ANNEX 1

HYDROLOGICAL STUDIES

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1. INTRODUCTION

For the detailed design study on the Water Transbasin Schemes for Chone-Portoviejo River Basins, the hydro-meteorological study in the Feasibility Study is reviewed and updated to confirm various parameters to be used in the design.

Considering the objectives of the project, this hydrological analysis report includes a streamflow generation in various points in the project area (Chone and Portoviejo River Basins) for a period of 29 years from 1964 to 1992.

Also, this report includes a regional rainfall analysis to compute Flood Frequency at important points related to the structures of the project. In addition, a study of reservoir sedimentation in the three reservoirs involved in the project is included to get future sediment levels at locations of the Inlet and Outlet structures of the transbasin works.

An analysis of reliability and consistency of the basic information was first executed to correct any non representative data.

In the streamflow generation study has been used a deterministic simulation model which was developed in CIDIAT in 1986. This model was fitted to define parameters involved in the Hydrologic Cycle, utilizing the observed streamflow data at streamflow gaging stations and the rainfall data related to the observed streamflows. Only reliable data were used for the calibration of the model after an analysis of reliability of the information. This means that all the existing streamflow data for all the registered period are not used for the calibration. The gaging stations used for the model fitting were the following: the Carrizal river at Calceta, the Chico river at Alajuela, and the Grande river at A.J. Mosquito.

In order to fit and to generate monthly discharges, was used the evaporation of tank type A recorded at Portoviejo Climatological Station in view of the reliability of this information because the evaporation data registered in other stations are fragmentary, limited and inconsistent.

The flood discharges can be defined by using the Regional Rainfall Intensity according to the requirement of the project, and applying a Rainfall-Flood model in order to predict the basin response.

2. REVIEW OF THE FEASIBILITY STUDY

The feasibility study was reviewed, updated and supplemented in this phase of the detailed design study.

The rainfall stations to be considered during this phase are the same that were considered during the feasibility design, and now the series are expanded to have a period of 29 years from 1964 to 1992. Because some rainfall stations are incomplete, the same correlation equations definded during the feasibility study are used to complete the data.

The basic information on sediment load and yield considered during the feasibility study is used in the detailed study, but some additional considerations are made to predict reservoir sedimentation levels.

3. DATA COLLECTION AND REVIEW

Hydrological data are the only source of information upon which quantitative hydrological investigations are generally based. For this reason their measurement data are to be supplemented to be the continuous data.

However, sometimes it is necessary to apply methods to adjust the observed records which are not representative. In case of rainfall, this happens due to change in location, poor maintenance of the rain gage, etc.

The basic hydrometeorological information was collected from records of Manabi Rehabilitation Center (CRM).

3.1. Precipitation

In this study has been used the following 8 precipitation stations that cover all the study area.

STATION	REGISTERED PERIOD
Dos Bocas	1964 - 1992
Chone	1964 - 1992
Portoviejo	1964 - 1992

Rocafuerte	1964 - 1992
Calceta	1964 - 1985
Chamotete	1970 - 1992
Santa Ana	1964 - 1985
Boyacá	1965 - 1992

The common period chosen during this phase of the study was 1964 - 1992 (29 years), for that reason, it was necessary to have an homogeneity of the series. In order to do that, were used some correlations between precipitation stations obtained during the feasibility study. Also, the double mass curve was used not only for correcting any inconsistency of the records, but also to compute some information from the annual value. In this last case, the monthly values were evaluated by considering a percentage defined with multiannual means.

The precipitation data of the Chamotete station were defined between 1964 and 1969 by using the correlation equation with Dos Bocas station evaluated during the feasibility study. Also, by using the correlation equation with Dos Bocas station, the data of Santa Ana station were completed from 1986 to 1992.

On the other hand, the data of Calceta station (from 1986) and Boyaca (year 1964) were completed by using the double mass curve as explained before.

In order to analyze the consistency of the precipitation data, it was necessary to apply for each station the Double Mass Curve Method by considering the accumulated annual precipitation of 4 stations. The curves are presented in Figures 3.1.1 to 3.1.6. As can be observed in Tables 3.1.1 to 3.1.8 and from the mentioned Figures, it was necessary to correct some years in order to avoid non-representatives factors.

Finally, in order to complete a non-registered month at any station, was used the Normal Proportion Method which uses the series of the stations located on the neighborhood.

