JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
MINISTRY OF SUSTAINABLE DEVELOPMENT AND ENVIRONMENT
MINISTRY OF ECONOMIC DEVELOPMENT
SANTA CRUZ REGIONAL DEVELOPMENT CORPORATION
REPUBLIC OF BOLIVIA

THE MASTER PLAN STUDY
ON
FLOOD CONTROL IN THE NORTHERN RURAL REGION OF SANTA CRUZ
IN
THE REPUBLIC OF BOLIVIA

FINAL REPORT

SUPPORTING REPORT

[illegible]

PACIFIC CONSULTANTS INTERNATIONAL, TOKYO
IN ASSOCIATION WITH
CENTRAL CONSULTANT INC., TOKYO

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The cost estimate was made based on prevailing market price in October 1995 and expresses in Bolivianos according to the following exchange rate.

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(As of October, 1995)

LIST OF SUPPORTING REPORTS

ABBREVIATIONS

AASANA:	Administración Autónoma de Servicios la Navegación Aérea
ADEPLE:	Asociación de Productores de Leche
CAICO:	Cooperativa Agropecuaria Integral Colonias Okinawa Ltda.
CAISY:	Cooperativa Agropecuaria Integral San Juan de Yapacaní Ltda.
CAO:	Cámara Agropecuaria del Oriente
CDF:	Center of Forest Development
CETABOL - JICA:	Centro Tecnológico Agropecuario en Bolivia - JICA
CIF:	Cost, Insurance and Freight
CNPV:	Encuesta Demográfica Nacional de Población y Vivienda
COD:	Chemical Oxygen Demand
CORDECRUZ:	Corporación Regional de Desarrollo de Santa Cruz (Santa Cruz Regional Development Corporation)
DHI:	Internacional Hydrological Decade
EDEN:	Encuesta Demográfica Nacional
EEC:	European Economic Community
EIA:	Environmental Impact Assessment
ENDSA:	Encuesta Nacional de Demografía y Salud
ENPV:	Encuesta Nacional de Población y Vivienda
FEGASACRUZ:	Federación de Ganaderos de Santa Cruz
FOB:	Free on Board
GDP:	Gross Domestic Product
GOB:	The Government of Bolivia
GOJ:	The Government of Japan
JICA:	Japan International Cooperation Agency (Agencia de Cooperación Internacional del Japón)
MDN:	Ministerio de Defensa Nacional (Ministry of National Defense)
MDSMA:	Ministerio de Desarrollo Sostenible y Medio Ambiente (Ministry of Sustainable Development and Environment)
OMM:	World Meteorological Organization
OTAI:	Organización de Técnicos de la Agro-Industria
SEARPI:	Servicio Encauzamiento de Aguas y Regularización del Río Piraií
SEDAMA:	Secretarías Departamentales del Medio Ambiente
SENAMHI:	Servicio Nacional de Meteorología e Hidrología
SENMA:	Secretaría Nacional de Medio Ambiente
SNA:	Servicio Nacional de Aerofotogrametría
SNC:	Servicio Nacional de Caminos

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1. General

Hydrological study has been conducted to clarify the meteo-hydrological condition of the study area, which causes floods as well as drought. Based on the hydrological study, hydraulic study for floods was conducted.

Following sub-sections describe general meteo-hydrological condition in the study area, characteristics of the storm rainfall, rainfall runoff analysis, flood analysis and analysis for drought rainfall. Final sub-section describes the summary of the findings of the hydrological study.

2. River System and Drainage Basin

2.1 Río Grande, Río Piray and Río Yapacani

The study area is bounded by the Río Grande in the east, Río Piray in the center and the Río Yapacani in the west. The Río Piray and the Río Yapacani are the major tributaries of the Río Grande. The Río Grande joins with the Río Ichilo and changes the name to Río Mamore and finally joins with the main stream of the Río Amazonas. The catchment areas of the Río Grande, Río Piray and Río Yapacani are about 106,000 km^2, 10,660 km^2 and 9,960 km^2 respectively.

2.2 River System and Drainage Basins in the Study Area

The river system and drainage basins between the Río Grande and the Río Yapacani are roughly divided into three parts. They are the central part, eastern part and western part. The river system and drainage basins of these three parts are composed of following rivers (refer to *Fig. A.2.1*):

1) Central Part

Río Piray	:	main stream
Others	:	tributaries of the Río Piray except Río Chané and Río Palometillas

2) Eastern Part

Río Chané	:	right tributary of the Río Piray
Río Pailón	:	right tributary of the Río Chané
Arroyo Los Sauces	:	main tributary of the Río Pailón (most upstream is Santa Cruz de la Sierra)
Quebrada Chané	:	left tributary of the Río Chané
Quebrada El Toro	:	left tributary of the Quebrada Chané
Quebrada Las Maras	:	left tributary of the Quebrada El Toro
Quebrada Las Chacras	:	left tributary of the Río Chané
Others	:	tributaries of the Río Grande

3) Western Part

Río Palometillas	:	left tributary of the Río Piray
Arroyo Asuvicito	:	tributary of the Río Palometillas
Arroyo Lupe	:	tributary of the Río Palometillas
Arroyo Quimori	:	tributary of the Río Palometillas
Río Palacios	:	right tributary of the Río Yapacani
Arroyo Piquircito	:	left tributary of the Río Palacios
Arroyo Tacuaral	:	left tributary of the Río Palacios
Arroyo Jochi	:	left tributary of the Río Palacios
Arroyo Yapacanicito	:	right tributary of the Río Yapacani
Arroyo Tejeria	:	right tributary of the Río Yapacani

2.3 River-morphological Characteristics

2.3.1 Río Chané and Río Pailón

The eastern part and the central part of the study area have been formed as an alluvial plain of the Río Piray like alluvial fan. Land elevation of the eastern part is higher in the southern - central area and lower in the north - eastern area. The Río Piray flows around the relatively higher portion of this alluvial plain. Río Chané flows on this alluvial plain.

By the floods of the Río Grande in the downstream reach near Okinawa I and Okinawa II, sediment deposition has been proceeded and natural levee has been formed with the maximum width of about 20 km for both sides of the river. The Río Pailón has been formed along the lowest elevation between the alluvial plain of the Río Piray and the natural levee of the Río Grande.

2.3.2 Arroyo Yapacanicito and Arroyo Jochi

Land of the downstream reaches of the Río Yapacani from National Road No.7 has been formed by sand deposition by the Río Yapacani. Soil characteristic along the Río Yapacani is sandy. Arroyo Yapacanicito has been formed on this alluvial plain of the Río Yapacani. As the sediment of the Arroyo Yapacanicito is clayey, the soil along the Arroyo Yapacanicito is clayey. Small natural levee is formed along the Arroyo Yapacanicito.

Arroyo Jochi flows in the right side of the Arroyo Yapacanicito. Sediment of the Arroyo Jochi is also clayey. Small natural levee is formed along the Arroyo Jochi.

3. Available Data

In this sub-section, available meteorological and hydrological data for the study is described.

3.1 Meteo-hydrological Observation Network

Fig. A.3.1 shows the meteo-hydrological observation network in and around the study area.

3.1.1 Rainfall Gauging Station

List of rainfall gauging stations in the study area is shown in *Table A.3.1 (1)*. The numbers of the rainfall stations are 34. They are the stations of SENAMHI, SEARPI, CETABOL - JICA, CAICO, CAISY and others. Among these stations, Santa Cruz - Trompillo and Viru Viru Aeropuerto are the general meteorological stations.

Aerial distribution of the rainfall gauging stations are thick in the main stream basin of the Río Piray (central part), rather rare in the Río Chané basin (eastern part) and very rare in the basins in the western part. Therefore, additional rainfall gauging stations are necessary for the eastern part and western part.

3.1.2 Water Level and Discharge Gauging Station

Existing water level and discharge gauging stations in and around the study area are as follows (refer to *Table A.3.1 (2) and (3)*);

Río Piray	:	Puente Eisenhower La Belgica
Río Grande	:	no gauging station
Río Yapacani	:	Puente Yapacani of National Road No.7
Río Chané and its tributaries	:	no gauging station
Tributary of Río Palacios	:	Río Palometillas at National Road No.7
Other rivers	:	no gauging station

Along the Río Grande, there are abandoned stations at Puerto Pailas and Abapó. Abapó locates about 150 km upstream from Puerto Pailas.

In order to know the effect of Río Grande and Río Yapacani on the floods in the study area, it is necessary to install more water level and discharge gauging stations along the Río Grande and Río Yapacani. Water level and discharge gauging stations are also necessary for the Río Chané, Río Palacios and others.

3.2 Meteo-hydrological Data Collected

3.2.1 Daily Rainfall Data

The collected daily rainfall data are listed in *Table A.3.1 (1)*. Number of the rainfall gauging stations which have daily rainfall data older than 1975 or 1976 is 10 stations. Among the 10 stations, following four stations have relatively long record:

5806 Santa Cruz - Trompillo	:	52 years record
61NP Saavedra	:	44 years record
Colonia San Juan de Yapacani	:	35 years record
Okinawa II	:	26 years record

Above four rainfall stations are selected as the principal stations for the study.

3.2.2 Hourly Rainfall Data

Available hourly rainfall data relating to the above principal stations are listed in below;

25NP Santa Cruz - Oficina	:	1973 - 1994 (21 years record)
61NP Saavedra	:	1951 - 1994 (44 years record)
Okinawa II	:	1986 - 1994 (8 years record)

As the Santa Cruz - Oficina and Saavedra have rather long record, these data were used to analyze hourly rainfall pattern.

3.2.3 Daily Water Level and Discharge Data

Collected daily water level and discharge data are listed in *Table A.3.1 (2)* and *(3)*. Water level and discharge data of the Río Piray has about 6 to 18 years record. Water level data of the Río Grande have only 4 years record. Discharge data of the Río Grande have 3 to 18 years record. Water level and discharge of the Río Grande are not observed now. Water level measurements of the Río Yapacani and right tributary of the Río Palacios (station: Río Palometillas) have been started only since 1994.

4. General Meteorological Condition

Table A.4.1 shows the general meteorological condition in the study area. Mean temperature is 20 °C to 27 °C. Difference between the maximum and minimum temperature is about 10 °C. The hottest months are November to February and the coldest months are June and July.

Average annual rainfall of the western, southern, northern and eastern parts are 1898 mm, 1356 mm, 1301 mm and 1274 mm respectively. There are dry season and wet season in the study area. Dry season is between April to October and rainy season is between October to March. Transition seasons are March to April and September to October. Rainfall amount in the rainy season is about 60 to 70 % of annual rainfall.

5. Rainfall Analysis

5.1 Monthly and Annual Rainfall

Table A.5.1 shows the comparison of monthly and annual rainfall of 1992, 1983 and average year for the selected 8 stations which have about 20 years rainfall record.

(1) Rainfall in 1992

Amount of annual rainfall of 1992 was about 2 to 2.5 times of that of average year. Amounts of monthly rainfall of January, February and December were about 2 to 3 times of that of average rainfall. Amounts of monthly rainfall of April and May were about 2 to 4 times of that of average rainfall. Hence, the study area was rather saturated condition during rainy season. Also, run-off rate and run-off coefficient during storm rainfall were rather high in 1992.

(2) Rainfall in 1983

Amount of annual rainfall of 1983 was about 1.0 to 1.5 times of that of average year. Amounts of monthly rainfall of March and May were about 1.5 to 2.0 times and 2.0 to 3.5 times of that of average year respectively. During March 1983 Floods, there was very heavy local rainfall in the upstream reach of the Río Piray. Hence, the rainfall of March in the study area was not the main reason for the floods of the Río Piray.

5.2 Daily Rainfall during Major Floods

Fig. A.5.1 and *Fig. A.5.2* shows amounts of daily rainfall of January 1992 and March 1983 for the four principal rainfall stations of Santa Cruz - Trompillo, Saavedra, Okinawa II and Col. San Juan de Yapacani.

(1) January 1992 Floods

Continuous rainfall with duration of about 4 to 6 days was observed in the whole area. The amounts of the continuous rainfall were 453.6 mm at Saavedra, 374.0 mm at Okinawa II, 293.3 mm at Col. San Juan de Yapacani and 168.1 mm at SC - Trompillo. Daily maximum rainfall was 220.4 mm at Saavedra, 196.5 mm at Col. San Juan de Yapacani, 194.0 mm at Okinawa II and 168.1 mm at SC-Trompillo. Daily maximum rainfall was observed on January 13 at SC - Trompillo, January 14 at Saavedra and January 15 at Okinawa II and Col. San Juan de Yapacani.

It can be said that the January 1992 Floods was caused by the very heavy rainfall in the northern, eastern and western part of the study area. The heavy rainfall concentrated in three days for the four stations. Therefore it can be estimated that rainfall amount of these three days affected the floods very much.

(2) March 1983 Floods

Floods occurred in 18 th. March, 1983. Rainfall amounts around 18 th. March for the four stations were small. Hence, it can be confirmed that the rainfall in the study area was not the main reason for the floods.

5.3 Frequency Analysis for One Day to Seven Day Rainfall

5.3.1 Frequency Analysis by Gumbel Method

Table A.5.2 to *Table A.5.5* show annual maximum rainfall of 1 day to 7 day for the four principal stations.

Frequency analysis for the annual maximum rainfall by Gumbel Method was conducted. The annual maximum rainfall of the four principal stations fit to Gumbel Distribution especially for Saavedra, Okinawa II and Col. San Juan de Yapacani as shown in *Fig. A.5.3* to *Fig. A.5.6*. *Table A.5.6* shows the summary of probable maximum rainfall.

5.3.2 Return Periods of 1992 Floods and 1983 Floods

Table A.5.7 shows the summary of return periods of January 1992 Floods and March 1983 Floods.

(1) January 1992 Floods

The return periods of the storm rainfall within 3 days are as follows:

Santa Cruz - Trompillo	:	2 to 5 year return period
Saavedra	:	over 100 year return period
Okinawa II	:	50 to 100 year return period
Col. San Juan de Yapacani	:	5 to 10 year return period

Note: Annual maximum rainfall at SC - Trompillo in 1992 was recorded in December. Annual maximum rainfall of other three stations were recorded during January 1992 Floods.

(2) March 1983 Floods

Annual maximum rainfalls of 1983 for the four principal stations were observed in January and February at SC - Trompillo, November and January at Saavedra, February at Okinawa II and May at Col. San Juan de Yapacani. Hence, the rainfall amount of March 1983 floods was smaller than the annual maximum rainfall of 1983. Therefore, the return period of the rainfall of March 1983 Floods were less than 2 years for the four stations.

5.4 Rainfall Intensity Curves

(1) Annual Maximum Data of Hourly Rainfall

Hourly rainfall data were analyzed to clarify the rainfall pattern within one day. *Table A.5.8* to *Table A.5.10* show the annual maximum rainfall of 0.5 hour to 12 hour for Saavedra, SC - Oficina and Okinawa II. Data of SC - Oficina was used together with the daily rainfall data of SC - Trompillo. Rainfall with heavy intensity does not continue more than 12 hours for the three stations. As Saavedra and SC - Oficina have rather long periods of records, these data were used for further analysis.

(2) Probable Maximum Hourly Rainfall

Probable maximum hourly rainfalls was calculated for Saavedra and SC - Oficina by Gumbel method. *Table A.5.11* shows the summary of calculation.

(3) Rainfall Intensity Curves

As the trends of accumulated rainfall of the above two stations are different around 4 hours, the rainfall intensity curves of 0 to 4 hours and 4 to 24 hours were made separately. The rainfall intensity curves of Saavedra and SC - Oficina are shown in *Fig. A.5.7* and *Fig. A.5.8*. Equations of the intensity curves are also shown by using Talbot pattern.

5.5 Design Rainfall Pattern

5.5.1 Correlation of Annual Maximum Daily Rainfall

Design rainfall patterns for the four principal rainfall stations of Santa Cruz, Okinawa II, Saavedra and Col. San Juan de Yapacani were studied. Rainfall intensity curves of Santa Cruz and Saavedra were used to make their own design rainfall patterns. Design rainfall patterns of Saavedra was also used for making those of Okinawa II and Col. San Juan de Yapacani. This is because correlation of annual maximum daily rainfall of these two stations with Saavedra are bigger than the correlations of these two stations with Santa Cruz as shown below.

Coefficient of Correlation for Annual Maximum Daily Rainfall:

1)	Saavedra - Okinawa II	:	0.51
2)	Saavedra - Col. San Juan de Yapacani	:	0.48
3)	Santa Cruz - Okinawa II	:	0.12
4)	Saavedra - Santa Cruz	:	0.06

5.5.2 Design Hyetograph

As mentioned in Sub-section 5.2, January 1992 Floods were affected by three day heavy rainfall. Furthermore, the rainfall of third day was the biggest among these three days. Therefore, three day rainfall with peak behind was adopted for daily rainfall pattern for the design rainfall. Hourly rainfall pattern of each day is set as peak center. Distribution of hourly rainfall was made by using the rainfall intensity curves. Rainfall amount of 1st. day to 3rd. day for 10 year return period are shown below for example;

	Rainfall Amount (mm/day)		
	1st. day	2nd. day	3rd. Day
Saavedra	25.6	35.4	161.4
Santa Cruz	10.3	24.9	174.2
Okinawa II	21.9	21.4	165.3
C. S. de Yapacani	19.3	39.8	220.8

Design rainfall of the four stations with various return periods are shown in *Table A.5.12* and *Table A.5.13*. *Fig. A.5.9* shows the design rainfalls of 10 year return period.

6. Water Level and Discharge Analysis

6.1 Río Grande, Río Piray and Río Yapacani

(1) Río Grande

There are two abandoned water level and discharge gauging stations along the Río Grande. They are Abapó and Puerto Pailas. Catchment areas of the Abapó and Puerto Pailas stations are 60,600 km^2 and 74,500 km^2 respectively. Among them, Puerto Pailas locates at the most upstream of the Río Grande in the study area. However, their observation periods were short and old.

There were several studies relating to the Río Grande. Among them, following two studies are the major ones.

1) Agrar and Hydrotechnik GMBH; Proyecto de Desarrollo Agroindustrial Abapó - Izozog, Sep. 1974
2) SOGREAH - GALINDO; Actualizacion del Estudio de Factibilidad del Proyecto Rositas, Dec. 1982

According to the above studies, flood discharge of the Río Grande becomes as follows;

Return Period	Abapó	Puerto Pailas
10-year	6800 m^3/s	4550 m^3/s
20-year	8200 m^3/s	5500 m^3/s
50-year	10300 m^3/s	6900 m^3/s
100-year	12000 m^3/s	8000 m^3/s

Specific discharges of Puerto Pailas are 0.07 to 0.13 $m^3/s/km^2$.

Above discharge indicates that the discharges of Puerto Pailas are smaller than those of Abapó. This seems to be caused by the inundation between the two stations as well as small rainfall runoff from the sub-catchments between them. However, observation of water level and discharge are necessary to be started again for studying the hydrological characteristics of the Río Grande. Hydrological study for Río Grande Basin will be necessary in the future.

(2) Río Piray

1) Annual Maximum Water Level and Discharge

Table A.6.1 shows the annual maximum water level and discharge of the Río Piray. Recently, rather big discharges were recorded in 1989 and 1991. The flood hydrograph continued about 3 days in 1989 and 4 days in 1991 at Eisenhower.

2) Probable Flood Discharge

Probable flood discharge was studied by the Master Plan of the Río Piray by SEARPI. The simulated probable flood discharges at Eisenhower (catchment area 4010 km^2) are as follows;

Return Period	Eisenhower
10-year	2700 m^3/s
20-year	3480 m^3/s
50-year	4660 m^3/s
100-year	5620 m^3/s

Specific discharges at Eisenhower are about 0.7 to 1.4 $m^3/s/km^2$.

(3) Río Yapacani

There is no adequate water level and discharge data for the Río Yapacani. Hydrological study for Río Yapacani Basin will be necessary in the future.

6.2 Discharge Measurement

Discharge measurement was conducted in the Río Chané, Río Pailon, Quebrada Chané, Arroyo Yapacanicito, Arroyo Jochi and Arroyo Tacuaral. *Fig. A.6.1* shows the sites of discharge measurement. The results of the discharge measurement are summaries in *Table A.6.2*.

7. Rainfall Runoff Analysis

In order to know runoff characteristics of the study area, rainfall runoff analysis was conducted. In this report, rainfall runoff analysis for Río Chané Basin and Río Yapacanicito-Jochi-Tacuaral-Tejeria Basins were conducted.

7.1 SCS Unit Hydrograph Method

Unit Hydrograph Method by U.S. Soil Conservation Service (SCS) was applied for the rainfall runoff analysis. Main parameters of SCS Method are as follows;

(1) Antecedent moisture conditions (AMC)

AMC (I) : dry condition
AMC (II) : average wet condition
AMC (III) : wet condition close to saturation

During 1992 Floods, the study area seemed to be very wet condition. Therefore, AMC (III) was used in this study.

(2) Dimensionless Curve Number (CN)

CN depends on land use condition and soil infiltration as shown in *Table A.7.1*.

(3) Lag Time (tl)

Time of concentration of basin is defined as the travel time of water from the hydraulically most upstream point to the most downstream point. Equation of California Bureau of Road (CBR) in below was used for calculating lag time in this study.

$$tl\ (hr) = (11.9\ (L/1.609)^3/(H/0.3048))^{0.385}$$

where, tl : lag time (hr)
L : hydraulic length of longest water course (km)
H : elevation difference of the water course (m)

7.2 Catchment Characteristics

Fig. A.7.1 and *Fig. A.7.2* show the sub-catchments and runoff points of the Río Chané Basin and Arroyo Yapacanicito-Jochi-Tacuaral-Tejeria Basins respectively. *Table A.7.2* shows the characteristics of sub-catchments and SCS parameters of these basins.

