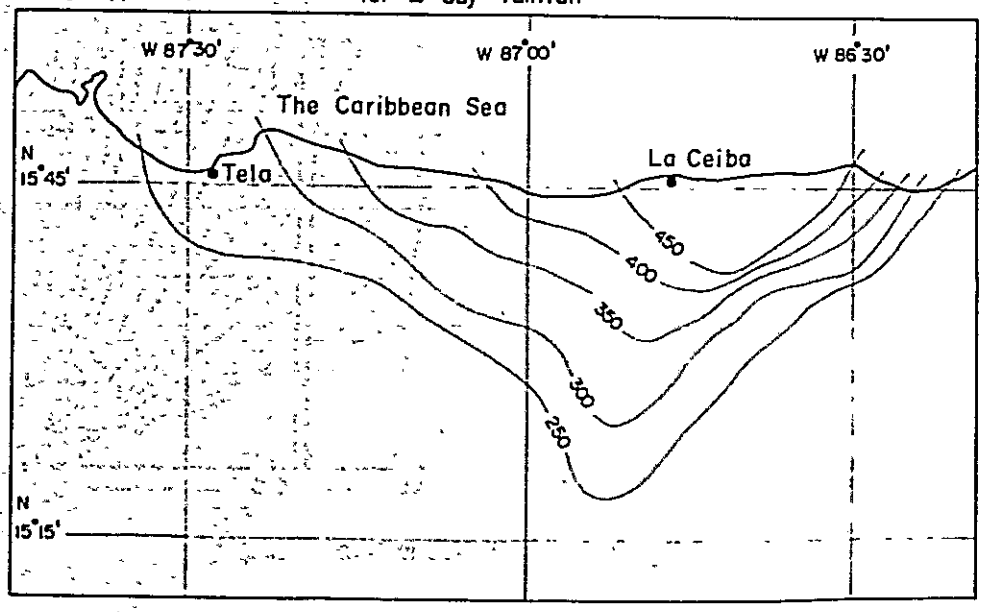
1974 Sep. 17. 18. 19



for 1-day rainfall



for 2-day rainfall



for 3-day rainfall

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Fig.-A8 MAXIMUM DEPTH-AREA-DURATION CURVES FOR THE STORM OF SEPT. 17 TO 19, 1974 (HURRICANE FIFI), CENTERED NEAR LA CEIBA

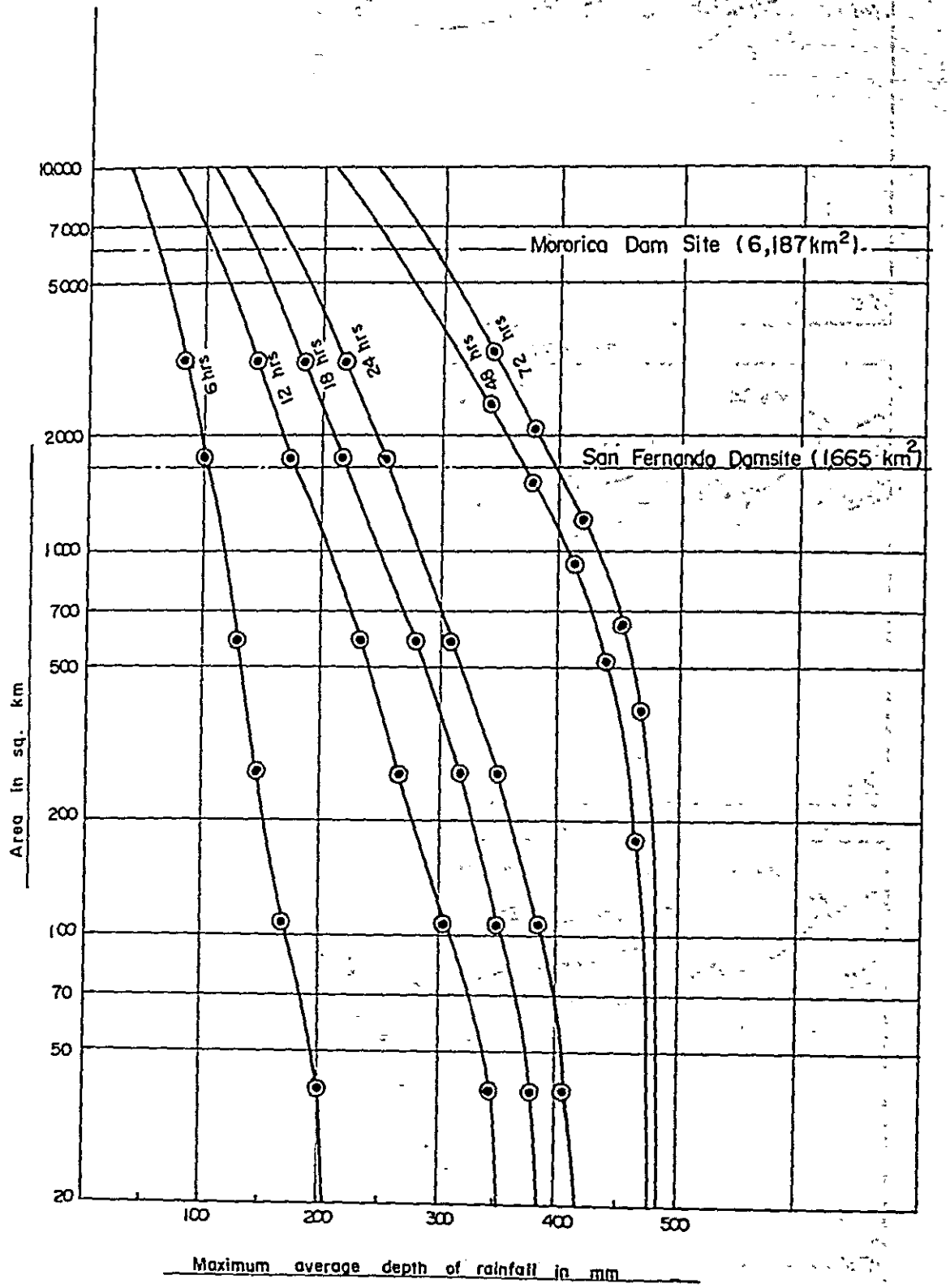

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Fig.-A9 PRESSURE-SURFACE DEWPOINT CURVES

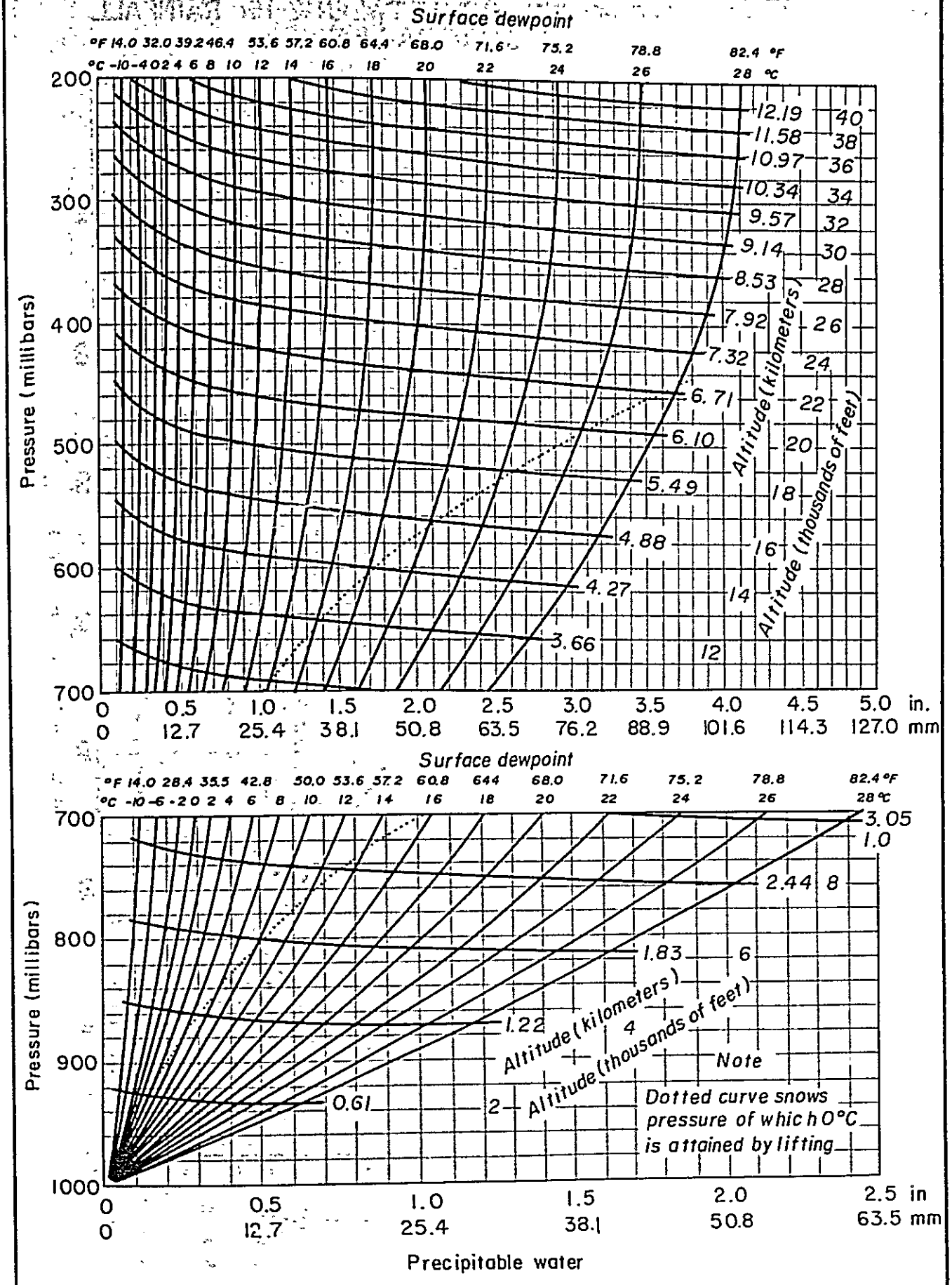

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Fig.-A10 THE RELATIONSHIP BETWEEN 2-HR RAINFALL AND 6-HR RAINFALL

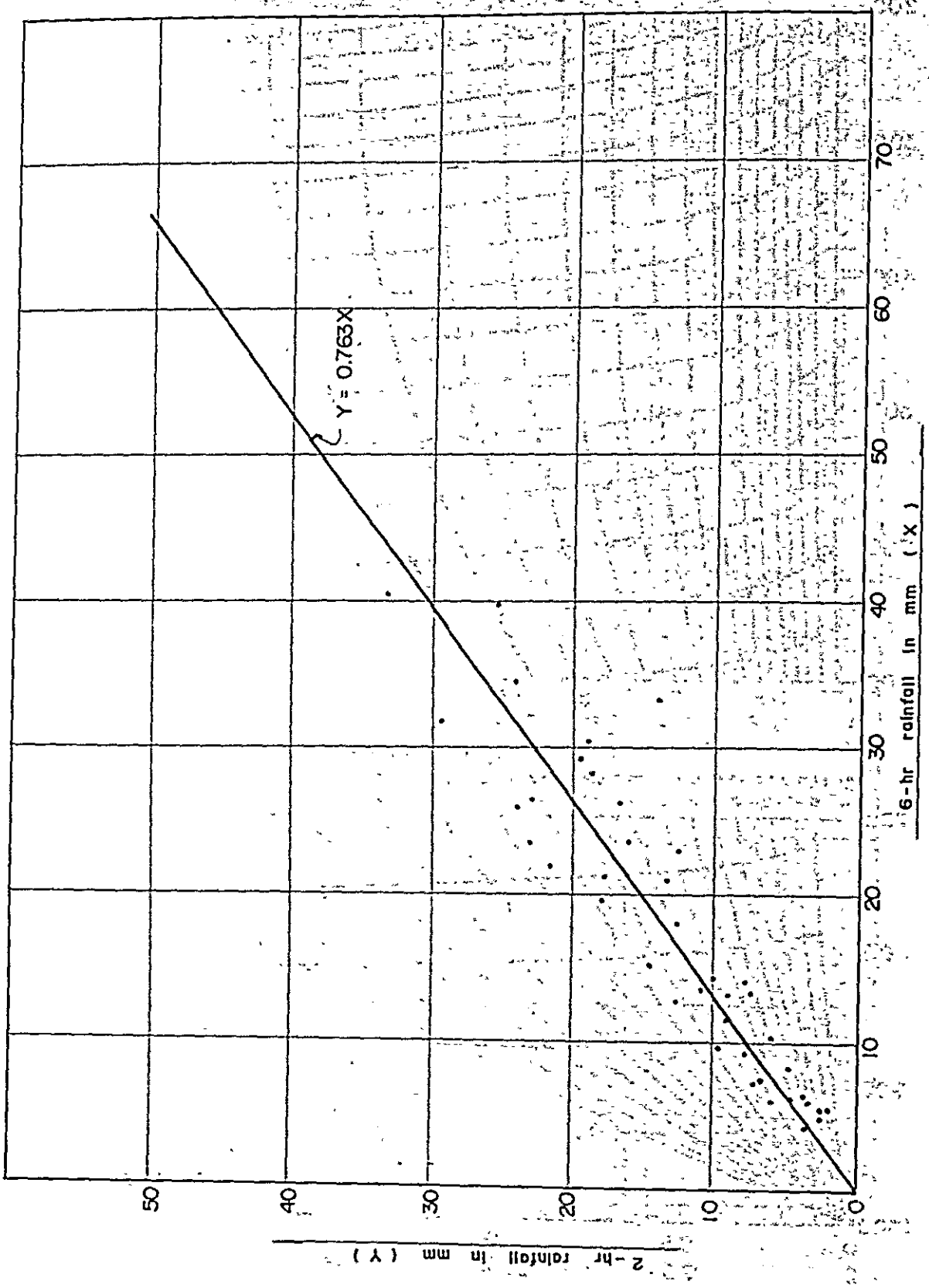

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Fig.-A11(1-1) RECORDED AND CALCULATED HYDROGRAPHS AT HERNANDO LOPEZ FLOOD No. 1

Tp = 9.0
Tk = 6.0

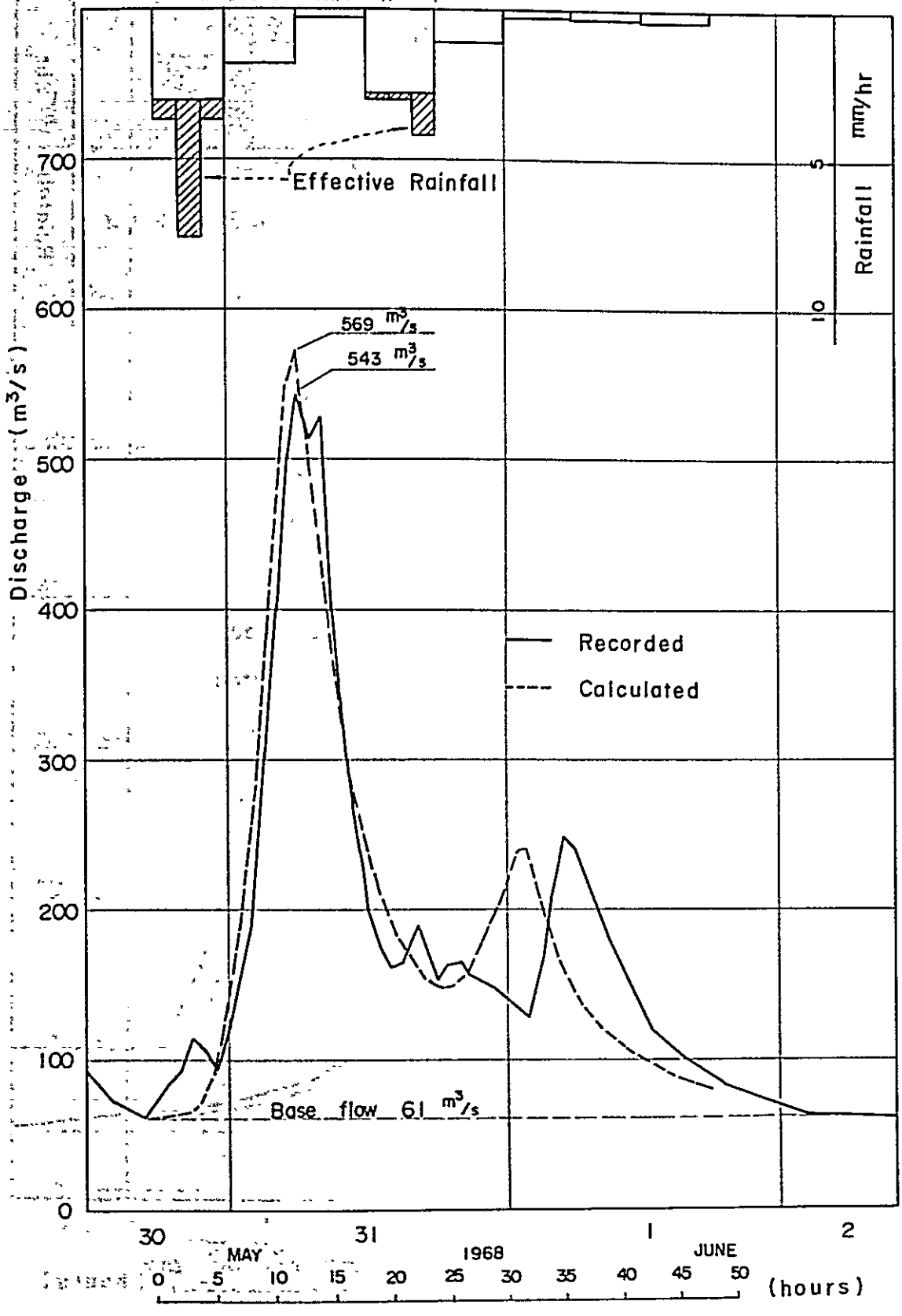

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Fig.-A11(2) RECORDED AND CALCULATED HYDROGRAPHS AT HERNANDO LOPEZ FLOOD No. 2

Tp = 9.0
Tk = 6.0

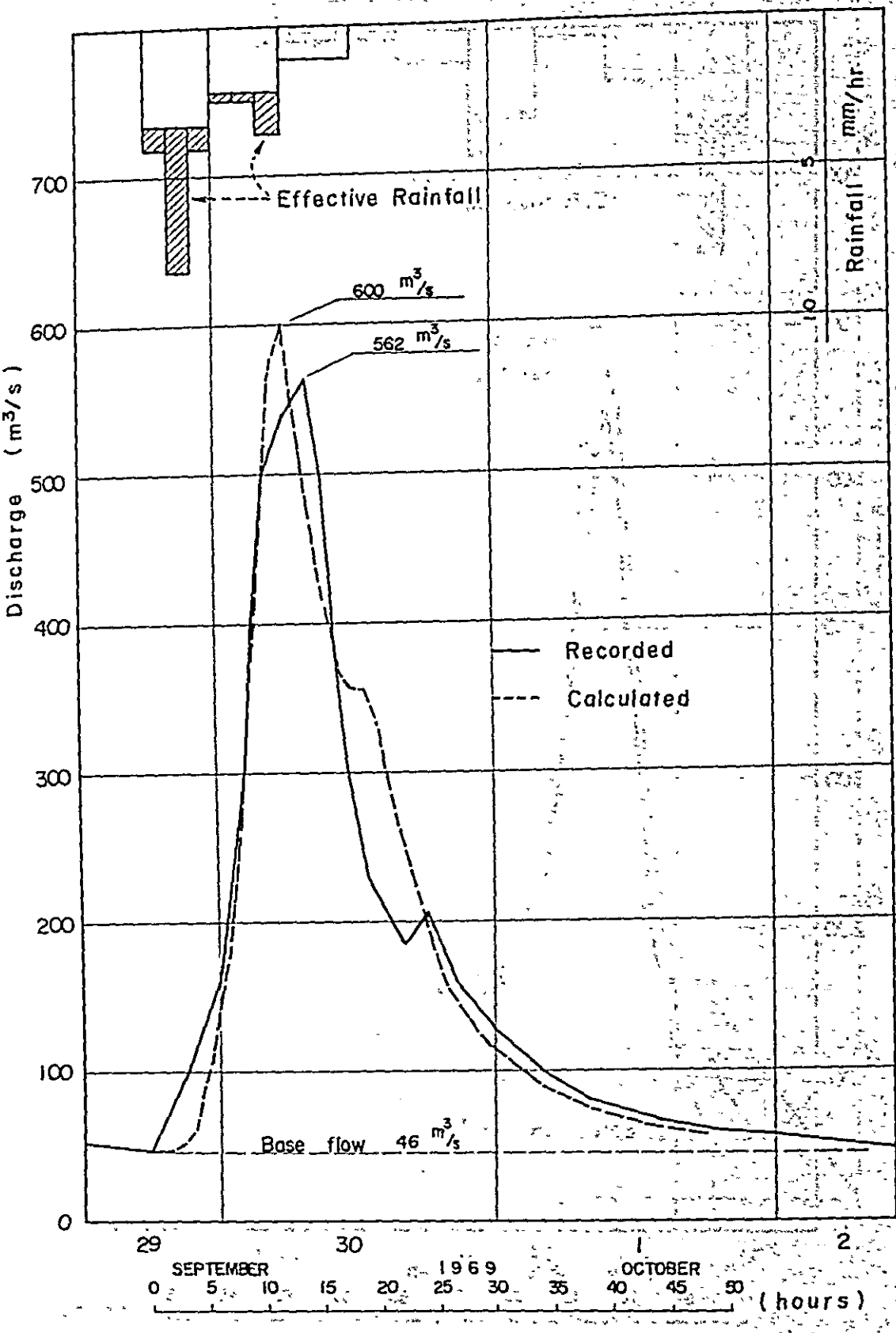

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Fig. A1.1(3) RECORDED AND CALCULATED HYDROGRAPHS AT HERNANDO LOPEZ FLOOD No. 3

Tp = 9.0
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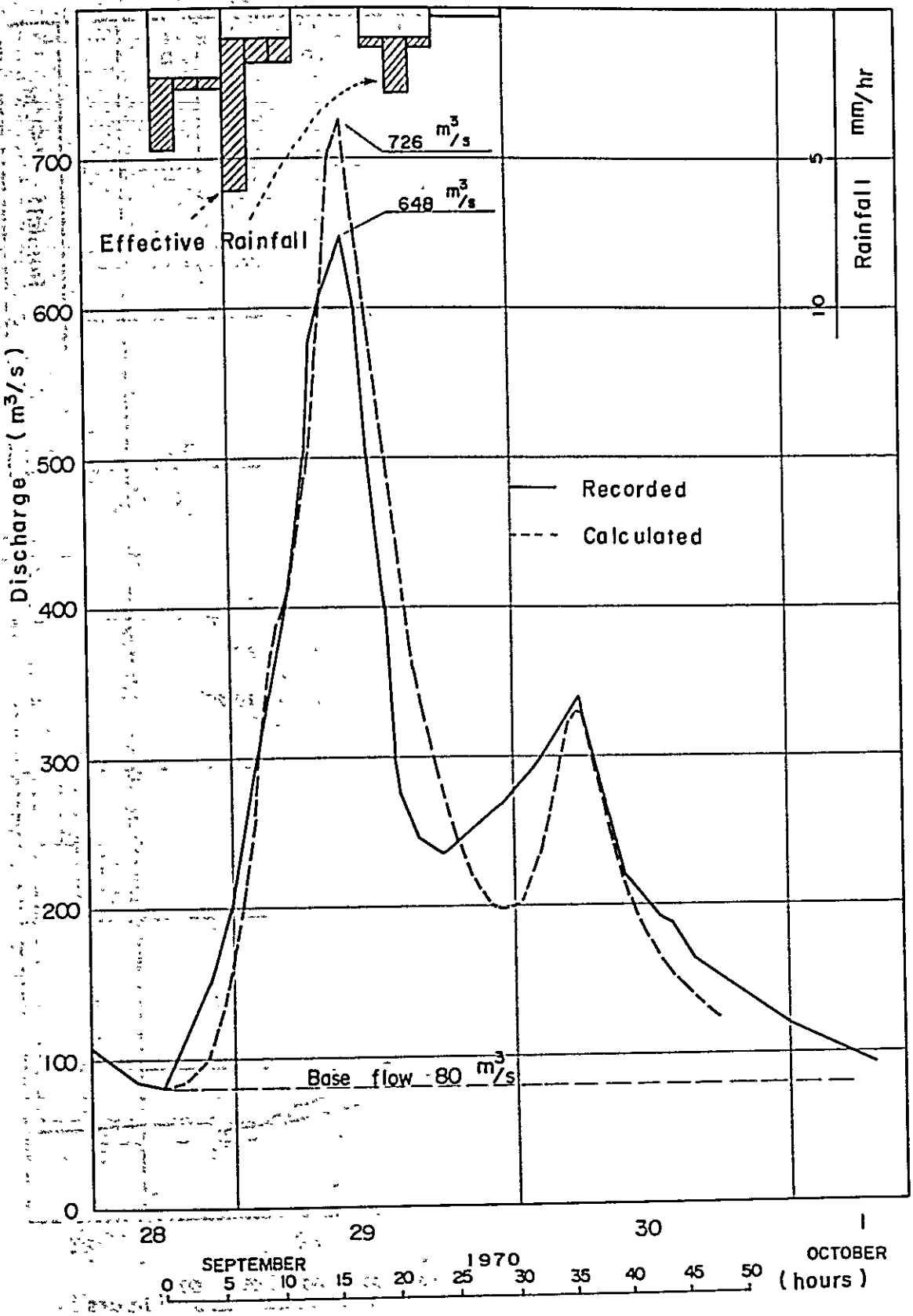