3.2. Evaporation

The Manabi Province has some stations with record of evaporation, but most of them use the Piche Atmometer. In reality, there are a few stations that have Evaporation Pan Class A. The information is generally limited and fragmentary. The exception is the Portoviejo station that has a good information.

In this context, the Portoviejo station was used as representative of the basins. The series can be seen in Table 3.2.1.

3.3. Streamflow

The streamflow observation in Manabi Province was started in 1963 at various important stations for the Water Resources Planning and Development. In spite of that, the recorded information is incomplete, fragmentary and unreliable.

More or less reliable streamflow recording stations with a continuous record are selected to fit the monthly hydrological model in such a way that covers the project area as much as possible.

The selected stations are as follows:

1. Carrizal river at Calceta
2. Chico river at Alajuela
3. Grande river at A.J. Mosquito

In Tables 3.3.1 to 3.3.3 are presented the streamflow series used during the model fitting.

4. RAINFALL

4.1. Regional Rainfall Analysis

4.1.1 Introduction

Most of the hydrologic processes are very complex that they must be interpreted and explained in a probabilistic sense. Hydrologic process is a result of natural events and involves many uncertainties and responds with random or stochastic component that can be investigated in records of hydrologic observations.

On the other hand, the historical data can be observed only once and then will not occur again. The measurement of basic information is a continuous activity since hydrologic data are the only source of information, resulting in ever-increasing large amount of sample data. In our study, the registered data began about 30 year ago, and it is fragmentary and limited, basically, in respect to the streamflow record.

One of the important tasks we have in our study is to assess, based on past record on hydrologic events, future probabilities of occurrence, not only through a Point-Frequency Analysis, but also through Regional Analysis, considering a homogeneous region in terms of hydrologic characteristics.

In this study, have been applied the statistical and probabilistic concepts in order to predict future events in relation to the works involved in the project.

4.1.2 Intensity of rainfall-duration-frequency curves

In order to design structures for Water Resources Development, the time variation of the rainfall is normally required. This information is obtained through automatic rainfall gage stations which permit to know the intensity of rainfall. However, none of the selected 8 stations is equipped with an automatic rainfall gage. Only daily rainfall data are available by a manual measurement of rainfall depth.

It was, therefore, necessary to estimate Intensity of Rainfall for different durations and frequency by using some relations that had been verified around the world.

The rainfall stations selected are given in Figure 4.1.1, covering all the basins almost uniformly. Frequency curves are first prepared for each station based on 24 hour rainfall data to define hydrologic characteristics by applying the Gumbel's Extreme Distribution Type I, that has been used successfully in Ecuador. This first evaluation for the 8 selected stations indicates that the upper bound be represented by the stations Chamotete, Dos Bocas and Chone, and the lower bound be basically represented by the stations Rocafuerte and Portoviejo. On the other hand, Calceta station represents an intermediate zone between the lower and upper bounds.

The Point-Frequency Curves are given in Figure 4.1.2 at the stations of Chamotete, Calceta, Rocafuerte, and Portoviejo which clearly show the variation of rainfall characteristics from the mountain to the sea.

It is considered to be convenient to define three zones which have their own pattern of precipitation and a particular intensity of rainfall as shown in Figure 4.1.1. This proposed zoning is almost the same as the classification of the bio-climatic indexes defined by Manabi Rehabilitation Center (CRM), based on precipitation and potential evapotranspiration.

The next step is to evaluate the rainfall-duration-frequency curve of each zone by considering the stations of Chamotete, Calceta, and Rocafuerte for the zones 1, 2, and 3, respectively.

The problem at this point is how to assume an hourly rainfall intensity curve from daily rainfall data registered at the representative rainfall stations. There are several automatic rainfall gaging stations in the Guayas River Basin immediately to the east of the project basins, where hourly rainfall data are available as well as daily rainfall data. The hourly rainfall distribution of the daily rainfall is determined as shown in Figure 4.1.3 based on the rainfall distribution in the Guayas River Basin.

Finally, the hourly rainfall distribution is applied to the stations of Chamotete, Calceta and Rocafuerte, and Intensity of Rainfall-Duration-Frequency Curves for zone 1, 2, and 3 are prepared as shown in Figures 4.1.4 to 4.1.6, respectively.

4.1.3 Rainfall distribution

Precipitation varies geographically, temporally and seasonally and should be understood that both regional and temporal variations are important in hydrological studies.

The intensity of rainfall-duration-frequency curves, as a result of the regional analysis, were used to define the rainfall depth for a certain duration of the storm. The rainfall depth is affected by a coefficient of areal distribution(only for drainage areas greater than 25 km^2) of the point rainfall that has been defined through the analysis of many storms recorded simultaneously in stations in Manabi Province, which is given in Figure 4.1.7.