Rainfall runoff was calculated for each runoff points with corresponding catchment area. *Table A.7.3* shows the runoff points with catchment area as well as their parameters for SCS. Although the Qda. Meco basin is included in the basin of Río Grande main stream, its water is assumed to be entered into Río Pailon upstream during floods. Therefore, Qda Meco basin was added on the basin of Río Chané.

7.3 Aerial Reduction Factor

Aerial reduction factor of point rainfall to aerial rainfall was applied for the study of Río Piray by SEARPI. In this study, this factor was checked by using the annual maximum daily rainfall of Saavedra and other stations. The results are shown in *Fig. A.7.3*. As the aerial reduction factor of SEARPI reveals a safer value, the curve of SEARPI was also applied in this study.

7.4 Runoff Discharge

7.4.1 Río Chané Basin

(1) Design Rainfalls

Design rainfalls with return periods 2, 5, 10, 20, 30, 50 and 100 year of Santa Cruz, Okinawa II and Saavedra were used for the runoff analysis. For the each runoff point, basin mean rainfall was calculated.

(2) Runoff Discharge

Fig. A.7.4 shows the calculated peak runoff discharge of each runoff point. *Fig. A.7.6(1)* shows the calculated specific discharges of the Río Chané Basin. *Fig. A.7.7* shows the runoff hydrograph of the Río Chané and Río Pailon etc. At the major runoff points, the probable runoff discharges are calculated as follows;

Probable Peak Runoff Discharge (m^3/s)

	Return Period (Year)		
	10-Year	20-Year	50-Year
Río Chané (downstream)	1270	1510	1820
Río Chané (upstream)	1200	1420	1700
Río Pailón (at Road 9)	1340	1580	1890
Qda Chané (at Road 9)	390	460	540

Specific discharges at the most downstream of Río Chané are about 0.2 to 0.8 $m^3/s/km^2$. These specific discharges coincide with the tendency of specific discharges of the Río Piray which was calculated by SEARPI.

7.4.2 Arroyo Yapacanicito-Jochi-Tacuaral-Tejeria Basins

(1) Design Rainfall

Design rainfalls with return periods 2, 5, 10, 20, 30, 50 and 100 year of Col. San Juan de Yapacani were used for the runoff analysis.

(2) Runoff Discharge

Fig. A.7.5 shows the calculated peak runoff discharge of each runoff point. *Fig. A.7.6(2)* shows the calculated specific discharges. *Fig. A.7.8* shows the runoff discharge of the Arroyo Yapacanicito, Jochi etc. At the major runoff points, the probable runoff discharges are calculated as follows;

Probable Runoff Discharge (m^3/s)

	Return Period (Year)		
	10-Year	20-Year	50-Year
A. Yapacanicito (downstream)	540	630	740
A. Yapacanicito (upstream)	220	250	290
A. Jochi (mid-stream)	270	310	360
A. Tacuaral (mid-stream)	330	380	440
A. Tejeria (downstream)	210	240	280

Tendency of specific discharges of this basin is almost same as that of the Río Chané basin.

8. Flood Analysis

8.1 Objects of Flood Analysis

Objects of flood analysis are as follows;

1) To simulate flood area with depth and duration for without flood mitigation and drainage improvement measures
2) To simulate flood area with depth and duration for with flood mitigation and drainage improvement measures
3) To make clear the hydraulic effects of flood mitigation and drainage improvement measures

8.2 Hydraulic Models

Hydraulic models were made for the Río Chané Basin and Arroyo Yapacanicito-Jochi-Tacuaral Basin. These basins correspond to the two target areas of structural measures for flood mitigation and drainage improvement. The target areas are Chané - Pailón and San Juan -Antofagasta.

8.2.1 Model Concept

Concept for the hydraulic models are as follows;

(1) Model Structure

Model structures are composed of river and drainage systems with sub-catchments as shown in *Fig. A.8.1* and *Fig. A.8.2.* Inundation areas and retarding basins are included in the river systems.

(2) Rainfall Runoff

Rainfall runoff of each sub-catchments is calculated by SCS method. Runoff hydrograph enter into channels as lateral inflow.

(3) Hydraulic Calculation

Hydraulic calculation is done by un-steady flow method. Considering the existing conditions of river channels, Manning's roughness coefficients of the river channels under without river improvement were set as 0.035 for Río Chané Basin and 0.040 for Arroyo Yapacanicito-Jochi-Tacuaral Basins. The Manning's roughness coefficient under with river improvement was set as 0.030. The Manning's roughness coefficient of the inundation area was 5 times of that of river channel.

8.2.2 Model Formulation

Hydraulic models for the Chané River Basin and Arroyo Yapacanicito-Jochi-Tacuaral Basins are formulated. Calibration of the models are done by comparing the actual condition of 1992 Floods with simulated flood conditions by the models.

Fig. A.8.3 and *Fig. A.8.4* shows the simulated inundation area and average flood depth along the rivers of the above two basins by the formulated models. The results of the calibration are as follows;

(1) Río Chané Basin

Although the simulated inundation depth is higher than the survey results, it is in the acceptable range comparing with the actual depth along the rivers. Simulated inundation area is almost same as the actual condition.

(2) Arroyo Yapacanicito-Jochi-Tacuaral Basin

The simulated inundation depth is in the acceptable range comparing with the actual depth. Although the simulated inundation area is a little smaller than the actual condition, it is in the acceptable range.

8.3 Simulation of Probable Floods

Simulation of probable floods for without flood mitigation and drainage improvement measures as well as with flood mitigation and drainage improvement measures are done. Simulated probable floods are 2, 5, 10, 20 and 50 year floods. Design rainfalls of these floods are 3 day rainfall with corresponding return periods.

8.3.1 Río Chané Basin

(1) Inundation Area and Depth

Followings describe the conditions of the simulated inundation area and depth for the without and with flood mitigation and drainage improvement measures of Chané - Pailón in the Río Chané Basin as well as Okinawa Drainage. On-going 7 bridge project of JICA is included in the river systems for both without and with conditions. Hydraulic effects of the Alternative I and Alternative II are described below.

1) Alternative I

Table A.8.1 and *Table A.8.2* show the simulated inundation depth and area of probable floods for without project and Alternative I. *Fig. A.8.5* and *Fig. A.8.6* show those of 10 year floods. Inundation conditions of Río Pailón, Qda. Chané, Chane - Chacras and Okinawa Drainage will be very much improved by Alternative I.

Although river improvement will be done for the Río Chané, flood water level of the Río Chané will be almost same or slightly increased by Alternative I. This will be caused by the increasing of flood discharge from the upstream basins due to the river and drainage improvements as well as the backwater effect of the Río Piray.

For reference, *Fig. A.8.7* shows the comparison of hydrograph of flood water level of the without project with that of Alternative I. *Fig. A.8.8* shows the maximum flood water level of the Río Chané, Río Pailon and Quebrada Chané of Alternative I.

2) Alternative II

Table A.8.3 shows the simulated inundation depth and area of probable floods for Alternative II. As the Río Pailon, Qda. Chané, Qda. Las Chacras will be improved by the Alternative II, inundation conditions of Río Pailón, Qda. Chané, Chane - Chacras and Okinawa Drainage will be also very much improved.

However, as the river improvement will not be done for the Río Chané, flood water level of Río Chané will be increased comparing with that of without project condition. The amount of increasing of the flood water level will be 0.5 to 0.9 m for 10 floods.

(2) Duration of Inundation

Durations of inundation of 10 year floods for Chané - Pailón of without project and Alternative I were simulated as follows;

	Without	Alternative I
Downstream of Road 9	6.0 day	2.4 day
Upstream of Road 9	2.8 day	2.1 day

Duration will be much decreased in the downstream area.

(3) Discharge Distribution

Fig. A.8.9 shows the distribution of peak discharge simulated for Alternative I.

8.3.2 Arroyo Yapacanicito-Jochi-Tacuaral Basin

(1) Inundation Area and Depth

1) Alternative I

Table A.8.4 and *Table A.8.5* show simulated inundation area and depth for the without and Alternative I of San Juan - Antofagasta in the Arroyo Yapacanicito-Jochi-Tacuaral Basin. *Fig. A.8.10* and *Fig. A.8.11* show the inundation area with depth of 10 year floods for without and with conditions respectively.

Inundation conditions of San Juan and Antofagasta will be very much improved by Alternative I for the reaches in which river and drainage improvement will be done.

For reference, *Fig. A.8.12* shows the comparison of hydrograph of flood water level of the without project with Alternative I. *Fig. A.8.13* shows the maximum flood water level of the Arroyo Yapacanicito and Arroyo Jochi of Alternative I.

2) Alternative II

Table A.8.6 shows the simulated inundation depth and area of probable floods for Alternative II. Flood condition will be also very much improved by Alternative II.

(2) Duration of Inundation

Durations of inundation for 10 year floods of without project and Alternative I of San Juan - Antofagasta were simulated as follows;

	Without	Alternative I
Arroyo Yapacanicito	1.1 day	0.3 day
Arroyo Jochi	1.5 day	0.4 day
Arroyo Tacuaral	2.0 day	0.0 day

Duration will be much decreased for the above three rivers.

(3) Discharge Distribution

Fig. A.8.14 shows the distribution of peak discharge simulated for Alternative I.

9. Study on Low-water Runoff

Eastern part of the study area has a problem of drought. In order to know the drought condition, low-water runoff is necessary to be studied. In this report, analysis of drought rainfall is presented.

9.1 Drought Rainfall

Table A.9.1 to *A.9.4* show continuous minimum rainfall of 1 month to 6 month of Santa Cruz - Trompillo, Saavedra, Okinawa II and Col. San Juan de Yapacani. *Table A.9.5* shows the results of frequency analysis for the four stations by log-normal distribution. Applicability of log-normal distribution was very good for 3 month to annual rainfall.

There are 3 years of drought between 1984 and 1994. They are 1988, 1993, 1994. 1995 is also said as drought year. Return periods of drought for these years for the above four stations are shown in *Table A.9.6.* SC-Trompillo, Saavedra, Okinawa II and Col. San Juan de Yapacani represent southern part, northern part, eastern part and western part of the study area. Drought scale of four month rainfall of them are shown below.

	Drought Scale (4 Month Rainfall)		
Station	1st.	2nd	3rd.
SC-Trompillo	1994	1988	1995
	(49.4)	(34.4)	(18.9)
Saavedra	1988	1995	1993
	(>200)	(31.9)	(3.5)
Okinawa II	1995	1988	1993
	(16.5)	(12.8)	(5.7)
Col. San Juan de Yapacani	1988	1995	1993
	(>200)	(145.6)	(28.6)

Remarks: values in parenthesis are return periods of drought.

Characteristics of drought rainfall are listed below;

1) Whole study area has experienced very severe drought rainfall in 1988.
2) Severe drought rainfall was observed in western part in 1993.
3) In 1994, severe drought rainfall was observed in southern part.
4) Whole study area experienced severe drought rainfall in 1995.

10. Summary of Findings

(1) Meteo-hydrological Observation Network

1) Meteo-hydrological observation network in and around the study area is necessary to be reinforced both for the rainfall gauging stations and water level and discharge gauging stations.

(2) 1992 Floods

1) Amount of annual and monthly rainfall of 1992 is much bigger than those of average year. River basins in the study area was seemed to be rather saturated condition in 1992.
2) Storm rainfall of January 1992 Floods is characterized as three day continuous rainfall with big amount.
3) Return periods of the storm rainfall during 1992 Floods are over 100 years in the northern part, 50 to 100 years in the eastern part, 5 to 10 years for the western part and 2 to 5 years for the southern part of the study area.

(3) Runoff Analysis

1) Rainfall intensity - duration curves were updated for Saavedra and Santa Cruz.
2) Three day rainfalls with peak behind were applied for the rainfall runoff analysis for the study area.
3) Runoff discharges of the Río Chané basin and Arroyo Yapacanicito-Jochi-Tacuaral-Tejeria basins were calculated and specific discharge curves were made.

(4) Flood Analysis

1) Flood analysis for without and with flood mitigation and drainage measures is being done.
2) Hydraulic effect of Alternative I and Alternative II of Chané - Pailón was simulated. Inundation condition will be much improved by Alternative I as well as Alternative II except Río Chané.
3) Hydraulic effect of Alternative I and Alternative II of San Juan - Antofagasta was simulated. Inundation condition will be much improved by Alternative I as well as Alternative II except the most downstream reach of the Arroyo Yapacanicito.

(5) Low-water Runoff

1) Study area have experienced drought rainfall in 1988, 1993, 1994 and 1995 in recent years.
2) Return periods of drought rainfall of 1988, 1993, 1994 and 1995 was calculated.

TABLES

TABLE A.3.1 LIST OF HYDROLOGICAL GAUGING STATIONS AND COLLECTED DATA (1/2)

1. LIST OF RAINFALL GAUGING STATIONS AND COLLECTED DAILY RAINFALL DATA

Station No.	Station Name	Location		Elevation	Observation Started						Data Collected					
		Latitude	Longitude	(El. m)	Manual			Automatic			Beginning			End		
					Day	Mon.	Year	Day	Mon.	Year	Day	Mon.	Year	Day	Mon.	Year
1. DATA FROM SEARPI																
09NP	San Pedro de Terevinto	17° 43' 05"	63° 26'	450	6	10	1988	-	-	-	6	10	1988	31	12	1994
20NP	Villa Diego	17° 35' 27"	63° 31' 25"	380	1	5	1988	-	-	-	1	5	1988	31	12	1994
22NP	Montero - Ciudad	-	-	-	1	2	1973	-	-	-	1	1	1989	31	12	1994
23NP	Patuju	-	-	-	1	1	1959	-	-	-	1	1	1989	31	12	1994
25NP	Santa Cruz-Oficina	17° 47'	63° 10'	416	11	11	1975	11	11	1975	11	11	1975	31	12	1994
28NP	Perotó	17° 29'	63° 10' 42"	350	1	5	1988	-	-	-	1	5	1988	31	12	1994
50NP	Viru Viru-Aeropuerto	17° 38' 51"	63° 07' 55"	360	1	8	1984	-	-	-	1	8	1984	31	12	1994
51NP	Warnes	17° 30'	63° 08'	330	16	2	1976	16	2	1976	16	2	1976	31	12	1994
52NP	San Isidro	17° 27'	63° 31'	332	8	11	1975	8	11	1975	8	11	1975	31	12	1994
55NP	Portachuelo	17° 21'	63° 24'	289	1	11	1975	-	-	-	1	11	1975	31	12	1994
56NP	La Belgica-Ingenio	17° 33'	63° 13'	378	1	2	1954	-	-	-	1	2	1954	31	12	1994
57NP	La Belgica-Puente	17° 32'	63° 13'	348	1	10	1977	-	-	-	1	10	1977	31	12	1994
58NP	Terevinto	17° 43'	63° 23'	425	1	9	1977	13	10	1986	1	9	1977	31	12	1994
59NP	Puente Eisenhower	17° 19'	63° 19'	277	1	10	1978	-	-	-	1	10	1977	31	12	1994
60NP	Gabetas	17° 20' 35"	63° 21' 25"	280	1	10	1981	-	-	-	1	10	1981	31	12	1994
61NP	Saavedra	17° 14'	63° 10'	320	1	8	1951	10	8	1951	1	8	1951	31	12	1994
62NP	Mineros (Unagro)	17° 06'	63° 14'	245	1	11	1975	-	-	-	1	11	1975	31	12	1994
5806	Santa Cruz-Trompillo	17° 47'	63° 10'	437	1	1	1943	-	-	-	1	1	1943	31	12	1994
5807	SantaCruz-Universidad	17° 46' 38"	63° 11'	725	18	1	1971	-	-	-	1	2	1971	31	12	1994
2. DATA FROM SENAMHI																
	Algodenera Boliviana	17° 33'	63° 09'	345			1958	-	-	-	-	-	-	-	-	-
	Algonodera Sta. Clara	17° 35'	63° 05'	344			1963	-	-	-	-	-	-	-	-	-
	Buen Retiro	17° 13'	63° 03'	275			1978	-	-	-	-	-	-	-	-	-
	Chocuete	17° 27'	63° 06'	313			1974	-	-	-	-	-	-	-	-	-
	Est. Exp. Vallecito	17° 46'	63° 09'	398				-	-	-	-	-	-	-	-	-
	Guapilo	17° 46'	63° 04'	325			1975	-	-	-	-	-	-	-	-	-
	Ingenio Esperenza	17° 18'	63° 03'	368			1944	-	-	-	-	-	-	-	-	-
	La Victoria	17° 36'	63° 03'	344			1969	-	-	-	-	-	-	-	-	-
	Okinawa I	17° 13'	62° 53'	252			1966	-	-	-	1	1	1977	31	12	1994
	Okinawa III	17° 32'	62° 55'	300			1963	-	-	-	-	-	-	-	-	-
	Puerto Pailas	17° 39'	62° 47'	280			1977	-	-	-	1	1	1977	31	12	1994
	Puesto Fernandez	17° 00'	63° 14'	230			1977	-	-	-	-	-	-	-	-	-
3. DATA FROM CETABOL - JICA																
	Okinawa II	17° 23'	62° 54'	280			1969				1	1	1969	31	12	1994
4. DATA FROM CAISY																
	Col. San Juan de Yapacai	17° 15'	63° 50'	350		1	1960	-	-	-	1	1	1960	31	12	1994
5. DATA FROM SPERNR																
13PY	Buena Vista	17° 27'	63° 40'	379	2	11	1990	-	-	-	2	11	1990	31	12	1993

Notes; SEARPI: Sevicio Encauzamiento de Aguas y Regularizacion del Rio Pirai
SENAMHI: Servicio Nacional de Meteorologia e Hidrologia
CETABOL-JICA: Centro Tecnologico Agropecuario en Bolivia-JICA
CAISY: Cooperativa Agropecuaria Integral San Juan de Yapacani Ltda.
SPERNR: Subproyecto de Proteccion de Etnias y Recursos Naturales Renovables

TABLE A.3.1 LIST OF HYDROLOGICAL GAUGING STATIONS AND COLLECTED DATA (2/2)

2. LIST OF WATER LEVEL GAUGING STATIONS AND COLLECTED DATA

Station No.	Station Name	Location		Catchment Area	Elevation	Observation Started						Data Collected					
		Latitude	Longitude			Manual			Automatic			Beginning			End		
				(km2)	(El. m)	Day	Mon.	Year	Day	Mon.	Year	Day	Mon.	Year	Day	Mon.	Year
1. WATER LEVEL DATA OF THE RIO PIRAY																	
0506	Angostura	18° 09' 59'	63° 34' 05'	1417.7	620.0	1	1	1976	-	-	-	1	10	1977	31	12	1994
0510	La Belgica	17° 32'	63° 13'	2815.3	348.0	1	10	1977	-	-	-						
0505	Bermejo	18° 06'	63° 38'	477.4	1000.0	1	11	1975	-	-	-	1	10	1976	31	12	1994
0504	Colorado	18° 08'	63° 08'	102.3	1020.0							1	1	1981	31	12	1994
0512	Eisenhower	17° 19'	63° 19'	4010.0	279.5	1	10	1977	-	-	-	1	10	1977	31	12	1994
0520	Espejos	17° 58' 30'	63° 34' 17'	236.0	496.7	1	4	1981	-	-	-	27	11	1976	31	12	1994
0530	San Pedro de Terevinto	17° 43' 05'	63° 26'	165.0	450.0	6	10	1988	-	-	-	6	10	1988	25	11	1993
2. WATER LEVEL DATA OF THE RIO GRANDE																	
0401	Puente Abapo			60600.0								1	9	1971	31	3	1974
0402	Puerto Pailas	17° 40'	62° 47'	74500.0								1	10	1971	23	3	1974
3. WATER LEVEL DATA OF THE RIO YAPACANI																	
00411	Rio Yapacani (Puente)	17° 24'	63° 43'	5970.0	283.0	25	7	1994	-	-	-	25	7	1994	31	12	1994
4. WATER LEVEL DATA OF THE TRIBUTARY OF RIO PALACIOS																	
00311	Rio Palometillas (Puente)	17° 23'	63° 32'	261.5	290.0	20	7	1994	-	-	-	20	7	1994	31	12	1994

3. LIST OF DISCHARGE GAUGING STATIONS AND COLLECTED DATA

Station No.	Station Name	Location		Catchment Area	Elevation	Observation Started						Data Collected					
		Latitude	Longitude			Manual			Automatic			Beginning			End		
				(km2)	(El. m)	Day	Mon.	Year	Day	Mon.	Year	Day	Mon.	Year	Day	Mon.	Year
1. DISCHARGE DATA OF THE RIO PIRAY																	
0506	Angostura	18° 09' 59'	63° 34' 05'	1417.7	620							24	12	1975	31	12	1993
0510	La Belgica	17° 32'	63° 13'	2815.3	348							1	4	1976	31	12	1991
0505	Bermejo	18° 06'	63° 38'	477.4	1000							17	1	1976	31	12	1993
0504	Colorado	18° 08'	63° 08'	102.3	1020							10	9	1981	31	12	1993
0512	Eisenhower	17° 19'	63° 19'	4010.0	279.5							4	2	1977	31	12	1991
0520	Espejos	17° 58' 30'	63° 34' 17'	236.0	496.7							27	11	1976	31	12	1993
0530	San Pedro de Terevinto	17° 43' 05'	63° 26'	165.0	450							6	10	1988	25	11	1993
2. DISCHARGE DATA OF THE RIO GRANDE																	
0401	Puente Abapo			60600.0								1	1	1964	30	9	1981
0402	Puerto Pailas	17° 40'	62° 47'	74500.0								13	6	1971	31	3	1974
3. DISCHARGE DATA OF THE RIO YAPACANI																	
00411	Rio Yapacani (Puente)	17° 24'	63° 43'	5970.0	283.0	15	9	1993	-	-	-	15	9	1993	23	11	1994
4. DISCHARGE DATA OF TRIBUTARY OF THE RIO PALACIOS																	
00311	Rio Palometillas (Puente)	17° 23'	63° 32'	261.5	290	2	7	1991	-	-	-	2	7	1991	8	12	1994