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Fig.-A11(4) RECORDED AND CALCULATED HYDROGRAPHS AT HERNANDO LOPEZ FLOOD No.4

Tp = 9.0
Tk = 6.0

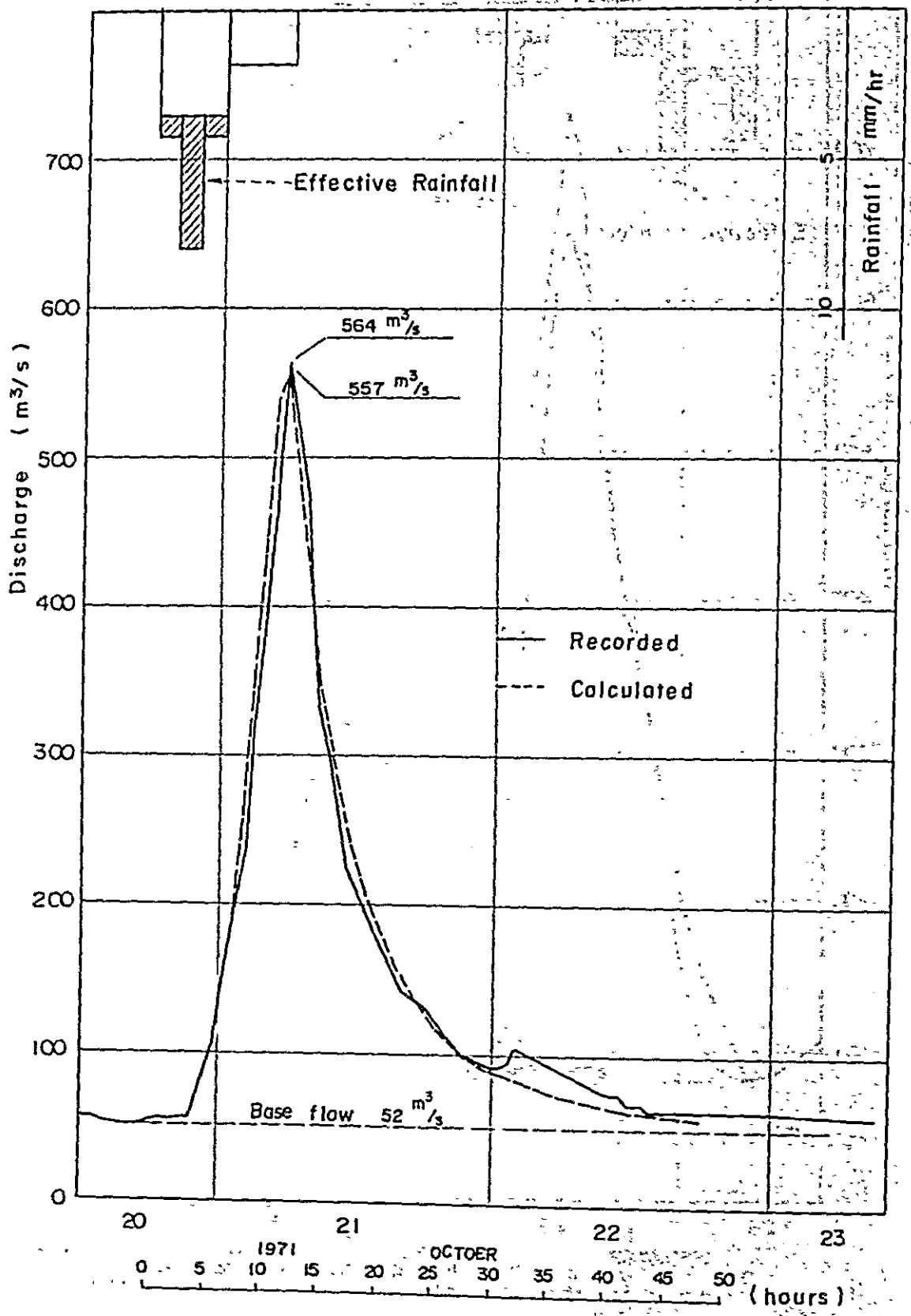

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Fig.-A12(1) RECORDED AND CALCULATED HYDROGRAPHS AT LOS ENCUENTROS FLOOD No.1

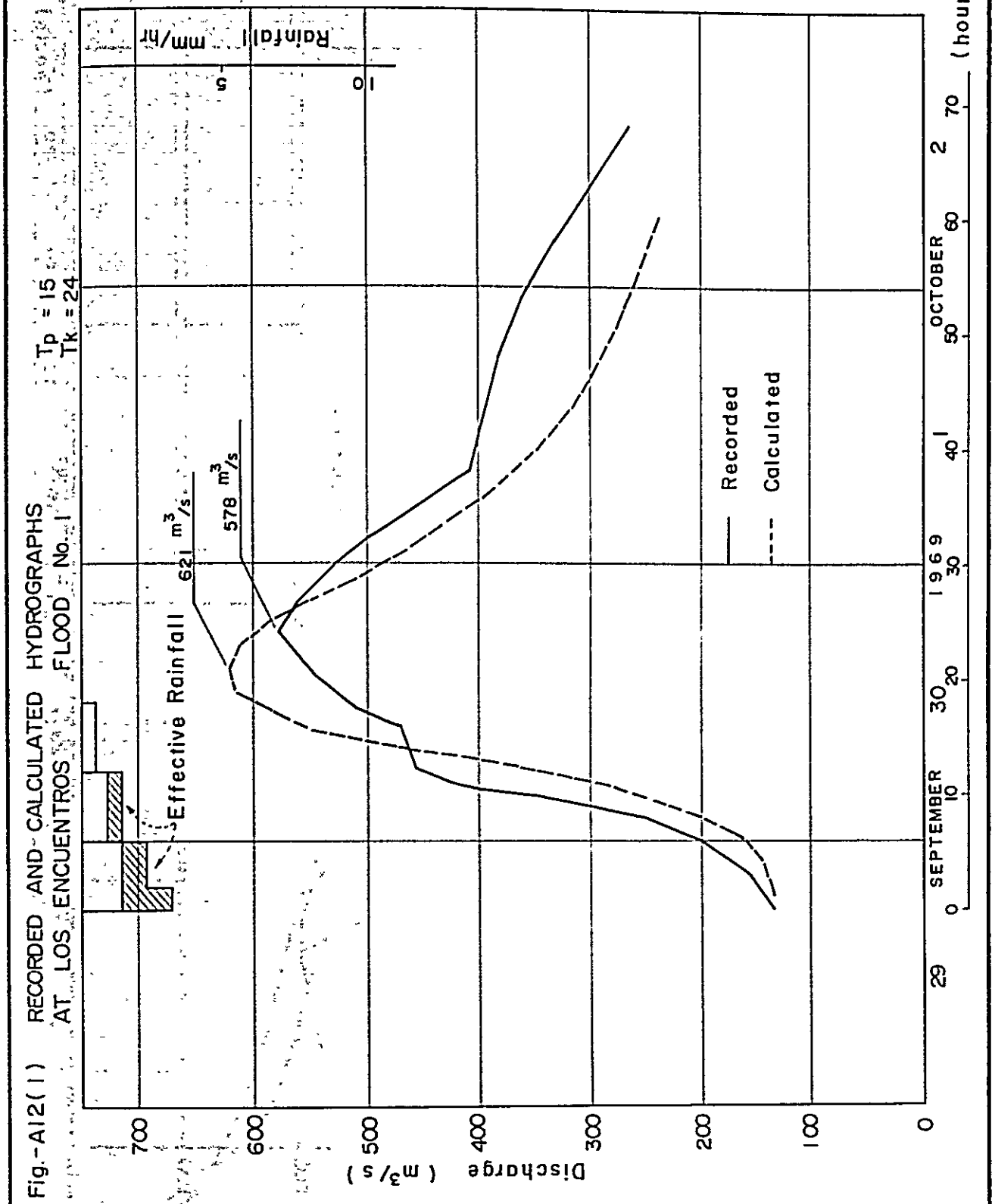

Fig.-A12(1) RECORDED AND CALCULATED HYDROGRAPHS AT LOS ENCUENTROS FLOOD No.1

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Fig.-A12(2) RECORDED AND CALCULATED HYDROGRAPHS AT LOS ENCUENTROS FLOOD No.2

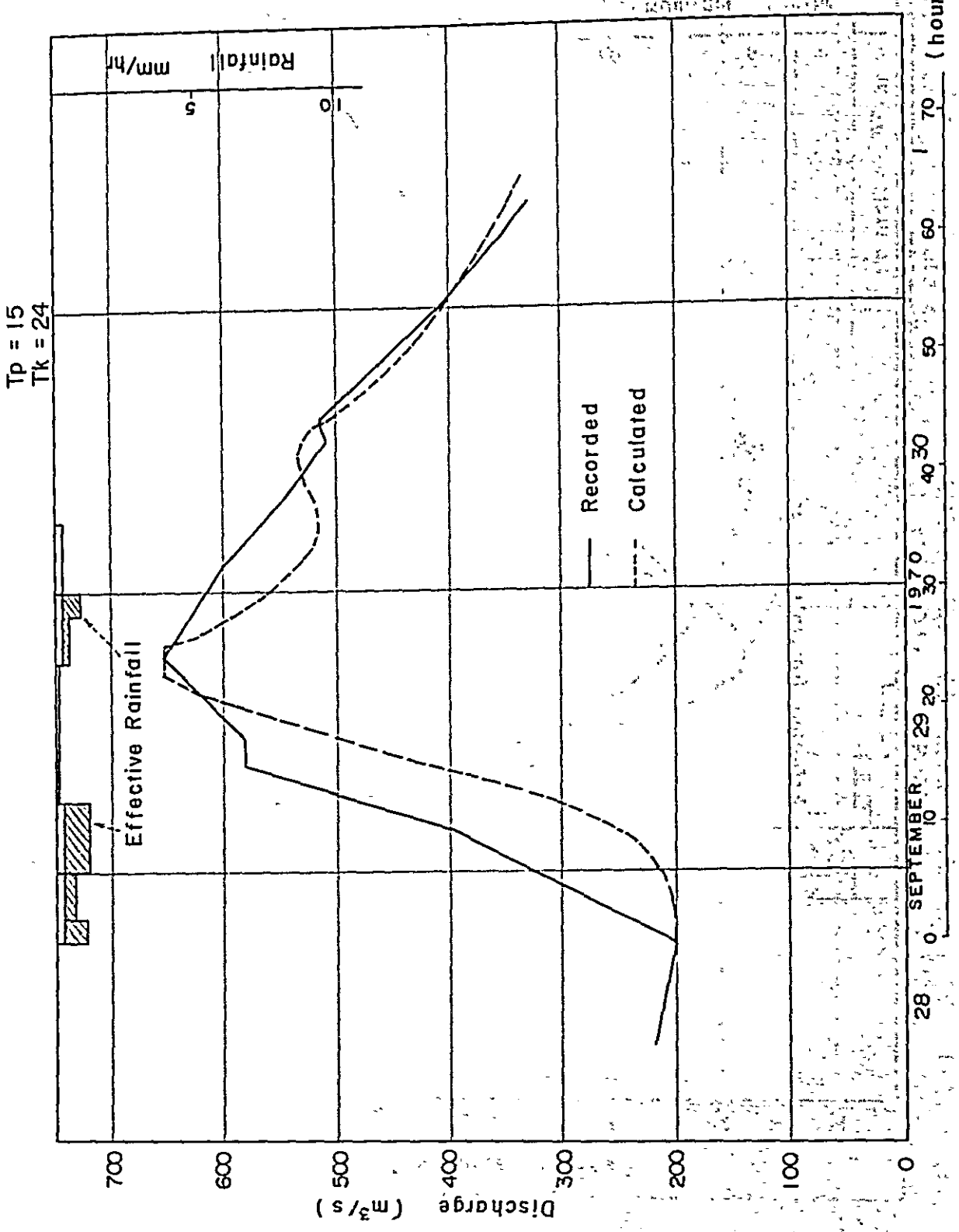

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Fig.-A13 PROBABLE MAXIMUM FLOOD

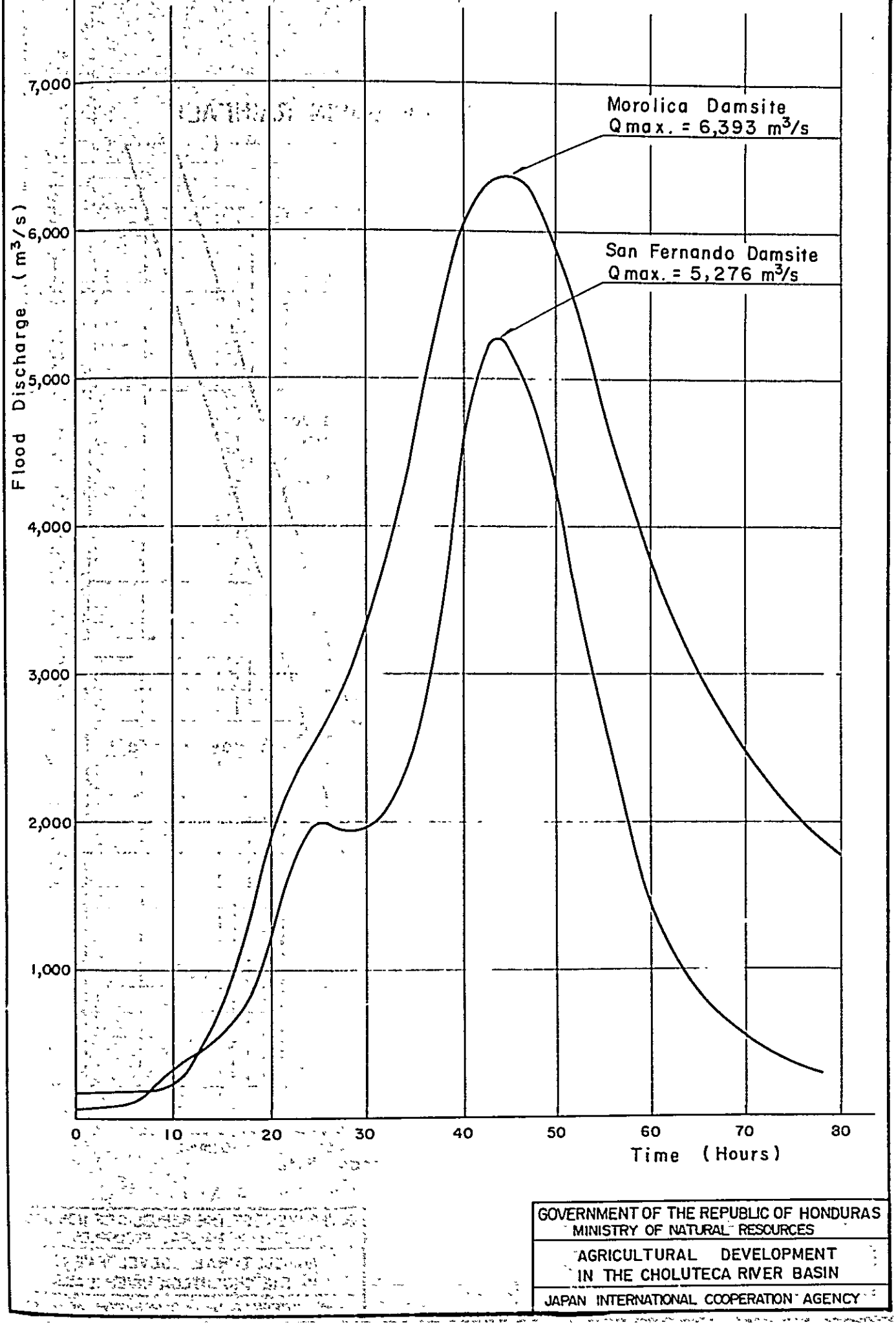

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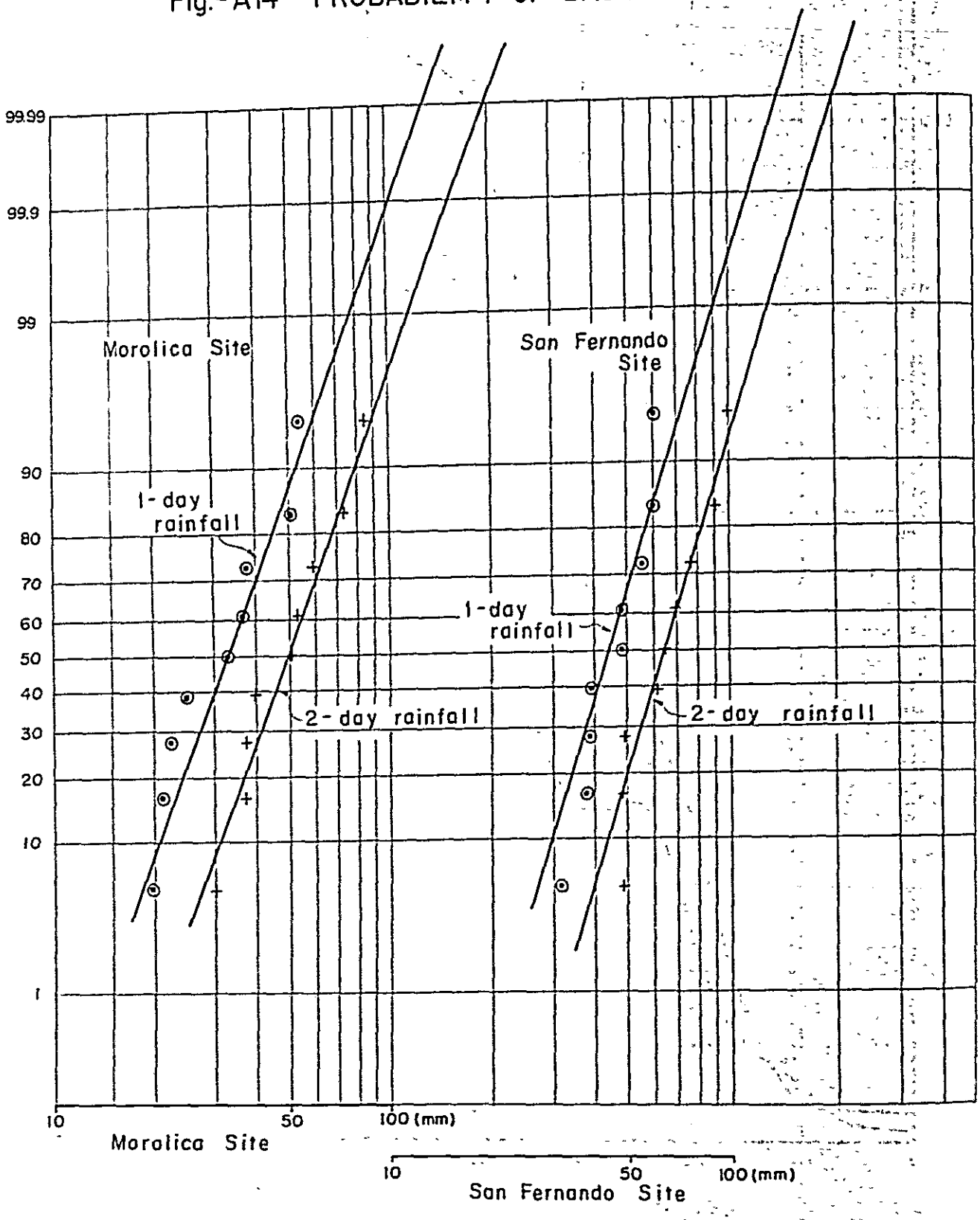
Fig.-A14 PROBABILITY OF BASIN RAINFALL



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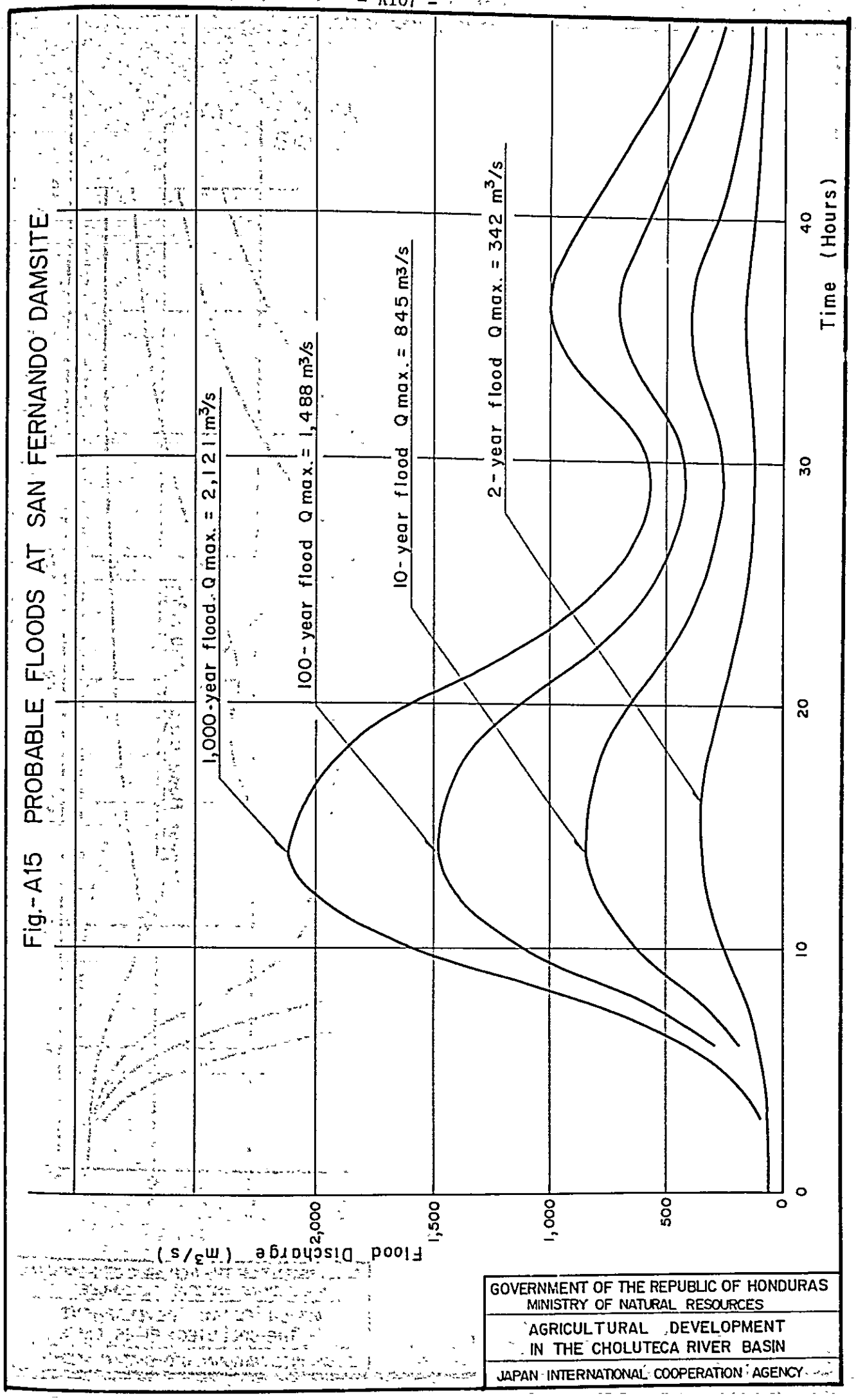
Fig.-A15 PROBABLE FLOODS AT SAN FERNANDO DAMSITE
1,000-year flood, Q max. = 2,121 m³/s
100-year flood Q max. = 1,488 m³/s
10-year flood Q max. = 845 m³/s
2-year flood Q max. = 342 m³/s
Flood Discharge (m³/s)
2,000
1,500
1,000
500
0
0
10
20
30
40
Time (Hours)
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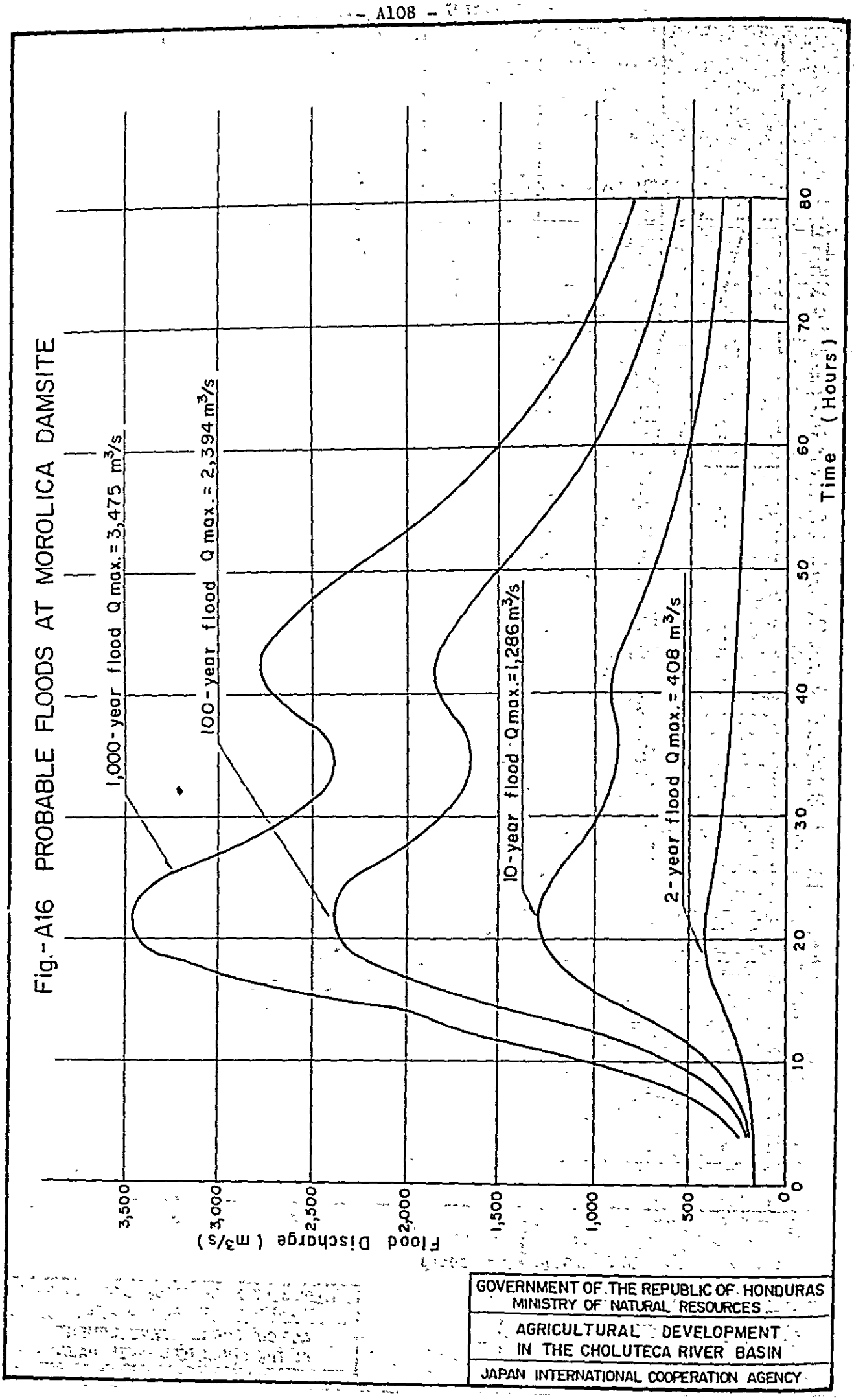
Fig.-A16 PROBABLE FLOODS AT MOROLICA DAMSITE
1,000-year flood Q max.=3,475 m³/s
100-year flood Q max.=2,394 m³/s
10-year flood Q max.=1,286 m³/s
2-year flood Q max.=408 m³/s
Flood Discharge (m³/s)
3,500
3,000
2,500
2,000
1,500
1,000
500
0
Time (Hours)
0
10
20
30
40
50
60
70
80
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Fig.-A17 ASSUMED TAILWATER CURVE AT SAN FERNANDO DAMSITE