On the other hand, the temporal distribution of daily rainfall was done by considering the Figure 4.1.3, that was developed for the project through the analysis of recorded hourly rainfall depths in the Guayas River Basins.

A hyetograph for calculation of flood hydrograph can be established in the following manner based on the criteria of the U. S. Corps of Engineers.

When we have an odd number of hourly rainfall data, the biggest one is placed in the center of the time of a storm and the next biggest is placed in an alternate way beginning from the left side of the center. If the number of rainfall data is even, place the biggest one in the central left of the storm time and then place the next biggest in an alternate way, beginning from the right side of the biggest one.

4.2. Rainfall - Flood Model

4.2.1 Description of the model

(1) Introduction

For a flood frequency analysis in this study has used a rainfall-flood model named Hydro, which is basically the same as the Hydrograph Evaluation of the Hydrologic Model Package of the Agricultural Research Service of the U. S. Department of Agriculture.

The model is briefly explained herein and the details can be referred to Reference 4.1.

(2) Mathematical formulation

The first input is related to physical parameters of the basin such as the drainage area in km^2 (S), the total length of the river course from the uppermost point to the point of interest in Km (L), and the difference of level between the highest point of the river and a level of the point of interest in m (H).

(A) Components of a unit hydrograph

A hydrograph to be generated by a unit effective rainfall of 10 mm during unit time interval of 30 minutes can be defined by several components shown in Figure 4.2.1, and the equations to calculate each component of the unit hydrograph are as follows:

a. Rising limb including crest segment

$$0 \leq t < t_0$$

$$q = q_p \left(\frac{t}{t_p}\right)^{(n-1)} e^{(1-n)\left(\frac{t}{tp} - 1\right)}$$

b. Falling limb

$t_o \leq t < t_1$

$$q = q_o e^{(to-t)/k}$$

c. Recession curve

$t \geq t_1$

$$q = q_1 e^{(t_1-t)/3k}$$

Where:

t_p and q_p are the time and the discharge at the peak of the unit hydrograph, t_o and q_o are the time and the discharge at the beginning of the falling limb after the peak segment, and t_1 and q_1 are the time and the discharge at the beginning of the recession curve.

k and t_p included in the formula are evaluated as follows:

$$k = 5.951 \, S^{0.231} * \left(\frac{H}{L}\right)^{-0.777} * \left(\frac{L^2}{S}\right)^{0.124}$$

$$t_p = 1.442 * S^{0.442} * \left(\frac{H}{L}\right)^{-0.46} * \left(\frac{L^2}{S}\right)^{0.133}$$

The exponent n_1 and n_2, which determine the shape of the unit hydrograph, are calculated by the following equations.

$$n_2 = 1 + \frac{1}{\sqrt{n_1 - 1}}$$

$$n_1 = \frac{0.05}{\left(\frac{k}{tp}\right) \left(\ln \left(\frac{n2}{n2+0.05}\right) + 0.05\right)} + 1$$

Then,

$$t_o = n_2 * t_p = \left(1 + \frac{1}{\sqrt{n_1 - 1}}\right) t_p, \quad t_1 = t_o + 2k$$

In order to calculate the peak discharge, it is necessary to compute the coefficient B, as follows:

$$B = \frac{2.777}{S_2 + S_1 \frac{k}{t_p}(1+2e^{-2})}$$

Where:

S_2 is the area of the dimensionless unit hydrograph until t_o, and S_1 is the ordinate at t_o, when q_p is set to be 1.0.

Finally, discharges of the unit hydrograph at the three control points are calculated by the following formula.

$$q_p = B \frac{S}{t_p}$$ (S is the drainage area in km^2)

$$q_o = q_p * S_1$$

$$q_1 = q_o^{e-2}$$

(B) Effective Rainfall (SCS Method)

The Soil Conservation Service developed a method for computing abstractions from storm rainfall. The hypothesis of the SCS method is that the ratios of the two actual to the two potential quantities are equal as follows.

$$\frac{Fa}{S} = \frac{Pe}{P-Ia}$$

$$P = Pe + Ia + Fa$$

Where P : Total rainfall (cm)
Pe : Effective rainfall (cm)
Ia : Initial abstraction (cm)
Fa : Continuing abstraction (cm)
S : Potential maximum retention (cm)