TABLE A.4.1 METEO-HYDROLOGICAL CONDITION IN THE STUDY AREA

1. MONTHLY AVERAGE TEMPERATURE (Unit : °C)

Station		Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual Average
5806 SC - Trompillo	Max.	30.4	30.5	30.1	28.5	26.0	23.9	24.6	27.4	29.2	30.5	30.8	30.8	28.6
	Mean	26.4	26.3	25.8	24.2	22.0	20.3	20.2	22.6	24.5	26.0	26.8	26.7	24.3
	Min.	21.4	21.4	20.8	19.0	17.4	16.5	15.3	16.5	18.4	19.8	20.7	21.3	18.5
61NP Saavedra	Max.	30.4	30.4	30.4	29.0	27.0	25.3	25.9	28.5	30.2	30.9	30.4	30.1	29.0
	Mean	26.0	25.2	24.9	23.4	21.6	19.9	20.2	21.3	23.9	25.2	24.4	25.3	23.4
	Min.	21.5	21.3	20.6	18.9	17.2	15.4	14.5	15.6	17.8	19.5	19.8	20.7	18.6
Okinawa 2	Max.	30.6	30.8	30.8	29.5	26.8	25.3	25.6	28.5	29.5	31.4	31.3	30.9	29.7
	Mean	26.0	25.7	25.4	24.2	21.6	19.9	19.6	21.8	23.3	25.6	26.1	26.1	23.8
	Min.	21.7	21.2	20.8	19.4	17.2	15.5	14.1	15.9	17.4	19.6	20.7	21.5	18.7
Col. San Juan de Yapacani	Max.	30.6	30.8	30.9	29.7	27.0	25.4	25.9	27.7	28.8	30.7	30.7	30.6	29.1
	Mean	26.3	26.4	26.2	24.7	22.5	20.8	20.6	21.8	23.1	25.2	25.6	26.3	24.1
	Min.	22.0	21.9	21.6	19.7	18.0	16.3	15.3	16.0	17.5	19.7	20.8	21.9	19.2

Data : SC-Trompillo (Jan. 1943 - Dec. 1992), Saavedra (Jan. 1952 - Dec. 1994)
Okinawa 2 (Apr. 1981 - Dec. 1994), Col. San Juan de Yapacani (Jan. 1973 - Dec. 1994)

2. MONTHLY AVERAGE RELATIVE HUMIDITY (Unit : %)

Station	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual Average
5806 SC - Trompillo	75.0	75.0	75.0	74.0	76.0	76.0	69.0	61.0	60.0	64.0	67.0	71.0	70.3
61NP Saavedra	75.0	76.0	73.0	72.0	73.0	71.0	63.0	56.0	56.0	61.0	66.0	73.0	68.0
Okinawa 2	83.2	82.0	82.6	81.7	81.2	79.0	73.4	69.0	68.5	70.9	75.7	79.5	74.8
Col. San Juan de Yapacani	80.1	79.7	77.8	77.3	78.2	78.4	73.7	69.8	69.2	70.3	74.0	78.5	75.6

Data : SC-Trompillo (Jan. 1943 - Dec. 1992), Saavedra (Jan. 1956 - Dec. 1992)
Okinawa 2 (Apr. 1981 - Dec. 1994), Col. San Juan de Yapacani (Jan. 1973 - Dec. 1994)

3. MONTHLY AVERAGE RAINFALL AND RAINY DAYS (Unit : mm) (Unit : day)

Station	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual Total
5806 SC - Trompillo	181.5	137.3	126.0	104.3	90.0	75.2	61.8	42.9	70.9	99.3	130.1	181.9	1301.2
	13	12	11	9	10	8	6	4	5	7	9	12	108
61NP Saavedra	224.1	161.4	114.0	84.5	83.5	69.3	45.2	48.2	71.9	106.5	147.1	200.4	1356.1
	13	11	10	7	8	5	4	4	5	7	9	12	94
Okinawa 2	200.8	166.1	109.4	82.9	88.8	58.3	48.4	52.1	66.8	101.5	122.6	176.5	1274.2
	11	10	8	6	6	5	3	3	4	6	7	10	77
Col. San Juan de Yapacani	301.7	239.4	180.3	122.7	156.9	97.4	69.2	77.9	83.9	134.0	161.3	272.7	1897.5
	17	15	13	10	10	8	6	5	6	9	10	15	125

Data : SC-Trompillo (Jan. 1943 - Dec. 1994), Saavedra (Jan. 1952 - Dec. 1994)
Okinawa 2 (Jan. 1969 - Dec. 1994), Col. San Juan de Yapacani (Jan. 1960 - Dec. 1994)

4. MONTHLY AVERAGE WIND SPEED AND DIRECTION (Unit : knot, 1 knot = 0.514 m/s)

Station	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual Average
5806 SC - Trompillo	NW-09	NW-09	NW-08	NW-08	NW-09	NW-11	NW-11	NW-11	NW-11	NW-10	NW-10	NW-09	NW-10
61NP Saavedra	N-07	N-07	N-07	S-08	S-10	N-11	N-12	N-11	S-11	N-10	N-09	N-08	N-09

Data : SC-Trompillo (Jan. 1943 - Dec. 1994), Saavedra (Feb. 1979 - Dec. 1992)

5. MONTHLY AVERAGE EVAPORATION (Unit : mm)

Station	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual Total
SC-Universidad	121.5	108.2	110.6	90.7	74.0	63.2	76.5	96.1	116.7	137.2	133.0	126.5	1254.1
Col. San Juan de Yapacani	88.0	77.4	95.5	94.1	75.4	65.5	90.4	105.4	114.7	123.1	111.8	93.9	1142.0

Data : SC-Universidad (1971 - 1994), Col. San Juan de Yapacani (Jan. 1974 - Sep. 1984)

TABLE A.5.1 ANNUAL AND MONTHLY RAINFALL OF 1992 AND 1983

(Unit : mm)

Station	Month												Annual
	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
YEAR 1992													
5806 Santa Cruz - Trompillo	193.7	313.7	114.5	413.5	183.8	132.6	47.1	100.2	234.0	71.1	149.4	295.6	2249.2
56NP La Belgica - Ingenio	343.1	334.6	137.5	391.6	206.7	82.3	28.4	90.4	210.1	123.2	128.2	476.7	2552.8
61NP Saavedra	500.2	340.1	182.3	349.2	191.0	62.2	24.7	124.0	238.5	68.2	137.6	490.3	2708.3
62NP Mineros (Unagro)	391.2	347.6	241.7	331.2	207.6	46.3	13.5	90.7	282.4	68.2	161.5	364.3	2546.2
Okinawa II	380.0	393.0	98.0	291.0	194.0	52.0	4.0	80.0	215.0	50.0	139.8	361.7	2258.5
55NP Portachuelo	360.7	445.0	128.0	371.0	232.2	101.6	21.0	83.9	242.8	117.6	89.7	436.0	2629.5
52NP San Isidro	463.3	432.4	201.6	511.8	282.7	141.4	53.1	146.7	244.3	118.5	184.5	539.0	3319.3
Col. San Juan de Yapacani	353.2	473.7	264.6	420.6	333.5	179.7	48.0	119.4	182.0	86.8	146.3	554.9	3162.7
YEAR 1983													
5806 Santa Cruz - Trompillo	395.3	94.9	270.3	166.7	228.3	78.1	144.0	24.6	10.5	174.1	242.3	116.5	1945.6
56NP La Belgica - Ingenio	258.5	111.5	252.6	119.5	292.6	44.7	127.3	39.3	21.5	472.8	159.4	221.6	2121.3
61NP Saavedra	302.3	150.1	179.3	61.9	242.8	39.9	70.6	19.1	41.4	92.5	272.2	258.7	1730.8
62NP Mineros (Unagro)	196.1	242.3	292.2	82.9	292.0	60.0	47.3	25.0	7.5	85.0	221.0	110.0	1661.3
Okinawa II	240.2	151.0	175.1	80.2	201.9	50.2	56.1	0.0	34.2	73.8	74.6	81.8	1219.1
55NP Portachuelo	263.5	116.1	243.7	106.6	241.2	89.8	124.6	10.3	13.9	163.2	139.2	208.6	1720.7
52NP San Isidro	316.3	269.2	316.9	156.6	407.7	67.4	202.3	19.2	21.2	128.4	199.3	135.8	2240.3
Col. San Juan de Yapacani	361.7	169.8	192.4	143.1	324.6	86.8	212.2	21.5	27.5	117.3	201.6	150.8	2009.3
AVERAGE YEAR													
5806 Santa Cruz - Trompillo	181.5	137.3	126.0	104.3	90.0	75.2	61.8	42.9	70.9	99.3	130.1	181.9	1301.2
56NP La Belgica - Ingenio	219.1	161.9	124.3	113.1	88.8	80.2	61.4	44.9	84.5	119.1	126.0	197.2	1417.0
61NP Saavedra	224.1	161.4	114.0	84.5	83.5	69.3	45.2	48.2	71.9	106.5	147.1	200.4	1356.1
62NP Mineros (Unagro)	272.4	196.8	144.2	92.1	116.3	76.5	34.3	59.3	80.6	97.1	178.3	202.7	1556.0
Okinawa II	200.8	166.1	109.4	82.9	88.8	58.3	48.4	52.1	66.8	101.5	122.6	176.5	1274.2
55NP Portachuelo	231.6	210.1	168.0	93.4	123.0	71.7	59.1	64.0	81.4	110.1	178.1	242.4	1639.0
52NP San Isidro	311.5	233.6	199.4	130.2	175.9	96.9	83.1	75.3	108.9	135.8	189.3	287.3	2066.0
Col. San Juan de Yapacani	301.7	239.4	180.3	122.7	156.9	97.4	69.2	77.9	83.9	134.0	161.3	272.7	1897.5

TABLE A.5.2 ANNUAL MAXIMUM RAINFALL
STATION: 5806 SANTA CRUZ - TROMPILLO

Year	1 Day Max.		2 Day Max.		3 Day Max.		4 Day Max.		5 Day Max.		6 Day Max.		7 Day Max.	
	(mm)	Date	(mm)	(Date)	(mm)	Date	(mm)	Date	(mm)	Date	(mm)	Date	(mm)	Date
1943	165.0	27/12	165.0	26/12	165.0	25/12	165.0	24/12	169.3	27/12	169.3	26/12	169.3	25/12
1944	87.0	25/10	150.0	25/10	153.8	25/10	154.5	24/10	154.5	23/10	154.5	22/10	164.9	20/10
1945	99.0	23/03	113.0	24/03	113.0	23/03	113.0	22/03	113.0	21/03	124.2	20/03	153.2	24/03
1946	114.7	10/05	177.5	10/05	180.3	10/05	181.8	09/05	181.8	09/05	181.8	09/05	181.8	09/05
1947	118.0	19/01	137.0	19/01	149.7	18/01	156.1	18/01	167.5	16/01	193.4	19/01	206.1	18/01
1948	93.3	28/07	186.3	27/07	187.3	27/07	198.3	25/07	223.3	24/07	224.3	24/07	224.3	24/07
1949	110.0	21/06	111.5	20/06	115.5	05/03	116.5	04/03	147.7	13/12	149.7	12/12	149.7	12/12
1950	92.8	03/03	137.7	02/03	137.9	01/03	140.9	28/02	149.9	27/02	149.9	27/02	149.9	27/02
1951	75.6	24/11	87.6	24/11	87.8	23/11	95.8	31/01	99.8	30/01	100.7	30/01	101.2	30/01
1952	107.5	05/09	130.4	05/09	130.4	05/09	130.4	05/09	130.4	05/09	130.4	05/09	130.4	05/09
1953	90.2	08/04	91.2	07/04	91.2	07/04	137.2	21/03	137.2	21/03	137.2	21/03	137.2	21/03
1954	107.5	04/01	110.0	08/03	120.0	28/04	213.0	06/03	216.4	05/03	216.4	05/03	217.4	03/03
1955	250.0	23/01	285.7	23/01	300.7	22/01	304.7	22/01	312.7	20/01	337.7	19/01	351.7	18/01
1956	163.5	06/01	163.6	05/01	205.5	06/01	208.7	06/01	211.2	06/01	212.2	06/01	213.7	06/01
1957	110.0	07/12	134.0	07/12	137.0	07/12	138.1	07/12	138.1	07/12	142.7	03/12	145.7	03/12
1958	100.0	18/02	102.1	24/12	113.7	24/12	113.7	24/12	117.7	22/12	140.1	20/12	151.7	20/12
1959	70.5	21/04	91.8	21/04	92.3	21/04	92.3	21/04	111.6	14/03	111.6	14/03	123.6	12/03
1960	64.0	03/02	67.5	01/04	68.5	31/03	81.0	30/03	81.0	30/03	81.3	28/03	86.6	30/03
1961	91.0	28/02	141.0	27/02	146.0	27/02	159.6	27/02	164.8	24/02	170.4	25/02	183.4	24/02
1962	62.3	18/12	62.3	18/12	87.3	18/12	87.3	18/12	110.3	18/12	111.4	18/12	119.9	18/12
1963	68.2	19/11	75.2	18/11	102.8	17/11	112.3	16/11	116.1	12/02	117.1	12/02	127.3	10/02
1964	89.0	11/01	105.0	17/11	105.0	17/11	108.2	17/11	108.2	17/11	126.9	17/11	126.9	17/11
1965	65.0	09/03	79.1	19/10	92.1	18/10	96.1	18/10	96.1	18/10	96.1	18/10	122.7	25/09
1966	102.6	12/11	102.6	12/11	102.6	12/11	102.7	09/11	103.9	08/11	103.9	08/11	103.9	08/11
1967	95.0	15/08	101.7	19/07	101.7	19/07	135.6	04/01	135.6	04/01	204.8	04/01	204.8	04/01
1968	112.2	24/12	119.2	23/12	121.7	16/01	186.2	21/12	187.2	20/12	197.2	19/12	197.2	19/12
1969	77.1	09/02	82.2	29/11	82.3	29/11	82.3	29/11	127.2	26/11	127.3	26/11	127.3	26/11
1970	110.5	27/11	111.7	27/11	111.7	27/11	111.7	27/11	127.0	27/11	127.0	27/11	127.0	27/11
1971	91.0	22/12	91.0	22/12	91.0	22/12	91.0	22/12	120.5	10/12	121.5	10/12	121.8	09/12
1972	144.0	03/04	149.0	03/04	149.3	02/04	149.3	02/04	149.3	02/04	149.3	02/04	154.0	03/04
1973	57.0	14/02	78.0	13/02	83.7	12/02	85.7	11/02	85.7	11/02	85.7	11/02	88.7	08/02
1974	100.0	25/10	116.0	24/10	117.0	24/10	134.5	22/10	148.1	21/10	198.1	20/10	199.1	20/10
1975	161.0	30/11	161.1	29/11	161.1	29/11	161.1	29/11	188.0	30/11	188.4	30/11	226.1	24/11
1976	60.1	27/12	91.6	27/12	93.6	26/12	93.6	26/12	101.2	27/12	135.6	22/12	167.1	22/12
1977	355.2	03/01	389.8	03/01	398.7	02/01	403.1	02/01	407.2	01/01	407.2	01/01	407.2	01/01
1978	100.8	14/01	115.8	13/01	120.0	15/06	121.8	16/06	146.4	10/01	164.9	09/01	192.5	08/01
1979	102.0	14/01	145.0	13/01	161.1	12/01	182.8	11/01	182.8	11/01	187.6	11/01	187.6	11/01
1980	83.2	30/04	87.4	30/04	92.9	30/05	92.9	30/05	94.3	30/05	113.2	20/02	122.2	19/02
1981	156.6	24/04	157.8	24/04	157.8	24/04	160.0	04/10	169.0	24/04	169.0	24/04	169.0	24/04
1982	147.6	02/10	148.0	02/10	163.7	18/02	163.7.	18/02	238.5	02/10	240.1	02/10	240.6	02/10
1983	126.4	31/01	129.6	31/01	129.6	31/01	142.4	28/02	152.7	28/02	170.4	09/01	170.7	09/01
1984	75.8	05/01	99.8	14/12	129.0	13/12	155.6	11/12	196.2	11/12	208.8	10/12	218.4	10/12
1985	91.0	08/03	101.3	08/03	117.8	08/03	126.2	07/03	130.8	07/03	139.3	03/03	154.1	04/03
1986	95.0	23/11	118.5	20/02	151.9	16/12	158.2	15/12	173.0	14/12	193.1	16/02	198.6	15/02
1987	110.9	17/12	167.4	27/07	170.2	27/07	170.2	27/07	170.2	27/07	170.2	27/07	170.2	27/07
1988	77.8	06/01	106.1	26/12	130.0	27/12	173.1	26/12	173.1	25/12	173.1	24/12	173.1	23/12
1989	116.8	22/02	139.8	21/02	142.7	21/02	142.7	20/02	142.7	19/02	145.9	12/12	151.8	12/12
1990	74.6	28/12	92.0	27/12	98.7	20/11	104.2	20/11	104.2	19/11	123.5	31/05	138.1	30/05
1991	141.6	26/01	151.6	26/01	153.0	25/01	192.9	26/01	230.2	26/01	231.6	25/01	232.0	24/01
1992	109.2	29/12	136.6	29/12	191.6	29/12	196.9	28/12	197.1	27/12	198.4	26/12	198.4	25/12
1993	101.2	06/02	146.2	06/02	146.4	05/02	146.4	04/02	146.4	03/02	184.4	02/02	206.8	01/02
1994	95.0	30/09	115.8	30/09	135.1	28/12	135.1	28/12	173.1	26/12	176.1	25/12	176.1	25/12
MAX	355.2		389.8		398.7		403.1		407.2		407.2		407.2	

TABLE A.5.3 ANNUAL MAXIMUM RAINFALL
STATION: 61NP SAAVEDRA (CIMCA)

Year	1 Day Max. (mm)	Date	2 Day Max. (mm)	(Date)	3 Day Max. (mm)	Date	4 Day Max. (mm)	Date	5 Day Max. (mm)	Date	6 Day Max. (mm)	Date	7 Day Max. (mm)	Date
1943														
1944														
1945														
1946														
1947														
1948														
1949														
1950														
1951	116.8	16/12	119.3	16/12	119.3	16/12	119.3	16/12	121.8	16/12	124.3	16/12	126.8	16/12
1952	96.5	12/01	114.2	04/09	114.2	04/09	114.2	04/09	134.3	24/01	134.3	24/01	139.3	22/01
1953	144.7	03/11	144.7	03/11	144.7	03/11	14.7	03/11	165.0	03/11	165.0	03/11	165.0	03/11
1954	137.1	03/01	144.7	02/01	144.7	02/01	152.3	03/01	159.9	02/01	159.9	02/01	159.9	02/01
1955	162.5	21/01	203.1	21/01	253.8	21/01	289.3	20/01	335.0	19/01	357.8	18/01	357.8	18/01
1956	165.0	11/09	208.1	10/09	208.1	10/09	208.1	10/09	208.1	10/09	208.1	10/09	208.1	10/09
1957	104.1	15/02	109.1	17/07	116.7	16/07	116.7	16/07	116.7	16/07	116.7	16/07	119.2	09/02
1958	149.8	06/12	152.3	05/12	170.1	06/12	185.3	06/12	187.8	05/12	203.0	06/12	238.5	30/11
1959	76.1	23/01	78.6	23/01	78.6	23/01	104.0	20/01	106.5	20/01	106.5	20/01	106.5	20/01
1960	91.4	09/04	99.0	08/04	99.0	08/04	99.0	08/04	99.0	08/04	99.0	08/04	99.0	08/04
1961	76.1	21/12	81.1	21/12	93.9	08/11	103.8	21/12	106.5	22/02	124.2	21/02	131.8	20/02
1962	101.5	08/01	106.5	07/01	109.0	07/01	109.0	07/01	114.1	06/03	114.1	06/03	136.9	02/01
1963	94.0	11/02	113.0	11/02	190.0	11/02	190.0	11/02	197.5	09/02	197.5	09/02	197.5	09/02
1964	109.2	03/12	109.2	03/12	109.5	08/02	122.2	08/02	122.2	08/02	124.5	28/11	124.5	28/11
1965	78.9	21/02	78.9	21/02	111.8	28/01	111.8	28/01	160.0	26/01	160.0	26/01	167.6	24/01
1966	99.1	19/12	101.6	18/12	101.6	18/12	101.6	18/12	152.4	15/12	152.4	15/12	152.4	15/12
1967	119.4	21/01	127.0	03/06	144.8	03/06	170.2	18/01	170.2	18/01	170.2	18/01	170.2	18/01
1968	73.7	17/10	81.3	17/10	81.3	22/12	114.3	21/12	114.3	21/12	127.0	19/12	127.0	19/12
1969	55.8	30/11	81.2	29/11	81.2	29/11	81.2	29/11	81.2	29/11	81.2	29/11	81.2	29/11
1970	38.2	21/12	61.0	24/10	61.0	24/10	63.5	24/10	68.6	24/10	68.6	24/10	68.6	24/10
1971	45.9	16/04	53.4	06/09	53.4	06/09	53.4	06/09	53.4	06/09	56.1	16/04	56.1	16/04
1972	72.0	03/10	95.5	03/10	101.7	16/11	106.9	15/11	114.4	14/11	119.6	13/11	121.5	14/11
1973	89.0	29/12	99.0	23/11	114.0	27/12	159.5	26/12	159.5	26/12	159.5	26/12	161.8	23/12
1974	93.0	24/10	140.0	24/10	151.0	24/10	159.0	24/10	160.3	24/10	174.8	24/10	174.8	24/10
1975	62.2	20/09	62.2	20/09	62.2	20/09	82.8	20/09	82.8	20/09	84.4	20/09	109.2	23/11
1976	108.0	23/12	129.0	23/12	144.1	22/12	144.6	21/12	144.8	20/12	146.0	23/12	161.1	22/12
1977	102.9	24/01	109.9	18/01	120.0	02/01	138.5	01/01	146.0	01/01	199.6	19/01	215.7	18/01
1978	99.5	22/11	126.5	26/11	126.5	26/11	126.5	26/11	126.5	26/11	196.0	21/11	226.0	22/11
1979	153.4	15/02	186.5	15/02	195.7	14/02	202.6	13/02	208.4	12/02	208.4	12/02	217.9	10/02
1980	102.6	30/04	135.2	02/04	143.2	02/04	160.5	02/04	166.1	01/04	176.8	31/03	176.8	31/03
1981	87.6	06/12	129.6	05/10	175.0	04/10	187.7	04/10	187.7	04/10	187.7	04/10	187.7	04/10
1982	143.7	14/12	146.4	14/12	183.0	12/12	207.5	11/12	216.0	10/12	289.0	10/06	290.8	10/06
1983	91.3	21/11	113.7	13/01	124.5	13/01	129.8	12/01	157.9	10/01	168.7	10/01	179.5	09/01
1984	66.5	23/11	83.3	14/02	98.0	13/12	116.5	10/12	135.8	11/12	161.3	10/12	166.8	09/12
1985	152.5	30/06	155.5	30/06	158.1	30/06	158.1	30/06	167.0	27/07	175.6	26/07	175.6	26/07
1986	103.7	11/08	103.7	11/08	103.7	11/08	123.3	11/08	137.5	16/05	140.9	15/05	140.9	15/05
1987	152.4	05/06	153.9	04/06	178.2	30/11	178.2	30/11	185.7	30/11	199.5	27/11	199.5	27/11
1988	76.2	26/11	76.2	25/11	87.9	26/12	101.3	03/01	105.6	03/01	106.1	03/01	109.8	03/01
1989	130.2	24/08	145.0	24/08	158.0	24/08	163.9	24/08	236.8	20/08	251.6	20/08	264.6	20/08
1990	92.0	20/11	136.9	01/06	160.4	31/05	179.0	30/05	181.1	30/05	186.8	30/05	197.4	30/05
1991	195.8	11/01	250.7	11/01	258.5	11/01	258.5	10/01	258.5	09/01	264.2	25/01	264.9	07/01
1992	220.4	14/01	282.3	13/01	360.3	12/01	400.1	12/01	421.3	11/01	453.6	10/01	453.6	09/01
1993	142.6	06/02	195.8	06/02	197.3	05/02	197.3	04/02	197.7	03/02	218.5	02/02	218.5	01/02
1994	115.2	20/06	222.8	19/06	225.4	19/06	225.6	19/06	225.6	19/06	226.6	19/06	226.6	19/06
MAX	220.4		282.3		360.3		400.1		421.3		453.6		453.6	