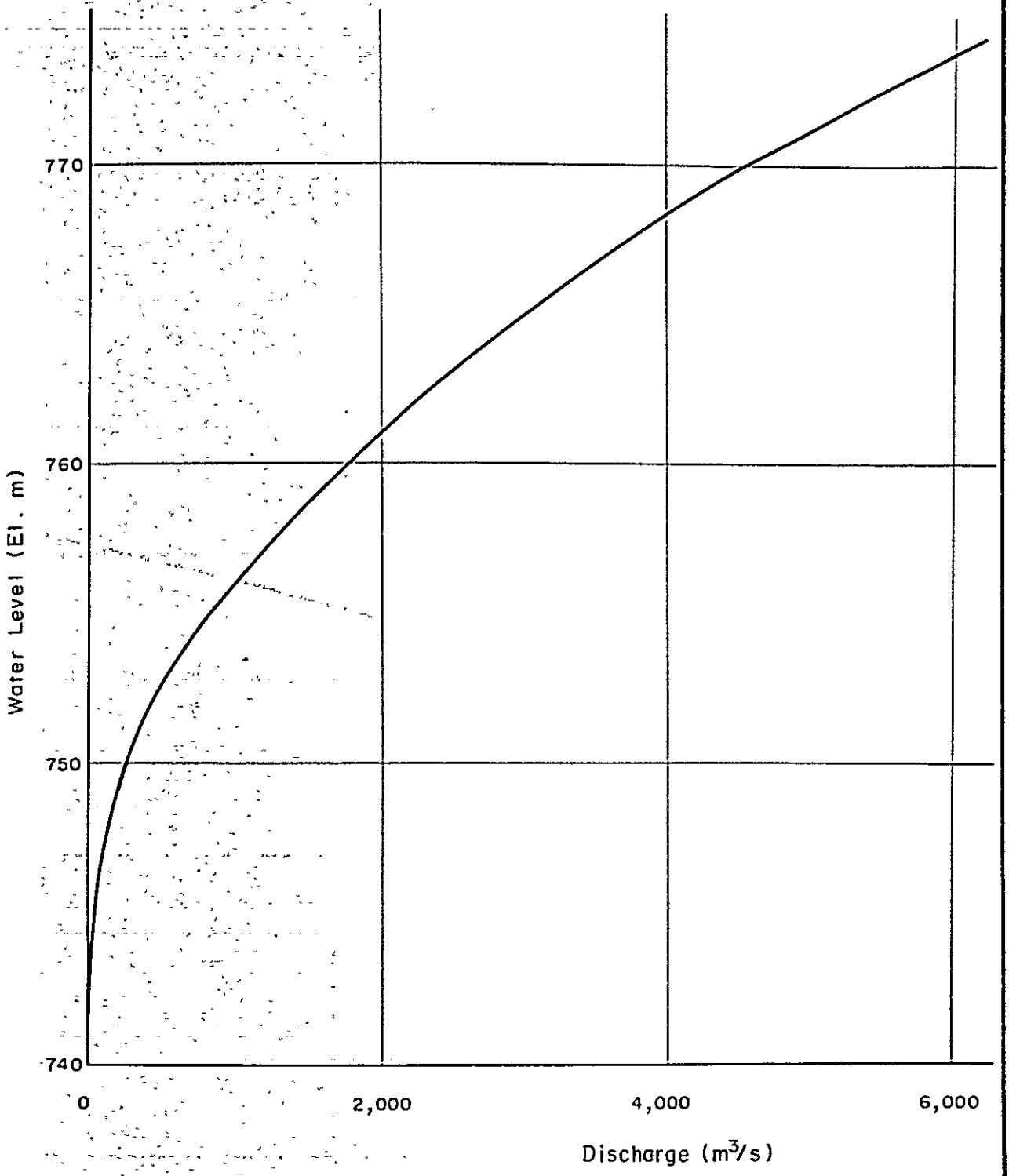

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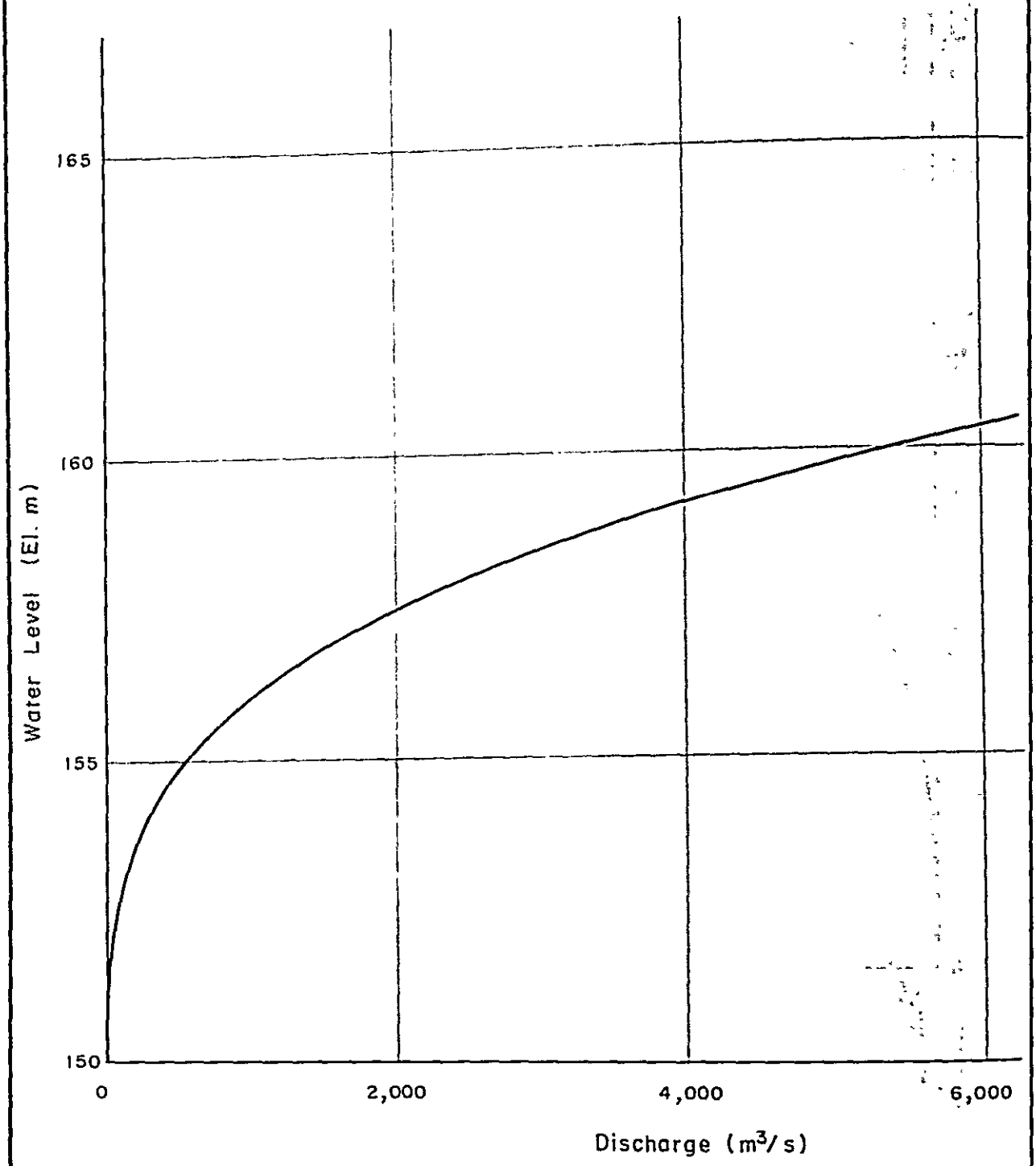
Fig.-A18 ASSUMED TAILWATER CURVE AT MOROLICA DAMSITE



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ANNEX B

SOILS AND LAND CAPABILITY

B SOIL AND LAND CAPABILITY

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B1. INTRODUCTION

Four reports on the previous soil surveys in the Choluteca River Basin are available as follows:

Area	Survey	Year	Scale	Complied by
Choluteca area	Reconnaissance	1952	-	MRN[1/], FAO
Choluteca area	Semi detailed	1968	1/50,000	IECO[2/]
Choluteca area	Semi detailed	Unpublished	1/250,000, 1/20,000	CSPE[3/]
San Juan de Flores area	Semi detailed	1968	1/50,000	IECO

Remarks: 1/ Ministerio de Recursos Naturales

2/ International Engineering Co.

3/ Consejo Superior de Planification Economica/USAID

Since these soil surveys were executed in conformity with the Soil Taxonomy Standard, U.S. Department of Agricultural Soil Conservation Services, and their results can be inferred as being reliable, the soil survey for this feasibility study was carried out by checking the representative soils for the purpose of land capability classification for planning of the future land use in the project area.

The soil checking was performed at the representative location selected at 31 places in the Choluteca area and at 5 sites in the San Juan de Flores area. Pits were dug to a depth of 1 meter and the profiles of each pit were examined with respect to the texture, structure, color, consistence, existence of mottlings and gravels, etc. The location of pits is shown in Plate No. 2 and Plate No. 5 of the main export. In the course of the profile examination, 51 samples of representative soils were taken from the major horizons or layers and analyzed in the MRN laboratory in Tegucigalpa.

The results of chemical and physical analyses are given in Table-B1 and B2.

The area surveyed in the Choluteca plain, the San Juan de Flores valley and the Middle Reach valleys are approximately 36,300 hectares, 1,740 hectares and 2,170 hectares, respectively.

B2. SOILS

B2.1 Choluteca Plain

From the geomorphological viewpoints, the lands in the Choluteca plain are primarily classified into the following four schematic topography:

(1) Coastal flood plain has very flat or almost flat topography but partly undulating with natural levees developed along the lower reaches of the Choluteca river and its tributaries. Most lands lie in elevations lower than 40 meters above mean sea level and they are deeply covered with finer textured sediments. The soils in this coastal plain are generally affected by salinity caused by the tidal intrusion of sea-water.

(2) Flood plain extends along the Choluteca river and its tributaries. Generally, the land in this flood plain has almost flat topography and deeply covered with moderately coarse to fine alluvium recently deposited by the rivers.

(3) Terrace land has gently undulating topography except some small hills scattering in this terrace. Almost all of the soils are derived from the old alluvium or diluvial materials containing some gravels and/or pebbles.

(4) Mountain or hill has relatively steep topography. The land surface is seriously washed out, and then the soils are shallow, gravelly and/or cobbly in general.

Among the four schematic land categories, coastal flood plain and mountain or hill have been precluded from this study because of unfavorable conditions respectively caused by soil salinity and steep topography.

The soils studied in the Choluteca plain are derived from the alluvium and/or diluvial materials deeply deposited by the Choluteca river and its tributaries. The parent materials of these soils are mixtures of volcanogenous rock, ash and shale in sedimentary rock.

Generally, the soils are rather coaser textured and have some fragments or gravels to some extent. The soil reaction varies from mild acid to moderate alkaline as indicated by PH values between 6.0 and 8.0. Most soils are well weathered through the hydromorphic soil formation process under the tropical savannah climate.

According to the Soil Taxonomy Standard, the soils in the Choluteca Plain are primarily identified as the Entisols, Mollisols, Inceptisols, Alfisols, Ultisols and Vertisols as the Order in the highest soil categories.

The Entisols are the recent fluventic soils which are mainly found in the flood plain developed along the Choluteca river and its tributaries. These soils generally lack distinct pedogenetic horizon, except for some ochric epipedon slightly developed in the soil surface. Textures of these soils are sandy loam to silty loam in the surface soil, and fine loam to silty clay and/or clay in the sub-soil. Some of the coaser textured soils are found in the narrow area adjacent to the Choluteca river. These soils are rather fertile and have good drainability in general. The Entisols in the Choluteca Plain are correlated with the Fluvents in Sub-Order, the Ustifluvents in Great Soil Group, the Typic Udifluent in Sub-group and Thick-loam-Mixed-Isohyperthermic-Slope of 0.5 to 3 per cent in Family as the lower soil categories.

The Mollisols are also derived from relatively recent alluvium deposited by the Choluteca river. These soils are distingushed from the Entisols by their genetic profile features. Namely, the soils have a cambic horizon or soil consists of only slightly altered parent materials below the mollic epipedon, and have a mottles of low chroma in the subsoil layer. Generally, the soils are loamy to clay loamy texture in sub-soil. The soils are fertile but have moderately poor to imperfect drainability in general. The Mollisols in the surveyed area are correlated with the Ustolls in Sub-order, and Haplustolls in Great Soil Group. In Sub-group in soil category, the Haplustolls are correlated with the Fluventic Haplustolls, the Fluvaquentic Haplustolls and the Aquic Haplustolls. The Fluventic Haplustolls are generally free

from the influence of groundwater, while the Fluvaquentic and Aquic Haplustolls have groundwater and mottles in a deep profile.

The Aquic Haplustolls are separated from the Fluvaquentic by their genetic profile features; i.e. low colour value or chroma of epipedon. Each sub-group has one to three Families in lower soil category which are mainly classified by texture qualities.

The Alfisols develop over a greater part of the terrace and mountainous or hilly land in the Choluteca Plain. The Alfisols have an ochric epipedon or mollic epipedon in the surface and an argillic horizon in the sub-soils. Generally, most of these soils have, more or less, gravels and stones, and texture of their soil matrixes are sandy loam in the surface and sandy clay to clay plinthite in the sub-soils. Consequently, drainability is imperfect in common.

According to the specific moisture regime, the Udic and Aquic Alfisols in the Project area are correlated with Ustalfs (reddish yellow Alfisols) and the Aqualfs (gray and mottled Alfisols) in Sub-order. Each sub-order is further correlated with the Paleustalfs and Tropaqualfs in Great Soil Group respectively. The Paleustalfs mainly extend over the high terrace and/or highland, while the Tropaqualfs are found lower terrace where land has gently sloped topography and groundwater is relatively shallow in general. Tropaqualfs are correlated with the Vertic tropaqualfs. Each Sub-group has one Family in lower soil category mainly defferentiated by their texture and slope.

The Ultisols, which are also terrace-soils, are only found in narrow extent in the Choluteca Plain. The soils of Urtisols are characterized by an albic horizon overlying an argillic horizon (plinthite) in the sub-soil. These specific horizons have developed with the formation process of leaching and illuviation of clay through the hydromorphic weathering under the tropical savannah climate.

Generally, texture of these soils are sandy clay loam to sandy clay in surface and sandy clay in sub-soil. Abundant ferric and manganic mottlings are found in a deep profile. A surface drainability is generally good, while it is imperfect in sub-soil due to compact and rather firmly

consolidated plinthite in a profile. The Ultisols in the project area are correlated with the Ustults in Sub-order and Pleustults in Great Soil Group, Udic Pleustults in Sub-group in higher soil category and the Fine loam - Mixed - Isohyperthermic - Slope of 2 - 7 per cent in Family in lower soil category.

The Vertisols are also the terrace soils which mainly extend in the Ola district. These soils have been put under the soil formation process of the hydromorphic weathering under the tropical savannah climate. These soils have specific characteristics of making cracking and gilgai micro-relief on the surface where the lands are dried up and intersecting slikenside and paralleled-piped structure in sub-soil. Texture of these soils are very fine clay throughout the profile. The sub-soils are generally abundant in small calcium concretions and faint mottlings.

The Vertisols in the Choluteca Plain are correlated with the Usterts in Sub-order, Pellusterts in Great Soil Group, the Typic Pellusterts in Sub-group in higher soil categories, and the Fine clayey - Montmorillonites - Isohyperthermic - Slope of 0.5 to 2.0 per cent in Family in lower soil category.

The Inceptisols are only found in a part of flood plain. These soils are correlated with Tropepts in Sub-order, the Ustropepts in Sub-groups in higher soil categories, and the Fine loam - Mixed - Isohyperthermic - Slope of 1 - 2 per cent in Family in lower category. Generally, the soils have deep profile with fine loamy soil in which on ochric epipedon and cambic horizon are the distinct profile features. Some of these soils have also a calcic horizon under the cambic horizon. Temperature and moisture regimes are respectively isohythermic and ustic in common. A good and/or perfect drainability is expectable on both surface and sub-surface.

The distribution of soils presented above is summarized in Table-B3. A soil map of Choluteca plain is illustrated in Plate No. 2 of the main report.

The Mollisols are the dominant soils on the right bank of the Choluteca river, while a greater part of lands on the left bank is covered by the Alfisols. The other soils are also found on both banks, but their coverage is considerably small.

B2.2 San Juan de Flores Valley

The San Juan de Flores valley extends along the upper reach of the Choluteca river. The lands primarily consist of the schematic landscape, i.e., (1) flood plain recently developed with alluvial deposition, (2) riverain terrace formed with rather old alluvium, (3) higher terrace developed with colluvium at the foot of the mountains and hills, and (4) mountains and/or hills.

The soils in the flood plain are derived from rather coarser textured alluvium deeply deposited by the Choluteca river. Generally these soils do not have the distinct pedogenetic horizon except for some ochric epipedon slightly developed in the soil surface. Thus, according to the soil appraisal specifications in the Soil Taxonomy, these soils are correlated with the Entisols in Order, Fluvents in Sub-order, Ustifluvents in Great Soil Group, and Typic Ustifluvent in Sub-group. On the basis of the soil properties examined on these soils, the Typic Ustifluvents are further defined into the Fine loam - Mixed - Isohyperthermic - Slope of less than 3 percent in Family as the lower soil category. In the light of their profile features, the land of these soils is highly suitable for irrigated farming, except for a small area where sandy soils lie nearby the river.

The soils in the riverain terrace are also derived from loamy alluvium which will be older than that in the recent flood plain. The soils generally have a mollic epipedon as the surface and cambic horizon as the common specific pedogenetic profile features. These soil also have groundwater and abundant ferric mottles of low chroma. Some of these soils have an argillic horizon or plinthite slightly developed under cambic horizon.

According to the soil Taxonomy system, these soils are correlated with the Mollisols in Order, Ustolls in Sub-order, and Haplustolls in Great Soil Group. These soils will be further correlated with the Fluvaquentic Haplustolls in Sub-group as the higher soil category and the Fine loam - Mixed - Isohyperthermic - Slope of less than 2 per cent in Family in lower soil category.

Generally, these soils are rather fertile and of mild alkalinity. Texture qualities are loamy in surface and sandy clayey to clayey soil in sub-soil. A good surface drainability can be expected, while it is moderately poor to imperfect in Sub-soil. In the light of the soil properties and profile features, the land in these soils will be highly suitable for irrigated farming the also suitable for wide ranges of the tropical and semitropical crops.

The soils in terrace or fans are originated from diluvial or colluvial materials inclusive of fragments and/or small gravels to a certain extent. These soils will also be correlated with Mollisols in Order, Ustolls in Sub-order and Haplustolls in Great Soil Group.

While classified in Sub-group in soil category, these soils might be distinguished from the Fluvaquentic Haplustolls due to the following reasons:

(1) The soils have a mollic epipedon which is low colour value and/or chroma in common.

(2) A greater part of these soils have no cambic horizon. The depth to a calcic horizon or the horizon that has secondary lime accumulation is deeper than others.

Therefore, these soils are primarily defined as the Aquic Haplustolls in Sub-group herein. Generally, these soils have poor soil fertility, mild alkalinity and fragmental coaser loamy texture qualities throughout the profile. Groundwater is deep in common in this area. In the light of the above soil properties, the land appears to be marginally suitable for irrigated forming.

The small part of the higher terrace or hill soils are found in the project area. The soils will be correlated with the Alfisols in Order and Haplustalfs in Great Soil Group.

The acreage by soil groups in the San Juan de Flores valley is shown in Table-B4, and a soil map is shown in Fig. - B1.

B2.3 Middle Reach Valleys in the Choluteca River Basin

The middle reach of the Choluteca river is geomorphologically a valley formation. Arable land is only found on narrow riverain terraces, recent alluvial fans and flood plain. Most of these lands have generally gentle and/or nearly flat topography, being detached to small patches by numerous natural drains.

The soils in the arable land are mainly drived from relatively coarser textured materials deposited by the Choluteca river and its tributaries. These materials have been developed under the hydromorphic weathering, and mollic and/or alfic soil formation have been proceeded under the tropical savannah climate. The soils are broadly classified into the highest soil category of the Entisols in the flood plain, Inceptisols in the recent alluvial fans, Mollisols, Alfisols and Vertisols in the riverain terraces.

The Entisols will be correlated with the Fluvents in Sub-order, Ustifluvents in Great Soil Group, Typic Ustifluvents in Sub-group, and Coarse loamy - Mixed - Isohyperthermic - Gentle slope in Family. Generally, these soils have little pedogenetic profile feature, except for ochric epipedon developed shallowly in the soil surface. Throughout the profile, the soils are loam to sandy loam in texture and rather firmly consolidated.

The Inceptisols will be correlated with the Tropepts in Sub-order, Ustropepets in Great Soil Group, Fluventic Ustropepets in Sub-group and the Loamy - Mixed - Isohyperthermic - Nearly flat topography in Family. These soils generally have deep profile with loamy texture and are good or perfect drainability on both surface and sub-surface soils. These soils are separated from the Typic Ustifluvents by their specific profile feature characterized by a cambic horizon which slightly developed under ochric epipedon.

The Mollisols are correlated with the Ustolls in Sub-order and Haplustolls in Great Soil Group. The Haplustolls will be classified into the Fluvaquentic Haplustolls and Fluventic Haplustolls in Sub-group, and each Sub-group will be correlated with the Loamy - Mixed - Isohyperthermic - Rather steep slope in Family, respectively. Generally, these Mollisols

have a mollic epipedon in the surface and a cambic horizon in the second layer. An effective soil depth is deeper than 150 cm with loam to clay loam in texture, in common.

The Alfisols are correlated with the Ustalfs in Sub-order, Peleustalfs in Great Soil Group, Aquic Peleustalfs in Sub-group, and Fragmental or stony loam - Mixed - Isohyperthermic - Rather steep slope in Family. Throughout the profile, these soils have abundant fragments of igneous rocks or gravels and the arability of these soils can be expected to a limited extent.

The Vertisols cover very small area. These soils will be correlated with Usterts in Sub-order, Pellusterts in Great Soil Group, Typic Pellusterts in Sub-group, and Fine loamy - Mixed -Isohyperthermic - nearly flat in Family. These soils generally have deep profile, and they are very firmly consolidated.

Regarding the soil chemical features, all the soils defined hereinabove have mild alkalinity throughout the profile, rich mineral compounds especially calcium carbonate, but rather poor organic matter even in the surface soils. In the light of the profile features, almost all the arable land will be suitable for irrigated farming with considerable crop productivity. The acreage of each soils is summarized in Table-B5, and a soil map is shown in Fig. - B2.

B3. LAND CAPABILITY CLASSIFICATION

The land classification has been previously made in the Choluteca Plain and San Juan de Flores valley by IECO in 1968. In this land classification in accordance with the USBR standard, the land was graded into six classes of their arability on the basis of the soil and topographic conditions. It provides sufficient information for the planning and design of the agricultural development in the right bank and the southern part of the left bank of the Choluteca river, as well as in the San Juan de Flores valley. The description of land classification in this report will therefore put to focuces on the unstudied area in the northern part on the left bank and the middle reach valleys of the Choluteca River.

B.3.1 Specification for Classification

Out of all the specifications of land evaluation defined in the USBR standard, the following factors are taken up as essential for evaluating the land suitability in the areas.

(1) Soil depth: limitation mainly caused by the gravel or stony layers in shallow profile.