Also, $Ia = 0.2\,S$ as an empirical relation. Then,

$$Pe = \frac{(P-0.2S)^2}{P + 0.8S}$$

The potential maximum retention can be calculated by the following formula, where CN is a dimensionless curve number varying from 0 to 100 depending on soil conditions, kind of vegetation and antecedent moisture condition.

$$S = 25.4\left(\frac{100}{CN} - 1\right)$$

It is to be noted that P, Pe and Fa are cumulative values from the start of a storm to a certain time after the storm starts. Then, a hyetograph of total rainfall given an input data can be converted to a hyetograph of effective rainfall as (Pe at t_i - Pe at t_{i-1}) after Ia is first taken into account.

(3) Total Hydrograph

A total hydrograph can be determined from the unit hydrographs based on the effective rainfall as calculated in (1) and (2).

5. HYDROLOGY

5.1. Long - Term Monthly Streamflow

Surface water hydrology deals with the transfer of water along the earth's surface and it is highly important to many applications related to water resources development such as municipal and industrial water supply, conservation, streamflow forecasting, water quality, reservoir design, irrigation, etc.

The relationship between precipitation and runoff is influenced by many factors on rainfall patterns and on basin characteristics, resulting in a complex phenomenon.

Because of these complexities, many approximate formulas have been developed to relate rainfall and runoff. The earliest of these were usually crude and empirical statement. In this study, however, has been used a model composed of sound rational equations based on physical principles.

5.2. Monthly Hydrological Model

(1) Introduction

In this study has been used a determinist model for hydrology simulation, where the Hydrologic Cycle is represented by a series of formulas which describe the system response to a certain input functions. The model was developed in 1986 in the INTERAMERICAN CENTER FOR THE WATER AND LAND DEVELOPMENT (CIDIAT) by Roberto A. Duque and Alex G. Barrios.

This section involves a brief description of the model and the details can be referred to Reference 5.1 of the CIDIAT documents.

This model has been applied to drainage areas with defined boundaries where a balance of the inflows and outflows are considered, resulting in a continuous system governed by the principle of mass conservation.

Because of the used time interval is a month, only the slow processes such as evapotranspiration, infiltration, percolation, surface runoff and base flow are considered.

(2) Mathematical Formulation

Various factors duly taken into account in the streamflow simulation model are explained hereunder.

(A) Precipitation

Because the precipitation is a point registered data, it is required to do some approximations in order to determine its areal distribution and its mean value for each drainage area.

The formula used to determine the adjusted mean precipitation for each area are as follows:

$$PRE_{i,l} = \left(\sum_{j=1}^{NEPRE} PP_{i,j} \times PORCP_{j,l} \right) \times FACPRE_l \qquad (1)$$

$$FACPRE_l = \frac{PMI_l}{PMT_l} \qquad (2)$$

Where;

$PRE_{i,l}$:	Adjustment mean precipitation, month **i** and sub-basin **l**
$PP_{i,j}$:	Point precipitation during month **i** in station **j**
$PORCP_{j,l}$:	Percentage of area of the sub-basin **l** covered by the rainfall station **j**
NEPRE:	Number of considered rainfall stations
$FACPRE_l$:	Adjustment factor for the mean precipitation in sub-basin **l**
PMI_l:	Mean precipitation estimated by the Isohyetal method
PMT_l:	Mean precipitation estimated by the Thiessen method

(B) Evapotranspiration

This model considers that the evaporation demand can only be supplied by the soil moisture storage. The same as precipitation, it is necessary to evaluate the adjusted mean evaporation for each area, as follows:

$$EVM_{i,l} = \left(\sum_{j=1}^{NEVAP} EV_{i,j} \times PORCE_{j,l} \right) \times FACEVA_l \qquad (3)$$

$$FACEVA_l = \frac{EMI_l}{EMT_l} \qquad (4)$$

Where;

$EVM_{i,l}$:	Adjustment mean evaporation, month **i** and sub-basin **l**

$EV_{i,j}$:	Point evaporation during month **i** in station **j**
$PORCE_{j,1}$:	Percentage of area of the sub-basin **1** covered by the evaporation station **j**
NEVAP:	Number of considered evaporation stations
$FACEVA_1$:	Adjustment factor for the mean evaporation in sub-basin **1**
EMI_1:	Mean evaporation estimated by the Isohyetal method
EMT_1:	Mean evaporation estimated by the Thiessen method