TABLE A.5.4 ANNUAL MAXIMUM RAINFALL
STATION: OKINAWA II (CETABOL - JICA)

Year	1 Day Max.		2 Day Max.		3 Day Max.		4 Day Max.		5 Day Max.		6 Day Max.		7 Day Max.	
	(mm)	Date	(mm)	(Date)	(mm)	Date	(mm)	Date	(mm)	Date	(mm)	Date	(mm)	Date
1943														
1944														
1945														
1946														
1947														
1948														
1949														
1950														
1951														
1952														
1953														
1954														
1955														
1956														
1957														
1958														
1959														
1960														
1961														
1962														
1963														
1964														
1965														
1966														
1967														
1968														
1969	81.4	30/11	101.4	30/11	106.0	29/11	106.0	29/11	106.0	29/11	107.3	26/11	107.3	26/11
1970	67.9	26/01	67.9	26/01	76.0	28/12	80.0	28/12	120.0	28/12	125.9	28/12	125.9	28/12
1971	66.0	09/02	67.0	09/02	75.0	09/02	86.0	09/02	89.0	09/02	102.0	09/02	119.0	09/02
1972														
1973	63.0	24/12	65.0	13/02	114.0	24/12	120.0	24/12	128.0	24/12	174.0	24/12	174.0	24/12
1974	110.0	24/10	132.0	24/10	132.0	24/10	154.5	24/10	158.0	24/10	172.0	24/10	172.0	24/10
1975	56.4	25/08	91.0	29/01	75.0	29/01	95.0	29/01	111.0	29/01	128.0	29/01	128.0	29/01
1976	159.4	24/12	177.8	23/12	182.4	23/12	182.4	23/12	182.4	23/12	196.4	23/12	209.4	23/12
1977	72.6	05/01	129.6	04/01	171.6	03/01	184.6	02/01	188.0	02/01	188.0	02/01	188.0	02/01
1978	92.0	27/11	125.0	17/06	128.0	17/06	134.0	17/06	134.0	17/06	135.0	17/06	157.8	09/01
1979	114.2	20/04	124.0	28/01	153.0	14/02	155.5	13/02	157.5	12/02	189.5	11/02	194.5	10/02
1980	131.0	29/04	143.2	28/04	143.2	28/04	143.2	28/04	143.2	28/04	149.6	24/04	149.6	24/04
1981	195.0	08/03	225.0	08/03	235.6	07/03	235.6	07/03	235.6	07/03	235.6	07/03	306.0	08/03
1982	111.6	12/12	113.8	19/12	122.0	19/12	164.6	12/12	167.8	12/12	183.2	10/06	183.2	10/06
1983	97.2	16/02	97.2	16/02	103.6	16/02	122.6	16/02	128.6	16/02	130.4	16/02	140.0	16/02
1984	82.0	14/02	120.2	14/02	140.2	13/02	140.2	13/02	142.2	11/02	144.2	10/02	176.6	09/02
1985	150.2	31/07	161.0	31/07	161.0	31/07	161.0	31/07	166.6	28/07	190.0	27/07	190.0	27/07
1986	162.2	20/05	163.8	20/05	167.2	18/05	220.6	17/05	234.0	16/05	235.6	16/05	238.6	16/05
1987	121.6	05/08	126.6	24/01	146.6	23/01	146.6	23/01	153.4	23/01	153.4	23/01	153.4	23/01
1988	63.0	06/01	76.0	06/01	82.0	06/01	82.2	06/01	84.9	13/02	98.2	12/02	98.2	12/02
1989	141.0	21/08	158.0	21/08	158.0	21/08	158.0	21/08	193.0	21/08	193.0	21/08	205.0	21/08
1990	120.0	17/01	126.0	16/01	147.6	04/05	158.6	04/05	186.6	04/05	186.6	04/05	188.6	04/05
1991	88.0	07/09	94.0	13/02	123.0	12/02	132.0	11/02	132.0	11/02	166.0	09/02	211.0	08/02
1992	194.0	15/01	226.0	14/01	295.0	13/01	297.0	12/01	374.0	11/01	374.0	11/01	374.0	11/01
1993	97.0	07/02	99.5	06/02	99.5	06/02	99.5	06/02	148.5	03/02	149.5	02/02	149.5	02/02
1994	102.5	20/06	146.0	20/06	147.5	19/06	147.5	19/06	147.5	19/06	147.5	19/06	147.5	19/06
MAX	195.0		226.0		295.0		297.0		374.0		374.0		374.0	

TABLE A.5.5 ANNUAL MAXIMUM RAINFALL
STATION: COLONIA SAN JUAN DE YAPACANI (JICA/CAISY)

Year	1 Day Max.		2 Day Max.		3 Day Max.		4 Day Max.		5 Day Max.		6 Day Max.		7 Day Max.	
	(mm)	Date	(mm)	(Date)	(mm)	Date	(mm)	Date	(mm)	Date	(mm)	Date	(mm)	Date
1943														
1944														
1945														
1946														
1947														
1948														
1949														
1950														
1951														
1952														
1953														
1954														
1955														
1956														
1957														
1958														
1959														
1960	277.5	30/05	426.0	29/05	426.0	29/05	426.0	29/05	426.0	29/05	426.0	29/05	426.0	29/05
1961	145.2	05/03	149.6	04/03	191.8	18/02	225.2	18/02	294.6	18/02	356.4	18/02	374.4	18/02
1962	94.4	10/03	101.2	23/02	106.5	08/03	134.4	07/03	162.9	06/03	162.9	06/03	168.3	04/03
1963	191.0	11/02	193.4	10/02	221.3	11/02	227.4	11/02	229.8	10/02	235.5	09/02	235.5	09/02
1964	111.2	01/10	125.7	16/11	136.7	15/11	149.2	17/04	162.3	27/09	189.6	26/09	189.6	26/09
1965	110.0	30/12	155.0	20/10	201.0	19/10	205.5	18/10	209.0	18/10	214.0	18/10	214.0	18/10
1966	97.0	31/01	156.5	18/12	156.5	18/12	238.5	16/12	238.5	16/12	238.5	16/12	253.5	13/12
1967	216.0	03/06	239.0	03/06	248.0	03/06	268.5	03/06	274.7	02/06	275.2	02/06	275.2	02/06
1968	113.0	16/12	126.0	16/12	163.5	19/01	208.5	18/01	222.0	17/01	230.5	16/01	289.5	15/01
1969	132.0	02/01	164.0	18/01	184.5	18/01	188.0	18/01	190.0	17/01	191.5	16/01	229.5	15/01
1970	97.0	11/11	111.0	01/03	111.5	28/02	128.0	27/02	129.0	26/02	169.0	31/12	172.0	31/12
1971	98.5	05/01	101.5	05/01	109.3	05/01	154.0	02/01	157.0	02/01	169.0	01/01	172.0	01/01
1972	106.0	16/06	165.5	25/08	216.5	25/08	250.5	25/08	250.5	25/08	256.5	25/08	258.5	25/08
1973	112.0	29/12	180.0	25/04	181.5	24/04	181.5	24/04	181.5	24/04	196.5	24/04	208.4	24/04
1974	94.0	25/10	116.0	24/10	118.8	24/10	163.9	24/10	166.6	24/10	170.1	24/10	170.1	24/10
1975	109.0	30/03	111.6	18/03	111.6	18/03	112.2	29/03	124.0	29/03	141.1	18/03	141.1	18/03
1976	107.0	18/10	113.7	03/03	158.5	02/03	163.0	01/03	163.2	01/03	163.2	01/03	163.2	01/03
1977	95.0	31/12	166.9	04/01	176.9	03/01	228.9	03/01	245.9	01/01	246.9	01/01	250.9	01/01
1978	146.6	05/12	152.6	04/12	189.8	03/12	193.0	29/12	193.0	29/12	206.0	29/12	206.0	29/12
1979	174.3	16/02	186.3	15/02	234.9	14/02	237.1	14/02	237.3	13/02	237.3	13/02	237.3	13/02
1980	253.4	23/11	255.1	22/11	299.9	21/11	299.9	21/11	312.4	01/04	312.4	01/04	315.4	30/03
1981	275.0	25/05	285.8	25/05	285.9	24/05	285.9	24/05	285.9	24/05	285.9	24/05	451.9	20/05
1982	191.3	02/10	193.3	02/10	195.1	13/06	219.6	12/06	261.1	11/06	305.6	10/06	305.7	10/06
1983	109.5	11/05	154.8	10/05	189.1	10/05	206.1	10/05	216.6	10/05	218.6	09/05	220.2	08/05
1984	132.0	01/12	152.0	01/12	152.0	01/12	163.6	11/12	180.4	10/12	186.4	10/12	191.4	09/12
1985	147.1	31/07	154.5	30/07	161.5	30/12	161.5	30/12	200.6	27/07	207.6	27/07	207.6	27/07
1986	152.2	16/12	187.2	15/12	242.1	16/12	246.5	14/12	281.6	14/12	281.6	14/12	282.3	12/12
1987	205.9	28/07	217.4	28/07	217.4	28/07	217.4	28/07	217.4	28/07	217.4	28/07	217.4	28/07
1988	122.1	27/12	174.5	27/12	181.7	26/12	190.7	26/12	190.7	26/12	194.4	24/12	203.1	23/12
1989	193.6	08/01	199.6	07/01	201.9	07/01	201.9	07/01	203.0	05/01	216.7	04/01	230.4	02/01
1990	151.1	14/01	151.1	14/01	162.1	14/01	168.1	14/01	242.2	14/01	271.5	30/05	281.9	31/05
1991	183.9	12/01	213.3	12/01	223.1	11/01	227.2	10/01	230.4	10/01	235.0	08/01	244.9	07/01
1992	196.5	15/01	232.3	14/01	256.9	13/01	292.9	12/01	293.3	11/01	293.3	11/01	303.1	28/12
1993	150.8	07/02	174.4	06/02	175.4	06/02	175.4	06/02	175.4	06/02	182.2	03/02	182.5	02/02
1994	94.2	26/01	105.0	04/12	105.5	04/12	112.7	04/12	119.6	25/01	121.7	25/01	135.0	25/01
MAX	277.5		426.0		426.0		426.0		426.0		426.0		451.9	

TABLE A.5.6 SUMMARY OF PROBABLE MAXIMUM RAINFALL BY GUMBEL METHOD

(Unit : mm)

Return Period (Year)	Probable Maximum Rainfall						
	1 Day	2 Day	3 Day	4 Day	5 Day	6 Day	7 Day
1. 5806 SANTA CRUZ TROMPILLO							
200	292.7	328.2	342.0	357.4	373.1	383.9	388.9
100	265.6	298.7	311.7	326.3	341.2	351.7	357.0
50	238.5	269.1	281.3	295.1	309.3	319.5	325.0
40	229.7	259.5	271.5	285.0	299.0	309.0	314.7
30	218.3	247.2	258.7	272.0	285.6	295.6	301.3
20	202.2	229.6	240.7	253.4	266.6	276.4	282.3
10	174.2	199.1	209.4	221.3	233.7	243.2	249.3
5	145.0	167.3	176.7	187.7	199.4	208.5	214.9
2	100.9	119.3	127.4	137.1	147.5	156.2	162.9
2. 61NP SAAVEDRA							
200	256.9	321.1	369.7	402.1	417.5	452.9	458.8
100	235.1	292.7	336.0	364.7	379.8	411.5	417.3
50	213.2	264.2	302.3	327.2	341.9	369.9	375.6
40	206.1	255.0	291.3	315.1	329.6	356.4	362.1
30	197.0	243.1	277.2	299.4	313.8	339.0	344.7
20	184.0	226.2	257.2	277.2	291.4	314.4	319.9
10	161.4	196.8	222.4	238.6	252.3	271.5	276.9
5	137.9	166.2	186.1	198.3	211.6	226.8	232.1
2	102.4	120.0	131.3	137.4	150.2	159.2	164.4
3. OKINAWA II							
200	266.3	296.2	332.6	345.7	391.3	391.4	416.9
100	243.2	271.2	304.3	316.6	357.3	358.9	382.0
50	220.1	246.1	275.9	287.4	323.2	326.2	346.9
40	212.6	238.0	266.7	278.0	312.2	315.6	335.6
30	202.9	227.5	254.8	265.8	297.9	302.0	320.9
20	189.2	212.6	237.9	248.5	277.7	282.6	300.1
10	165.3	186.7	208.6	218.5	242.5	248.9	263.9
5	140.4	159.7	178.1	187.1	205.9	213.7	226.2
2	102.8	119.0	131.9	139.8	150.5	160.7	169.3
4. COL. SAN JUAN DE YAPACANI							
200	352.4	417.6	440.7	445.8	459.2	471.1	522.5
100	322.4	381.7	404.0	410.7	423.8	435.4	481.0
50	292.2	345.7	367.1	375.4	388.4	399.6	439.2
40	282.4	334.1	355.2	364.0	376.9	388.0	425.8
30	269.8	319.0	339.8	349.3	362.1	373.1	408.3
20	251.9	297.7	317.9	328.4	341.0	351.8	383.6
10	220.8	260.6	279.9	292.0	304.4	314.9	340.6
5	188.3	221.9	240.3	254.1	266.3	276.4	295.7
2	139.3	163.5	180.5	196.9	208.7	218.2	228.0

TABLE A.5.7 RETURN PERIODS OF ANNUAL MAXIMUM RAINFALLS OF 1992 AND 1983

Station	Annual Maximum Rainfall						
	1 Day	2 Day	3 Day	4 Day	5 Day	6 Day	7 Day
1. YEAR 1992							
1-1 Annual Maximum Rainfall							
							(Unit : mm)
5806 Santa Cruz - Trompillo	109.2	136.6	191.6	196.9	197.1	198.4	198.4
61NP Saavedra	220.4	282.3	360.3	400.1	421.3	453.6	453.6
Okinawa II	194.0	226.0	295.0	297.0	374.0	374.0	374.0
Col. San Juan de Yapacani	196.5	232.3	256.9	292.9	293.3	293.3	303.1
1-2 Return Period							
							(Unit : year)
5806 Santa Cruz - Trompillo	2.6	3.1	7.2	6.3	4.9	4.4	4.1
61NP Saavedra	64.6	81.5	170.0	193.8	210.7	200.0	186.2
Okinawa II	23.3	29.3	83.3	67.4	150.0	147.8	89.1
Col. San Juan de Yapacani	6.2	6.5	7.0	10.0	8.5	7.1	5.9
2. YEAR 1983							
2-1 Annual Maximum Rainfall							
							(Unit : mm)
5806 Santa Cruz - Trompillo	126.4	129.6	129.6	142.4	152.7	170.4	170.7
61NP Saavedra	91.3	113.7	124.5	129.8	157.9	168.7	179.5
Okinawa II	97.2	97.2	103.6	122.6	128.6	130.4	140.0
Col. San Juan de Yapacani	109.5	154.8	189.1	206.1	216.6	218.6	220.2
2-2 Return Period							
							(Unit : year)
5806 Santa Cruz - Trompillo	3.8	2.7	2.1	2.3	2.3	2.8	2.5
61NP Saavedra	1.0	1.6	1.6	1.6	2.4	2.4	2.7
Okinawa II	1.6	1.6	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Col. San Juan de Yapacani	< 1.0	1.6	2.4	2.6	2.4	2.1	1.6

TABLE A.5.8 ANNUAL MAXIMUM HOURLY RAINFALL OF SAAVEDRA

STATION: 61NP SAAVEDRA

(Unit: mm)

Year	Duration (hr)								
	0.5	1.0	2.0	3.0	4.0	5.0	6.0	9.0	12.0
1951		72.4	73.7	73.7	73.7	85.1	91.4	116.8	116.8
1952		43.2	57.2	59.7	59.7	66.0	73.2	87.1	102.4
1953		55.9	83.8	106.7	119.4	125.7	133.4	144.8	144.8
1954		61.0	76.2	96.5	113.0	116.8	124.5	135.9	137.2
1955		78.7	90.2	100.3	105.4	106.7	108.0	114.8	118.1
1956		50.8	99.1	100.3	101.6	114.3	114.3	114.3	114.3
1957		73.7	73.7	73.7	73.7	135.9	142.2	144.8	144.8
1958		73.7	95.3	105.4	106.7	120.7	124.5	133.4	147.3
1959		30.5	34.3	44.5	55.9	58.4	61.0	67.3	73.7
1960		35.6	43.2	59.7	66.0	67.3	81.3	90.2	91.4
1961		48.3	50.8	53.3	54.6	58.4	62.2	66.0	74.9
1962		35.6	47.0	68.6	80.0	89.7	99.1	115.1	118.1
1963		33.0	49.5	59.7	64.8	73.7	81.3	94.0	94.0
1964		63.5	71.1	83.8	90.2	94.0	96.5	104.1	104.1
1965		55.9	58.4	62.2	81.3	83.8	83.8	83.8	83.8
1966		50.8	50.8	58.4	61.0	63.5	71.1	82.6	95.3
1967		58.4	85.1	90.2	100.3	104.1	106.7	109.2	111.8
1968		50.8	53.3	53.3	55.9	58.4	66.0	72.4	72.4
1969		44.5	45.7	49.5	50.8	50.8	50.8	57.2	57.2
1970		29.2	33.0	34.3	34.3	34.3	34.3	34.3	34.3
1971		25.4	34.3	35.6	38.1	39.4	41.9	43.2	45.7
1972		33.0	35.6	48.3	58.4	62.2	63.5	66.0	66.0
1973		37.6	45.7	53.0	62.0	66.0	67.2	71.9	86.1
1974	16.3	32.5	44.5	53.5	60.4	74.4	82.9	91.2	91.7
1975		42.3	61.2	63.0	63.0	63.0	63.0	69.7	69.7
1976	11.1	22.2	42.2	45.8	49.3	51.2	54.4	57.6	62.6
1977		13.5	20.3	25.0	29.6	30.9	36.1	52.1	64.0
1978		28.8	48.5	54.8	61.9	69.9	73.9	79.8	84.2
1979		46.3	63.0	87.0	113.0	145.0	160.5	176.0	179.7
1980		56.8	80.8	90.8	93.0	93.7	95.4	96.1	138.8
1981		42.9	67.0	87.0	87.3	87.3	91.0	97.0	99.6
1982		67.4	129.1	138.1	139.1	139.3	140.2	141.6	141.6
1983		40.0	55.2	69.2	74.7	75.2	79.8	92.5	99.9
1984		36.7	40.5	45.3	47.3	47.3	47.3	67.3	69.1
1985		20.0	31.0	50.0	51.0	58.5	58.5	58.5	58.5
1986		40.2	51.5	58.7	61.7	64.7	64.7	65.2	69.8
1987		37.4	67.4	82.4	85.9	106.4	112.2	131.2	134.9
1988	20.0	40.0	68.0	70.0	70.3	70.5	73.0	76.0	76.0
1989		57.0	82.2	117.5	127.3	130.2	133.2	140.2	145.0
1990	37.0	73.1	86.0	98.4	113.6	117.6	121.9	125.9	130.0
1991	26.0	51.7	83.0	105.0	126.0	137.0	153.0	178.3	199.8
1992	30.0	60.0	102.5	124.5	127.5	150.2	177.2	208.4	229.0
1993	25.0	50.0	84.0	109.0	124.0	134.0	138.1	169.0	185.0
1994	40.0	58.9	68.9	83.9	88.9	93.9	98.9	106.4	106.4