(2) Drainability: limitation caused by the impenetrable argillic horizon or plinthite layer shallowy developed in the profile or by the vertisolic features of soils.

(3) Texture: limitation mainly cuased by the high content of gravels, stones and/or fragments in the soils.

(4) Topography: limitation due to the unsuitable land elevation, slope and/or land size for economical irrigation development.

Among the four conditions mentioned above, effective soil depth is a key factor for land evaluation in the surveyed areas. Generally,

a greater part of the soils correlated with the Alfisols have limitation in effective soil depth. Other soils than the Alfisols generally have sufficient soil depth for rooting of plants.

Poor or imparfect drainability prevails in all the soils except for the Entisols. In reality, however, the drainability of soils other than the Alfisols and Vertisols will not be so serious due to coarser texture quality extended in their profile.

Generally, almost all of the soils in the area are classified into loamy soil. This textural quality is acceptable for irrigated farming. In case of the Alfisols, however, fragments, gravels and/or stones will largely restrict an economical land reclamation and farming practices.

Almost all the land in the area has very gentle undulation or nearly flat topography. The topographic constraint only prevails in the land where it is uneconomical to irrigate by gravity.

As for the soil chemical constraints, salinity, alkalinity and/or acidity problems will be negligible in the areas. Deficiency in organic matters and nitrogen is pointed out on the Alfisols, Vertisols, Inceptisols and Entisols. It is anticipated however that such a deficiency can be supplemented by application of manure and chemical fertilizers. The deficiency in organic matters and nitrogen will therefore be considered as a supplemental factor in the land classification procedure.

The soil and land classification and their specific degree corresponding to the land suitability classes are summarized in the Table -B6.

B.3.2 Land Capability Classification

On the basis of the above specifications of land suitability classification, the lands in the area are classified into the following five land suitability classes:

Class I: Highly suitable land; namely highly productive for the defined land use and yields, highly beneficial and amply justifiable to the required capital and recurrent farm inputs. No significant limitation exists to reduce crop yield or increase recurrent cost for production and/or soil and land conservation.

Class II: Moderately suitable land; namely moderately productive for irrigated farming, moderately beneficial and justifiable to the required capital investment and recurrent inputs. There exist some limitations such as rather shallow soil depth limited by gravel layer, impermeable argillic horizon or plinthite layer, rather coarse texture, rather steep slope, etc. The limitations will reduce crop yields and/or increase recurrent cost for soil and land conservation.

Class III: The land graded into class III is also suitable for irrigated farming. However, the land has rather low productivity for the defined land use and is marginally justifiable to recurrent cost and capital investiment. The limitations are mainly caused by shallow soil depth, gravelly and/or stony soils, rather steep topography and low soil fertility. They will rather severely reduce crop yields and/or increase recurrent cost for production and soil conservation.

Class IV: The land has rather serious limitations mainly cuased by the very shallow soil depth, steep topography, small tract in land size, imperfect drainability, etc. The land will be only marginally or conditionsally suitable for the defined land use. For the development of this land, selection of special crops or specific land use plan will be necessary.

Class VI: Class VI is the unsuitable land in grade. The land can not justify economical development due to serious limitations caused by soil and topographic deficiencies. The land should be precluded from the development plan.

The lands by class in the Choluteca Plain and the San Juan de Flores valley are summarized in Table-B7, and B8. A land capability map of the Choluteca Plain is shown in Plate 3 of the main report, and a land capability map of the San Juan de Flores Valley is shown in Fig. - B1.

B.3.3 Recommendation

In terms of the agricultural soil utilization, the soils in the surveyed area are suitable for irrigated cultivation except for the soils defined as unsuitable for irrigation due to topography, shallow soil, salinity etc.

The land graded into Class I has no significant limitation on both soil and topography for irrigated cultivation of upland crops. For rice cultivation, however, it will be rather unsuitable because of small water retaining capacity of soil due to coarser texture quality and rather rapid percolation throughout the profile.

The land Class II is suitable for both upland crops and rice cultivation with submerged condition. As for the cultivation of upland crops, drainage control will be required to a certain extent, particularly the land of Mollisols.

The land Class III is also suitable for cultivation of both upland crops and rice.

To establish the Land Use plan, however, the following conditions should be taken into account.

(1) Rather shallow soil depth limited by impenetrable plinthite and firmly consolidated argillic horizon.

(2) Fragmental and/or gravelly soil.

(3) Vertisolic soil feature or imperfect drainability of soil.

(4) Rather steep topography

To provide sufficient soil depth for normal rooting of crops, it is recommended to modify such unfavourable sub-soil or layer by use of a sub-soiler. Besides, proper soil management and soil fertilization should be successively carried out year by year.

The land having impermeable sub-soils such as argillic horizon, plinthite and/or vertisolic soils, will be highly suitable for rice cultivation, while it is necessary to satisfy drainage control for upland crops.

The land graded into Class IV has rather serious limitation caused by the soil and topographic deficiencies. With the limiting conditions in view, it is recommendable to utilize it for pasture.

Table-01 RESULTS OF OBSERVATIONS AND ANALYSIS OF SAMPLES IN THE CHOLUTECA PROJECT AREA. (1977)

Sample No.	Location	Observation								Analysis								
		Depth(mm)	Texture	Color	Consistence	Crack	Concretion	Mottling	Gravel	Vegetaion	PH	Organic Matter %	Avail.P (ppm)	Avail.K (ppm)	E.C. (mmhos/cm)	Clay (%)	Silt (%)	Sand (%)	Texture
1.	Larua de Gerardo	0-13	SiL	5YR 4/2	S.H	V:2-5mm L:1-70cm			-	Natural grass pasture	6.4	1.81	21.0	12.0	-	22.0	30.6	47.4	L
		13-50	SiC	25YR 3/3	V.H				-		6.3	1.34	9.0	35.0	0.192	52.0	16.2	21.8	Heavy C
		50-100	SC	2.5YR 6/5	V.H		$CaCO_3$.Concretion dia,1-5mm,abundant	Fe. Mn. mattling	-		6.6	0.94	2.0	198.0	0.148	28.0	24.2	47.8	L.C.S
2.	La Pozas																		
		0-10	SiL	5YR 4/3	S.S	-	-	-	-	Cotton									
		1-40	SiL	7.5YR 5/4	S.S	-	-	-	-										
		40-100	CL	5YR 3/2	S.S	-	-	-	-										
3.	La Sombra																		
		0-40	SiL	7.5YR 4/4	S	-	-	-	-	Seed cane									
		40-75	SL	7.5YR 5/4	S.S	-	-	-	-										
		75-100	SC	5YR 3/3	S	-	-	-	-										
4																			
		0-20	SiL	5YR 3/3	S.S	-	-	-	-	Ratoon cane									
		20-100	SC	5YR 3/6	S.S	-	-	-	-										
5.	Paso de la Rana																		
		0-40	SL	7.5YR 4/3	S	-	-	-	-	Improved pasture grass									
		40-75	S	7.5YR 5/4	S	-	-	-	-										
		75-100	S	7.5YR 6/3	S	-	-	-	-										
6.	Piedra de Agua																		
		0-50	SL	7.5YR 2/1	S.S	-	-	-	-	Natural grass pasture									
		50-100	C	7.5YR 4/3	S.S	-	-	-	-										
7.																			
		0-15	SL	5YR 3/2	S.S	-	-	-	-	Natural grass pasture									
		15-65	C	7.5YR 4/3	S.S	-	-	-	-										
		65-100	CL	7.5YR 3/1	S.S	-	-	-	-										
8.	Los Mangles																		
		0-40	SL	5YR 3/3	S	-	-	-	-	Plant cane									
		40-100	SC	7.5YR 4/3	S.S	-	-	-	-										
9.	Santa Cruz																		
		0-40	CL	7.5YR 3/2	S.S	-	-	-	-	Ratoon cane									
		40-100	C	7.5YR 3/3	S.S	-	-	-	-										
10.																			
		0-50	SL	7.5YR 6/3	S.S	-	-	-	-	Improved pasture									
		50-70	SiC	10R 3/1	S.S	-	-	-	-										
		70-100	SC	7.5YR 5/3	S	-	-	-	-										

to be continued

Sample No.	Location	Observation									Analysis								
		Depth(mm)	Texture	Color	Consistence	Crack	Concretion	Mottling	Gravel	Vegetation	PH	Organic Matter %	Avail.P (ppm)	Avail.K (ppm)	E.C. (mmhos/cm)	Clay (%)	Silt (%)	Sand (%)	Texture
11.		0-35	CL	7.5R 3/2	SS	-	-	-	-	Plant cane									
		35-100	SC	7.5YR 4/4	SS	-	-	-	-										
12.	Cleote Gonzalen																		
		0-35	CL	7.5YR 3/2	H	-	-	-	-	Maize									
		35-100	C	7.5YR 5/6	SH	-	-	-	-										
13.																			
		0-30	LC	5R 4/1	S	-	-	-	-	Seed cane									
		30-100	C	7.5YR 4/3	S	-	-	-	-										
14	El Palenque																		
		0-20	SL	7.5YR 2/2	S	-	-	-	-	Ratoon cane									
		20-100	CS	10YR 6/3	S	-	-	-	-										
15.	Palo Seco																		
		0-20	SL	5YR 5/ 3	SS	-	-	-	-	Natural grass pasture	6.7	4.03	88.0	120.0		20.4	48.2	31.4	L
		20-70	LC	7.5YR 4/1	SH	-	-	-	-		6.8	0.0	9.0	225.0		14.4	64.2	21.4	SiL
		70-100	SIC	7.5YR 3/3	SS	-	-	-	-		7.1	0.0	6.0	100.0		28.4	40.2	31.4	LC
16.																			
		0-10	CL	2.5YR 3/2	S	-	-	-	-	Improved pasture grass	6.5	1.60	14.5	19.0		18.0	26.6	55.4	LS
		10-30	SIC	7.5YR 6/1	SS	-	-	-	-		6.8	1.34	11.0	19.0		38.0	20.6	41.4	LC
		30-100	SIC	7.5YR 2/2	SS	-	-	-	-		6.4	1.27	6.0	80.0		36.0	34.2	29.8	LC
17.	Monjaras																		
		0-10	CL	5YR 4/4	CL	-	-	-	-	Improved pasture grass									
		10-60	SC	7.5YR 5/3	SC	-	-	-	-										
		60-100	SC	5YR 2/3	SC	-	-	-	-										
18.																			
		0-20	SL	2.5YR 3/1	SS	-	-	-	-	Natural grass pasture									
		20-40	SL	5RY 2/3	SS	-	-	-	-										
		40-60	CS	5YR 4/3	SS	-	-	-	-										
19.																			
		0-20	SiL	7.5YR 4/2	H	W:2-3mm	-	-	gravel dia.2-5cm, abundant	Natural grass pasture	6.8	1.34	16.0	32.8	0.148	48.0	22.6	29.4	C
		20-60	LC	7.5YR 3/1	V.H	L:30-40cm	-	-			6.8	1.47	12.0	14.0	0.112	24.0	42.6	33.4	L
		Digging was obligated to stop at 60cm in depth due to very hard.																	
20.	Las Gevaceas																		
		0-30	CL	7.5YR 3/2	H	-	-	-	gravel dia 3-5cm abundant	Improved pasture grass	6.7	1.41	12.0	40.0	1.840	36.0	26.6	37.4	LC
		30-100	C	5YR 3/2	VH	-	-	-			6.8	1.34	12.0	18.4	0.240	20.0	32.6	47.4	L

to be continued

Sample No.	Location	Observation									Analysis								
		Depth(mm)	Texture	Color	Consistence	Crack	Concretion	Mottling	Gravel	Vegetation	PH	Organic Matter %	Avail.P (ppm)	Avail.K (ppm)	E.C. (mmhos/cm)	Clay (%)	Silt (%)	Sand (%)	Texture
21.	Colama																		
		0-15	SiL	2.5YR 6/1	SH	-	-	Mottlings of Fe, Mn	SC surface dia.5-10cm stone, scattered		6.8	1.88	10.0	65.0	-	18.4	56.2	25.4	LSi
		15-40	CS	1pR 4.1	SH	-	-	do	gravel dia.1-2cm, abundant		6.9	0.0	6.5	70.0	-	26.6	10.0	68.4	LCS
		40-60	C	2.5GY 6/1	VH	-	-				6.9	0.0	10.0	22.5		63.2	13.6	23.2	Heavy C
22.	Tizaate																		
		0-15	SiL	7.5YR 5/1	S.S	-	-	Mottlings of Fe, Mn	Stone, dia.5-10cm, abundant		6.7	0.0	10.0	260.0	3.84	19.2	37.6	43.2	L
		15-50	LS	5YR 4/6	H	-	-	do	do	Improved pasture grass	6.9	0.0	2.5	100	0.23	11.2	23.6	65.2	LS
		50-60	LC	5Y 6/1	H	-	-				6.9	0.0	0.5	30	0.17	59.2	11.6	29.2	Heavy C
		Digging was obliged to stop at 60cm in depth due to very hard.																	
23.																			
		0-25	C	7.5YR 4/2	SH	-	-	Mottlings of Fe, Mn	dia.5-10 stone scattered	Improved	6.6	1.34	6.5	19.6	-	44.0	25.2	30.8	C
		25-45	C	5YR 3/4	H	-	-	-	gravel dia.1-3cm abundant	pasture grass	6.7	1.34	6.5	9.0	-	53.2	14.4	32.4	C
		45-60	CL	7.5YR 4 2	VH	-	-	-	-		6.9	1.34	6.5	70.0	-	36.6	15.6	47.8	CS
24.	El Anilla																		
		0-20	SL	7.5YR 3/2	SS	-	-	-	-	Improved pasture grass									
		20-70	CL	5YR 3/2	SS	-	-	-	-										
		70-100	SL	7.5YR 4/3	SS	-	-	-	-										
25.	La Tronconada																		
		0-25	SL	5YR 3/3	S	-	-	-	-	Improved pasture grass									
		25-55	LC	5YR 4/4	SS	-	-	-	-										
		55-75	S	7.5YR 4/6	S	-	-	-	-										
		75-100	SC	7.5YR 5/4	SS	-	-	-	-										
26.																			
		0-10	SiL	5YR 3/3	SH	-	-	-	-	Improved pasture grass	6.7	1.71	11.0	70.0	9.00	43.2	43.6	13.2	CL
		10-80	CL	5YR 4/3	H	-	-	-	-		6.8	0.0	12.0	250.0	3.84	39.2	47.6	13.2	LCS:
		80-100	C	7.5YR 3/4	SH	-	-	-	-		7.0	1.74	9.0	255.0	0.23	45.2	48.6	11.2	CS:
27.	La Trinidad																		
		0-20	LS	7.5YR 3/4	H	-	-	-	gravel dia.1-5 cm, abundant	Improved pasture grass	7.0	0.0	9.0	100.0		17.2	25.6	57.2	L.S
		20-30	SiL	7.5YR 4/3	H	-	-	-			7.2	0.0	6.0	500.0		17.2	7.6	75.2	L.S
		30-60	C	7.5YR 2/3	V.H	-	-	Fe, Mn mottlings abundant	gravel dia. 1-2cm abundant		6.7	0.0	10.0	650.0		37.2	7.6	55.2	C.S
		Digging was obliged to stop at 60cm in depth due to ver hard.																	

to be continued

Sample No.	Location	Observation								Analysis								
		Depth(mm)	Texture	Color	Consistence	Crack	Concretion	Mottling	Gravel	Vegetation	PH	Organic Matter %	Avail.P (ppm)	Avail.K (ppm)	E.C. (mmhos/cm)	Clay (%)	Silt (%)	Sand (%)	Texture
28.	San Jose								dia.10-20cm stone,scattered										
		0-10	LiS	5YR 3/4	SH	-	-	-		Course	6.3	0.94	10.0	47.0		9.2	3.6	87.2	L.S
		10-60	SiL	7.5YR 4/3	H	-	-	2.5YR 5/8 mottlings abundent	5-10cm stone abundent	Forest (Pasture)	6.5	0.0	11.0	20.0		39.2	13.6	47.2	CS
		60-100	CL	2.5YR 6/2	VH	-	-	do	do		6.7	0.0	11.0	5.0		31.2	45.6	23.2	CL
29.																			
		0-20	SiL	7.5YR 4/2	SH	-	-	-	-	Natural grass pasture	6.6	2.41	30.0	150.0	0.36	39.2	47.6	17.2	L
		20-85	SiL	7.5YR 2/1	SH	-	-	-	-		6.9	0.94	14.5	110.0	0.15	31.2	51.6	25.4	L
		85-100	L	5YR 3/3	H	-	-	-	-		6.9	0.94	10.0	120.0	0.13	25.2	49.4	39.2	L
30.	Trito																		
		0-20	SL	7.5YR 3/2	S	-	-	-	-	Fallow (Plowed field)	6.7	1.74	41.0	100	0.65	13.2	47.6	39.2	L
		20-80	L	7.5YR 4/6	S	-	-	1-2mm Fe mottling	-		6.9	0.94	11.0	70	0.23	15.2	47.6	37.2	L
		80-100	LS	7.5YR 3/3	S	-	-	little	-		7.3	0.94	10.0	125	3.30	13.2	37.6	49.2	LS
31	Zapote																		
		0-5	SL	5YR 3/2	SS	-	-	1-2mm Fe mottlings little	-	Fallow (After maize)	6.7	3.49	42.0	155.0	-	21.2	31.6	47.2	L
		5-40	SiL	5YR 2/3	H	-	-		-		7.2	0.94	42.0	230.0	-	19.6	41.0	39.4	L
		40-100	SiL	5YR 4/2	H	-	-	-	-		7.2	0.94	13.0	190.0	-	17.6	59.0	23.4	LS:

Remarks: Consistence;S:Soft , H:Hard

Table-B2 RESULTS OF OBSERVATION AND ANALISIS OF SAMPLES IN THE SAN JUAN DE FLORES AREA

Sample No.	Location	Depth	Texture	Color	Consistence	Crack	Concreation	Mottling	Gravel	Vegitation	Analysis								
											PH	Organic matter (%)	Avil.P	Avil.K	E.C.	Clay	Silt	Sand	Texture
41.	San Juan de Flores	0-10	SL	5YR 3/2	SS	-	-		1-3cm gravel little	Natural Pasture	6.8	3.83	14.5	100		18.6	31.6	49.8	L
		10-30	LC	5YR 3/3	SS	-	-				6.9	1.14	8.0	40		22.6	23.6	53.8	LCS
		30-100	C	2.5YR 3/4	SH	-	Smalle concretion of $CaCO_3$ dia.1-2mm, little	reddish brown mottlings			6.8	1.02	2.0	50		36.6	17.6	45.8	LS
42.	Suyapa (Out of Project area)	0-20	SiL	7.5YR 3/3	SH	-		-	-	Maize	6.9	2.62	16.0	40		24.6	31.6	43.8	L
		20-55	LC	5YR 2/1	SH	W:1-2mm L: 30cm		Fe,Mn,mottlings little	-		6.5	1.00	14.5	75		42.6	27.6	29.8	C
		55-100	SiC	7.5YR 3/2+ 7.5YR3/1 mixed	H	-	Small concretion of $CaCO_3$ little	-	-										
43.		0-35	SL	10YR 2/2	S	-	-	-	-	Fallow (Proved field)	6.7	2.15	28.0	125		16.6	21.6	61.8	LS
		35-100	SiC	2.5YR 3/4	SH	-	$CaCO_3$ small concretion, little	-	-		7.4	2.95	42.0	210		28.6	15.6	55.8	LCS
44.		0-10	SiL	5YR 3/4	H	-	-	-	-	Fallow (After maize)	7.2	1.68	20.0	118		30.6	45.6	23.8	LS
		10-60	C	5YR 2/4	H	-	-	-	-		7.7	1.14	20.0	175		46.6	35.6	17.8	C
		60-100	C	2.5YR 3/4	H	-	-	-	-		7.7	2.35	42.00	25		52.8	27.4	19.8	Heavy C
45.	Le Pacón	0-25	SiL	7.5YR 3/4	HV	-	-	-	5-15cm stone scattered on surface		7.2	2.08	20.0	265		15.2	21.0	63.8	LS
		25-60	C	2.5YR 3/6	VH	-	-	-	1-3cm gravel very abundent										
		Digging was obliged to stop at 60cm in depth due to very hard.								Natural grass pasture									

Remarks: Consistence ; S:Soft , H:Hard

Table B1 COMPOSITION OF THE SOILS IN THE CHOLUTECA PLAIN

Area	Land Category	Taxonomy of Soils				Family of Soils	Symbol of Soils	Acreage (ha)	Percentage to the total area (%)	Remarks
		Order	Suborder	Great Group	Subgroup					
Right Bank of the Choluteca Plain	Alluvial, (Plain/or delta)	Inceptisols	Tropept	Ustropepts	Fluventic Ustropept	Fine loam, mixed, isohyperthermic, slope of 1-2 %	Ll	410	1.1 (2.4)	Well drained soils
	do	Entisols	Fluvents	Ustifluvents	Typic Ustifluvent	Thick loam, mixed, isohyperthermic slope of 0.5-3 %	Llt	1,900	5.2 (11.2)	do
	do	Mollisols	Ustolls	Haplustolls	Fluventic Haplustoll	Fine loam, mixed, isohyperthermic, slope of 0-2 %	Jd			drained soils
	do	Mollisols	Ustolls	Haplustolls	Aquic Haplustoll	Fine loam, mixed, isohyperthermic, slope of 0-2 %	Gt	12,140	33.5 (71.3)	Imperfect drained soils
	do	Mollisols	Ustolls	Haplustolls	Fluventic Haplustoll	Fine sandy clayey loam, mixed, isohyperthermic, slope of 0-2 %	Mn			do
	do	Mollisols	Ustolls	Haplustolls	Fluvaquentic Haplustall	Fine loam, mixed, isohyperthermic, slope of 0-2 %	Pq.			do
	Terrace	Vertisols	Usterts	Pollusterts	Typic Pellustert	Fine clay, montmorinitic, isohyperthermic, slope of 0.5-2 %	Tt	1,410	3.9 (8.3)	Imperfect drained soils
	do	Alfisols	Ustalfs	Haplustalf	Aquic Haplustalf	Fine sandy loam, fragmental, mixed, isohyperthermic, slope of 1-4 %	Ch l,	90	0.3 (0.5)	do
	Mountain	Alfisols	Ustalfs	Haplustalf	Udic Haplustalf	Fragmental sandy loam, fine loam mixed, isohyperthermic, slope of 15-30 %	Gl-Sm	300	0.8 (1.7)	
	Hill	Alfisols	Ustalfs	Haplustalf	Udic Haplustalf	do	Gl-GC3			
	Mountain	Alfisols	Ustalfs	Haplustalf	Udic Haplustalf	do	Gl-Cr			
	Others							780	2.1 (4.6)	River, river bed, pond
	Sub-total							17,030	46.9	
Left bank of the Choluteca Plain	Alluvial Plain/or delta	Inceptisols	Tropepts	Ustropept	Fluventic Ustropept	Fine loam, mixed, isohyperthermic, slope of 1-2 %	Ll	180	0.5 (0.9)	Well drained soils
	do	Entisols	Fluvent	Ustifluvent	Typic Ustifluvent	Thick loam, mixed, isohyperthermic slope of 0.5-3 %	Llt	1,560	4.3 (8.1)	do
	do	Mollisols	Ustolls	Haplustolls	Fluventic Haplustoll	Fine loam, mixed, isohyperthermic, slope of 0-2 %	Jd			Moderately well drained soils
	do	Mollisols	Ustolls	Haplustolls	Aquic Haplustoll	Fine loam, mixed, isohyperthermic slope of 0-2 %	Gt	4,000	11.0 (20.8)	Imperfect drained soils
	do	Mollisols	Ustolls	Haplustolls	Fluventic Haplustoll	Fine sandy clayey loam, mixed, isohyperthermic, slope of 0-2 %	Mn			do
	do	Mollisols	Ustolls	Haplustoll	Fluvaquentic Haplustoll	Fine loam, mixed, isohyperthermic, slope of 0-2 %	Pq			Imperfect drained soils
	do	Mollisols	Ustolls	Haplustoll	Fluvaquentic Haplaquoll	Fine loamy clay, mixed, isohyperthermic, slope of 0-1 %	Ps			Poor drained soils
	Terrace	Alfisols	Ustalfs	Haplustalf	Aquic Haplustalf	Fine sandy loam, fragmental, mixed, isohyperthermic, slope of 1-4 %	CH1, CH2			Imperfect drained soils
	do	Alfisols	Ustalfs	Aqualfs	Vertic Tropaqualf	Fine loam, skeletal, mixed, isohyperthermic, slope of 1-2 %	Mc	11,760	32.4 (61.0)	do
	do	Ultisol	Ustalfs	Paleustalt	Udic Paleustalt	Fine loam, mixed, isohyperthermic, slope of 2-7 %	Sp	320	0.9 (1.7)	do
	do	Vertisols	Usterts	Pollustert	Typic Pollustert	Fine clay, montmorinitic, isohyperthermic, slope of 0.5-2 %	Tt	290	0.8 (1.5)	do
	Hill	Alfisols	Ustalfs	Haplustalf	Udic Haplustalf	Fine sandy loam, mixed, isohyperthermic, slope of 7-12 %	Chp-Cr	630	1.7 (3.3)	
	do	Alfisols	Ustalfs	Haplustalf	Udic Haplustalf	Fragmental, sandy loam, fine loam, mixed isohyperthermic, slope of 15-30 %	Gl-Sm	160	0.5 (0.8)	
	Others							370	1.0 (1.9)	River, pond
	Sub-total							19,270	53.1	
	Total							36,300	100.0	