TABLE A.5.9 ANNUAL MAXIMUM HOURLY RAINFALL OF SANTA CRUZ - OFICINA

STATION: 25NP SANTA CRUZ - OFICINA

(Unit: mm)

Year	Duration (hr)								
	0.5	1.0	2.0	3.0	4.0	5.0	6.0	9.0	12.0
1951									
1952									
1953									
1954									
1955									
1956									
1957									
1958									
1959									
1960									
1961									
1962									
1963									
1964									
1965									
1966									
1967									
1968									
1969									
1970									
1971									
1972									
1973		38.5	62.5	69.9	75.5	78.3	80.4	84.6	84.6
1974		54.4	57.3	61.7	64.1	64.8	65.2	83.6	88.1
1975	29.0	57.7	78.1	91.8	112.2	127.8	134.5	142.6	152.8
1976	19.5	39.0	58.0	68.0	77.8	84.5	87.0	88.5	88.5
1977	35.0	70.0	130.0	191.5	239.9	253.7	270.5	322.8	347.5
1978	23.0	45.9	60.1	80.1	99.8	100.8	101.2	107.2	111.1
1979	12.7	25.4	32.1	41.6	53.2	64.6	79.2	97.0	97.1
1980	29.8	59.6	116.6	121.5	121.5	124.3	127.9	139.3	140.7
1981	30.1	60.2	95.4	109.1	122.0	130.6	143.5	155.6	158.1
1982		68.9	87.8	89.0	89.0	89.0	89.9	114.7	116.1
1983	27.3	54.5	73.9	85.1	96.1	100.4	101.4	107.6	122.0
1984	20.2	40.4	60.4	75.3	81.6	82.7	82.7	82.7	95.1
1985	47.0	47.4	48.7	51.6	54.6	64.9	72.9	78.2	82.2
1986	24.5	49.0	73.5	88.2	108.1	118.1	128.1	151.6	152.3
1987	34.8	69.6	106.8	117.1	119.6	120.0	126.1	126.1	126.1
1988	20.0	40.0	60.0	72.2	99.4	106.3	107.3	107.6	108.3
1989		69.4	87.0	98.0	127.5	134.8	142.8	143.7	143.7
1990	17.8	35.5	56.5	79.4	93.4	94.4	106.4	108.0	108.0
1991	33.9	67.8	99.6	107.8	111.9	112.4	114.9	116.3	116.5
1992	31.0	62.0	77.0	97.0	122.1	142.1	157.1	176.3	183.0
1993	18.8	37.5	67.5	97.5	107.5	108.5	110.5	127.8	157.9
1994									

TABLE A.5.10 ANNUAL MAXIMUM HOURLY RAINFALL OF OKINAWA II

STATION: OKINAWAII - CETABOL JICA

(Unit: mm)

Year	Duration (hr)								
	0.5	1.0	2.0	3.0	4.0	5.0	6.0	9.0	12.0
1951									
1952									
1953									
1954									
1955									
1956									
1957									
1958									
1959									
1960									
1961									
1962									
1963									
1964									
1965									
1966									
1967									
1968									
1969									
1970									
1971									
1972									
1973									
1974									
1975									
1976									
1977									
1978									
1979									
1980									
1981									
1982									
1983									
1984									
1985									
1986	37.5	75.0	112.5	150.0	155.5	161.0	161.0	161.0	161.3
1987									
1988	26.5	53.0	53.0	53.0	53.0	53.0	53.0	53.0	55.0
1989	20.0	40.0	44.5	49.0	53.0	57.0	59.0	61.0	61.5
1990	13.0	24.0	35.0	46.0	57.0	68.0	79.0	90.0	101.0
1991	20.0	40.0	49.5	59.0	64.0	70.5	80.0	80.0	80.0
1992	34.8	46.8	58.8	61.8	72.0	82.8	91.8	100.8	102.0
1993	9.0	18.0	20.5	23.0	25.5	28.0	30.5	33.0	35.5
1994	18.0	29.0	37.5	50.0	55.0	60.0	65.0	70.6	75.6

TABLE A.5.11 PROBABLE MAXIMUM RAINFALL WITHIN 24 HOURS BY GUMBEL METHOD

STATION: SAAVEDRA

(Unit: mm)

Duration	Return Period (Year)							
(hr)	2	5	10	20	30	40	50	100
0.5	26.0	37.9	45.9	53.5	57.9	61.0	63.3	70.7
1.0	44.2	58.6	68.1	77.3	82.5	86.2	89.1	98.0
2.0	59.1	79.8	93.5	106.7	114.3	119.6	123.8	136.6
3.0	69.1	93.0	108.9	124.1	132.9	139.0	143.8	158.6
4.0	74.9	100.9	118.1	134.6	144.1	150.8	156.0	172.0
5.0	81.3	111.0	130.7	149.6	160.4	168.1	174.0	192.3
6.0	85.8	118.0	139.2	159.6	171.3	179.6	186.0	205.8
9.0	94.2	130.0	153.7	176.4	189.5	198.7	205.8	227.8
12.0	99.2	137.5	155.2	177.9	191.0	200.2	207.3	229.3
24.0	102.4	137.9	161.4	184.0	197.0	206.1	213.2	235.1

STATION: SANTA CRUZ - OFICINA

(Unit: mm)

Duration	Return Period (Year)							
(hr)	2	5	10	20	30	40	50	100
0.5	26.5	36.5	43.1	49.4	53.0	55.6	57.6	63.7
1.0	49.8	62.3	70.7	78.6	83.2	86.5	89.0	96.7
2.0	71.7	94.0	108.8	122.9	131.1	136.8	141.3	155.0
3.0	85.0	113.9	133.0	151.3	161.9	169.3	175.0	192.8
4.0	97.3	133.0	156.7	179.4	192.5	201.7	208.8	230.9
5.0	97.5	140.7	165.7	189.7	203.5	213.2	220.8	244.0
6.0	97.7	140.9	166.1	201.9	216.8	227.3	235.4	260.4
9.0	98.2	141.6	167.5	202.0	217.1	227.7	235.9	261.3
12.0	98.7	142.3	168.8	202.0	217.3	228.1	236.4	262.1
24.0	100.9	145.0	174.2	202.2	218.3	229.7	238.5	265.6

TABLE A.5.12 DESIGN RAINFALLS FOR SAAVEDRA AND SANTA CRUZ

DESIGN RAINFALL OF SAAVEDRA

(Unit mm)

Time	Return Period (Year)						
	2	5	10	20	30	50	100
1st. Day Total	11.3	19.9	25.6	31.0	34.1	38.1	43.3
1	0.0	0.1	0.1	0.1	0.1	0.1	0.1
2	0.0	0.1	0.1	0.1	0.1	0.1	0.2
3	0.1	0.1	0.1	0.1	0.2	0.2	0.2
4	0.1	0.1	0.1	0.2	0.2	0.2	0.2
5	0.1	0.1	0.2	0.2	0.2	0.3	0.3
6	0.1	0.2	0.2	0.3	0.3	0.4	0.4
7	0.1	0.3	0.3	0.4	0.4	0.5	0.5
8	0.2	0.4	0.5	0.6	0.6	0.7	0.8
9	0.3	0.5	0.7	0.9	0.9	1.0	1.2
10	0.5	0.9	1.2	1.5	1.6	1.8	2.0
11	1.1	1.9	2.5	3.0	3.3	3.7	4.2
12	4.7	8.2	10.6	12.8	14.1	15.7	17.9
13	2.0	3.5	4.5	5.4	6.0	6.7	7.6
14	0.7	1.2	1.6	1.9	2.1	2.4	2.7
15	0.4	0.7	0.9	1.1	1.2	1.3	1.5
16	0.2	0.4	0.6	0.7	0.7	0.8	0.9
17	0.2	0.3	0.4	0.5	0.5	0.6	0.6
18	0.1	0.2	0.3	0.3	0.4	0.4	0.5
19	0.1	0.2	0.2	0.3	0.3	0.3	0.4
20	0.1	0.1	0.2	0.2	0.2	0.2	0.3
21	0.1	0.1	0.1	0.2	0.2	0.2	0.2
22	0.0	0.1	0.1	0.1	0.1	0.2	0.2
23	0.0	0.1	0.1	0.1	0.1	0.1	0.2
24	0.0	0.1	0.1	0.1	0.1	0.1	0.1
2nd. Day Total	17.6	28.3	35.4	42.2	46.1	51.0	57.6
25	0.1	0.1	0.1	0.1	0.2	0.2	0.2
26	0.1	0.1	0.1	0.2	0.2	0.2	0.2
27	0.1	0.1	0.2	0.2	0.2	0.2	0.3
28	0.1	0.2	0.2	0.2	0.3	0.3	0.3
29	0.1	0.2	0.3	0.3	0.3	0.4	0.4
30	0.2	0.3	0.3	0.4	0.4	0.5	0.5
31	0.2	0.4	0.4	0.5	0.6	0.6	0.7
32	0.3	0.5	0.6	0.8	0.8	0.9	1.0
33	0.5	0.8	1.0	1.2	1.3	1.4	1.6
34	0.8	1.3	1.7	2.0	2.2	2.4	2.7
35	1.7	2.8	3.4	4.1	4.5	5.0	5.6
36	7.3	11.7	14.6	17.4	19.0	21.0	23.8
37	3.1	5.0	6.2	7.4	8.1	9.0	10.1
38	1.1	1.7	2.2	2.6	2.8	3.2	3.6
39	0.6	1.0	1.2	1.5	1.6	1.8	2.0
40	0.4	0.6	0.8	0.9	1.0	1.1	1.3
41	0.3	0.4	0.5	0.6	0.7	0.8	0.9
42	0.2	0.3	0.4	0.5	0.5	0.6	0.6
43	0.1	0.2	0.3	0.3	0.4	0.4	0.5
44	0.1	0.2	0.2	0.3	0.3	0.3	0.4
45	0.1	0.1	0.2	0.2	0.2	0.3	0.3
46	0.1	0.1	0.2	0.2	0.2	0.2	0.2
47	0.1	0.1	0.1	0.2	0.2	0.2	0.2
48	0.1	0.1	0.1	0.1	0.1	0.2	0.2
3rd Day Total	102.4	137.9	161.4	184.0	197.0	213.2	235.1
49	0.3	0.6	0.7	0.8	0.9	1.0	1.1
50	0.4	0.6	0.8	1.0	1.1	1.2	1.3
51	0.5	0.8	1.0	1.2	1.3	1.4	1.6
52	0.6	0.9	1.2	1.4	1.5	1.7	1.9
53	0.7	1.2	1.5	1.7	1.9	2.1	2.3
54	1.0	1.5	1.9	2.2	2.4	2.7	2.9
55	1.3	2.0	2.4	2.9	3.1	3.5	3.8
56	1.8	2.7	3.3	3.9	4.3	4.7	5.1
57	2.8	4.0	4.9	5.7	6.1	6.7	7.4
58	4.8	6.5	7.8	8.9	9.5	10.3	11.4
59	10.0	11.6	12.7	13.6	14.4	15.2	16.8
60	42.2	58.7	69.4	79.8	85.8	93.2	102.8
61	18.0	22.1	24.8	27.3	28.8	30.6	33.8
62	6.3	7.2	7.7	8.3	8.7	9.1	10.0
63	3.6	5.1	6.1	7.0	7.5	8.2	9.0
64	2.2	3.3	4.0	4.7	5.1	5.5	6.1
65	1.5	2.3	2.8	3.3	3.6	4.0	4.4
66	1.1	1.7	2.1	2.5	2.7	3.0	3.3
67	0.8	1.3	1.6	1.9	2.1	2.4	2.6
68	0.7	1.1	1.3	1.6	1.7	1.9	2.1
69	0.5	0.9	1.1	1.3	1.4	1.6	1.7
70	0.4	0.7	0.9	1.1	1.2	1.3	1.4
71	0.4	0.6	0.7	0.9	1.0	1.1	1.2
72	0.3	0.5	0.6	0.8	0.8	0.9	1.0
Total Rain	131.3	186.1	222.4	257.2	277.2	302.3	336.0

DESIGN RAINFALL OF SANTA CRUZ

(Unit mm)

Time	Return Period (Year)						
	2	5	10	20	30	50	100
1st. Day Total	8.1	9.4	10.3	11.1	11.5	12.2	13.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.1	0.1	0.1	0.1
11	1.3	1.5	1.6	1.8	1.8	1.9	2.1
12	3.7	4.4	4.8	5.1	5.3	5.6	6.0
13	2.0	2.4	2.6	2.8	2.9	3.1	3.3
14	0.9	1.0	1.1	1.2	1.2	1.3	1.4
15	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17	0.0	0.0	0.0	0.0	0.0	0.0	0.0
18	0.0	0.0	0.0	0.0	0.0	0.0	0.0
19	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22	0.0	0.0	0.0	0.0	0.0	0.0	0.0
23	0.0	0.0	0.0	0.0	0.0	0.0	0.0
24	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2nd. Day Total	18.4	22.3	24.9	27.4	28.9	30.6	33.1
25	0.0	0.0	0.0	0.0	0.0	0.0	0.0
26	0.0	0.0	0.0	0.0	0.0	0.0	0.0
27	0.0	0.0	0.0	0.0	0.0	0.0	0.0
28	0.0	0.0	0.0	0.0	0.0	0.0	0.0
29	0.0	0.0	0.0	0.0	0.0	0.0	0.0
30	0.0	0.0	0.0	0.0	0.0	0.0	0.0
31	0.0	0.0	0.0	0.0	0.0	0.0	0.0
32	0.0	0.0	0.0	0.0	0.0	0.0	0.0
33	0.0	0.0	0.1	0.1	0.1	0.1	0.1
34	0.1	0.1	0.1	0.1	0.1	0.1	0.2
35	2.9	3.5	3.9	4.3	4.6	4.8	5.2
36	8.5	10.3	11.5	12.7	13.4	14.2	15.3
37	4.6	5.6	6.3	6.9	7.3	7.7	8.3
38	2.0	2.4	2.7	3.0	3.1	3.3	3.6
39	0.1	0.1	0.1	0.1	0.1	0.1	0.1
40	0.0	0.0	0.0	0.0	0.0	0.1	0.1
41	0.0	0.0	0.0	0.0	0.0	0.0	0.0
42	0.0	0.0	0.0	0.0	0.0	0.0	0.0
43	0.0	0.0	0.0	0.0	0.0	0.0	0.0
44	0.0	0.0	0.0	0.0	0.0	0.0	0.0
45	0.0	0.0	0.0	0.0	0.0	0.0	0.0
46	0.0	0.0	0.0	0.0	0.0	0.0	0.0
47	0.0	0.0	0.0	0.0	0.0	0.0	0.0
48	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3rd Day Total	100.9	145.0	174.2	202.2	218.3	238.5	265.6
49	0.0	0.2	0.3	0.4	0.5	0.6	0.7
50	0.0	0.2	0.3	0.5	0.6	0.7	0.8
51	0.0	0.3	0.4	0.6	0.7	0.8	1.0
52	0.0	0.3	0.5	0.7	0.9	1.0	1.2
53	0.0	0.4	0.6	0.9	1.1	1.3	1.5
54	0.1	0.5	0.8	1.2	1.4	1.6	2.0
55	0.1	0.7	1.2	1.6	1.9	2.2	2.6
56	0.1	1.1	1.7	2.3	2.7	3.1	3.7
57	0.2	1.7	2.7	3.6	4.1	4.7	5.6
58	0.5	3.2	4.9	6.2	7.0	8.1	9.4
59	15.9	20.6	23.7	26.6	28.3	30.4	33.2
60	46.7	61.9	72.1	61.7	87.3	94.2	103.6
61	25.4	33.1	38.2	43.0	45.9	49.4	54.1
62	10.9	14.0	16.1	18.0	19.2	20.6	22.5
63	0.3	2.3	3.6	4.6	5.2	6.1	7.1
64	0.2	1.3	2.1	2.8	3.3	3.8	4.5
65	0.1	0.9	1.4	1.9	2.2	2.6	3.1
66	0.1	0.6	1.0	1.4	1.6	1.9	2.3
67	0.1	0.5	0.7	1.1	1.2	1.4	1.7
68	0.0	0.3	0.6	0.8	1.0	1.1	1.4
69	0.0	0.3	0.5	0.7	0.8	0.9	1.1
70	0.0	0.2	0.4	0.5	0.6	0.8	0.9
71	0.0	0.2	0.3	0.5	0.5	0.6	0.8
72	0.0	0.2	0.3	0.4	0.5	0.5	0.6
Total Rain	127.4	176.7	209.4	240.7	258.7	281.3	311.7

TABLE A.5.13 DESIGN RAINFALLS FOR OKINAWA II AND COL. SAN JUAN DE YAPACANI

DESIGN RAINFALL OF OKINAWA II

(Unit mm)

Time	Return Period (Year)						
	2	5	10	20	30	50	100
1st. Day Total	12.9	18.4	21.9	25.3	27.3	29.8	33.1
1	0.0	0.1	0.1	0.1	0.1	0.1	0.1
2	0.1	0.1	0.1	0.1	0.1	0.1	0.1
3	0.1	0.1	0.1	0.1	0.1	0.1	0.2
4	0.1	0.1	0.1	0.1	0.2	0.2	0.2
5	0.1	0.1	0.2	0.2	0.2	0.2	0.2
6	0.1	0.2	0.2	0.2	0.3	0.3	0.3
7	0.2	0.2	0.3	0.3	0.3	0.4	0.4
8	0.2	0.3	0.4	0.5	0.5	0.5	0.6
9	0.4	0.5	0.6	0.7	0.7	0.8	0.9
10	0.6	0.9	1.0	1.2	1.3	1.4	1.6
11	1.3	1.8	2.1	2.5	2.7	2.9	3.2
12	5.3	7.6	9.0	10.4	11.3	12.3	13.7
13	2.3	3.2	3.8	4.4	4.8	5.2	5.8
14	0.8	1.1	1.4	1.6	1.7	1.8	2.0
15	0.5	0.6	0.8	0.9	1.0	1.1	1.2
16	0.3	0.4	0.5	0.6	0.6	0.7	0.7
17	0.2	0.3	0.3	0.4	0.4	0.4	0.5
18	0.1	0.2	0.2	0.3	0.3	0.3	0.4
19	0.1	0.2	0.2	0.2	0.2	0.2	0.3
20	0.1	0.1	0.1	0.2	0.2	0.2	0.2
21	0.1	0.1	0.1	0.1	0.1	0.2	0.2
22	0.1	0.1	0.1	0.1	0.1	0.1	0.1
23	0.0	0.1	0.1	0.1	0.1	0.1	0.1
24	0.0	0.1	0.1	0.1	0.1	0.1	0.1
2nd. Day Total	16.2	19.3	21.4	23.4	24.6	26.0	28.0
25	0.1	0.1	0.1	0.1	0.1	0.1	0.1
26	0.1	0.1	0.1	0.1	0.1	0.1	0.1
27	0.1	0.1	0.1	0.1	0.1	0.1	0.1
28	0.1	0.1	0.1	0.1	0.1	0.1	0.2
29	0.1	0.1	0.2	0.2	0.2	0.2	0.2
30	0.2	0.2	0.2	0.2	0.2	0.2	0.3
31	0.2	0.2	0.3	0.3	0.3	0.3	0.4
32	0.3	0.3	0.4	0.4	0.4	0.5	0.5
33	0.4	0.5	0.6	0.6	0.7	0.7	0.8
34	0.8	0.9	1.0	1.1	1.2	1.2	1.3
35	1.6	1.9	2.1	2.3	2.4	2.5	2.7
36	6.7	8.0	8.8	9.7	10.1	10.7	11.5
37	2.8	3.4	3.8	4.1	4.3	4.6	4.9
38	1.0	1.2	1.3	1.4	1.5	1.6	1.7
39	0.6	0.7	0.8	0.8	0.9	0.9	1.0
40	0.4	0.4	0.5	0.5	0.5	0.6	0.6
41	0.2	0.3	0.3	0.3	0.4	0.4	0.4
42	0.2	0.2	0.2	0.3	0.3	0.3	0.3
43	0.1	0.2	0.2	0.2	0.2	0.2	0.2
44	0.1	0.1	0.1	0.2	0.2	0.2	0.2
45	0.1	0.1	0.1	0.1	0.1	0.1	0.1
46	0.1	0.1	0.1	0.1	0.1	0.1	0.1
47	0.1	0.1	0.1	0.1	0.1	0.1	0.1
48	0.0	0.1	0.1	0.1	0.1	0.1	0.1
3rd Day Total	102.8	140.4	165.3	189.2	202.9	220.1	243.2
49	0.3	0.6	0.7	0.9	0.9	1.0	1.2
50	0.4	0.7	0.8	1.0	1.1	1.2	1.4
51	0.5	0.8	1.0	1.2	1.3	1.5	1.7
52	0.6	1.0	1.2	1.4	1.6	1.8	2.0
53	0.7	1.2	1.5	1.8	2.0	2.2	2.5
54	1.0	1.5	1.9	2.3	2.5	2.7	3.1
55	1.3	2.0	2.5	3.0	3.2	3.6	4.0
56	1.8	2.8	3.4	4.0	4.4	4.8	5.4
57	2.8	4.1	5.0	5.8	6.3	6.9	7.7
58	4.9	6.7	8.0	9.2	9.8	10.6	11.7
59	10.0	11.8	13.0	14.2	14.9	15.7	16.8
60	42.4	59.7	71.1	82.1	88.4	96.2	106.8
61	18.1	22.5	25.4	28.1	29.6	31.6	34.2
62	6.4	7.3	7.9	8.6	8.9	9.4	10.0
63	3.6	5.2	6.2	7.2	7.8	8.5	9.4
64	2.3	3.4	4.1	4.8	5.2	5.7	6.4
65	1.5	2.4	2.9	3.4	3.7	4.1	4.6
66	1.1	1.7	2.2	2.6	2.8	3.1	3.5
67	0.8	1.3	1.7	2.0	2.2	2.4	2.8
68	0.7	1.1	1.3	1.6	1.8	2.0	2.2
69	0.5	0.9	1.1	1.3	1.4	1.6	1.8
70	0.4	0.7	0.9	1.1	1.2	1.3	1.5
71	0.4	0.6	0.8	0.9	1.0	1.1	1.3
72	0.3	0.5	0.7	0.8	0.9	1.0	1.1
Total Rain	131.9	178.1	208.6	237.9	254.8	275.9	304.3