1/ ( ) : percentage in each bank

Table-B1 COMPOSITION OF SOILS IN SAN JUAN DE FLORES VALLEY

Area	Land Category	Taxonomy of Soils				Family of Soils	Simbol of Soils	Acreage (ha)	Percentage to the total area(%)	Remarks
		Order	Suborder	Great Group	Sub-group					
Existing Area (Irrigated Area)	Alluvial	Entisols	Fluvents	Ustifluvents	Typic Ustifluvent	Thick loam, mixed, isohyperthermic, slope of 0.5-3 %	Llt	340	19.5 (25.4)	Well drained soils
	do	Mollisols	Ustolls	Haplustoll	Aquic Haplustoll	Fine loam, mixed, isohyperthermic, slope of 0-2 %	Gt	830	47.7 (61.9)	Imperfect drained soils
	do	Mollisols	Ustolls	Haplustoll	Fluvaquentic Haplustoll	Fine loam, mixed, isohyperthermic, slope of 0-2 %	Pq			do
	Terrace	Alfisols	Ustalfs	Haplustalf	Aquic Haplustalf	Fine sandy loam, fragmental, mixed isohyperthermic, slope of 1-4 %	Chl	170	9.8 (12.7)	Imperfect drained soils
	Sub-total							1,340	77.0	
Expanded area	Alluvial	Entisols	Fluvents	Ustifluvent	Tpic Ustifluvent	Thick loam, mixed, isohyperthermic, slope of 0.5-3 %	Llt	60	3.4 (15.0)	Well drained soils
	do	Mollisols	Ustolls	Haplustall	Aquic Haplustoll	Fine loam, mixed, isohyperthermic, slope of 0-2 %	Gt	310	17.8 (77.5)	Imperfect drained soils
	do	Mollisols	Ustolls	Haplustoll	Fluvaquentic Haplustoll	Fine loam, mixed, isohyperthermic slope of 0-2 %	Pq			
	Terrace	Alfisols	Ustalfs	Haplustalf	Aquic Haplustalf	Fine sandy loam, fragmental, mixed isohyperthermic, slope of 1-4 %	Chl.	30	1.8 (7.5)	do
	Sub-total							400	23.0	
	Total							1,740	100.0	

Table-B5 COMPOSITION OF SOILS IN THE MIDDLE CHOLUTECA VALLEYS

Area	Land Category	Taxonomy of Soils				Family of Soils	Symbol of soil	Acreage (ha)	Percentage to the total area(%)	Remarks
		Order	Suborder	Great Group	Sub-group					
Morolica area	Alluvial	Inceptisols	Tropept	Ustropept	Fluventic Ustropept	Fine loam, mixed, isohyperthermic slope of 1-2 %	Ll	290	13.4 (82.9)	Well drained soils
	do	Entisols	Fluvents	Ustifluvents	Typic Ustifluvent	Thick loam, mixed, isohyperthermic slope of 0.5-3 %	Llt	40	1.8 (11.4)	do
	Terrace	Alfisols	Ustalfs	Haplustalf	Aquic Haplustalf	Fine sandy loam, fragmental, mixed, isohyperthermic, slope 1-4 %	Chl	20	0.9 (5.7)	Imperfect drained soil
	Sub-total							350	16.1	
Orocuina area	Alluvial	Inceptisols	Tropept	Ustropept	Fluventic Ustropept	Fine loam, mixed, isohyperthermic, slope of 1-2 %	Ll	470	21.6 (29.0)	Well drained soil
	do	Entisols	Fluvents	Ustifluvents	Typic Ustifluvent	Thick loam, mixed, isohyperthermic, slope of 0.5-3 %	Llt	220	10.1 (13.6)	do
	do	Mollisols	Ustolls	Haplustoll	Fluventic Haplustoll	Fine loam, mixed, isohyperthermic, slope of 0-2 %	Jd	330	15.1 (20.4)	Imperfect drained soil
	do	Mollisols	Ustolls	Haplustoll	Fluvaquentic Haplustoll	Fine loam, mixed, isohyperthermic, slope of 0-2 %	Pq			
	Terrace	Ultisols	Ustult	Paleustults	Udic Paleustults	Fine loam, mixed, isohyperthermic, slope of 2-7 %	Sp	110	5.0 (6.8)	do
	do	Alfisols	Ustalf	Haplustalf	Aquic Haplustalf	Fine sandy loam, fragmental, mixed, isohyperthermic, slope of 1-4 %	Chl	180	8.3 (11.1)	do
	do	Alfisols	Ustalf	Aqualf	Aeric Tropaqualf	Fine loam, stong, mixed isohyperthermic, slope of 2-7 %	Ml	50	2.3 (3.1)	do
	do	Vertisols	Usterts	Pollusterts	Typic Pellustert	Fine clay, montmorinitic, isohyerthermic, slope of 0.5-2 %	Tt	260	11.9	
	do	Vertisols	Usterts	Pollusterts	Typic Pellustert	do	Ttp		(16.0)	
	Sub-total							1,620	74.3	
Oropoli area	Alluvial	Mollisols	Ustolls	Haplustoll	Fluventic Haplustoll	Fine loam, mixed, isohyperthermic, slope of 0-2 %	Jd	210	9.6 (100.0)	Moderately drained soil
	Sub-total							210	9.6	
	Total							2,180	100.0	

Table-B6 SPECIFICATION FOR LAND CLASSIFICATION

(USBR)

Land Characteristics	Class 1	Class 2	Class 3
Texture	Sandy laom to friable clay loam	Loamy sand to permeable clay	Loamy sand to permeable clay
Depth To sand, gravel Cobbles	90 cm, plus good free working soil of fine sandy loam or finer, or 105 cm of sandy loam	60 cm, plus free working soil of fine sandy loam or finer, or 75 cm-90 cm of sandy loam to loamy sand	45 cm, plus good free working soil of fine sandy loam or finer, or 60 cm to 75 cm of coarser textured soil
To shale, raw soil from shale or similar material	150 cm plus or 135 cm with minimum of 15 cm of gravel overlying impervious material or sandy loam throughout	120 cm or 105 cm with minimum 15 cm of gravel overlying impervious material or loamy sand throughout	105 plus or 90 cm with minimum of 15 cm of gravel overlying impervious material or loamy sand throughout
To penetrable lime zone	45 cm with 150 cm penetrable	35 cm with 120 cm penetrable	25 cm with 90 cm penetrable
Alkalinity	PH less than 9.0 unless soil is calcareous, total salts are low and evidence of black alkali is absent	PH 9.0 or less, unless soil is calcareous, total salts are low and evidence of black alkali is absent	PH 9.0 or less, unless soil is calcareous, total salts are low and evidence of black alkali is absent
Salinity	Total salts not to exceed 0.2%. May be higher in open permeable soils and under good drainage conditions.	Total salts not to exceed 0.5%. May be higher in open permeable soils and under good drainage conditions.	Total salts not to exceed 0.5%. May be higher in open permeable soils and under good drinage conditions.

Land Characteristics	Class 1	Class 2	Class 3
Topograhpy			
Slops	Smooth slopes up to 4% in general gradient in reasonably large size bodies sloping in the sameplace	Smooth slopes up to 8% in general gradient in reasonable large size bodies sloping in the same plane; or rougher slopes which are less than 4% in general gradient	Smooth slopes up to 12% in general gradient in reasonably large sized bodies sloping in the same plane; or rougher slopes which are less than 8% in general gradient
Surface	Even enough to require only small amount of leveling and no heavy grading.	Moderate grading required but in amount found feasible at reasonable cost in comparable irrigated area	Heavy and expensive grading required in spots but in amount found feasible in comparable irrigated areas
Cover (loose rocks and vegetatation)	Insufficient to modify productivity or cultural practices, or clearing cost small	Sufficient to reduce productivity and interferes with cultural practices. Clearing required but at moderate cost	Present in sufficient amounts to require expensive but feasible clearing

Class 4
Includes lands having excessive deficies and restricted utility but which special economic and engineering studies have shown to be irrigable.

Class 5
Includes land which will require additional economic and engineering studies to determine their irrigability and lands classified as temporarily nonproductive pending construction of corrective works and redamation

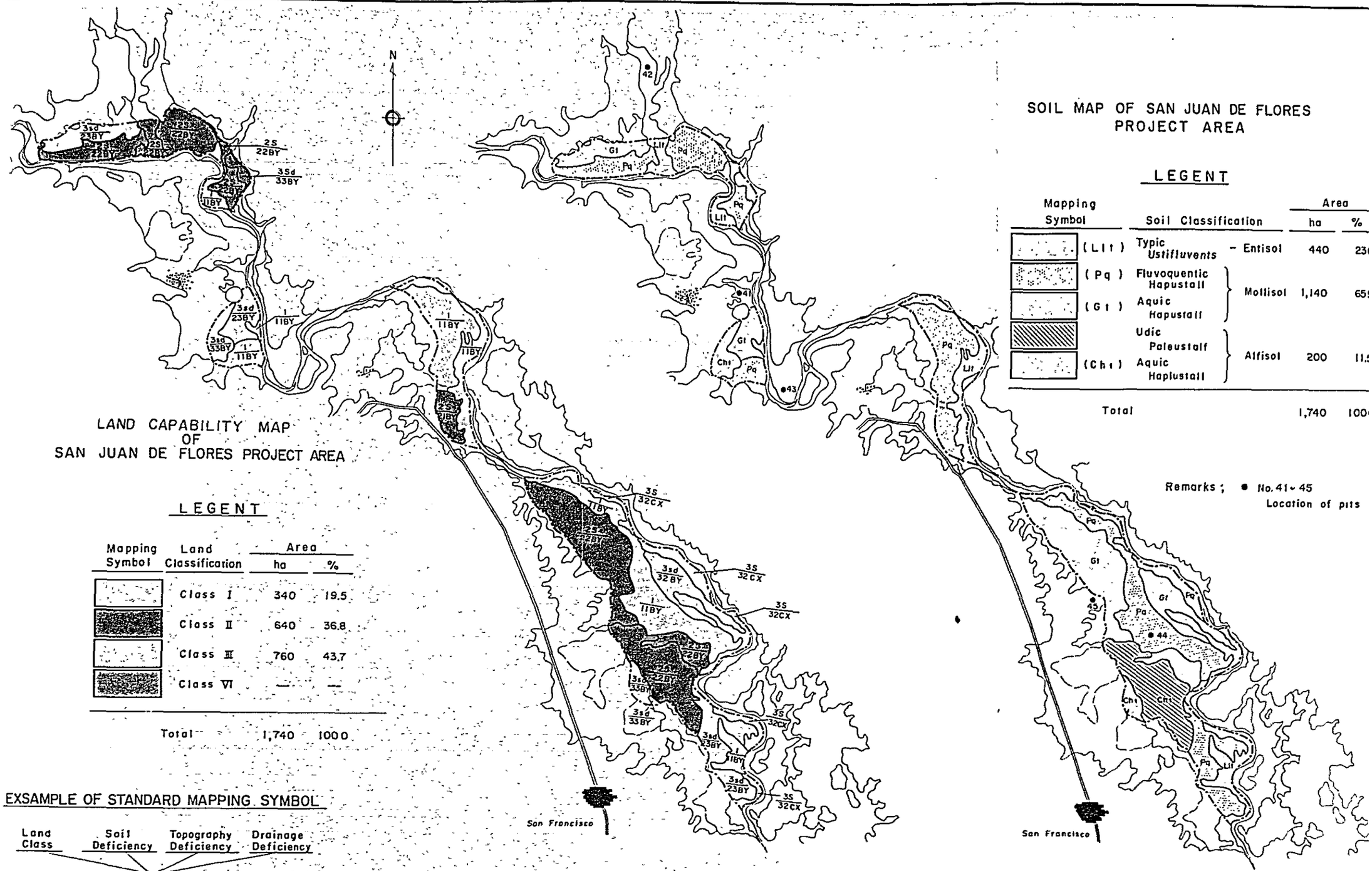
Class 6
Includes land which do not meet the minimum requirements of the next higher class mapped in a particular survey and small areas of arable land lying within larger bodies of nonarable land.

Table-B8 LAND CAPABILITY CLASSIFICATION IN THE CHOLUTECA PLAIN

Land Class	Western Plain		Eastern Plain		Total	
Class I	6,740 ha	30.0%	110 ha	0.8%	6,850 ha	18.9%
Class II	6,750	30.1	1,420	10.2	8,170	22.5
Class III	7,590	33.9	9,650	69.4	17,240	47.5
Class IV	130	0.6	2,200	15.8	2,330	6.5
Class VI	260	1.2	300	2.1	560	1.5
River, viberbedetc.	930	4.2	220	1.6	1,150	3.1
Total	22,400	100.0	13,900	100.0	36,300	100.0

Table-B8 LAND CAPABILITY CLASSIFICATION IN SAN JUAN DE FLORES VALLEY

Land Class	Area	%
Class I	340 ha	19.5
Class II	640	36.8
Class III	760	43.7
Class VI	-	-
Total	1,740 ha	100

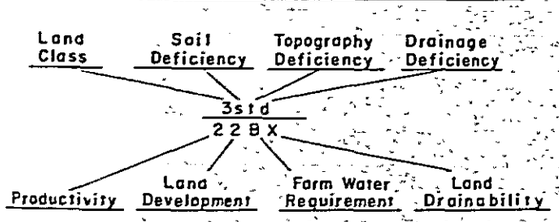


LAND CAPABILITY MAP OF SAN JUAN DE FLORES PROJECT AREA

LEGENT

Mapping Symbol	Land Classification	Area ha	Area %
	Class I	340	19.5
	Class II	640	36.8
	Class III	760	43.7
	Class VI	—	—
Total		1,740	1000

EXSAMPLE OF STANDARD MAPPING SYMBOL



Productivity and Development : 1,2,3,4 or 6 denoting land class level factor, such as : Class 2 productivity, class 2 development cost - "22"

Farm Water Requirement : A - Low, B - Medium, C - High.

Land Drainability : X - Good, Y - Restrict, C - Poor or negligible.

SOIL MAP OF SAN JUAN DE FLORES PROJECT AREA

LEGENT

Mapping Symbol	Soil Classification		Area ha	Area %
(Lit)	Typic *Ustifluvents*	- Entisol	440	23
(Pq)	Fluvoquentic Hapustall	Mollisol	1,140	65
(Gl)	Aquic Hapustall			
	Udic Paleustalf	Alfisol	200	11
(Chl)	Aquic Haplustall			
Total			1,740	100

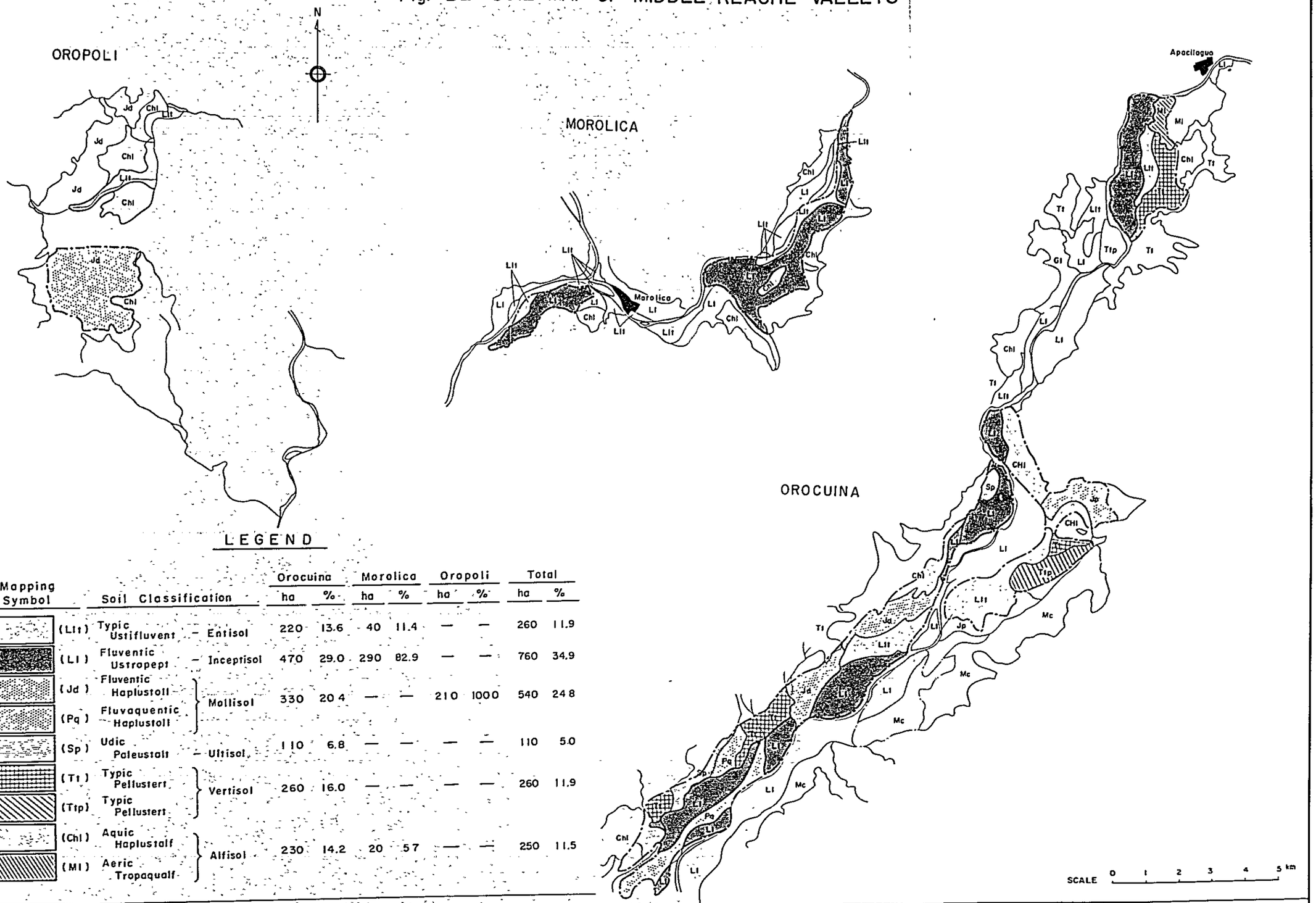
Remarks ; ● No. 41 ~ 45 Location of pits

Fig. - B1 SOIL AND LAND CAPABILITY MAP OF SAN JUAN DE FLORES VALLEY

SCALE 0 1 2 3 4 5

GOVERNMENT OF THE REPUBLIC OF HONDURAS MINISTRY OF NATURAL RESOURCES	TITLE OF DRAWING SOIL AND LAND CAPABILITY MAP OF SAN JUAN DE FLORES VALLE
AGRICULTURAL DEVELOPMENT IN THE CHOLUTECA RIVER BASIN	DWG NO 1104 JAPAN INTERNATIONAL COOPERATION AGENCY

Fig.-B2 SOIL MAP OF MIDDLE REACHE VALLEYS



LEGEND

Mapping Symbol	Soil Classification		Orocuina ha	Orocuina %	Morolica ha	Morolica %	Oropoli ha	Oropoli %	Total ha	Total %
(Llt)	Typic Ustifluvent	– Entisol	220	13.6	40	11.4	—	—	260	11.9
(Ll)	Fluventic Ustropept	– Inceptisol	470	29.0	290	82.9	—	—	760	34.9
(Jd)	Fluventic Haplustoll	– Mollisol	330	20 4	—	—	210	1000	540	24 8
(Pq)	Fluvaquentic Haplustoll									
(Sp)	Udic Paleustalf	– Ultisol	110	6.8	—	—	—	—	110	5.0
(Tl)	Typic Pellustert	– Vertisol	260	16.0	—	—	—	—	260	11.9
(Tlp)	Typic Pellustert									
(Chl)	Aquic Haplustalf	– Alfisol	230	14.2	20	57	—	—	250	11.5
(Ml)	Aeric Tropaqualf									
Total			1,620	100.0	350	1000	210	100.0	2,180	1000

SCALE 0 1 2 3 4 5 km

GOVERNMENT OF THE REPUBLIC OF HONDURAS MINISTRY OF NATURAL RESOURCES	TITLE OF DRAWING SOIL MAP OF MIDDLE REACHE VALLEYS
AGRICULTURAL DEVELOPMENT IN THE CHOLUTECA RIVER BASIN	DWG.NO. 1102 JAPAN INTERNATIONAL COOPERATION AGENCY.

ANNEX C

DAM SITE GEOLOGY AND CONSTRUCTION MATERIAL

C DAM SITE GEOLOGY AND CONSTRUCTION MATERIAL

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C1. DAM SITE GEOLOGY

C1.1 General Geology

Geological basement of Honduras is an undifferentiated Paleozoic metamorphic rocks, which form exposed zones in the northern and eastern areas of the country. In the middle part of these areas, the surface of the Paleozoic basement is depressed and covered by Mesozoic sedimentary series. These extensive areas of pre-Tertiary rocks which cover almost two-third of the country are dissected by the northerly river systems pouring into the Caribbean Sea. On the other hand, the south-western area of the country is extensively covered with Tertiary volcanic rocks, which form highlands of several hundred meters to more than 1500 m in elevation. Drainage systems are south bound in the most parts of this Tertiary zone, except for its north-western part.

The Choluteca river pouring into the Gulf of Fonseca on the southern coast of Honduras is located in the eastern part of the Tertiary zone. The Choluteca river, originating at the ridges with some 1400 - 2000 m of ground height in M. Yer ba Buena to the south of Tegucigalpa, takes its course first to the north through the city of Tegucigalpa, then to the east to San Juan de Flores, and to the south-east to the vicinity of Oropoli, and finally to the south-west toward the Choluteca plain. In the easterly course to San Juan de Flores, especially in the section of about 8 km downstream from the Hernando Lopez bridge on the highway to Olancho, a deep narrow gorge with very steep slopes on both banks is formed, while the valley is fairly wide open in the other sections.

The Tertiary rocks which occupy the most part of the basin are composed dominantly of acidic pyroclastic rocks of various grain sizes, ranging from volcanic breccia to fine tuff, some of which are welded. Lava flows of rhyolite, andesite and basalt are also prevalent member of the Tertiary zone. Obsidian is occasionally included. The pyroclastic rocks are, in general, horizontally bedding or mildly folding. Two trends of faulting, NW-SE to NWW-SEE and NE-SW, are dominant.

Other than the Tertiary rocks (Jutiapa formation), a narrow belt of Jurasic-Cretaceous sedimentary rock formations of conglomerate, sandstone, shale, limestone and other calcareous rocks are developed through the ridge between the basin of Talanga and the Choluteca river, and through San Juan de Flores area to the eastern part of Tegucigalpa.

C1.2 Geological Investigations Performed

Surface geological investigations were performed in the proposed damsites and surrounding areas of Zorrillo, San Fernado, Morolica I (the upstream site) and Morolica II (the downstream site), as well as at two alternative intake weir sites at Las Basas and El Papalon. Construction material surveys were also conducted. Geological maps were prepared for the four alternative damsites. Geological maps for Zorrillos, Morolica I and Morolica II damsites are shown in Fig.-C1, Fig.-C2 and Fig.-C3, respectively. A geological map for San Fernando damsite is shown in Drawing No.1201 of the main report.

Core drillings were performed and water pressure tests (packer tests) were made in some of the drill holes as tabulated below:

Site	Location	Hole No.	Depth (m)	Water pressure test (section)
San Fernando	Left bank EL.835m	SF-1	31.4	2
	Left bank EL.770m	SF-2	61.0	7
	Right bank EL.835m	SF-3	48.7	
Morolica I	Right bank EL.255m	MI-1	30.5	
	Right bank EL.267m	MI-2	61.0	
	River bed EL.175m	MI-3	30.5	
Morolica II	River bed EL.150m	MII-1	30.5	2
Las Basas	Right bank EL.49m	B-1	16.8	
El Paplon	River bed EL.21.5m	P-1	15.5	
		Total	325.9	11

(Length of a section for water pressure test was 5 m, but a few sections were longer.)

Laboratory rock tests (density, absorption, unconfined compression and tensile strength in Brasilian test) were performed on the drill cores from San Fernando.

C1.3 Geology of Zorrillo Damsite

(1) Location

N14°16'50", W87°10'33". Approximately 500 m downstream from the Hernando Lopez bridge on the highway to Olancho.

(2) Topography

The valley is wide open upstream of the Hernando Lopez bridge, whereas it grows narrower with steeper slopes downstream. The river flows to the north north-east at the proposed damsite, where the river bed is at the height around EL.755 m. Slopes on the both banks rise up to EL.810 m within 100 m of horizontal distance from the brink of the river channel. Above EL.810 m, the slopes are milder and rises up to peaks in EL.860 m on the left bank and EL. 880 m on the right bank. The hills are blocked by incising gullies, such as, one named Rio Jucuare trending NEE-SWW behind the right bank abutment, one trending NW-SE on the downstream right bank, one trending NNW-SSE on the downstream left bank, etc. A saddle dyke is planned on a saddle in the north-western part of the left bank hill.

(3) Geology

Rocks in outcrops are rhyolitic welded tuffs which are hard to moderately hard, with bedding plane dipping 10 to 15 degrees southward at the damsite. Vertical joints are strongly developed, with dominant strikes of N55°E, N20°W and E-W. Gullies and saddles as described above are deemed reflecting faults. Hot spring is observed on the right brink of the Choluteca river at about 100 meters upstream of the damsite. where passes a fault line which is supposed to run along the gully Rio Jucuare on the right bank.

According to the Feasibility Report by IECO in 1968. with core drilling, tuff below EL. 746 m in the river channel has numerous 2-to 4-cm-diameter open voids, seemingly resulted from rock alteration related to hot-springs along faults. Also, a bed of tuff of less hardness is observed in EL. 760 - 770 m at the bottom of the gully in the downstream left bank. These show that the rock foundation is not always of homogeneous solidity, but varies in its quality in different horizons.

As the difference of solidity is due to the original nature of rock beds and not due to weathering from surface, it is possible that an underlying bed is softer than the overlying one.

(4) Technical remarks

Though some faults are developed in the area surrounding the damsite, they will not result in any essential difficulties, or can be treated if necessary within a reasonable cost. Problem of very frequent joints and open cracks can be solved by excavation to a reasonable depth (10 to 12 m of depth to groutable tuff, according to the Report in 1968) and foundation grouting. In view of the strength of rocks generally similar to those in the San Fernando damsite as described in the following section and change in hardness of rock by stratum, it is deemed questionable to plan concrete gravity or arch dam at this site. The most appropriate type can be fill dam.

C1.4 Geology of San Fernando Damstie

(1) Location

N14°17'25", W87°09'42". Approximately 2 km downstream from Zorrillo damsite.

(2) Topography

The river bed is at El.742 m, with 20 to 30 m in width. The river channel turns its course from northward to eastward at the damsite, with the right bank protruding at the corner. Cliffs with 70° to 80° of inclination, and partly vertical or overhanging, are formed on both banks, up to a terrace at EL.835 m without terrace deposit. On the left bank, the width of the terrace is only 50 m, and slope rises from the end of the terrace up to EL. 1100 m, while, on the right bank, the terrance has about 200 m in width and the slope behind rises up to more than EL. 1300 m. A short steep gully is formed on the left abutment of the damsite down to EL. 765 m and the rest 23 m of height is a steep rock wall.

There is another gully on the right bank, which starts at the foot of the slope behind the terrace and runs down to reach to the river at about 300 m upstream of the damsite. No water flows are seen in these gullies except for short time runoff at heavy rainfall in the rainy season.

(3) Geology

Exposed rocks are rhyolitic welded tuffs almost similar to those in the Zorrillo site. Bedding planes strike N-W to N20°E and dip middly 10° to 15° to south-east. Vertical joints or joints of steep inclination are developed. Their major trends are N-S/90°, N20 - 25°W/75 - 80°NE and E-W/60°S, that accord with the directions of the river course and the gully on the left bank. Besides these, joints of N40°E/85°SE are rather dominant on the right bank. These vertical joints are apt to be open in the upper parts of the cliffs because of stress relief. A fault line is assumed along the gully behind the terrace on the right bank. A gedogical profile is shown in Drawing No. 1202 of the main report.

In core drilling at Hole No. SF-1 from EL. 835 m on the left bank, slight weatherings are seen at places in the welded tuff to about 22 m in depth and a few openings with brown water stains are encountered at the depths around 23 m and 25 m, though the rock condition is sound enough in general below 15 m in depth. In the shallower zone than 15 m, core recovery was less than 50 % in some sections presumably due to fracturing and friableness of rocks. Water leakage condition shows high value of 18 Lugeon unit at 30 m of depth, where no stable water table is encountered. This is deemed to imply open cracks developing to a considerable depth. However, in so far as the cut-off works against leakage is concerned, treatment by grouting can be effective for every depth of the rock bed. As for the stability for dam foundation, the zone to the depth of 15 m will have to be excavated, except for the case of fill-type dam.

On the right bank, drilling No. SF-3 from the terrace at El. 835 m revealed that white rhyritic welded tuff is moderately hard from

the top, but more or less weathered to the bottom of the hole at 48 m of depth, and bears vertically elongated open void with 1 to 10 mm of width at places which are often water-stained. These voids are, however, not always continuous. Below 38 m, some distortion of lamination is observed in rather porous sandy tuff of moderate hardness, and the rock is almost homogeneously stained in light orange colour presumably due to permeation of water. Core recovery and R.Q.D. (Rock Quality Designation, i.e. recovery rate of cylindrical cores not shorter than 10 cm) are generally high, except in a few sections where vertical cracks are developed.

According to the drilling No. SF-2 from EL.770m at the end of the short gully on the left bank, that is the spot about 28 m higher than the river bed, core recovery is very low to the depth of 10 m, presumably reflecting weathered and cracky condition in the surfacial zone of the welded tuff, whereas the rock is generally stable enough below 10 m. A noticeable fact is that a thick bed of green altered tuff with very thin shale layers at the top and the bottom is intercalated in the depth from 37.25 m to 50.0 m, that is, in the level 9 to 22 m below the river bed.[1] This altered tuff is horizontally stratified, comparatively dense and massive, but liable to break. It has a tendency of slaking or collapsing when soaked in water in unconfined condition. Its thickness is 12.75 m. This is underlain by solid grey muddy tuff and propylitic tuff. In water pressure tests in the drill hole, leakage is very much to the depth of 30 m, because of open vertical joints, but it decreases to the order of 7 Lugeon unit below 30 m, except for a section (5 m) with 17 Lugeon in the said altered tuff, and further decreases to 3 Lugeon unit in the tuffaceous sandstone and rhyolite below 50 m of depth (EL.715 m).

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[1]: According to the drilling described in the Report in 1968, this bed was encountered in 7.9 m to 18 m under the river bed. Horizontal change in thickness and height is suggested.

The result of laboratory rock tests is as shown in Table-C1. The shear strengths have been obtained from the results of unconfined compression test and Brasilian test of tensile strength, by the use of envelope of Mohr's circles of stress for compressive failure and tensile failure, or the following formula.

$$Ss = \frac{1}{2}\sqrt{Sc \times St}$$

Where, Ss : Shearing strength
Sc : Compressive strength
St : Tensile strength

However, these obtained values are of drill core test pieces which are more homogeneous than the actual condition of the rock bed and with no cracks and joints. Therefore, actual value of the rock bed as far larger mass should be considered far less than the test results. Though in-situ shear test has not been done, empirically it is very probable that the in-situ test would give shear strength not more than 10 kg/cm^2 for this condition of rock.

(4) Technical remarks

From viewpoint of the strength of foundation, dam type with the least difficulty is fill dam, though it implies some problems such as too steep slopes for abutment of impervious core zone and difficult accessibility of heavy construction machines and also scarcity of fill material. Some difficulties are seen for high concrete gravity dam or arch dam to be constructed on the foundation of strength as above. However, there may still be a possibility for these dam types by adjusting the section of dam or direction of thrust. In any case, the altered tuff bed below the river bed should not be exposed to water by excavation because of its slaky nature. Leakage through open joints or cracks can be cut off by means of grouting.

C1.5 Geology of Morolica Damsites

Two alternative sites have been selected for investigation, i.e. Morolica I in the upstream and Morolica II in the downstream. Distance between these two sites is approximately 5 km on a streight line and 7 km along the river channel.

C1.5.1 Morolica I (the upstream site)

(1) Location

N13°32'58", W86°57'00". Approximately 5 km west south-west from the town of Morolica.

(2) Topography

A topographic characteristic of this area is the incised meander of the Choluteca river dissected in the basement of Tertiary tuffs, that forms mild slopes on the convex side of the river bend and steep slope or cliff on the concave side by combined downward and lateral erosion. Another topographic feature is well developed river terrace which are seen at the height of around 50 m above the river bed between the two alternative damsites. In the site of Morolica I, a flat is formed at about 100 m in height from the river bed, that is, at EL.270 m - 290 m. The flat on the right bank, which slopes mildly to the upstream direction, is composed of mud flow deposit, and its upstream sloping is deemed due to erosion by a secondary minor water flow on the flat.

The river bed is at EL.175 m at the damsite and is about 100 m wide. Slope on the left bank shows around 45° of inclination up to the narrow flat at EL.280 m. The right bank is steeper in the upstream parts, with more than 50° of inclination and with almost vertical cliffs of the mud flow deposit, whereas it slopes milder in the downstream part with deposits of slumped slope.

(3) Geology

Base rock of this site is geenish coloured tuff including angular fragments of andesite and felsitic material, with low or

moderate hardness, which shows N60 - 70°E in strike and 10 - 30°NW of dip. It is exposed on the left bank slope. The tuff is overlain by rhyolite flow which forms the height rising behind the wide flat at EL.270 to 290 m on the right bank. The flat with 200 to 300 m of width and the slope of about 100 m in height between the rhyolite hill and the river brink on the right bank are composed of thick quaternary mud flow deposit which consists of angular to sub-angular debris of rock, mainly of rhyolite, with various sizes up to 50 cm in diameter and large rock blocks of more than 1 m in diameter with unconsolidated silty to sandy matrix of dominantly volcanic ash origin. The left bank is also covered thick by the mud flow in the upstream parts. A geological profile is shown in Fg.-C4.

In drilling No.MI-3 at the river bed, the river deposit with sand-gravels and boulders shows 9 m of thickness and fresh tuff bed is encountered immediately under the river deposit. Mudstone is intercalated below 25 m of depth.

Expecting to encounter solid rock bed within a reasonable depth for dam foundation in view of what appeared outcrops of tuff on the upper parts of the slope on the right bank, two holes MI-1 and MI-2 were drilled on the right bank. However, these drill holes could not reach to the bed rock at the depths of 30 m and 60 m respectively, and the seeming outcrops of tuff is judged as moved rock mass without connection with the basal rock bed.

As a conclusion, it is clear that the surface of the rock bed that can be foundation of dam is very deep under the extensive deposit of soft mud flow and the abutment is far behind the slope in the present topography, on the right bank of the damsite.

(4) Technical remarks

Because of the said geological condition on the right bank that will necessitate unreasonably big excavation and dam volume. this site is not recommendable.

C1.5.2 Morolica II (the downstream site)

(1) Location

N13°30'58", W86°59'15". Approximately 10 km west south-west from the town of Morolica and approximately 1 km south from the village of El Potrero.

(2) Topography

The river bed is at EL.150 m and has 200 m to 250 m of width, of which 60 m is the width of the present river channel. The left bank is the north-western slope of the mountain Cerro de Calaboso, 860 m high, and shows around 30° of inclination. The right bank has 45° of slope on the proposed dam axis, and it reaches up to a minor peak at EL.320 m at 250 m of distance from the right rim of the river bed. There is a small depression trending NEE - SWW behind the minor peak and the slope rises again to another peak at EL500 m. The highest part of the above depression is at EL.290 m. A short gully runs along this depression for about 250 m of distance toward east north-east at first, and then, turning southward, reaches to the Choluteca river at the immediate upstream of the damsite.

(3) Geology

Stratigraphic sequence in the site is as follows :-

Upper volcanic breccia
- - - - - - - - - - - - unconformity
Andesite
- - - - - - - - - - - - unconformity
Lower volcanic breccia
- - - - - - - - - - - - unconformity
Tuff

The basal tuff is light green or brown coloured, moderately consolidated, partly including small fragments of andesite and felsitic material. Its outcrops are observed only in the area more than 600 m upstream of the proposed dam axis. The lower volcanic breccia consists of angular fragments and blocks of andesite and

rhyolite with diameter ranging from 1 cm to 30 cm, and mostly 4 to 10 cm, with compact matrix of medium to coarse tuffaceous material. It is exposed in the upstream right bank and very partially at the foot of the right bank slope downstream of the dam axis. Also, it is seen captured among the overlying andesite lava. It is deemed that the surface of the lower volcanic breccia lies shallow under the andesite on the right bank, whereas it depressed deep in the river bed and on the left bank. A geological profile is shown in Fig.-C4.

The andesite bed is composed of dark coloured, fine and dense, basic or basaltic andesite and irregularly intercalating dacite. It covers the undulating surface of the lower volcanic breccia as lava flow with 100 to 200 m of thickness, and the area of its distribution along the river is rather limited. Drilling MII-1 at the river bed confirmed the solid andesite-dacite bed, under 11.75 m of river gravel and boulder deposit to the depth of 30 m. Results of water pressure tests show that the rock is fairly water-tight below 20 m of depth (EL.130 m) with Lugeon value less than 4. In the outcrops, joints of vertical or steeply dipping planes and those with very mild southward dips are intensively developed in the andesite. Especially on the right bank, the mild dipping joints are very frequent with 10 to 20 cm of intervals, and surfacial rocks are generally loosened presumably due to relief of stress on the steep slope.

The andesite is overlain by the upper volcanic breccia, which is composed of sub-angular fragments and blocks of basalt and andesite, ranging from around 1 cm to 1 m in size with brownish grey tuffaceous material as matrix. The upper volcanic breccia bed lies in the upper part of the slope higher than EL.275 m on the dam axis.

(4) Technical remarks

In case that the dam crest is not higher than EL.250 m, the dam body will wholy be situated within the zone of andesite which is solid enough for foundation of fill-type dam. Because of

loosening in the surfacial zone on the right bank slope, and for removing thick talus deposits, deep excavation over 10 m will be required for foundation of impervious core zone. Excavation depth in the river bed is to be about 12 m and that on the left bank will be several meters. The lower volcanic breccia may be encountered at the foot of the right bank. However, this will not cause any essential difficulties for the dam foundation.

C1.6 Geology of Intake Weir Sites

C1.6.1 Las Basas

(1) Location

N13°20'32", W87°09'50". Approximately 5 km north-east from the city of Choluteca.

(2) Topography

The site is situated in alluvial plain formed in the wide valley downstream from Orocuina. The river bed is at EL.37 m. Flood plain at the level of EL.50 m is developed in 350 m of width to the left side of the river channel and in 850 m of width to the right side. On the left bank, a low hill rises behind the flood plain, and further behind it, rises another hill up to more than EL.80 m. On the right bank, behind the flood plain develops a flat land which is only 5 to 10 m higher than the flood plain.

(3) Geology

The nearest rock outcrop is rhyolitic tuff at the hill about 700 m distant to the left bank side from the river channel. The flood plain is covered by silty to fine sandy material. The river deposit consists of gravels of andesite, rhyolite, basalt and tuffs, including boulders up to about 40 cm in diameter, and sand. Gravel bed is deemed to develop under the fine deposits on the surface of the flood plain. According to the hole No.B-1 drilled at the end of the flood plain close to the river brink on the left bank, the river sand and gravels has 13.7 m of thickness and is underlain

by massive and moderately hard tuff breccia.

(4) Technical remarks

Considering uneconomical deep excavation and large concrete volume required for founding the structure on the bed rock, the weir structure of floating dam type is recommendable.

C1.6.2 El Papalón

(1) Location

N13°18'54", W87°15'53". Near the town of El Papalón, approximately 7.8 km west from the city of Choluteca.

(2) Topography

The site is situated in the northern margin of the Choluteca alluvial plain, and the hills of Tertiary tuff and rhyolite are developed on the right (northern) bank. The elevation of the river bed is 21 m, and the width is 100 m. Natural river bank is 5 to 7 m higher than the river bed. Between the hill and the river brink on the right bank, there is a flat with about 150 m of width which gradually rises toward the hill. Flat alluvial plain with around EL.28 m of height develops extensively on the left bank, and there is a small isolated hill with the height of 20 m above the river bed and the width less than 100 m at the left side brink of the river channel.

(3) Geology

The flat on the right bank is composed of volcanic breccia, but dacitic andesite crops out near the river brink. The isolated hill on the left bank consists of dacitic tuff in the downstream half and of rhyolite in the upstream half portion. Drilling No.P-1 at the river bed, through the river deposit with sand and gravels of andesite, dacite, rhyolite and tuffs up to 15 cm in diameter, reached to weathered andesite at 9.4 m of depth and to solid andesite at 13.1 m. From the above, it is deemed that the

foundation is andesite and rhyolite under the whole river bed to the left bank, on the weir axis, which about to volcanic breccia on the right bank. The alluvial plain on the left bank is covered by silty fine deposits. The surface of the base rock under the alluvial deposits is deemed dipping down toward the south.

(4) Technical remarks

The weir in floating dam type will be worth consideration to evade deep excavation, if the weir is not equipped with any appurtenant structure that may reject possibility of slight tilting. If the structure is to be founded on the rock bed, the weathered andesite at 9.4 m of depth is stable enough for foundation of the low weir structure.

C1.7 Reservoir Geology

C1.7.1 Zorrillo

In case when a dam is constructed at the Zorrillo site, reservoir area is wide open valley with mild inclination of slopes, composed of massive Tertiary tuff. There is no problem of leakage through thin ridges or porous rock beds except in the saddle behind the hill on the left bank of the damsite. The height of the saddle is EL.810 m as against the river bed in the damsite at EL.755 m. Saddle dyke is necessary when high water level of the reservoir is designed higher than the above elevation. White acidic tuff is intensively weathered and weak on the surface, several meters of excavation will be required for the saddle dyke foundation. Though a fault is assumed passing through this saddle, serious problem is not foreseen for water leakage because the saddle ridge is fairly thick with gentle slope of around 10^{o}. Grouting for cut-off curtain without much depth will be sufficient. No possibility of large scale sliding or collapse of slope, such as to jeopardize the dam structure, is seen in the wide open valley developing in the reservoir area.

C1.7.2 San Fernando

In case when a dam is constructed at the San Fernando site, the reservoir area will be added to that in case of theZorrillo site by 2 km of narrow valley between Zorrillo and San Fernando. Within this additional 2 km, there is a slope with coverings of debris and loose rocks on the left bank of the river. However, these coverings are not thick and the possibility of sliding more than very minor local slips is deemed very little. Serious leakage through the rim of the reservoir is not probable.

C1.7.3 Morolica

Reservoir area is underlain by massive Tertiary tuffs and the valley is generally wide. Surrounding hills are sufficiently thick and no possibility of leakage is seen on the rim of the reservoir. As for sliding, Quaternery mud flow deposit and thick coverings of debris in the downstream area from the town of Morolica should be drawn to attention. Especially, the mud flow deposit in Morolica I site which forms high cliffs will require work for reforming the slope. Close examination of the slope stability of this part will be necessary in the future stage of detailed design, based on further drilling and geophysical exploration.

C2. CONSTRUCTION MATERIAL

C2.1 Zorrillo and San Fernando damsites

C2.1.1 Concrete aggregate

Sand is obtainable from the river deposit of the Choluteca river in the upstream reaches from the Hernando Lopez bridge where the valley is flat and the river channel is wider.
As for the coarse aggregate, the river gravels are not usable because of tuffaceous soft gravels included at seemingly about 20 %. Hard dacite flow, exposing on the hill of mild slope in the east of the station 27 km (form Tegucigalpa) on the new highway from Tegucigalpa to Talanga, is the nearest source of available coarse aggregate. The thickness of the decite which develops horizontally is more than 10 m. and estimated quantity is 400,000 cu.m. at least. Distance to the damsite is approximately 10 km, assuming to use the present highway up to La Canāda and to improve a now unused narrow road from La Canāda to thedamsite. Another big source of coarse aggregate is a hill in the east of the station 21 km on the said highway where andesite lava flow develops extensively and quantity is more than sufficient for the purpose. Additional 6 km of distance is effected in the latter case.

C2.1.2 Material for fill type dam

Rock material is obtained from hard welded tuff bed within 3 km of distance from the damsite. However, as hardness of the welded tuff beds tends to vary, proportion of the usable material to the quantity of excavation may not be very high. Appropriate material for impervious core zone is not found in sufficient quantity within a reasonable distance. Artificial materials, such as asphalt, have to be considered for the impervious zone.

C2.2 Morolica II

C2.2.1 Concrete aggregate

Fine aggregate is obtained from the river deposit of the

Choluteca river in the vicinity of the damsite which has around 10 m of thickness according to the drilling at the damsite. The river gravels are not usable for coarse aggregate because of the soft rock content. Possible quarry site is the slopes of andesite on both banks within 600 m upstream from the dam axis. Evading the area of influence on the structures, such as dam, spillway and diversion tunnel, estimatedly about 4,000,000 cu.m. of quarry rock is available.

C2.2.2 Material for fill type dam

The above quarry rock can be utilized for rock material of fill dam. Besides the above, approximately 1,000,000 cu.m. of andesite will be obtained from excavation of spillway. Furthermore, dacite on the right bank about 2 km downstream can be utilized for supplementary requirement. For material of impervious core zone, sandy loam with around 10 % of clay and 50 to 75 % of sand, which is SM and ML in the unified soil classification system, is found in the alluvial deposit in wide valley between La Vega and Apacilagua, 5 to 10 km downstream of the damsite. However, its thickness is only 1 m to 1.5 m, underlain by sand or gravel deposit. Therefore, as difficulties are seen for its actual utilization, the use of artificial material such as asphalt will have to be considered.

C2.3 Las Basas and El Panalón weir site

For the source of concrete aggregate, the Choluteca river deposit shows the similar condition to the above described damsites, that is, good for fine aggregate but not favourable for coarse aggregate because of included soft rock. Quarry site is proposed at a small rhyolite hill on the right bank of Quebrada Grande and 300 m north from the highway connecting the City of Choluteca and San Lorenzo at about 7 km from Choluteca. The distance is approximately 4 km from El Papalón and 12 km from Las Basas.

C2.4 Embankment material for the irrigation canal

The alluvial plain to the south from Choluteca is covered with rather fine material, which is deemed to be classified in ML or CL. This is not always so good material for compaction and stability of embankment as it is favourable for water-tightness. However, no better metarial being available, it has to be utilized by mixing coarser material or making a slope in low gradient.

Table-C1 RESULTS OF LABORATORY ROCK TESTS OF DRILL CORE SAMPLES FROM SAN FERNANDO DAMSITE

Sample No.	Location		Apparent specific gravity (G)	Water absorption	Apparent porosity	Condition	Unconfined compressive strength	Static modulus of elasticity	Brazilian tensile strength	Shear strength	Rock	Remarks
	Hole No.	Depth	(in natural condition)		(%)		(kg/cm^2)	(kg/cm^2)	(kg/cm^2)	(kg/cm^2)		
SP-1 (1)	SP-1	4.5m - 5.5m	2.427	11.20		Dry			22	24	Welded tuff	
SP-1 (2)	SP-1	4.5m - 5.5m	2.448	11.28		Dry	111				"	
SP-1 (3)	SP-1	15.5m - 16.1m	2.469	10.29		Saturated	147		33	34	"	
SP-1 (4)	SP-1	19.8m - 21.9m	2.507	9.21		Dry	210			50	"	
SP-1 (5)	SP-1	19.8m - 21.9m	2.507	9.78		Dry			48		"	
SP-1 (6)	SP-1	21.9m - 22.5m	2.467	10.16		Saturated	305		48	60	"	
No. 1	SP-2	13.1m - 13.4m	1.975	10.18	19.53	Natural	232	1.89×10^4	17.1	31	Slightly weathered welded tuff	
						Saturated	202	1.89×10^4	18.1	30		
No. 2	SP-2	22.2m - 22.6m	2.034	9.21	18.13	Natural	305	1.97×10^4	-	-	Welded tuff	
						Saturated	274	2.28×10^4	14.2	32		
No.3	SP-2	42.0m - 42.4m	2.598	-	-	Natural	238	8.30×10^3	-	-	Altered tuff	Sample was collapsed by slaking when saturated
No.4	SP-2	45.3m - 45.6m	2.613	-	-	Natural	139	5.30×10^3	18.0	25	"	"
No.5	SP-2	50.3m - 50.6m	2.085	12.73	24.61	Natural	436	2.17×10^4	-	-	Muddy tuff	Sample was cracked when saturated
No. 6	SP-2	59.4m - 59.7m	2.047	10.72	20.59	Natural	663	2.57×10^4	56.2	97	Propylitic tuff	
						Saturated	286	2.17×10^4	28.6	45		
No. 7	SP-3	17.4m - 17.8m	2.011	8.85	9.54	Natural	160	1.61×10^4	13.5	23	Weathered welded tuff	
						Saturated	91	1.38×10^4	9.3	15		
No. 8	SP-3	23.5m - 23.8m	2.035	17.65	18.97	Natural	308	2.53×10^4	30.3	48	Welded tuff	
						Saturated	290	2.18×10^4	21.7	40		
No. 9	SP-3	29.9m - 30.7m	2.189	8.86	18.49	Natural	490	2.85×10^4	28.8	59		
						Saturated	377	2.43×10^4	33.8	56	"	
						Saturated	440	2.78×10^4	29.8	57		
No. 10	SP-3	42.1m - 42.4m	1.949	8.70	16.56	Natural	237	2.35×10^4	19.5	31		
						Saturated	163	1.89×10^4	19.8	28	"	
		44.8m - 45.1m				Saturated	179	2.05×10^4	18.8	29		

Note: Diameter of test piece is 47 mm for samples No.7 - No.10, and 54 mm for the others.

Rate of length/diameter of the test pieces for the compression test is 2, and for the Brazilian test is 1.

For the test pieces of compression test which has not the L/D rate of 2, the result was converted to the value for the L/D rate of 2.

Fig.-C1 GEOLOGICAL MAP, ZORRILLO DAMSITE

N

CHOLUTECA RIVER

Covering of debris and soil, thicker than 1m.

Terroce deposit, with gravels up to 20cm in diameter.

Welded tuff rhyolitic, hard to moderately hard Open joints developing in syrfacial zone.

Strike and dip of bedding plane.

Strike and dip of joint.