DESIGN RAINFALL OF COL. SAN JUAN DE YAPACANI

(Unit mm)

Time	Return Period (Year)						
	2	5	10	20	30	50	100
1st. Day Total	17.0	18.4	19.3	20.2	20.8	21.4	22.3
1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
2	0.1	0.1	0.1	0.1	0.1	0.1	0.1
3	0.1	0.1	0.1	0.1	0.1	0.1	0.1
4	0.1	0.1	0.1	0.1	0.1	0.1	0.1
5	0.1	0.1	0.1	0.1	0.2	0.2	0.2
6	0.2	0.2	0.2	0.2	0.2	0.2	0.2
7	0.2	0.2	0.2	0.3	0.3	0.3	0.3
8	0.3	0.3	0.3	0.4	0.4	0.4	0.4
9	0.5	0.5	0.5	0.6	0.6	0.6	0.6
10	0.8	0.9	0.9	1.0	1.0	1.0	1.1
11	1.7	1.8	1.9	2.0	2.0	2.1	2.2
12	7.0	7.6	8.0	8.3	8.6	8.8	9.2
13	3.0	3.2	3.4	3.5	3.7	3.8	3.9
14	1.1	1.1	1.2	1.2	1.3	1.3	1.4
15	0.6	0.6	0.7	0.7	0.7	0.8	0.8
16	0.4	0.4	0.4	0.4	0.5	0.5	0.5
17	0.3	0.3	0.3	0.3	0.3	0.3	0.3
18	0.2	0.2	0.2	0.2	0.2	0.2	0.2
19	0.1	0.2	0.2	0.2	0.2	0.2	0.2
20	0.1	0.1	0.1	0.1	0.1	0.1	0.1
21	0.1	0.1	0.1	0.1	0.1	0.1	0.1
22	0.1	0.1	0.1	0.1	0.1	0.1	0.1
23	0.1	0.1	0.1	0.1	0.1	0.1	0.1
24	0.1	0.1	0.1	0.1	0.1	0.1	0.1
2nd. Day Total	24.2	33.6	39.8	45.8	49.2	53.5	69.3
25	0.1	0.1	0.1	0.1	0.2	0.2	0.2
26	0.1	0.1	0.2	0.2	0.2	0.2	0.2
27	0.1	0.2	0.2	0.2	0.2	0.3	0.3
28	0.1	0.2	0.2	0.3	0.3	0.3	0.3
29	0.2	0.2	0.3	0.3	0.4	0.4	0.4
30	0.2	0.3	0.4	0.4	0.5	0.5	0.6
31	0.3	0.4	0.5	0.6	0.6	0.7	0.7
32	0.4	0.6	0.7	0.8	0.9	1.0	1.1
33	0.7	0.9	1.1	1.3	1.3	1.5	1.6
34	1.1	1.6	1.9	2.2	2.3	2.5	2.8
35	2.4	3.3	3.9	4.5	4.8	5.2	5.8
36	10.0	13.9	16.4	18.9	20.3	22.1	24.5
37	4.2	5.9	7.0	8.0	8.6	9.4	10.4
38	1.5	2.1	2.5	2.8	3.0	3.3	3.7
39	0.9	1.2	1.4	1.6	1.7	1.9	2.1
40	0.5	0.7	0.9	1.0	1.1	1.2	1.3
41	0.4	0.5	0.6	0.7	0.7	0.8	0.9
42	0.3	0.4	0.4	0.5	0.5	0.6	0.6
43	0.2	0.3	0.3	0.4	0.4	0.4	0.5
44	0.2	0.2	0.3	0.3	0.3	0.3	0.4
45	0.1	0.2	0.2	0.2	0.3	0.3	0.3
46	0.1	0.1	0.2	0.2	0.2	0.2	0.3
47	0.1	0.1	0.1	0.2	0.2	0.2	0.2
48	0.1	0.1	0.1	0.1	0.1	0.2	0.2
3rd Day Total	139.3	188.3	220.8	251.9	269.8	292.2	322.4
49	0.5	0.8	0.9	1.1	1.3	1.4	1.6
50	0.5	0.9	1.1	1.3	1.5	1.6	1.9
51	0.7	1.1	1.3	1.6	1.7	1.9	2.2
52	0.8	1.3	1.6	1.9	2.1	2.3	2.7
53	1.0	1.6	2.0	2.4	2.6	2.9	3.3
54	1.3	2.1	2.5	3.0	3.3	3.6	4.1
55	1.8	2.7	3.3	3.9	4.3	4.7	5.3
56	2.5	3.7	4.6	5.4	5.8	6.4	7.2
57	3.8	5.5	6.7	7.8	8.4	9.1	10.2
58	6.6	8.9	10.7	12.2	13.0	14.1	15.6
59	13.6	15.8	17.4	18.9	19.8	20.9	22.3
60	57.4	80.1	95.0	109.3	117.5	127.7	141.6
61	24.5	30.2	33.9	37.4	39.4	42.0	45.3
62	8.6	9.8	10.6	11.4	11.9	12.5	13.3
63	4.9	6.9	8.3	9.6	10.3	11.2	12.5
64	3.1	4.5	5.5	6.4	6.9	7.6	8.5
65	2.1	3.2	3.9	4.6	5.0	5.5	6.1
66	1.5	2.3	2.9	3.4	3.7	4.1	4.7
67	1.1	1.8	2.2	2.7	2.9	3.2	3.6
68	0.9	1.4	1.8	2.1	2.3	2.6	2.9
69	0.7	1.2	1.5	1.7	1.9	2.1	2.4
70	0.6	1.0	1.2	1.5	1.6	1.8	2.0
71	0.5	0.8	1.0	1.2	1.4	1.5	1.7
72	0.4	0.7	0.9	1.1	1.2	1.3	1.5
Total Rain	180.6	240.3	279.9	317.9	339.8	367.1	404.0

TABLE A.6.1 ANNUAL MAXIMUM WATER LEVEL AND DISCHARGE OF THE RIO PIRAY

1. ANNUAL MAXIMUM WATER LEVEL OF THE RIO PIRAY

(Unit: m)

YEAR	0506 Angostura	0510 La Belgica	0505 Bermejo	0504 Colorado	0512 Eisenhower	0520 Espejos
1975						
1976						
1977			3.70			2.30
1978						
1979						
1980	1.65	1.76	2.72		2.38	1.90
1981	2.20	2.20	3.50	*1.64*	2.87	2.28
1982	*2.06*		*2.02*	*1.22*	*1.97*	
1983	*5.76*		*9.73*	*5.10*	*2.43*	
1984	*1.96*		*1.61*		*1.53*	*1.38*
1985	*2.62*	*2.41*	*2.22*	*1.96*	*1.89*	*0.96*
1986	2.82	3.31	2.55	2.55	2.62	2.60
1987	2.85	1.54	3.76	2.06	3.10	2.40
1988	2.70	1.20	2.70	1.95	2.06	2.01
1989	2.36	1.34	1.93	1.65	2.49	2.79
1990	2.49	1.38	2.15	1.60	2.40	2.52
1991	3.59	1.64	4.48	3.06	2.31	4.15
1992	4.15	1.69	3.63	2.09	2.40	3.50
1993	3.68	1.63	3.48	2.80	2.21	4.12
1994	2.42	0.98	2.50	1.67	1.82	2.92
AVER.	2.89	1.76	3.29	2.26	2.30	2.56

Note: 1) Italic value shows the monthly maximum of daily average water level.
2) Water level indicates the water level on staff gauge and does not indicate the topographic elevation.

2. ANNUAL MAXIMUM DISCHARGE OF THE RIO PIRAY

(Unit: m3/s)

YEAR	0506 Angostura	0510 La Belgica	0505 Bermejo	0504 Colorado	0512 Eisenhower	0520 Espejos
1975						
1976	*43.57*					
1977	*78.72*	*589.07*	*72.56*			
1978	*210.44*	*310.19*	*140.33*		*390.44*	*266.00*
1979	*247.18*	*224.50*	*128.47*		*884.03*	*85.73*
1980	*150.00*	*152.69*	*42.92*		*386.00*	*48.15*
1981	*226.00*		*197.70*		444.00	33.00
1982	*458.42*		*77.21*	*41.22*		
1983	*248.71*		81.24			
1984		*562.40*	*73.60*			
1985		*406.09*	*104.47*	*1.96*		*67.58*
1986	482.59	777.75	142.64	173.40	591.41	173.38
1987	200.14	963.60	278.18	53.98	566.18	250.39
1988	483.43	668.57	287.92	59.36	769.75	332.34
1989	370.95	349.40	114.65	59.56	1635.80	630.40
1990	405.63	857.10	43.72	54.38		234.24
1991	644.40	1819.50	525.40	37.37	2092.70	638.66
1992	822.51		417.42	26.12		149.23
1993	737.38		384.30	26.12		394.63
1994						
AVER.	363.13	640.07	183.10	53.35	862.26	254.13

Note: Italic value shows the monthly maximum of daily average discharge.

TABLE A.6.2 RESULTS OF DISCHARGE MEASUREMENT

	River/Measurement Site	Section No.	Date	Water Depth (m)	Area (m2)	Surface Velocity (m/s)	Discharge (m3/s)
1.	**Rio Chane**						
1-1	Chane Bridge near Puesto Fernandez	R301	Dec. 6, 1995	0.40	6.12	0.21	1.09
1-2	Bridge at Caimanes	R310	Dec. 6, 1995	0.55	9.70	0.05	0.37
2.	**Rio Pailon**						
2-1	Bridge of National Road No.9	R210	June 5, 1995	0.20	0.90	0.25	0.19
			Dec. 5, 1995	0.10	0.20	0.00	0.00
2-2	Bridge of Main Road Okinawa I to II	R214	Dec. 5, 1995	0.25	0.50	0.00	0.00
3.	**Quebrada Chane**						
3-1	Bridge of National Road No.9	R319	Dec. 5, 1995	0.10	0.20	0.00	0.00
4.	**Quebrada Toro**						
4-1	Bridge of National Road No.9	QT05	Dec. 5, 1995	0.15	0.19	0.01	0.00
5.	**Quebrada Las Chacras**						
5-1	Bridge of the Main Road to Caimanes	QCH02	Dec. 5, 1995	0.20	0.40	0.00	0.00
6.	**Arroyo Yapacanicito**						
6-1	Most Downstream bridge	Y01(temporary)	Dec. 5, 1995	0.40	3.10	0.25	0.66
7.	**Arroyo Jochi**						
7-1	Bridge of Main Road	A206	Dec. 5, 1995	0.67	4.37	0.08	0.30
8.	**Arroyo Tacuaral**						
8-1	Bridge of Main Road	AT02	Dec. 5, 1995	0.67	3.09	0.64	1.68

TABLE A.7.1 DIMENSIONLESS CURVE NUMBER OF SCS (CN)

SCS CURVE NUMBERS (CN)

Land Use Description	Hydrologic Soil Group			
	A	B	C	D
1. Cultivated Land				
1) Without conservation treatment	72	81	88	91
2) With conservation treatment	62	71	78	81
2. Pasture or Range Land				
1) Poor condition	68	79	86	89
2) Good Condition	39	61	74	80
3. Meadow: good condition	30	58	71	78
4. Wood or Forest Land				
1) Thin stand, poor cover, no mulch	45	66	77	83
2) Good cover	25	55	70	77
5. Open Spaces, Lawns, Parks, Golf Courses, Cemetries etc.				
1) Good condition: grass cover on 75% or more	39	61	74	80
2) Fair condition: grass cover on 50% to 75%	49	69	79	84
6. Commercial and Business Area (85% impervious)	89	92	94	95
7. Industrial Districts (72% impervious)	81	88	91	93
8. Residential Area				
1) 1/8 acre or less: 65% impervious	77	85	90	92
2) 1/4 acre: 38% impervious	61	75	83	87
3) 1/3 acre: 30% impervious	57	72	81	86
4) 1/2 acre: 25% impervious	54	70	80	85
5) 1 acre: 20% impervious	51	68	79	84
9. Paved Parking Lots, Roofs, Driveways etc.	98	98	98	98
10. Streets and Roads				
1) Paved with curbs and storm sewers	98	98	98	98
2) Gravel	76	85	89	91
3) Dirt	72	82	87	89

Notes: Hydrological Soil Groups

Groupe A: low runoff potential with high infiltration rates.
deep sand, deep loess, sandy loam.

Groupe B: moderate infiltration rates.
shallow loess, aggregated silt.

Groupe C: slow infiltration rates.
clay loams, shallow sandy loam, soils low in organic content and soils usually high in clay.

Groupe D: high runoff potential with very slow infiltration rates.
soils swell significantly under wet condition, heavy plastic clays etc.

TABLE A.7.2 CHARACTERISTICS AND SCS PARAMETERS OF THE RIO CHANE BASIN AND ARROYO YAPACANICITO-JOCHI-TACUARAL-TEJERIA BASINS

1. CHARACTERISTICS OF SUB-CATCHMENT OF THE RIO CHANE BASIN

Sub-catchment	Area	Hydraulic Length	Average Catchm. Slope	Ground Condition (Average %)						SCS Curve Number(CN)	CBR method	
				Hydraulic Soil Groupe C			Hydraulic Soil Groupe D				Lag Time	Velocity
				Cultivated	Pasture	Forest	Cultivated	Pasture	Forest			
	(km2)	(m)	(%)	83.0	80.0	73.5	86.0	84.5	80.0		(hr)	(m/sec)
A - 1	63.35	12500	0.08	5.0	5.0	20.0	45.0	5.0	20.0	82	7.2	0.48
A - 2	198.68	22000	0.03	25.0	10.0	15.0	25.0	10.0	15.0	82	16.9	0.36
A - 3	164.7	23000	0.07	30.0	5.0	15.0	30.0	5.0	15.0	82	12.2	0.52
A - 4	60.08	4200	0.07	25.0	10.0	15.0	25.0	10.0	15.0	82	3.3	0.36
A - 5	15.8	4000	0.05	30.0	5.0	15.0	30.0	5.0	15.0	82	3.6	0.31
A - 6	211.87	22000	0.15	25.0	5.0	15.0	35.0	5.0	15.0	82	8.8	0.70
A - 7	112.68	28000	0.19	20.0	10.0	15.0	30.0	10.0	15.0	82	9.6	0.81
A - 8	270.08	39000	0.22	17.5	17.5	10.0	27.5	17.5	10.0	82	11.7	0.93
A - 9	141.89	32000	0.23	17.5	17.5	10.0	27.5	17.5	10.0	82	10.0	0.89
A-10	66.14	28000	0.21	17.5	17.5	10.0	27.5	17.5	10.0	82	9.2	0.85
A-11	275.46	42000	0.23	17.5	17.5	10.0	27.5	17.5	10.0	82	12.2	0.96
B - 1	6.72	2500	0.08	12.5	12.5	20.0	22.5	12.5	20.0	81	2.1	0.33
B - 2	153.49	32000	0.13	20.0	15.0	15.0	20.0	15.0	15.0	82	12.4	0.72
B - 3	64.04	16000	0.21	20.0	20.0	10.0	20.0	20.0	10.0	82	6.0	0.74
C - 1	3.18	4000	0.15	10.0	10.0	20.0	30.0	10.0	20.0	81	2.4	0.47
C - 2	35.03	14500	0.14	20.0	20.0	10.0	20.0	20.0	10.0	82	6.6	0.61
C - 3	197.4	40000	0.23	20.0	20.0	10.0	20.0	20.0	10.0	82	11.9	0.94
C - 4	38.77	11500	0.14	20.0	20.0	10.0	20.0	20.0	10.0	82	5.5	0.58
C - 5	11.36	4500	0.13	20.0	20.0	10.0	20.0	20.0	10.0	82	2.7	0.46
C - 6	121.16	28000	0.24	20.0	20.0	10.0	20.0	20.0	10.0	82	8.8	0.89
C - 7	23.93	7000	0.19	20.0	20.0	10.0	20.0	20.0	10.0	82	3.3	0.58
C - 8	38.43	21000	0.22	20.0	20.0	10.0	20.0	20.0	10.0	82	7.3	0.80
D - 1	244.82	33000	0.19	20.0	10.0	10.0	40.0	10.0	10.0	83	11.0	0.83
E - 1	105.9	24300	0.08	35.0	7.5	7.5	35.0	7.5	7.5	83	12.2	0.56
E - 2	69.70	13700	0.14	35.0	7.5	7.5	35.0	7.5	7.5	83	6.3	0.61

2. CHARACTERISTICS OF SUB-CATCHMENT OF YAPACANICITO-JOCHI-TACUARAL-TEJERIA BASINS

River	Sub-catchment	Area	Hydraulic Length	Average Catchment Slope	Ground Condition (Average %)						SCS Curve Number(CN)	CBR method	
					Hydraulic Soil Groupe C			Hydraulic Soil Groupe D				Lag Time	Velocity
					Cultivated	Pasture	Forest	Cultivated	Pasture	Forest			
		(km^2)	(km)	(%)	83.0	80.0	73.5	86.0	84.5	80.0		(hr)	(m/sec)
Yapacanicito	R_Y1_1	66.8	10.3	0.050	12.5	12.5	25.0	12.5	12.5	25.0	80	7.5	0.38
	R_Y1_2	98.4	19.6	0.050	12.5	12.5	25.0	12.5	12.5	25.0	80	12.2	0.44
	R_Y1_3_1	32.8	3.5	0.050	30.0	10.0	10.0	30.0	10.0	10.0	83	3.2	0.30
	R_Y1_3_2	21.1	2.4	0.125	30.0	10.0	10.0	30.0	10.0	10.0	83	1.7	0.39
	R_Y1_3_3	42.0	13.8	0.125	30.0	10.0	10.0	30.0	10.0	10.0	83	6.6	0.56
Subtotal	R_Y1_3	95.9	19.7	0.112							83	9.0	0.61
	R_Y1_4_1	8.3	2.5	0.200	30.0	10.0	10.0	30.0	10.0	10.0	83	1.5	0.47
	R_Y1_4_2	10.0	2.5	0.200	30.0	10.0	10.0	30.0	10.0	10.0	83	1.5	0.47
	R_Y1_4_3	8.9	2.1	0.200	30.0	10.0	10.0	30.0	10.0	10.0	83	1.3	0.45
	R_Y1_4_4	4.3	1.5	0.200	30.0	10.0	10.0	30.0	10.0	10.0	83	1.0	0.42
	R_Y1_4_5	3.4	3.2	0.200	30.0	10.0	10.0	30.0	10.0	10.0	83	1.8	0.50
Subtotal	R_Y1_4	34.9	11.8	0.200							83	4.9	0.67
	R_Y2_1	62.8	19.4	0.050	20.0	10.0	20.0	20.0	10.0	20.0	81	12.1	0.44
	R_Y2_2_1	10.5	4.2	0.083	30.0	10.0	10.0	30.0	10.0	10.0	83	3.1	0.38
	R_Y2_2_2	1.4	2.3	0.083	30.0	10.0	10.0	30.0	10.0	10.0	83	1.9	0.33
Subtotal	R_Y2_2	11.9	6.5	0.083							82	4.3	0.42
Subtotal	Yapacanicito	370.7											
Jochi	R_J_1	41.6	13.6	0.070	7.5	7.5	35.0	7.5	7.5	35.0	79	8.1	0.47
	R_J_2	11.8	2.1	0.070	15.0	10.0	25.0	15.0	10.0	25.0	80	1.9	0.30
	R_J_3_1	5.3	2.6	0.070	20.0	10.0	20.0	20.0	10.0	20.0	81	2.3	0.32
	R_J_3_2	6.3	2.5	0.070	20.0	10.0	20.0	20.0	10.0	20.0	81	2.2	0.32
	R_J_3_3	64.7	21.0	0.115	25.0	10.0	15.0	25.0	10.0	15.0	82	9.4	0.62
Subtotal	R_J_3	76.3	26.1	0.106							82	11.4	0.63
	R_J_4	18.3	5.0	0.120	25.0	10.0	15.0	25.0	10.0	15.0	82	3.1	0.46
Subtotal	Jochi	148.0											
Tacuaral	R_T_1	38.2	10.2	0.050	7.5	7.5	35.0	7.5	7.5	35.0	79	7.4	0.38
	R_T_2	88.2	26.0	0.100	15.0	10.0	25.0	15.0	10.0	25.0	80	11.7	0.62
	R_T_3_1	10.0	4.7	0.110	15.0	10.0	25.0	15.0	10.0	25.0	80	3.0	0.43
	R_T_3_2	67.0	19.8	0.110	15.0	20.0	15.0	15.0	20.0	15.0	81	9.1	0.60
Subtotal	R_T_3	77.0	24.5	0.110							80	10.7	0.63
	R_T_4	49.4	13.2	0.200	10.0	20.0	20.0	10.0	20.0	20.0	81	5.3	0.69
Subtotal	Tacuaral	252.8											
Tejeria	R_TJ	43.6	17.0	0.180	25.0	10.0	15.0	25.0	10.0	15.0	82	6.7	0.70