Fault

SCALE 0 0.5 1.0km

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Fig.-C2 GEOLOGICAL MAP, MOROLICA I DAMSITE

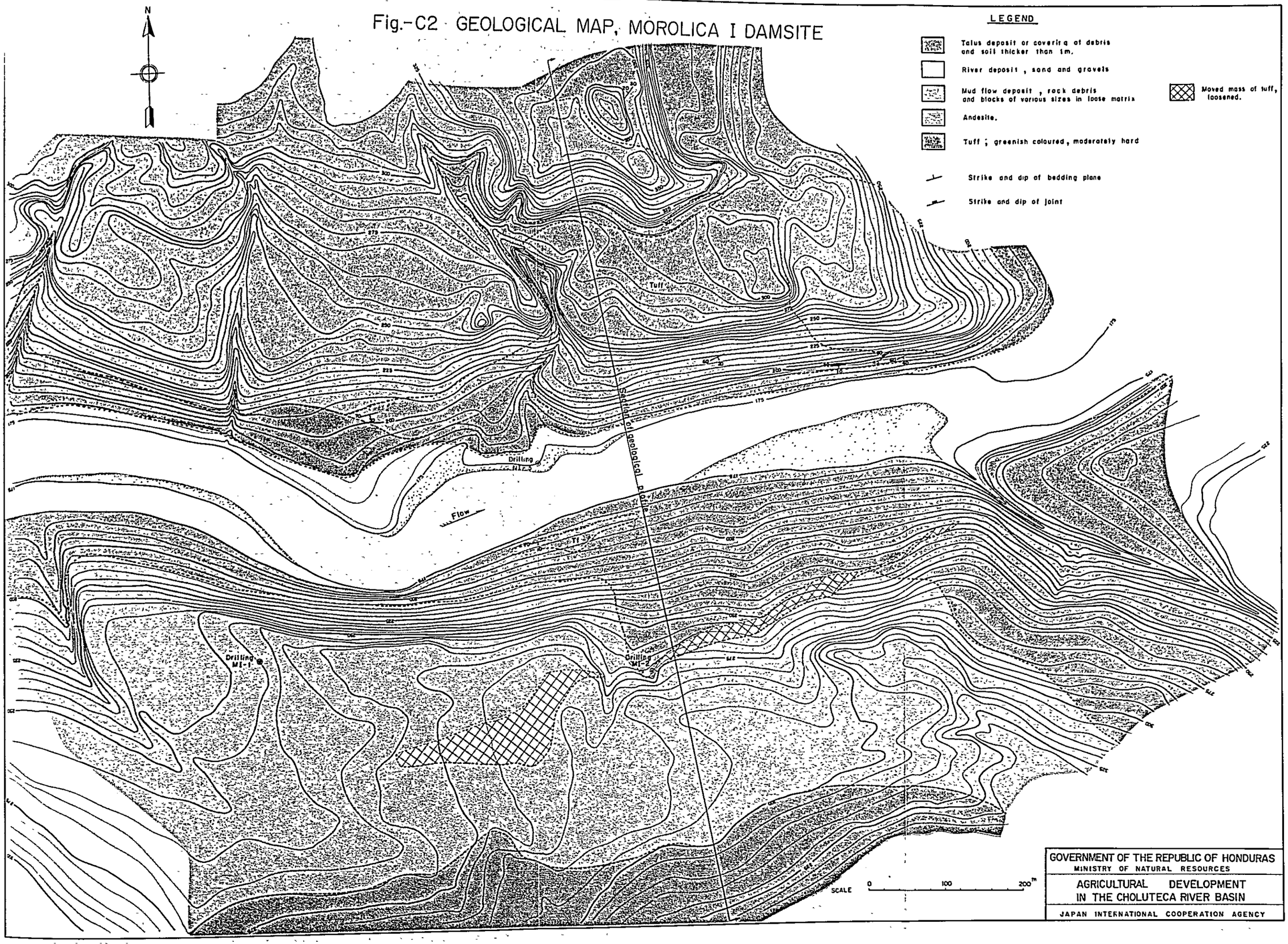

Fig. C3 GEOLOGICAL MAP, MOROLICA II DAMSITE

LEGEND

- Talus deposit or covering of debris thicker than 1m
- River deposit, sand and gravels
- Upper volcanic breccia
- Andesite, basaltic andesite, dacite
- Lower volcanic breccia
- Tuff, light green or brown partly tuff breccia
- Assumed fault
- Strike and dip of bedding plane
- Strike and dip of joint

Flow

Drilling ⊕ MII-1

Section of geological profile

SCALE 0 100 200m

GOVERNMENT OF THE REPUBLIC OF HONDURAS
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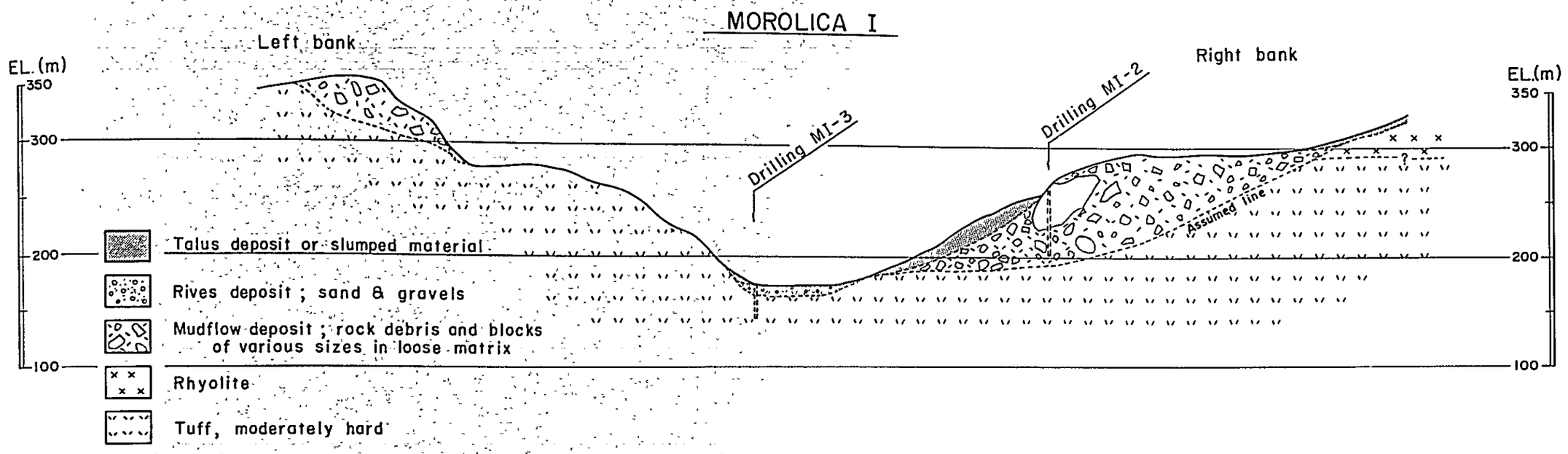
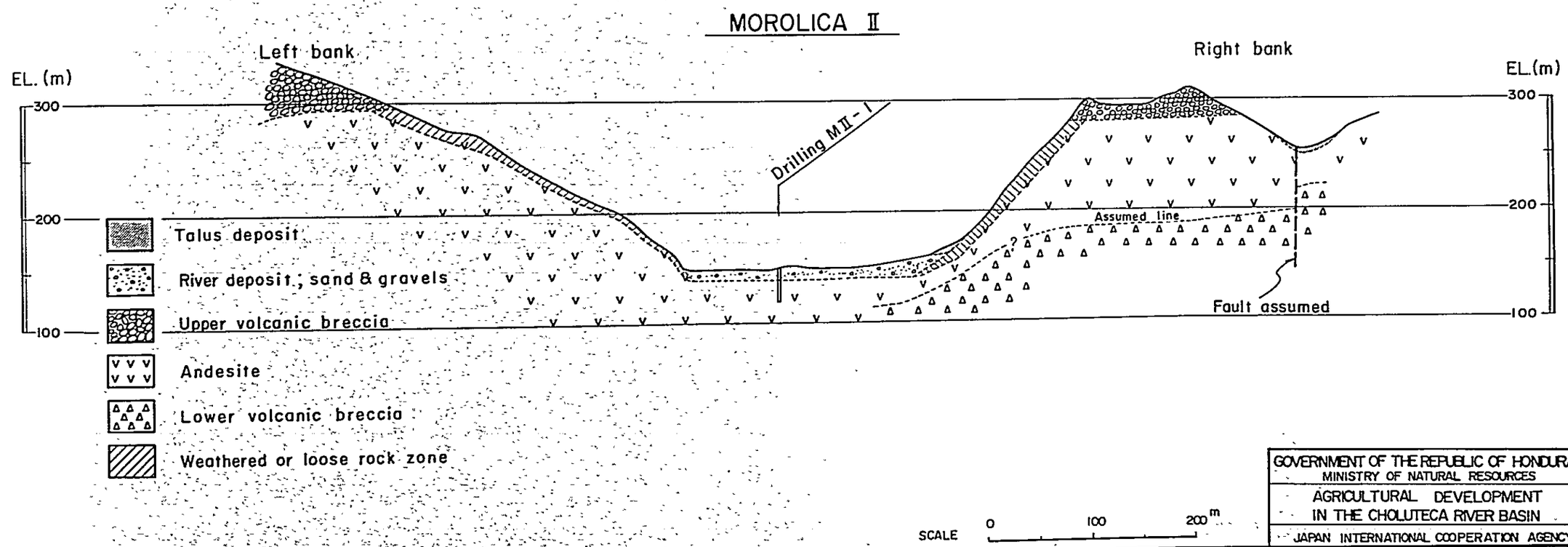
AGRICULTURAL DEVELOPMENT IN THE CHOLUTECA RIVER BASIN

JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. - C4 GEOLOGICAL PROFILE MOROLICA I, II DAMSITE





GOVERNMENT OF THE REPUBLIC OF HONDURAS
MINISTRY OF NATURAL RESOURCES
AGRICULTURAL DEVELOPMENT IN THE CHOLUTECA RIVER BASIN
JAPAN INTERNATIONAL COOPERATION AGENCY

ANNEX D

PRESENT SITUATION OF AGRICULTURE

D PRESENT SITUATION OF AGRICULTURE

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D1. POPULATION, LAND HOLDING AND LAND TENURE

D1.1 Population

The Choluteca Plain is provisionally divided into two areas; one is the area mainly extending on the right bank of the Choluteca River with the gross acreage of 22,000 ha and considered as the first priority area for the agricultural development, (called as the Western Plain Area), and the other is the area extending on the left bank of the Choluteca river with the gross acreage of 14,300 ha and considered as the second priority area the agricultural development (called as the Eastern Plain Area).

The major villages encompassed in the Choluteca Plain of 36,300 ha are 7 villages for Western Plain and 4 villages for Eastern Plain. Population and farmers' population in the Choluteca Plain are presented in Table-D1 and D2.

The Western Plain is relatively densely populated. According to the population census in 1974, the Western Plain had population of about 13,000 with its population density of 59 per Km^2. The number of households and family size were about 2,440 households and 5.3 persons per family. The population depending on agriculture in the Western Plain is estimated at about 11,000 persons or 2,070 households based on the work force by kind of economic activities in rural area of the Choluteca Department in 1974. Out of 2,0970 households, land owners are estimated to be 830 households and remaining 1,240 households are considered as landless farmers, according to the Cadastral Map prepared by the National Cadastral Office.

The Eastern Plain is less populated than the Western Plain and the Choluteca Department as a whole. The plain encompassed population of about 3,900, and the population density was 28 persons per Km^2 in 1974. The number of total households was 880. with its family size of 4.5 persons per family. The population depending on agriculture was estimated to be 3,300 or 740 households. According to the Cadastral Map, the number of land owners is estimated at 250 households and the remaining 490 households are considered as landless farmers.

D1.2 Land Holding and Land Tenure

The holding size of farm land in the Project area has been estimated as shown in Table-D3 on the basis of the Cadastral Map. In the Western Plain, the large holders of more than 200 ha, occuping only 1.6% of total land owners, are holding 33% of the total farm land (average acreage of 401.5 ha), while the small holders of less than 50 ha, occuping 94% of total land owners, are holding 49% of the total farm land (average acreage of 12.6 ha). In the Eastern Plain, about 82% of the total land owners are small holders of less than 50 ha, occuping only 17% of the total farm land.

The land tenure in the Choluteca Plain is estimated on the basis of the Third Abricultural Census - 1974 in the Choluteca Department. The land tenure in the Choluteca Plain is classified into four groups, (1) owned land - 66%, (2) national or communal land - 12%, (3) rented land - 7% and (4) others - 15%.

D2. PRESENT LAND USE OF THE CHOLUTECA PLAIN

As indicated in Table-D4, the land use in the Choluteca Plain, the land used for upland crops accounts for 37% of the total area in the Western Plain Area, while it makes up for only 5% of the area in the Eastern Plain Area. The total area of the pasture land and the forest or bush lands account for 50% of the total area in the Western Plain Area and 81% in the Eastern Plain Area. The Pasture, bush and forest lands mainly extending on the left bank of the Choluteca river, appears to be a potential land for expansion of food and industrial crop production in the future.

D3. PRESENT SITUATION OF CROPPING PATTERN AND FARMING PRACTICES

D3.1 Production in the Choluteca Plain

The Choluteca Plain has been developed as an agricultural production center in the south region of Honduras. The land productivity, however, still remains much to be improved due to lack of irrigation water and defficiency in supporting services.

Major crops cultivated in the project area are maize, sorghum, sesame, rice as food crops, sugar cane and cotton as industrial crops, and pasture for cattle grazing. The present cropping calendar of these crops is illustrated in Fig-D1. The present agricultural production in the Choluteca Plain is shown in Table-D5.

D3.2 Present Situation of Farming Practices

The farming practices for crop production are mainly represented by semi-mechanized farming. The land prepalation is done by tractors, except for a part of small-holders' farms, but other operations for crop cultivation are generally carried out by hand. According to the farm survey in the field, the percentage of semi-mechanization was approximately 100 percent in sugar can cultivation, 100 percent in cotton cultivation, 80 percent in maize, 40 percent in sorghum, and 100 percent in sesame cultivation. The farming practices by crops grown in the Choluteca Plain are described as follows:

(1) Maize

Maize is a staple food in Honduras, and the area cultivated for maize totals approximately 1,800 ha in the Western Plain area and 120 ha in the Eastern Plain area. Main varieties of maize cultivated in the Choluteca Plain are HPB, Sintetico Tuxpeno and V. Criollas. The two former varieties are middle maturing varieties (110 - 120 days). and the last one is an early maturing variety (80 - 90 days). Maize is cropped once a year, but double cropping in the wet season is also practised to some extent. The farming calendar of double cropping of maize is as follows:

Farming Practices	1st Crop	2nd Crop
Land preparation	March - April	July - August
Seeding and application of fertilizers	April - May	August - Sept.
Application of insecticides	May - October	Sept. - October
Cultivation and weeding	May - July	Sept. - October
Harvest	July - August	Nov. - Dec.

Generally, little fertilizers are applied, and the yield is low or 1.6 - 2.0 tons per ha. in the Choluteca Plain. Major pests and diseases are army worm (S. podoptera frugiperda), measuring worm (Alabama Sp.), stem borer (Diatraea saccharalis) as insects and common rust (Pussinia soghi), southern rust (Pussinia polysora) as diseases. For control of insects, Furadan or Malathion diluted at 1:1000 ratio is applied. Yields of maize in the Choluteca Plain are estimated at approximately 2.0 tons per ha in semi-mechanized farming and, approximately 1.6 tons per ha in traditional farming at present.

(2) Sorghum

The existing production area of sorghum in the Choluteca Plain is limited to approximately 200 ha, because it is mainly cropped on the fields unsuitable for maize growing, or at the foots of mountains. Grain of sorghum is used for both human diet and animal feed.

The varieties generally cultivated are classified into two groups as follows:

For human consumption - CENTA S-1,

For animal consumption - ICA NATAIMA, E59 Dekalb, E57 Dekalb, 8417 Pioneer

Seeding is generally done in May and harvest is in August. Little fertilizers are applied. Control of insects and diseases are in the same way as in the case of maize.

Yields of sorghum in the Choluteca Plain are estimated at approximately 1.0 ton per ha at present.

(3) Rice

At present, rice production area in the Choluteca Plain is approximately 200 ha due to mainly difficulty in irrigation water supply. The rice cultivation is mainly carried out by applying large scale commercial farming methods with full mechanization and supplemental irrigation. Only one crop, however, is grown in the rainy season due to shortage of water in the dry season. Prevalent varieties grown in the area are CICA 4, CICA 6, Blue bonnet - 50 and IR 100. CICA 4 is a variety introduced from Colombia, and the yield is good but susceptible to blast disease (Pyricularia oryzae). CICA 6 appears to be more promising from the view points of germination, resistance to blast and yield. Blue bonnet - 50 is a native variety. Although its taste is good, it is susceptible to blast. Cropping calendar of rice is as follows:

Land preparation	April - May
Seeding and basic fertilizer application	June - July
Harvest	October - December

Seeding is done by direct seeding method with seeding machine (drill seeding on a dry field). Fertilizers are applied 130 kg to 150 kg of compound fertilizer (12:24:12 or 15:15:15) and 10 to 20 kg of urea per ha as a basic fertilizer application, and 60 to 70 kg of urea per ha in 30 to 40 days after seeding as a top - dressing. Weed control is done by using herbicides. The dominant pests are army warm (Spodoptra frugiperda) and stem borer (Diatera Saccharalis, Rupella albinella), which are controlled by periodical application of insecticides during growth period. Harvest is done by hand or by a grain combine and the paddy is transported to the rice mills. Yields of rice are estimated at approximately 2.5 to 3.0 tons per ha (in paddy).

(4) Sugar Cane

The existing cane fields are approximately 5,040 ha in the Western Plain area and 30 ha in the Eastern Plain area. They extend mainly in the alluvial soils on the right bank of the Choluteca river.

The results of cane production by ACHSA in 1976/77 are tabulated as follows:

AZUCARERA CHOLUTECA (1976/77)

	Cane area	Cane produced	Unit yield
Estate farm	874 ha	83,192 t	95.2 t/ha
Farmer's farm and Cooperatives' farm	1,189 ha	101,401 t	85.3 t/ha
Total:	2,603 ha	184,593 t	89.5 t/ha

Farming calendar of sugar cane is as follows:

	Plant Cane	Ratoon Cane
Land preparation, Planting or ratooning and basic fertilizer application	Aug. - Oct.	Nov. - May
Top dressing	Oct. - Dec. or May - July	Dec. - June
Earthing	Oct. - Dec.	
Weeding	May - Nov.	May - Nov.
Harvesting	Nov. - Jan.	Nov. - May

Growth duration of sugar cane is approximately 13 - 16 months for plant cane and 11 to 12 months for ratoon cane. Ratooning is generally done 4 to 6 times depending on the soil conditions.

Varieties of cropped sugar cane are NCO310, B43-62 and CP3437. NCO310 is cropped in more than 90% of the total cane fields. Fertilizer application systems are 250 kg of compound fertilizers and 90 kg of urea per ha for both plant cane and ratoon cane in ACHSA fields, and only 140 kg of urea in ACENSA field as it has been recently reclamated. About 50% of ACHSA estate is irrigated by pumping up from the Choluteca river and by pumping up ground water. Little damage by insect and disease has been experienced, except for rat damages. Manual harvesting is practised. Labor charge in the estate farm was around L.2.60/s.t (US$1.43/t), and transportation charge to the factory was about L.3.00/s.t/4km (US$1.65/t/4km) on an average in 1977.

(5) Cotton

Cotton farming is practised on relatively sizable scale with mechanization. Cooperatives are organized or cotton fields are formed collectively to enable mechanized farming. The existing cotton field in the project area is estimated to be approximately 900 ha. The major varieties are Stonville 213 and Conal-S. Quality of lint produced in the Choluteca Plain is excellent.

Cropping calendar of cotton farming is summarized as follows:

Land preparation	May - June
Seeding, application of basic fertilizers	July - August
Reseeding, thinning	August - September
Application of herbicides	July - August
Application of top-dressing	August - October
Weeding	August - October
Application of insecticides	September - March
Harvest	January - March

Compound fertilizers (12:24:12 or 15:15:15) of 130-150 kg and urea of 10-20 kg per ha are applied as basic fertilizer, and urea of 60-70 kg per ha as top-dressing. Weed control is done by using herbicides and supplementaly by hand.

Major insects are aphid, army worm, boll weevil and boll worm, especially boll wievil (Anthonomus grandis) and boll worm (Pectinophora gossypiella) cause serious damage to cotton production. Application of herbicides and insecticides, which is the most important work for cotton cultivation, is made by aircraft. Insecticides are applied 10 to 20 times throughout the growth period. Harvesting is done by hand. (One labor can pick 30 to 70 kg of seed cotton a day). Yields of seed cotton are estimated at about 2 tons per ha.

(6) Melon and Water melon

The cultivated lands of melon and water melon are 200 ha and 300 ha respectively. These crops are mostly cultivated under without

irrigation. As melon and water melon require adequate humidity in soils but dislike stagnant water, light texture soils are selected for their ultivation.

The varieties of melon grown in the Choluteca Plain are SJ45 and TAm Dew. SJ45 has nets on its pericap and is small in fruit size, while TAm Dew has no net and is white sarcocarp and bigger in size. Cropping calendar of melon is as follows:

	SJ45		TAm Dew	
	Seeding	Harvest	Seeding	Harvest
	Nov-Dec	Jan-Feb	Nov-Dec	Feb-Mar
Growth duration	60 - 65 days		70 - 75 days	

Seeding is done by direct seeding method. Compound fertilizer (20:20:0) of 190 kg, potassium nitrate of 130 kg, and urea of 90 kg are applied per ha. Major insects are aphid (Aphis gossypii), white fly (Bemissia tabaci), nematodes (no identification), army warm (Spodoptera SPP), fruit borer (Diaphania nitidalis) etc. Major diseases include Dawny mildew (Pseudo perronospora cubensis) and Powder mildew (Erysiphe cichroracearum).

The main variety of watermelon cultivated in the Choluteca Plain is Charlston Grey. Cropping calendar is:

Seeding	May - August
Harvest	October - December
Growth duration	approximately 80 days

Farming practices as seeding, fartilizer application, insect and disease control are almost the same as that of melon. Yields of melon and watermelon range 3 to 5 tons and 5 to 10 tons per ha. respectively.

(7) Livestock Raising

The total lands used for cattle grazing in the Choluteca Plain are approximately 22,500 ha, of which 12,600 ha are pasture lands and 9.900 ha are forest lands used for cattle grazing. The pasture lands consist of 9,000 ha of improved grass pastures (70%) and 4,000 ha of natural

grass pastures (30%). Number of cattles raised is around 44;000 - 45,000 heads or about 2 heads (including calves) per ha. Major improved pasture grasses are Estrella Africana (Cynodm Pleistost a chyus), Elephant grass (Pennisetum SP.), Guinea grass (Panicum maximum), Jaragua grass (Hypasshema rufa), etc. Estrella Africana is recommended by MRN because of strong resistance to draught and vigorous growth under non-irrigated conditions.

Non-irrigated grass land can feed cattles in the wet seasons, but lack of grass in the dry seasons makes cattle emaciated, and a mortality rate of cattle becomes higher. In the dry seasons, stock-farmers are seeking places where enough grass is available. Most cattle is fed by grass only, except for a few cases of milk cow raising. Cebuinas and improved native meat cattle (Hybrid between Cebuinas and Native mean cattle) and bred for meat, Holstein and Guernsey for milk, and Brown Zwiss for dual purpose.

Common diseases are hemorrhagical septicema, septicicemia, peculiar anthracenose, mastitis and parsitic diseases. Averaged rates of birth and mortality are 60 percent and 15 percent respectively. Yield of milk per cow is estimated at about 200 liters a year.

D4. INSTITUTIONS, SUPPORTING SERVICES AND AGRO-INDUSTRY

D4.1 Institutions and Supporting Services

The Institutions related to the Agricultural Development in the Choluteca River Basin are INA, MRN, BNF and cooperatives and resettlement associations. INA is an executing agency for the agrarian reform and is responsible for land acquisition, re-distribution, resettlement, agricultural cooperative activities, etc. MRN provides agricultural extension services, researches, seed multiplication, farmers training, etc. BNF is responsible for agricultural credits and a part of marketing. Their present activities in the Choluteca Plain are described below:

(1) INA

To promote agrarian reform under Decreto-Ley No.170 and to attain efficient land utilization, INA is responsible for land reform by means of land acquisition and redistribution, as well as for resettlement of farmers by organizing cooperatives and resettlement associations. More than 150 cooperatives and associations have been organized in the Choluteca Department. On an average, a cooperative or association is formed by 18 members and holds same 110 ha (gross).

In the Choluteca Plain, 21 cooperatives and associations have been formed (17 in Western Plain and 4 in Eastern Plain). The major INA programs include 1) Monjaras-Buena Vista District and 2) Ola District.

The Monjaras-Buena Vista scheme was originally formed in 1958-59 in the area bounded on the north by the Ola scheme, on the east by the Choluteca river and on the south and west by the Fonseca Bay. By the end of 1976, 24 groups of cooperatives and associations with 557 members were settled in the total area of 2,372 ha (4.2 ha/member on an average). INA has a plan to further promote the settlement by incorporating about 8,750 ha for additional settlement of 1,667 families. The Ola scheme was initiated in 1958 and the land was once distributed to 462 lots of 20 ha each. However, no development has actually been achieved. INA

has a program to revive the development in the Ola district by redistributing the area of some 3,760 ha (crop land of 2,700 ha) for 740 families as the initial stage. Major crops contemplated under the Ola scheme are sugar cane for ACENSA mill, rice, sesame, cashu nuts (in sloped land), etc.

(2) MRN

MRN is responsible for technical aspects of agricultural development in cooperation with INA for the promotion of agrarian reform. MRN activities include extension services, experiments and research, planning and study on development schemes, seed multiplication, lease of agricultural machineries, training of farmers, etc. MRN has its regional office in Choluteca.

MRN Choluteca Office has at present 16 extension offices served by 16 - extensionists, of which 3 are located in the Choluteca Plain (Choluteca, Monjaras and Marcovia). Primary activities of the extensionists are to assist farmers in applying inputs such as improved variety, fertilizers agro-chemicals, and to give technical advices in farming practices. Despite efforts by individual extensionists, the total number of the extensionists appears to be insufficient yet.

MRN has an experimental station (200 ha) at La Lujosa in the Choluteca Plain, where research works and multiplication of improved varieties are executed for sorghum and sesame (as a national center for experiment), and rice, maize and peanuts (as a regional center). The La Lujosa Experimental Station is organized into 2 sections, the Investigation Section and the Production Section. The Investigation Section has at present 4-engineer agronomists, 1-agronomist and 1-chief superintendent in the services for research work. The Production Section has 1-agronomist and 1-assistant agronomist in the service for multiplication of improved varieties.

Adjacent to he Lujosa Experimental Farm, an agricultural training center is under construction. MRN programs to train its agricultural extensionists, as well as to train the cooperative and agricultural association members and the agricultural agents.

The training center has a farmland of 120 ha for training in the Lujosa Experimental Station

(3) BNF

Agricultural credits are extended by BNF. It has 3 types of agricultural credits, as follows:

i) Refaccionario

- For acquisition of houses, machinery, etc.
- Repayment period: 4-5 years.
- Grace period : 1-2 years.
- Annual interest rate: 11%

ii) Avio

- For farm inputs and other necessities for cultivation of annual crops, purchase of livestock, etc.
- Repayment period: max. 1.5 years.
- Annual interest rate: 11% (9% in case of IDB programs).

iii) Hipotecario

- For factory construction, land acquisition, etc.
- Repayment period: max. 15 years.
- Grace period : 2 years.
- Annual interest rate: 10% for factory construction and 11% for land acquisition.

For "Avio" credits for farm inputs and other necessities, BNF has its own criteria and credit limitation as follows:

	Criteria	Limit (US$/ha)
1.	Cotton	679
2.	Cane (plant cane)	725
	" (ratoon Cane)	586
3.	Sesame	214
4.	Rice (Irrigated condition)	495
	" (non-irrigated condition)	410
5.	Maize	211
6.	Sorghum	132
7.	Livestock	1,500/person

In 1976, a total of US$3.75 million (L. 7.5 million) were loaned for cultivation of 9,170 hectares in the Choluteca Department. In this total loan for cultivations, loan for cotton cultivation accounted for about 36%.

D4.2 Agro-Industries

As facilities for processing agricultural products, there exist 2-sugar mills, 2-rice mills, 1-ginning factory, 1-seed oil factory, 2-slaughter houses, and 1-cheese factory in and around the Choluteca Plain. These processing facilities have sufficient capacity for the agricultural production in the area.

The 2-sugar mills are Azucarera Choluteca S.A. (ACHSA) operated since 1968 with the mill capacity of 1,300 tons per day and Azucarera Central S.A. (ACENSA) which is scheduled to be put in operation by the end of 1977 with the mill capacity of 4,500 tons per day. ACHSA has its own cane fields of 1,540 ha, and the farms cultivating cane under contract to ACHSA are 1,160 ha in total. ACENSA has its own farm of 3,240 ha (including 1,120 ha in Santa Ana outside the Choluteca Plain) and contracted farms of 510 ha. For ACENSA mill, the cane production from 3,750 ha is insufficient to feed the 4,500 tons capacity mill. ACENSA's own cane estate cannot be extended under the Agrarian Reform Law, and efforts have been made to increase productivity, to promote cane cultivation in the INA cooperative lands, and to cultivate cane in the Santa Ana district located some 40 km apart from the mill.

Other than the cane produced by the estate farms, the sugar factories purchase cane from farmers who contract with the factory to produce cane for the factory. The price of cane at the factory's yard was L. 17.50 per s. ton (US$9.65/t) in 1976/77.

The annual sugar production of AZUCARERA CHOLUTECA is shown as follows:

Year	Total Operation Days	Factory Stoppage (%)	Cane Milled (t)	Sugar Produced (t)	Sugar Recovery (%)
1968/69	158	50.8	84,650	4,940	5.8
1969/70	155	35.9	98,680	7,500	7.6
1970/71	139	31.6	101,160	9,640	9.5
1971/72	152	21.5	123,710	11.990	9.7
1972/73	174	26.1	155,260	12,370	8.0
1973/74	177	24.2	170,690	16,240	9.5
1974/75	185	19.0	184,030	18,070	9.8
1975/76	190	18.7	191,590	19,090	10.0
1976/77	226	15.6	226,610/1	21,110	9.3

/1 Including quantity of sugar cane purchased from AZUCARERA CHOLUTECA.

The sugar factory is operated in the dry season (from the middle or the end of November to the middle or the end of May) taking into account the best conditions of sugar contents in cane.

The operation days of the sugar factory (AZUCARERA CHOLUTECA) are varied from 160 to 190 days depending on the conditions of manufacturing equipment, quantity of cane and climate, etc.

The factory was operated for very long duration as 226 days in 1976/77, because the construction of the AZUCARERA CENTRAL's factory was delayed and AZUCARERA CHOLUTECA was obliged to process the cane produced by AZUCARERA CENTRAL.

To minimize a sugar production cost. the net operation days of a sugar factory should be as long as possible. but it is limited by a rainfall which decreases the sugar content of cane. From the rainfall data in the project area, the optimum operation days of the sugar factory will be around 150 - 160 net days.

The ginning factory at San Lorenzo is operated by the Cooperativa Agropecuaria Algodonera del Sur. The processing capacity is at present 90 tons per day. A new plant of 160 tons per day is scheduled to be completed soon. With the expansion of ginning plant, the processing capacity will be much more than the cotton production under without project condition.

There are 2 - slaughter houses (IGHSA and CARNILANDIA) in Choluteca. The capacities of the slaughter houses are 300 heads and 100 heads per day, respectively. The cattle slaughtered at IGHAS totaled about 25,000 heads in 1976 or about a half of its full capacity.

There are 2 - rice mills in Choluteca. One has a processing capacity of 1.1 tons per hour, and the other has a capacity of 0.4 tons per day. Paddy harvested in a large scale paddy field is milled in San Pedro Sula or outside the Choluteca Department.

Cotton seed products from the ginning factory are all processed by a seed oil factory located adjacent to the ginning factory at San Lorenzo. The seed oil factory has enough capacity for processing (20,000 tons per year), and has problem in shortage of raw materials.

D.5 MARKETING

D5.1 Distribution of Farm Inputs

Farm inputs as fertilizers and agro-chemicals have been distributed by tradesmen. Seeds for maize, sorghum, beans, rice, etc. are supplied by MRN, while seed cane and cotton seed are supplied by processing factories of these crops. Seeds for melon and water melon have been mainly imported from USA through tradesman. The capacity of seed supply for sugar cane, cotton, melon and water melon cultivations appears to be relatively sufficient, but the improvement in seed supply capacity for maize, sorghum, beans and rice will be necessary if and when the cultivation of these crops develops in the future.

D5.2 Distribution of Farm Products

Major farm products in the Choluteca Plain are sugar cane, cotton, cattle and cereals such as maize, sorghum and rice. Present marketing system of these farm products is briefly summarized as follows.

(1) Sugar cane

Sugar cane harvested in the Choluteca Plain is brought to the sugar mills in the Choluteca Plain. All sugar produced by the sugar mills is dealt with by a sole agent organized by 7 sugar mills in Honduras, and marketed through this sole agent. Purchasing and selling prices of sugar by the sole agent in 1976/77 were US$470/ton (L. 21.5/100 lbs.) and US$510/ton (L. 23/100 lbs.), respectively. Sugar produced in Honduras has so far been destinated for domestic consumption which made up for over 90% of total sugar production.

(2) Cotton

Seed cotton harvested in the Choluteca Plain is brought to the ginning factory at San Lorenzo. All seed cotton or cotton raw is ginned, stored and exported by the Cooperativa Agropecuaria Algodonera del Sur. Cotton raw produced in Honduras have been mainly destined for export in recent years. (In 1976/77, 99.6% of total cotton raw production or

6,300 tons was exported.) Purchasing price of seed cotton at the ginning factory in 1976/77 was US$562/tons (L. 51/100 lbs.), while export price (FOB) of cotton raw was US$1,457/ton (L. 134/100 lbs.) in 1976/77.

(3) Cattle

Cattle produced in the Choluteca Plain are mainly slaughtered at two slaughter houses in Choluteca and distributed through these slaughter houses. Beef produced at these slaughter houses in Choluteca has been exported mainly to USA which accounted for 90% of total production. Purchasing price of slaughter house in 1977 was US$0.35/kg (liveweight).

(4) Cereals

Cereals such as maize, sorghum and rice are mainly for internal consumption. Most of cereals are distributed through BNF and middlemen. BNF sets up the minimum purchasing price for maize, sorghum, beans and rice every year to stabilize the price in the country.

D6. SAN JUAN DE FLORES AND MIDDLE REACH AREA

D6.1 San Juan de Flores Area

D6.1.1 Present Land Use

The San Juan de Flores Area consists of 1,340 ha (gross) of the existing irrigated area of The San Juan de Flores Project and 400 ha (gross) of the proposed extension area, totaling 1,740 ha.

Present land use of the San Juan de Flores Area is estimated as follows.

Existing irrigated Area	1,340 ha
- Sugar Cane field	(1,140)
- Others /1	(200)
Proposed Extension Area	400
- Upland field	(340)
- Others /1	(60)
Total	1,740

Note: /1 ... road, housing land. etc.

D6.1.2 Present Situation of Agricultural Production

There is a sugar factory (ACANSA) having milling capacity of 2,000 s.tons per day (1,814 t/d) in the area. This factory started its operation at the end of 1977.

The cultivation of crop in the San Juan de Flores Area will have to be concentrated on sugar cane production to meet the demand of the sugar factory. At present, some 84% of the cultivated area is used for sugar cane, and the remainder is used mainly used for maize and pasture.

Yields of sugar cane (plant cane) and maize are estimated at about 100 tons and 1.6 tons per ha, respectively. The present crop production in the area is shown as follows.

Present Crop Production
in the San Juan de Flores Area

Crop	Area (ha)	Unit Yield (t/ha)	Production (t)
Sugar cane	1,250		123,900
- Irrigated	(1,140)	(100.0 t)	(114,000)
- Non-irrigated	(110)	(90.0)	9,900
Maize	180	1.6	290
Pasture	50	-	-
Total	1,480	-	-

D6.2 Middle Reach Valleys

D6.2.1 Project Area

Major middle reach valleys, except for the San Juan de Flores Area, are Onopoli Valley (210 ha), Morolica Valley (350 ha) and Orocuina Valley (1,640 ha), totaling 2,200 ha, as shown in Table-D7.

D6.2.2 Present Cropping Area and Crop Production

Major crops grown in the Middle Reach Valleys are maize, rice, sorghum and pasture grass. The present cropping area and crop production are shown in Table-D7.

D7. THE WITHOUT-PROJECT

D7.1 Choluteca Plain

D7.1.1 Cropping Area

The two sugar mills require 870,000 tons of sugar cane annually for an efficient operation. Since about 70,000 tons of sugar canes will be produced outside of the project area, it is necessary to secure cane production of 800,000 tons in the project area.

In the Choluteca Plain, it is possible to grow sugar canes even under rainfed condition though unit yields will be loss and unstable. Sugar canes can survive until the end of the by season when grown on soils with a good water holding capacity. Therefore, it is probable that sugar cane fields will expand further under strong initiative of the sugar mills, even if the project is not implemented.

Because of low productivity per ha, pasture and forest lands are likely to be shifted to sugar cane fields. The present pasture and forest lands are 10,930 ha in the project area. For the sugar cane production of 800,000 tons in the project area, it is assumed that more than 60 % of the pasture and forest lands, or 6,800 ha, will be shifted to cane fields in addition to the present cane fields of 5,040 ha.

Due to the expanding pressure of sugar cane fields, it is assumed that no improvement will be attained for other crops in terms of cropping areas and farming practices.

The future cropping area in the Choluteca Plain area under the without-project condition is estimated as follows:

Cropping Area under Without-project

Crop	Cropping Area ha
Sugar cane	11,840
- Estate Farm	(3,400)
- Existing Former's Farm	(1,640)
- Expanded Farmer's Farm	(6,800)
Cotton	740
Maize	1,480
- Semi mechanized	(1,110)
- Traditional	(370)
Sorghum	190
- Semi mechanized	(80)
- Traditional	(110)
Sesame	130
Rice	360
Melon	260
Water melon	210
Pasture	2,440
Forest	1,690
Total	19,340

D7.1.2 Agricultural Production

The agricultural production under without-project condition will be increased to some extent by means of expansion of areas. However, yield of sugar cane per hectare will decrease to some extent in comparison with the present yield due to a rapid expansion of cane areas to meet the demand of the sugar factories.

The estimate of the future agricultural production under without-project condition is shown in Table-D8.

D7.2 San Juan de Flores Area

The future cropping area and crop production under without-project in the San Juan de Flores Area are estimated as follows.

Crop	Area (ha)	Unit Yield (t/ha)	Production (t)
Crop			
Sugar cane	1,480		113,400
- Irrigated	(1,140)	(78.6)	(89,600)
- Non-irrigated	(340)	(70.0)	(23,800)
Maize	180	1.6	300
Pasture	70	-	-
Livestock			
Milk	70	190 ℓ	13 kℓ
Meat	70	130 kg	9 t

D7.3 Middle Reach Valleys

The future crop production under without-project in the Middle Reach Valleys will be the same as the present condition.

Table-D1 POPULATION OF THE CHOLUTECA PLAIN IN 1974

Village	Population	Household
Western Plain		
El Palenque	823	183
La Joyada	947	197
Los Llanitos	1,489	268
Los Mangles	703	127
Monjaras	6,281	1,143
Punta Raton	416	63
San Jose	1,075	206
Santa Cruz	1,254	251
Sub-total	12,988	2,438
Eastern Plain		
El Carrizo	371	94
San Jose de Landa	373	86
Marcovia	2,720	607
Gervasia	461	93
Sub-total	3,925	880
Total	16,913	3,318

Source: Censo Poblacion y Vivienda 1974, Direccion General de Estadistica y Censos, Secretaria de Economia.

Table-D2 FARMERS' POPULATION AND HOUSEHOLD OF THE CHOLUTECA PLAIN IN 1974

	Western Plain	Eastern Plain	Total
Population	12,988	3,925	16,913
Household	2,438	880	3,318
Family size	5.3	4.5	5.1
Farmers' population /1	11,000	3,300	14,300
Farmers' household	2,070	740	2,810

/1 Estimated at 84.5% of population on the basis of work force by kind of economic activity in rural area of the Choluteca Department.

Table-D3 HOLDING SIZE OF FARM LAND IN THE CHOLUTECA PROJECT AREA

Holding Size	Western Plain				Eastern Plain				Total			
	Land Holder	%	ha	%	Land Holder	%	ha	%	Land Holder	%	ha	%
0 - 5	132	15.9	270	1.7	106	42.2	200	1.7	238	22.0	470	1.7
5 - 10	213	25.6	1,660	10.4	29	11.5	200	1.7	242	22.4	1,860	6.8
10 - 50	439	52.9	5,780	36.5	70	27.9	1,500	13.1	509	47.0	7,280	26.6
50 - 100	22	2.6	1,470	9.2	16	6.4	980	8.5	38	3.5	2,450	8.9
100 - 200	12	1.4	1,500	9.4	19	7.6	2,440	21.3	31	2.9	3,940	14.4
200 - 300	6	0.7	1,230	9.7	4	1.6	940	8.2	10	0.9	2,170	7.9
300 - 500	3	0.4	990	6.2	2	0.8	640	5.6	5	0.5	1,630	6.0
More than 500	4	0.5	3,000	18.9	5	2.0	4,590	39.9	9	0.8	7,590	27.7
	831	100.0	15.900	100.0	251	100.0	11,490	100.0	1,082	100.0	27,390	100.0

/1 Exclude holding area of sugar factory (about 3,170 ha)

/2 Exclude holding are of sugar factory (360 ha).

Source: Data from Cadastral Office.

Table-D4 PRESENT LAND USE OF THE CHOLUTECA PLAIN

	Western Plain		Easter Plain		Total Area	
	Area(ha)	%	Area(ha)	%	Area(ha)	%
Upland field	8,180	36.5	710	5.1	8,890	24.5
- Sugar cane	(5,170)		(30)		(5,200)	
- Cotton	(740)		(150)		(890)	
- Rotation of Maize, sorghu, etc.	(2,270)		(530)		(2,800)	
Rice field	360	1.6	160	1.2	520	1.4
Pasture land	6,750	30.1	5,880	42.3	12,630	34.8
Forest land	4,180	18.7	4,700	33.8	8,880	24.4
Sub-total	19,470	86.9	11,450	82.4	30,920	85.1
Bush and scrub land	490	2.2	550	4.0	1,040	2.9
Village	420	1.9	290	2.0	710	2.0
Others /1	2,020	9.0	1,610	11.6	3,630	10.0
Total	22,400	100.0	13.900	100.0	36,300	100.0

Remark: /1 : Road, housing land, etc.

Table-D5 PRESENT SITUATION OF AGRICULTURAL PRODUCTION IN THE CHOLUTECA PLAIN

Crop	Western Plain Area ha	Western Plain Unit yield t/ha	Western Plain Production t	Eastern Plain Area ha	Eastern Plain Unit yield t/ha	Eastern Plain Production t	Total Area ha	Total Production t
Sugar cane	5,040		382,000	30		2,100	5,070	384,100
- Estate farm	(3,400)	(78.6)	(267,200)	(-)	(-)	(-)	(3,400)	(267,200)
- Farmer's farm	(1,640)	(70.0)	(114,800)	(30)	(70.0)	(2,100)	(1,670)	(116,900)
Cotton	740	2.0	1,500	150	2.0	300	890	1,800
Maize	1,480		2,800	480		900	1,960	3,700
- Semi-mechanized	(1,110)	(2.0)	(2,200)	(360)	(2.0)	(700)	(1,470)	(2,900)
- Traditional	(370)	(1.6)	(600)	(120)	(1.6)	(200)	(470)	(800)
Sorghum	190		400	10		20	200	400
- Semi-mechanized	(80)	(2.0)	(200)	(-)	(-)	(-)	(80)	(200)
- Traditional	(110)	(1.6)	(200)	(10)	(1.6)	(20)	(120)	(200)
Sesame	130	1.3	200	10	1.3	10	140	200
Rice	360	3.0	1,100	160	3.0	500	520	1,600
Melon	260	5.2	1,400	20	5.2	100	280	1,500
Watermelon	210	8.0	1,700	10	8.0	100	220	1,800
Pasture	6,750			5,880			12,630	
Forest	4,180			4,700			8,880	
Total	19,340			11,450			30,790	
Livestock								
Milk	10,930 ha	190 ℓ	2,000kℓ	10,580 ha	190 ℓ	2,000 kℓ	21,510 ha	4,000 kℓ
Meat	10,930 ha	140kg	1,400 t	10,580 ha	140 kg	1,400 t	21,510 ha	2,800 t

Table-D6 PRESENT LAND USE IN MIDDLE REACH VALLEYS

	Oropoli (ha)	Morolica (ha)	Orocuina (ha)
Non-irrigated area			
Sugar cane filed	-	-	-
Upland filed	-	70	240
Rice filed	-	-	-
Pasture	-	120	610
Forest	210	60	240
Bush and scrub	-	60	30
Others /1	-	40	120
Sub Total	210	350	1,240
Irrigated area			
Sugar cane filed	-	-	-
Upland field	-	-	330
Others /1	-	-	70
Sub Total	-	-	400
Total	210	350	1,640

Remark: /1: Road, housing land, etc.

Table-D7 PRESENT SITUATION OF CROP PRODUCTION IN THE MIDDLE REACH VALLEYS

	Oropoli Valley			Morolica			Orocuina			Total	
	Area (ha)	Unit Yield (t/ha)	Production (t)	Area (ha)	Unit Yield (t/ha)	Production (t)	Area (ha)	Unit Yield (t/ha)	Production (t)	Area (ha)	Production (t)
Rice /1	-	-	-	-	-	-	170	3.0	510	170	510
Maize	-	-	-	70	-	110	280			350	570
- Irrigated	(-)	(-)	(-)	(-)	(-)	(-)	(80)	(2.0)	(160)	(80)	(160)
- Non Irrigated	(-)	(-)	(-)	(70)	(1.6)	(110)	(200)	(1.6)	(320)	(270)	(430)
Sorghum /2	-	-	-	-	-	-	40	1.6	60	40	60
Cotton /1	-	-	-	-	-	-	80	2.0	160	80	160
Pasture /2	-	-	-	120	-	-	610	-	-	730	-
Forest /3	210	-	-	60	-	-	240	-	-	510	-
Total	210	-	-	250	-	-	1,420	-	-	1,880	-

Remarks: /1: Rice, cotton are cultivated by irrigated condition.
/2: Sorghum, pasture are cultivated by non-irrigated condition.
/3: Forest is used for livestock raising.

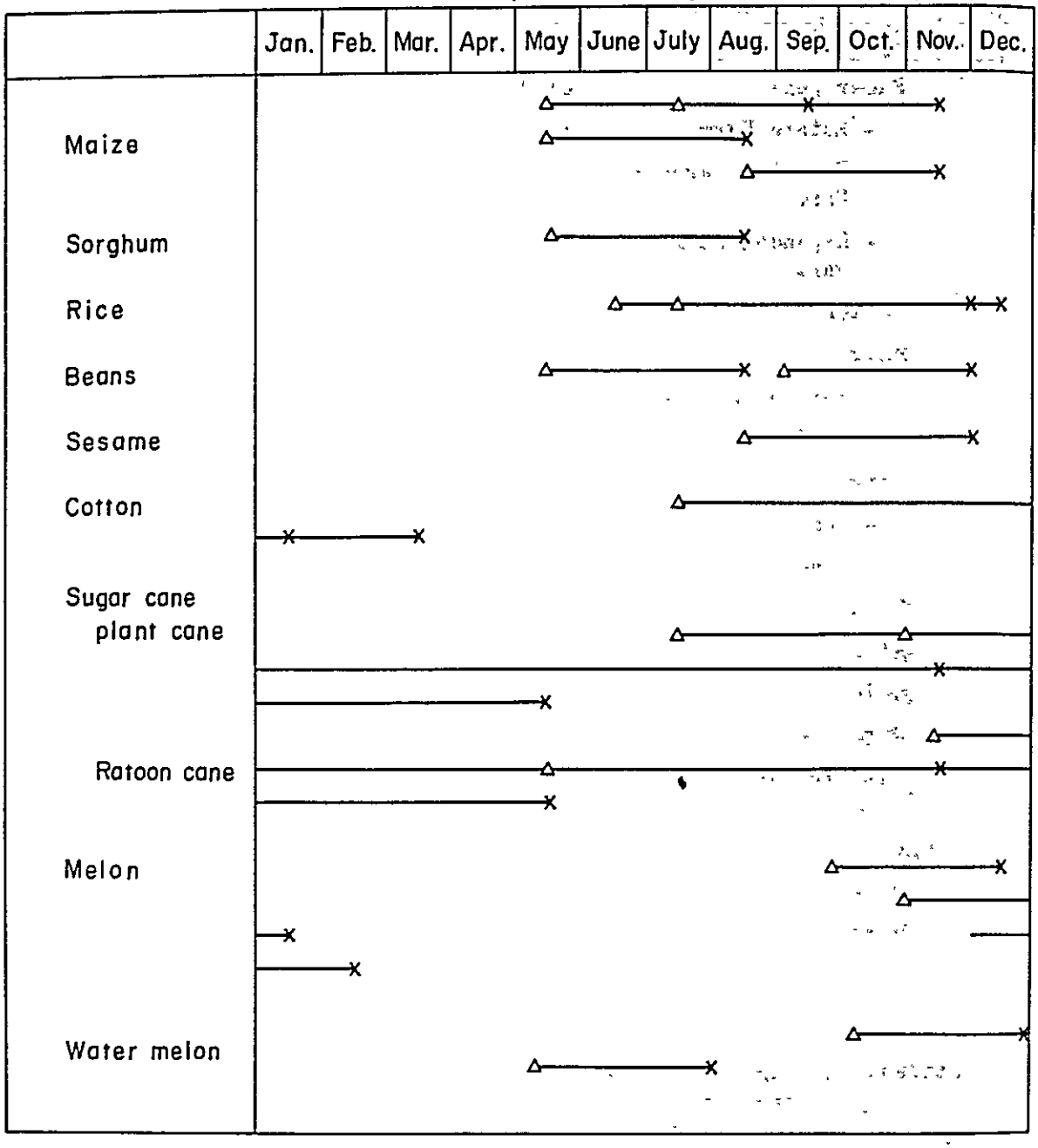
Table-D8 AGRICULTURAL PRODUCTION UNDER WITHOUT-PROJECT IN THE CHOLUTECA WESTERN PLAIN

	Area	Unit Yield	Production
	(ha)	(t ha)	(t)
Crop			
Sugar cane	11,840		799,500
- Estate Farm	(3,400)	(78.6)	(267.200)
- Existing Farmers Farm	(1,640)	(70.0)	(114.800)
- Expanded Farmers Farm	(6.800)	(61.4)	(417.500)
Cotton	740	2.0	150
Maize	1,480		2.800
- Semi mechanized	(1,110)	(2.0)	(2.200)
- Traditional	(370)	(1.6)	(600)
Sorghum	190		400
- Semi mechanized	(80)	(2.0)	(200)
- Traditional	(110)	(1.6)	(200)
Sesame	130	1.3	200
Rice	360	3.0	1,100
Melon	260	5.2	1,400
Water melon	210	8.0	1.700
Pasture/Forest	4,130		
Livestock			
Milk	4,130	190 (	780 kl
Meat	4,130	130 kg	540 t

Remarks: /1: Sugar cane area is estimated to be expanded to meet the demand of the sugar factories under non-irrigated condition.

/2: Forest is used for livestock raising.

Fig. - D 1 EXISTING CROPPING CALENDAR
(CHOLUTECA PLAIN)



△ Mark means sowing time
× Mark means harvesting time

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