TABLE A.7.3 RUNOFF POINTS AND SCS PARAMETERS OF THE RIO CHANE BASIN AND ARROYO YAPACANICITO-JOCHI-TACUARAL-TEJERIA BASINS

1. CHACHMENT CHARACTERISTICS FOR RUNOFF POINTS OF THE RIO CHANE BASIN

Point Code	Sub-catchments	Chach-ment Area (km^2)	Hydraulic Length (km)	Grand Slope (%)	SCS Curve Number (CN)	CBR method Lag Time (hr)	CBR method Velocity (m/sec)
P-1	A-1_11,B-1_3,C-1_8,D-1	2519.1	132700.0	0.133	82	36.6	1.01
P-2	A-2_11,B-1_3,C-1_8,D-1	2455.7	120200.0	0.139	82	33.4	1.00
P-2-1	A-2_11,C-1_8,D-1	2231.5	120200.0	0.139	82	33.4	1.00
P-2-2	B-1_3	224.3	50500.0	0.152	82	16.5	0.85
P-3	A-3_11,C-1_8,D-1	2032.8	98200.0	0.118	82	30.4	0.90
P-3-1	D-1,A-3_11	1563.5	98200.0	0.164	82	26.8	1.02
P-3-2	C-1_8	469.3	58500.0	0.198	82	16.7	0.97
P-4	D-1,A-4_11	1398.8	75200.0	0.193	82	20.5	1.02
P-5	D-1,A-5_11	1338.7	71000.0	0.200	82	19.3	1.02
P-5-1	D-1,A-5_10	1063.3	71000.0	0.200	82	19.3	1.02
P-5-2	A-11	275.5	42000.0	0.231	82	12.2	0.96
P-6	D-1,A-6_10	1047.5	67000.0	0.209	82	18.2	1.02
P-6-1	D-1,A-6	456.7	55000.0	0.173	82	16.8	0.91
P-6-2	A-7_9	524.7	67000.0	0.209	82	18.2	1.02
P-6-3	A-10	66.1	28000.0	0.207	82	9.3	0.83
P-7	A-8,A-9	412.0	39000.0	0.223	82	11.7	0.93
P-7-1	A - 8	270.1	39000.0	0.223	82	11.7	0.93
P-7-2	A - 9	141.9	32000.0	0.225	82	10.0	0.89
P-8	B-2,B-3	217.5	48000.0	0.156	82	15.7	0.85
P-9	B - 3	64.0	16000.0	0.213	82	6.0	0.74
P-10	C-2_8	466.1	54500.0	0.202	82	15.7	0.96
P-10-1	C-4_8	233.7	44000.0	0.205	82	13.3	0.92
P-10-2	C-2,C-3	232.4	54500.0	0.202	82	15.7	0.96
P-11	C - 3	197.4	40000.0	0.225	82	11.9	0.94
P-12	C-5_8	194.9	32500.0	0.228	82	10.1	0.90
P-12-1	C-7,C-8	62.4	28000.0	0.211	82	9.3	0.84
P-12-2	C-5,C-6	132.5	32500.0	0.228	82	10.1	0.90
P-13	C - 6	121.2	28000.0	0.243	82	8.8	0.89
P-14	C - 8	38.4	21000.0	0.219	82	7.3	0.80
P-15	D - 1	244.8	33000.0	0.188	83	11.0	0.83

2. CHACHMENT CHARACTERISTICS FOR RUNOFF POINTS OF THE YAPACANICITO-JOCHI-TACUARAL-TEJERIA BASIN

River	Point Code	Sub-catchments	Chach-ment Area (km^2)	Hydraulic Length (km)	Grand Slope (%)	SCS Curve Number (CN)	CBR method Lag Time (hr)	CBR method Velocity (m/sec)
Yapacanicito	P_Y1	Y1_1, Y1_2, Y1_3, Y1_4, Y2_1, Y2_2	370.7	61.4	0.099	80	22.7	0.75
	P_Y2	Y1_2, Y1_3, Y1_4, Y2_1, Y2_2	303.9	51.1	0.108	80	19.0	0.75
	P_Y2_1	Y1_2, Y1_3, Y1_4	229.2	51.1	0.108	81	19.0	0.75
	P_Y3	Y1_3, Y1_4	130.8	31.5	0.145	83	11.7	0.75
	P_Y4	Y1_4	34.9	11.8	0.200	83	4.9	0.67
	P_Y2_2	Y2_1, Y2_2	74.7	25.9	0.058	81	14.3	0.50
	P_Y5	Y2_2	11.9	6.5	0.083	82	4.3	0.42
Jochi	P_J1	J_1, J_2, J_3, J_4	148.0	46.8	0.096	80	18.6	0.70
	P_J2	J_2, J_3, J_4	106.4	33.2	0.106	81	13.8	0.67
	P_J3	J_3, J_4	94.6	31.1	0.108	82	13.0	0.67
	P_J4	J_4	18.3	5.0	0.120	82	3.1	0.46
Tacuaral	P_T1	T_1, T_2, T_3, T_4	252.8	49.7	0.121	80	17.8	0.77
	P_T2	T_2, T_3, T_4	214.6	39.5	0.140	80	14.1	0.78
	P_T2_1	T_2	88.2	26.0	0.100	80	11.7	0.62
	P_T3	T_3, T_4	126.4	37.7	0.142	80	13.6	0.77
	P_T4	T_4	49.4	13.2	0.200	81	5.3	0.69
Tejeria	P_TJ1	TJ_1	43.6	17.0	0.180	82	6.7	0.70

TABLE A.8.1 INUNDATION AREA AND DEPTH OF CHANE - PAILON
WITHOUT FLOOD MITIGATION AND DRAINAGE IMPROVEMENT

Target Area	Distance (km)	Potential Inundation Area (km2)	Inundation Depth (m) Return Period (Year)					Inundation Area (km2) Return Period (Year)				
			2	5	10	20	50	2	5	10	20	50
A. DOWNSTREAM OF ROUTE 9	**185.80**	**845.1**	**0.68**	**0.90**	**1.06**	**1.19**	**1.36**	**601.3**	**725.6**	**779.7**	**799.2**	**820.7**
B. UPSTREAM OF ROUTE 9	**24.40**	**179.1**	**0.19**	**0.28**	**0.37**	**0.46**	**0.58**	**49.5**	**68.5**	**83.3**	**97.3**	**115.7**
1. RIO CHANE	35.00	107.4	0.88	1.18	1.39	1.57	1.81	93.3	106.0	107.4	107.4	107.4
1-1 Jct. Rio Piray - Jct. Qda. Chacras	12.50	63.4	1.24	1.57	1.72	1.86	2.03	63.4	63.4	63.4	63.4	63.4
1-2 Jct. Qda. Chacras - Jct. Qda. Chané	22.50	44.0	0.68	0.97	1.20	1.41	1.69	29.9	42.7	44.0	44.0	44.0
2. RIO PAILON	42.90	260.5	0.58	0.77	0.93	1.07	1.27	170.4	182.6	190.0	197.7	209.3
2-1 Jct. Rio Chané - Route 9	23.50	164.7	0.97	1.26	1.49	1.69	1.96	159.8	164.7	164.7	164.7	164.7
2-2 Route 9 - Jct. A. Sauces	8.00	50.8	0.13	0.22	0.32	0.42	0.56	6.6	11.2	16.3	21.3	28.4
2-3 Jct. A. Sauces - Okinawa II	11.40	45.0	0.09	0.15	0.20	0.26	0.36	4.1	6.8	9.0	11.7	16.2
3. QDA. CHANE	43.30	159.5	0.33	0.50	0.63	0.75	0.88	56.9	81.1	100.7	112.4	123.2
3-1 Qda. Chané: Jct. Rio Chané - Route 9	18.00	38.2	0.17	0.39	0.56	0.70	0.85	6.5	14.9	21.4	26.7	32.5
3-2 Qda. Chané: Upstream of Route 9	1.00	22.0	0.68	0.86	0.96	1.05	1.16	15.0	18.9	21.1	22.0	22.0
3-3 Qda. Toro: Jct. Qda. Chané - Route 9	15.50	50.1	0.67	0.83	0.96	1.09	1.24	33.6	41.6	48.1	50.1	50.1
3-4 Qda. Toro: Upstream of Route 9	1.00	18.0	0.05	0.17	0.26	0.39	0.56	0.9	3.1	4.7	7.0	10.1
3-5 Qda. Maras: Jct. Qda. Toro - Route 9	6.80	23.9	0.04	0.08	0.15	0.17	0.22	1.0	1.9	3.6	4.1	5.3
3-6 Qda. Maras: Upsream of Route 9	1.00	7.3	0.00	0.10	0.24	0.33	0.45	0.0	0.7	1.7	2.4	3.3
4. CHANE - CHACRAS	63.00	318.9	0.73	0.93	1.07	1.18	1.32	233.1	296.8	318.9	318.9	318.9
4-1 Qda. Chacras: Jct. Rio Chané - Route 9	36.00	160.2	0.73	0.93	1.07	1.18	1.32	117.0	149.0	160.2	160.2	160.2
4-2 Qda. Chacras: Upstream of Route 9	1.00	4.0	0.80	1.05	1.19	1.33	1.49	3.2	4.0	4.0	4.0	4.0
4-3 Chané Drainage	26.00	154.7	0.73	0.93	1.07	1.18	1.32	112.9	143.9	154.7	154.7	154.7
5. OKINAWA DRAINAGE	26.00	177.9	0.55	0.73	0.85	0.93	1.07	97.1	127.5	146.1	160.2	177.6
5-1 Downstream of Route 9	25.00	145.9	0.53	0.71	0.82	0.90	1.04	77.3	103.6	119.6	131.3	145.9
5-2 Upstream of Route 9	1.00	32.0	0.97	1.30	1.50	1.68	1.90	19.8	23.9	26.5	28.8	31.7

TABLE A.8.2 INUNDATION AREA AND DEPTH OF CHANE - PAILON
WITH FLOOD MITIGATION AND DRAINAGE IMPROVEMENT (ALTERNATIVE I)

	Target Area	Distance (km)	Potential Inundation Area (km2)	Inundation Depth (m) Return Period (Year)					Inundation Area (km2) Return Period (Year)				
				2	5	10	20	50	2	5	10	20	50
A.	**DOWNSTREAM OF ROUTE 9**	**185.80**	**845.1**	**0.17**	**0.33**	**0.51**	**0.67**	**0.83**	**106.6**	**196.8**	**325.5**	**443.7**	**554.4**
B.	**UPSTREAM OF ROUTE 9**	**24.40**	**179.1**	**0.06**	**0.23**	**0.32**	**0.41**	**0.52**	**26.5**	**53.4**	**67.4**	**82.5**	**100.8**
1.	RIO CHANE	35.00	107.4	0.78	1.21	1.45	1.67	1.93	84.5	103.4	107.4	107.4	107.4
1-1	Jct. Río Piray - Jct. Qda. Chacras	12.50	63.4	1.33	1.76	1.91	2.16	2.50	63.4	63.4	63.4	63.4	63.4
1-2	Jct. Qda. Chacras - Jct. Qda. Chané	22.50	44.0	0.48	0.91	1.19	1.40	1.61	21.1	40.0	44.0	44.0	44.0
2.	RIO PAILON	42.90	260.5	0.04	0.14	0.27	0.42	0.59	11.6	36.9	72.2	115.1	162.5
2-1	Jct. Río Chané - Route 9	23.50	164.7	0.05	0.09	0.26	0.47	0.70	8.2	14.8	42.8	77.4	115.3
2-2	Route 9 - Jct. A. Sauces	8.00	50.8	0.04	0.31	0.41	0.52	0.62	2.0	15.7	20.8	26.4	31.5
2-3	Jct. A. Sauces - Okinawa II	11.40	45.0	0.03	0.14	0.19	0.25	0.35	1.4	6.3	8.6	11.3	15.8
3.	QDA. CHANE	43.30	159.5	0.06	0.14	0.26	0.35	0.44	14.4	28.2	46.6	59.5	75.9
3-1	Qda. Chané: Jct. Río Chané - Route 9	18.00	38.2	0.00	0.05	0.14	0.23	0.31	0.0	1.9	5.3	8.8	11.8
3-2	Qda. Chané: Upstream of Route 9	1.00	22.0	0.19	0.38	0.43	0.49	0.58	4.2	8.4	9.5	10.8	12.8
3-3	Qda. Toro: Jct. Qda. Chané - Route 9	15.50	50.1	0.16	0.29	0.46	0.56	0.70	8.0	14.5	23.1	28.1	35.1
3-4	Qda. Toro: Upstream of Route 9	1.00	18.0	0.12	0.15	0.23	0.32	0.46	2.2	2.7	4.1	5.8	8.3
3-5	Qda. Maras: Jct. Qda. Toro - Route 9	6.80	23.9	0.00	0.01	0.13	0.16	0.20	0.0	0.2	3.1	3.8	4.8
3-6	Qda. Maras: Upsream of Route 9	1.00	7.3	0.00	0.06	0.21	0.32	0.43	0.0	0.4	1.5	2.3	3.1
4.	CHANE - CHACRAS	63.00	318.9	0.00	0.09	0.29	0.48	0.63	0.0	28.7	92.5	153.1	200.9
4-1	Qda. Chacras: Jct. Río Chané - Route 9	36.00	160.2	0.00	0.09	0.29	0.48	0.63	0.0	14.4	46.5	76.9	100.9
4-2	Qda. Chacras: Upstream of Route 9	1.00	4.0	0.00	0.09	0.29	0.48	0.63	0.0	0.4	1.2	1.9	2.5
4-3	Chané Drainage	26.00	154.7	0.00	0.09	0.29	0.48	0.63	0.0	13.9	44.9	74.2	97.4
5.	OKINAWA DRAINAGE	26.00	177.9	0.06	0.26	0.39	0.49	0.60	22.6	53.1	74.2	91.1	108.6
5-1	Downstream of Route 9	25.00	145.9	0.04	0.23	0.36	0.46	0.56	5.8	33.6	52.5	67.1	81.7
5-2	Upstream of Route 9	1.00	32.0	0.60	0.94	1.13	1.31	1.53	16.8	19.5	21.7	24.0	26.9

TABLE A.8.3 INUNDATION AREA AND DEPTH OF CHANE - PAILON
WITH FLOOD MITIGATION AND DRAINAGE IMPROVEMENT (ALTERNATIVE II)

Target Area	Distance (km)	Potential Inundation Area (km2)	Inundation Depth (m) Return Period (Year)					Inundation Area (km2) Return Period (Year)				
			2	5	10	20	50	2	5	10	20	50
A. DOWNSTREAM OF ROUTE 9	**185.80**	**845.1**	**0.31**	**0.46**	**0.64**	**0.80**	**0.96**	**106.6**	**196.8**	**325.5**	**443.7**	**554.4**
B. UPSTREAM OF ROUTE 9	**24.40**	**179.1**	**0.06**	**0.23**	**0.32**	**0.41**	**0.52**	**26.5**	**53.4**	**67.4**	**82.5**	**100.8**
1. RIO CHANE	35.00	107.4	1.49	1.93	2.14	2.33	2.59	84.5	103.4	107.4	107.4	107.4
1-1 Jct. Río Piray - Jct. Qda. Chacras	12.50	63.4	1.68	2.10	2.29	2.46	2.65	63.4	63.4	63.4	63.4	63.4
1-2 Jct. Qda. Chacras - Jct. Qda. Chané	22.50	44.0	1.38	1.83	2.06	2.26	2.56	21.1	40.0	44.0	44.0	44.0
2. RIO PAILON	42.90	260.5	0.04	0.14	0.27	0.42	0.59	11.6	36.9	72.2	115.1	162.5
2-1 Jct. Río Chané - Route 9	23.50	164.7	0.05	0.09	0.26	0.47	0.70	8.2	14.8	42.8	77.4	115.3
2-2 Route 9 - Jct. A. Sauces	8.00	50.8	0.04	0.31	0.41	0.52	0.62	2.0	15.7	20.8	26.4	31.5
2-3 Jct. A. Sauces - Okinawa II	11.40	45.0	0.03	0.14	0.19	0.25	0.35	1.4	6.3	8.6	11.3	15.8
3. QDA. CHANE	43.30	159.5	0.06	0.14	0.26	0.35	0.44	14.4	28.2	46.6	59.5	75.9
3-1 Qda. Chané: Jct. Río Chané - Route 9	18.00	38.2	0.00	0.05	0.14	0.23	0.31	0.0	1.9	5.3	8.8	11.8
3-2 Qda. Chané: Upstream of Route 9	1.00	22.0	0.19	0.38	0.43	0.49	0.58	4.2	8.4	9.5	10.8	12.8
3-3 Qda. Toro: Jct. Qda. Chané - Route 9	15.50	50.1	0.16	0.29	0.46	0.56	0.70	8.0	14.5	23.1	28.1	35.1
3-4 Qda. Toro: Upstream of Route 9	1.00	18.0	0.12	0.15	0.23	0.32	0.46	2.2	2.7	4.1	5.8	8.3
3-5 Qda. Maras: Jct. Qda. Toro - Route 9	6.80	23.9	0.00	0.01	0.13	0.16	0.20	0.0	0.2	3.1	3.8	4.8
3-6 Qda. Maras: Upsream of Route 9	1.00	7.3	0.00	0.06	0.21	0.32	0.43	0.0	0.4	1.5	2.3	3.1
4. CHANE - CHACRAS	63.00	318.9	0.00	0.09	0.29	0.48	0.63	0.0	28.7	92.5	153.1	200.9
4-1 Qda. Chacras: Jct. Río Chané - Route 9	36.00	160.2	0.00	0.09	0.29	0.48	0.63	0.0	14.4	46.5	76.9	100.9
4-2 Qda. Chacras: Upstream of Route 9	1.00	4.0	0.00	0.09	0.29	0.48	0.63	0.0	0.4	1.2	1.9	2.5
4-3 Chané Drainage	26.00	154.7	0.00	0.09	0.29	0.48	0.63	0.0	13.9	44.9	74.2	97.4
5. OKINAWA DRAINAGE	26.00	177.9	0.06	0.26	0.39	0.49	0.60	22.6	53.1	74.2	91.1	108.6
5-1 Downstream of Route 9	25.00	145.9	0.04	0.23	0.36	0.46	0.56	5.8	33.6	52.5	67.1	81.7
5-2 Upstream of Route 9	1.00	32.0	0.60	0.94	1.13	1.31	1.53	16.8	19.5	21.7	24.0	26.9

TABLE A.8.4 INUNDATION AREA AND DEPTH OF SAN JUAN - ANTOFAGASTA WITHOUT FLOOD MITIGATION AND DRAINAGE IMPROVEMENT

Target Area	Distance (km)	Potential Inundation Area (km2)	Inundation Depth (m) Return Period (Year)					Inundation Area (km2) Return Period (Year)				
			2	5	10	20	50	2	5	10	20	50
A. WHOLE AREA	**111.40**	**663.1**	**0.29**	**0.42**	**0.48**	**0.53**	**0.59**	**315.8**	**419.5**	**464.2**	**495.0**	**533.4**
1. SAN JUAN	63.20	355.1	0.48	0.69	0.79	0.88	0.97	187.8	259.4	283.4	297.6	315.8
1-1 Arroyo Yapacanicito: Downstream	32.40	165.0	0.77	0.97	1.07	1.16	1.25	127.1	160.1	165.0	165.0	165.0
1-2 Arroyo Yapacanicito: Mid-stream	21.30	96.0	0.24	0.47	0.59	0.68	0.78	23.0	45.1	56.6	65.3	74.9
1-3 San Juan Drainage Main: km 24 - km 28		15.5	0.49	0.50	0.50	0.50	0.54	7.6	7.8	7.8	7.8	8.4
1-4 San Juan Drainage Main: km 17 - km 9		35.0	0.32	0.59	0.69	0.75	0.83	11.2	20.7	24.2	26.3	29.1
1-5 Arroyo Tejeria: Downstream of Road Main	7.50	14.0	0.06	0.26	0.40	0.54	0.68	0.8	3.6	5.6	7.6	9.5
1-6 Arroyo Tejeria: Upstream of Road Main	2.00	29.6	0.61	0.75	0.82	0.87	0.98	18.1	22.2	24.3	25.8	29.0
2. ANTOFAGASTA	48.20	308.0	0.37	0.50	0.59	0.66	0.74	128.0	160.1	180.8	197.4	217.6
2-1 Arroyo Jochi: Mid-stream	7.00	76.0	0.16	0.26	0.32	0.37	0.41	12.2	19.8	24.3	28.1	31.2
2-2 Arroyo Joch: Upstream	18.60	24.0	0.31	0.47	0.60	0.70	0.81	7.4	11.3	14.4	16.8	19.4
2-3 Arroyo Tacuaral: Mid-stream	6.20	159.0	0.54	0.63	0.69	0.74	0.81	85.9	100.2	109.7	117.7	128.8
2-4 Arroyo Tacuaral: Upstream	16.40	49.0	0.46	0.59	0.66	0.71	0.78	22.5	28.9	32.3	34.8	38.2

TABLE A.8.5 INUNDATION AREA AND DEPTH OF SAN JUAN - ANTOFAGASTA WITH FLOOD MITIGATION AND DRAINAGE IMPROVEMENT (ALTERNATIVE I)

Target Area	Distance (km)	Potential Inundation Area (km2)	Inundation Depth (m) Return Period (Year)					Inundation Area (km2) Return Period (Year)				
			2	5	10	20	50	2	5	10	20	50
A. WHOLE AREA	**111.40**	**663.1**	**0.21**	**0.30**	**0.37**	**0.43**	**0.51**	**160.2**	**223.7**	**253.9**	**285.8**	**326.4**
1. SAN JUAN	63.20	355.1	0.35	0.49	0.60	0.71	0.83	133.7	182.4	202.0	223.6	250.3
1-1 Arroyo Yapacanicito: Downstream	32.40	165.0	0.81	1.01	1.13	1.22	1.32	133.7	165.0	165.0	165.0	165.0
1-2 Arroyo Yapacanicito: Mid-stream	21.30	96.0	0.00	0.04	0.11	0.21	0.32	0.0	3.8	10.6	20.2	30.7
1-3 San Juan Drainage Main: km 24 - km 28		15.5	0.00	0.13	0.21	0.28	0.41	0.0	2.0	3.3	4.4	6.4
1-4 San Juan Drainage Main: km 17 - km 9		35.0	0.00	0.23	0.38	0.51	0.70	0.0	8.1	13.3	17.9	24.5
1-5 Arroyo Tejeria: Downstream of Road Main	7.50	14.0	0.00	0.10	0.26	0.45	0.63	0.0	1.4	3.7	6.3	8.9
1-6 Arroyo Tejeria: Upstream of Road Main	2.00	29.6	0.00	0.07	0.21	0.33	0.50	0.0	2.1	6.2	9.9	14.9
2. ANTOFAGASTA	48.20	308.0	0.25	0.37	0.45	0.51	0.59	26.6	41.3	51.9	62.2	76.1
2-1 Arroyo Jochi: Mid-stream	7.00	76.0	0.00	0.06	0.12	0.17	0.21	0.0	4.6	9.1	12.9	16.0
2-2 Arroyo Joch: Upstream	18.60	24.0	0.31	0.47	0.60	0.70	0.81	7.4	11.3	14.4	16.8	19.4
2-3 Arroyo Tacuaral: Mid-stream	6.20	159.0	0.00	0.00	0.00	0.01	0.04	0.0	0.0	0.0	1.6	6.4
2-4 Arroyo Tacuaral: Upstream	16.40	49.0	0.39	0.52	0.58	0.63	0.70	19.1	25.5	28.4	30.9	34.3

TABLE A.8.6 INUNDATION AREA AND DEPTH OF SAN JUAN - ANTOFAGASTA
WITH FLOOD MITIGATION AND DRAINAGE IMPROVEMENT (ALTERNATIVE II)

Target Area	Distance (km)	Potential Inundation Area (km2)	Inundation Depth (m) Return Period (Year)					Inundation Area (km2) Return Period (Year)				
			2	5	10	20	50	2	5	10	20	50
A. WHOLE AREA	**111.40**	**663.1**	**0.22**	**0.31**	**0.38**	**0.44**	**0.50**	**161.9**	**228.1**	**258.2**	**286.9**	**322.5**
1. SAN JUAN	63.20	355.1	0.35	0.51	0.62	0.72	0.82	135.3	186.8	206.2	224.7	246.5
1-1 Arroyo Yapacanicito: Downstream	32.40	165.0	0.82	1.03	1.15	1.24	1.33	135.3	165.0	165.0	165.0	165.0
1-2 Arroyo Yapacanicito: Mid-stream	21.30	96.0	0.00	0.11	0.19	0.26	0.34	0.0	10.6	18.2	25.0	32.6
1-3 San Juan Drainage Main: km 24 - km 28		15.5	0.00	0.13	0.21	0.28	0.36	0.0	2.0	3.2	4.3	5.6
1-4 San Juan Drainage Main: km 17 - km 9		35.0	0.00	0.16	0.28	0.41	0.56	0.0	5.8	9.9	14.3	19.4
1-5 Arroyo Tejeria: Downstream of Road Main	7.50	14.0	0.00	0.10	0.26	0.45	0.63	0.0	1.4	3.7	6.3	8.9
1-6 Arroyo Tejeria: Upstream of Road Main	2.00	29.6	0.00	0.07	0.21	0.33	0.50	0.0	2.1	6.2	9.9	14.9
2. ANTOFAGASTA	48.20	308.0	0.25	0.37	0.45	0.51	0.59	26.6	41.3	51.9	62.2	76.1
2-1 Arroyo Jochi: Mid-stream	7.00	76.0	0.00	0.06	0.12	0.17	0.21	0.0	4.6	9.1	12.9	16.0
2-2 Arroyo Joch: Upstream	18.60	24.0	0.31	0.47	0.60	0.70	0.81	7.4	11.3	14.4	16.8	19.4
2-3 Arroyo Tacuaral: Mid-stream	6.20	159.0	0.00	0.00	0.00	0.01	0.04	0.0	0.0	0.0	1.6	6.4
2-4 Arroyo Tacuaral: Upstream	16.40	49.0	0.39	0.52	0.58	0.63	0.70	19.1	25.5	28.4	30.9	34.3

TABLE A.9.1 CONTINUOUS MINIMUM MONTHLY RAINFALL
STATION: 5806 SANTA CRUZ - TROMPILLO

(Unit : mm)

YEAR	Continuous Minimum Rainfall						Annual Rainfall
	1 Month	2 Month	3 Month	4 Month	5 Month	6 Month	
1943	17.5	40.5	67.0	144.8	195.1	272.9	1220
1944	6.2	80.5	87.6	177.3	211.3	262.5	907
1945	1.0	89.3	122.4	215.9	235.6	269.1	927
1946	13.8	94.7	208.4	358.0	426.7	516.0	1758
1947	43.9	172.7	331.5	396.9	592.4	653.9	1836
1948	7.5	23.8	82.8	231.6	446.7	504.9	1723
1949	0.0	0.7	27.6	96.7	260.0	414.8	1354
1950	3.0	16.6	64.8	169.1	293.8	364.7	1128
1951	0.4	75.3	145.7	168.0	231.5	306.4	1117
1952	1.7	9.4	140.3	237.5	260.4	327.4	1222
1953	0.0	12.7	34.5	70.3	197.1	370.5	1208
1954	18.0	62.8	133.1	214.9	239.9	270.9	1184
1955	0.0	23.0	79.3	228.7	324.6	394.8	1538
1956	2.1	35.2	82.9	132.4	160.0	261.6	1161
1957	23.0	123.9	184.9	304.8	440.8	510.3	1492
1958	12.2	33.9	130.6	215.0	315.4	369.7	1265
1959	9.4	42.4	117.6	170.6	202.0	283.8	1154
1960	22.2	58.6	97.2	153.8	220.6	304.5	933
1961	7.2	25.7	52.5	77.6	142.9	214.1	1233
1962	13.6	29.3	45.1	93.1	132.2	220.3	820
1963	5.4	32.2	86.5	148.8	216.8	254.6	849
1964	3.6	43.7	64.6	102.9	169.7	243.3	1180
1965	2.0	83.9	136.6	202.3	235.8	307.4	1096
1966	1.5	4.7	41.2	147.4	251.1	262.8	1044
1967	11.0	47.7	91.5	181.6	315.6	438.8	1235
1968	2.0	30.1	41.2	79.5	87.4	140.2	918
1969	5.0	6.0	70.2	170.4	270.9	383.7	1106
1970	6.0	15.4	62.9	89.1	149.9	189.7	711
1971	13.6	52.0	101.3	134.7	190.1	222.4	848
1972	8.0	102.8	202.7	248.8	353.2	431.8	1073
1973	0.2	30.1	56.8	78.0	148.2	161.2	844
1974	0.3	40.8	149.8	213.5	227.4	354.4	1343
1975	15.4	93.0	160.4	264.0	413.2	559.6	1317
1976	1.1	16.0	48.9	123.1	142.0	237.6	1087
1977	9.6	48.4	148.1	230.1	409.8	518.5	1789
1978	2.2	40.2	83.2	154.3	279.1	332.2	1170
1979	0.0	37.1	75.9	157.1	177.1	267.3	1153
1980	38.1	99.9	183.9	284.0	333.2	442.5	1335
1981	4.4	34.6	122.7	262.4	507.9	577.1	2010
1982	37.1	103.7	202.4	397.6	642.3	696.8	2096
1983	10.5	35.1	179.1	257.2	431.3	659.6	1946
1984	33.1	84.7	138.9	172.0	242.8	334.3	1546
1985	31.0	99.3	181.8	301.5	412.3	453.4	1404
1986	47.9	220.9	306.8	469.5	582.9	694.6	1617
1987	19.1	66.5	186.5	355.3	561.1	718.8	1934
1988	8.8	29.7	39.3	70.9	118.9	193.9	1055
1989	12.5	39.7	125.9	194.7	353.3	432.5	1530
1990	40.6	140.8	250.5	291.1	406.4	605.4	1347
1991	5.7	49.9	123.4	215.9	327.5	435.9	1580
1992	47.1	147.3	279.9	463.7	697.7	734.4	2249
1993	13.5	82.1	140.0	227.9	258.0	342.8	1177
1994	3.4	22.6	34.4	63.5	93.4	152.3	891
AVER.	12.4	58.3	122.2	204.0	298.8	382.2	1301

TABLE A.9.2 CONTINUOUS MINIMUM MONTHLY RAINFALL
STATION: 61NP SAAVEDRA

(Unit : mm)

YEAR	Continuous Minimum Rainfall						Annual Rainfall
	1 Month	2 Month	3 Month	4 Month	5 Month	6 Month	
1943							
1944							
1945							
1946							
1947							
1948							
1949							
1950							
1951							
1952	0.0	0.0	93.4	174.8	192.4	250.6	1350
1953	2.5	7.5	45.3	85.8	197.3	318.9	1257
1954	0.0	2.5	80.9	131.5	189.6	273.2	982
1955	0.0	5.0	68.4	108.8	174.5	260.6	1474
1956	20.2	146.8	222.7	298.5	488.5	546.7	1656
1957	48.1	144.5	238.1	311.6	473.6	605.1	1461
1958	0.0	35.4	98.6	151.4	303.5	351.3	1596
1959	0.0	30.3	101.1	192.2	204.8	303.6	1154
1960	12.6	45.4	106.0	169.4	232.7	303.6	959
1961	0.0	20.2	73.2	133.9	187.0	262.9	1240
1962	5.0	20.1	50.4	73.1	121.0	186.8	1006
1963	7.6	15.2	55.8	88.8	129.4	170.0	1036
1964	5.0	20.2	55.8	93.9	159.9	241.2	1299
1965	2.5	38.1	177.8	182.8	269.2	375.9	1394
1966	0.0	0.0	68.6	155.0	162.6	259.1	1115
1967	10.2	38.1	83.8	121.9	218.4	330.2	1133
1968	2.5	43.1	58.3	101.5	134.5	225.9	1072
1969	0.0	20.3	38.1	82.6	151.2	227.4	817
1970	2.5	10.1	17.7	91.4	139.6	172.6	622
1971	5.0	10.0	43.0	88.7	170.0	215.7	664
1972	17.8	55.9	134.6	172.7	271.8	319.3	1322
1973	5.0	25.1	72.7	78.4	150.4	187.3	1225
1974	6.0	79.0	139.0	191.2	268.7	322.2	1316
1975	6.2	69.2	139.1	188.6	293.4	358.8	1088
1976	0.0	10.6	39.8	153.1	182.3	279.1	1213
1977	6.8	26.5	42.1	116.7	194.6	246.6	1333
1978	3.2	12.0	81.9	163.7	210.0	279.9	1333
1979	0.0	13.7	33.9	48.8	142.3	192.4	1386
1980	8.1	25.8	56.7	171.5	244.7	408.4	1661
1981	9.0	34.3	130.3	270.5	432.0	621.2	2063
1982	9.8	74.5	152.7	306.7	405.8	701.3	1908
1983	19.1	60.5	129.6	171.0	263.5	475.7	1731
1984	19.2	46.5	84.3	137.2	167.3	237.3	1564
1985	1.0	113.8	189.6	322.2	443.6	573.9	1408
1986	5.4	76.4	237.3	330.7	432.0	511.6	1459
1987	22.3	120.3	261.2	359.2	532.6	651.4	1986
1988	1.7	5.5	16.6	35.1	60.1	168.7	1021
1989	16.3	76.8	155.2	215.7	400.6	505.7	1636
1990	43.0	95.3	138.7	206.3	383.3	607.4	1636
1991	0.5	23.7	64.7	137.2	236.2	308.7	1559
1992	24.7	86.9	210.9	401.9	517.6	655.2	2708
1993	8.0	48.2	59.4	122.2	149.5	189.6	1130
1994	5.2	64.2	147.0	228.5	287.5	491.2	1410
AVER.	8.4	44.1	104.5	171.3	255.1	352.9	1358

TABLE A.9.3 CONTINUOUS MINIMUM MONTHLY RAINFALL
STATION: OKINAWA II

(Unit : mm)

YEAR	Continuous Minimum Rainfall						Annual
	1 Month	2 Month	3 Month	4 Month	5 Month	6 Month	Rainfall
1943							
1944							
1945							
1946							
1947							
1948							
1949							
1950							
1951							
1952							
1953							
1954							
1955							
1956							
1957							
1958							
1959							
1960							
1961							
1962							
1963							
1964							
1965							
1966							
1967							
1968							
1969	0.0	45.7	117.2	185.9	283.6	352.3	1071
1970	0.0	0.0	0.0	5.0	20.0	42.0	584
1971	10.0	38.0	73.0	124.0	188.0	226.0	674
1972	33.8	80.3	155.6	229.2	315.4	389.0	1295
1973	3.5	38.5	57.0	101.0	143.5	151.5	942
1974	4.0	52.0	82.7	137.2	192.0	228.5	1263
1975	0.0	84.5	156.5	257.0	389.0	498.5	1131
1976	0.0	4.2	62.1	108.2	166.1	252.4	1172
1977	2.5	38.5	74.0	112.7	148.2	190.4	1066
1978	1.4	18.4	104.5	207.1	228.5	270.6	1156
1979	0.0	23.6	26.6	82.7	170.1	226.2	1156
1980	17.0	46.0	63.2	160.6	222.6	354.8	1600
1981	14.0	47.4	126.4	226.0	369.5	556.5	2199
1982	12.3	88.3	162.1	359.4	464.8	539.6	1683
1983	0.0	34.2	90.3	140.5	214.3	288.9	1219
1984	4.0	22.8	54.2	79.2	110.2	146.0	1308
1985	10.8	53.6	181.4	262.8	357.5	515.1	1267
1986	1.2	66.2	202.7	267.5	324.3	454.1	1622
1987	10.0	114.4	229.4	318.8	406.4	495.6	1653
1988	0.0	3.2	13.3	35.6	58.9	114.4	708
1989	2.0	39.0	119.3	183.8	259.8	366.1	1231
1990	41.4	124.9	212.9	361.9	460.6	620.6	1710
1991	0.0	50.0	116.0	193.0	283.0	399.0	1268
1992	4.0	56.0	136.0	330.0	401.0	540.8	2259
1993	0.0	19.7	21.1	57.6	85.8	105.0	739
1994	0.0	71.5	137.0	170.5	253.0	403.0	1155
AVER.	6.6	48.5	106.7	180.7	250.6	335.7	1274

TABLE A.9.4 CONTINUOUS MINIMUM MONTHLY RAINFALL
STATION: COL. SAN JUAN DE YAPACANI

(Unit : mm)

YEAR	Continuous Minimum Rainfall						Annual Rainfall
	1 Month	2 Month	3 Month	4 Month	5 Month	6 Month	
1943							
1944							
1945							
1946							
1947							
1948							
1949							
1950							
1951							
1952							
1953							
1954							
1955							
1956							
1957							
1958							
1959							
1960	44.3	129.4	221.6	274.5	418.1	628.0	1819
1961	61.1	138.3	295.1	372.3	559.3	718.4	2833
1962	4.0	8.9	20.4	67.0	99.0	196.9	1181
1963	20.8	48.6	176.4	208.2	240.2	360.9	1917
1964	15.6	64.1	113.5	191.6	319.7	488.4	1893
1965	44.5	140.8	296.5	374.3	521.4	635.1	2146
1966	1.0	28.0	162.0	312.5	452.0	602.5	1964
1967	49.5	149.0	262.5	350.0	451.5	565.0	1869
1968	11.0	62.3	81.4	173.7	208.7	360.7	1750
1969	15.5	89.8	226.9	305.9	463.7	628.9	2043
1970	8.5	32.5	74.2	127.2	200.5	343.2	1403
1971	34.5	83.7	136.5	182.7	242.6	330.9	1396
1972	52.7	171.5	296.0	411.9	553.7	751.9	1929
1973	8.2	54.6	92.5	126.8	182.5	308.9	1653
1974	13.0	71.7	134.2	185.5	216.0	299.1	1747
1975	26.1	141.3	287.3	402.5	525.9	657.4	1718
1976	13.9	39.1	66.3	173.9	203.1	364.8	1551
1977	32.4	99.1	212.6	313.5	417.6	531.1	2085
1978	20.6	87.4	190.8	321.9	407.6	511.0	1998
1979	1.4	34.8	71.7	203.1	268.4	355.6	1495
1980	13.8	31.4	140.6	291.9	339.5	692.9	2561
1981	1.7	85.1	183.4	312.6	601.3	841.3	3264
1982	53.4	206.2	387.2	731.9	939.4	1120.4	3002
1983	21.5	49.0	166.3	348.0	465.3	666.9	2009
1984	22.1	83.8	210.6	329.7	412.5	539.3	1856
1985	12.8	91.6	114.1	227.2	364.7	511.5	1561
1986	48.0	134.4	215.8	308.5	385.2	538.2	1728
1987	6.6	44.3	153.3	357.4	624.3	735.8	2100
1988	0.0	18.8	23.1	46.2	71.5	209.4	1016
1989	12.8	72.8	96.2	249.8	319.4	356.3	1565
1990	39.2	100.8	180.7	261.4	507.0	683.9	1996
1991	54.9	117.9	190.5	263.9	400.7	514.6	1759
1992	48.0	167.4	347.1	436.2	582.5	762.2	3163
1993	5.1	43.4	72.7	87.5	142.5	195.4	1084
1994	2.6	28.8	90.6	184.2	219.8	281.6	1359
AVER.	23.5	84.3	171.2	271.9	380.8	522.5	1898

TABLE A.9.5 SUMMARY OF PROBABLE MONTHLY DROUGHT RAINFALL BY LOG-NORMAL DISTRIBUTION

(Unit : mm)

Return Period	Probable Monthly Rainfall for Drought						Annual
(Year)	1 Month	2 Month	3 Month	4 Month	5 Month	6 Month	Rainfall
1. 5806 SANTA CRUZ TROMPILLO							
200	0.1	2.7	21.2	48.2	75.0	117.1	623.9
100	0.1	3.5	24.7	54.8	84.8	130.2	667.6
50	0.1	4.7	29.3	63.2	97.3	146.7	720.3
20	0.3	7.3	37.7	78.1	119.0	174.6	805.1
10	0.5	10.7	47.0	93.9	142.1	203.5	887.6
5	1.1	17.0	61.5	117.7	176.4	245.4	1000.1
2	5.1	41.1	103.0	181.1	266.7	350.8	1256.0
2. 61NP SAAVEDRA							
200	0.0	0.3	15.1	37.3	65.4	104.5	629.6
100	0.0	0.4	17.9	42.7	73.9	116.5	675.9
50	0.0	0.7	21.6	49.6	84.7	131.7	731.7
20	0.1	1.4	28.4	62.0	103.3	157.5	822.0
10	0.2	2.6	36.2	75.3	123.0	184.3	910.4
5	0.4	5.6	48.8	95.5	152.4	223.3	1031.5
2	2.6	24.1	85.9	150.3	229.1	322.1	1309.2
3. OKINAWA II							
200	0.0	0.3	0.4	10.4	29.0	49.7	499.5
100	0.0	0.5	0.7	13.4	35.1	59.0	544.3
50	0.0	0.8	1.2	17.9	43.5	71.3	599.2
20	0.0	1.7	2.8	27.0	59.7	94.2	689.7
10	0.1	3.2	5.6	38.9	78.7	120.3	780.3
5	0.2	7.0	13.4	60.8	110.3	162.2	907.5
2	1.3	31.1	70.3	142.2	210.4	287.1	1210.6
4. COL. SAN JUAN DE YAPACANI							
200	0.3	10.7	23.0	54.2	78.1	154.3	900.4
100	0.4	12.9	27.5	62.6	90.0	172.3	964.6
50	0.6	15.7	33.5	73.5	105.4	194.9	1041.9
20	1.1	21.1	44.8	93.1	132.9	233.5	1166.4
10	1.9	27.4	57.9	114.6	162.9	273.6	1288.0
5	3.8	37.6	79.0	147.8	208.9	332.1	1453.9
2	13.4	68.9	143.2	239.9	335.7	480.8	1832.3

TABLE A.9.6 RETURN PERIOD OF DROUGHT RAINFALL (1984 - 1994, JAN - SEP. 1995)

	Return Period of Drought Rainfall (Year)						
	1 Month	2 Month	3 Month	4 Month	5 Month	6 Month	Annual
1) SC-Trompillo							
1988	< 2	3.4	18.3	34.4	20.0	13.3	4.4
1993	< 2	< 2	< 2	< 2	2.3	2.2	2.9
1994	3.3	4.3	31.8	49.4	65.6	43.9	9.4
1995	< 2	4.4	5.1	18.9			
2) Saavedra							
1988	3.2	5.0	146.4	>200	>200	15.8	5.4
1993	< 2	< 2	4.1	3.5	5.5	9.3	3.9
1994	< 2	< 2	< 2	< 2	< 2	< 2	< 2
1995	10.0	3.6	139.3	31.9			
3) Okinawa II							
1988	>20	10.0	5.0	12.8	21.5	12.2	18.0
1993	>20	3.4	4.6	5.7	8.9	15.9	14.6
1994	>20	< 2	< 2	< 2	< 2	< 2	2.6
1995	>20	4.3	4.1	16.5			
4) Col. San Juan de Yapacani							
1988	>200	32.8	200.0	>200	>200	38.7	66.8
1993	4.6	4.4	6.5	28.6	16.8	49.6	39.9
1994	8.2	9.3	4.5	3.8	4.7	9.3	7.9
1995	7.3	37.3	93.7	145.6			