In order to evaluate the monthly real evapotranspiration, a limit of soil moisture is considered which means that below this value the real evapotranspiration is less than the potential one. The mathematical formula are as follows:

$$ETR_{i,1} = \begin{cases} ETP , & \text{if } HSM \geq CLE \quad (5a) \\ ETP \times (HSM/CLE) , & \text{if } HSM < CLE \quad (5b) \end{cases}$$

$$ETP = EVM_{i,1} \times CT_1 \quad (6)$$

$$CLE = 0.25 \times HSN_1 \quad (7)$$

Where;

$ETR_{i,1}$:	Real evapotranspiration during month **i** and sub-basin **1**
ETP:	Potential evapotranspiration
HSM:	Mean soil moisture during the month
CLE:	Limit of moisture amount
$EVM_{i,1}$:	Mean evaporation during month **i** and sub-basin **1**
CT_1:	Factor in order to convert the mean evaporation to potential evapotranspiration.
HSN_1:	Soil moisture storage for the sub-basin **1**

(C) Infiltration

The flow of the water through the soil surface is called infiltration. Generally, infiltration has a high initial rate which gradually reduces during continued rainfall toward a nearly constant lower rate.

On the other hand, when the moisture supply on the soil surface exceeds the infiltration velocity, the maximum infiltration is attained for the existing conditions and is called as the potential infiltration, which is evaluated as follows:

$$AINFP = CINF_1 \times [\frac{HSN_1}{HSM}]^{2.0} \qquad (8)$$

Where;

AINFP:	Potential infiltration
$CINF_1$:	Infiltration capacity for the sub-basin 1
HSN_1:	Soil moisture storage for the sub-basin 1
HSM:	Mean soil moisture during the month

In order to evaluate the real infiltration, the following two cases are considered, depending upon the value of moisture supply.

$$AINFRE = \begin{cases} 0.5 \times AINFP & , \text{ if } HDI \geq AINFP \qquad (9a) \\ HDI \dfrac{(HDI)^{0.2}}{2.0 \times AINFP} & , \text{ if } HDI < AINFP \qquad (9b) \end{cases}$$

$$HDI = PRE_{i,1} + ASUPI \qquad (10)$$

$$ASUPI = ESCURT^{(i-1)} + ESCUTA \qquad (11)$$

Where;

AINFRE	:	Real infiltration during the month
HDI	:	Available moisture for infiltration
ASUPI	:	Initial moisture on surface storage
$ESCURT^{(i-1)}$	:	Retarded runoff
ESCUTA	:	Total runoff

(D) Percolation

Percolation is a fraction of the infiltration that goes to the groundwater storage and is dependent on the relation of the groundwater storage.

The following two cases of groundwater storage are considered to evaluate this fraction of the infiltration.

$$PERC = FPER \times AINFRE \qquad (12)$$

$$REL = HSM/HSN_1 \qquad (13)$$

$$\mathrm{POT} = 10.0 \times [\mathrm{REL} - 0.75] + 1.0 \qquad (14)$$

$$\mathrm{FPER} = \left(\frac{1.0}{1.0 + \mathrm{POT}}\right)^{\mathrm{POT}}, \quad \text{if REL} < 0.75 \qquad (15a)$$

$$\mathrm{FPER} = 1.0 - \left(\frac{1.0}{1.0 + \mathrm{POT}}\right)^{\mathrm{POT}}, \quad \text{if REL} \geq 0.75 \qquad (15b)$$

Where;

PERC: Percolation during the month
FPER: Fraction of real infiltration that percolates
REL: Relation of soil moisture
POT: Adjustment factor of FPER and REL to the curve that relates both factors.

(E) Surface Storage

The surface storage considered in the model includes not only the precipitation, but also the storage volume in the streams. The formula used are as follows:

$$\mathrm{ASUP} = \mathrm{PRE}_{i,1} + \mathrm{ESCURT}^{(i-1)} + \mathrm{ESCUTA} - \mathrm{AINFRE} \qquad (16)$$

$$\mathrm{ASUPF} = \mathrm{ASUP} + \mathrm{ESCOTA} + \mathrm{ESCORT}^{(i-1)} - \mathrm{ESCD} - \mathrm{ESCORR} \qquad (17)$$

Where;

ASUPF: Final surface storage
ASUP: Surface storage during the month
ESCOTA: Total streamflow
ESCD: Runoff during the month
ESCORR: Fraction of ESCOTA and $\mathrm{ESCORT}^{(i-1)}$ that is a part of the streamflow during the month.
$\mathrm{ESCORT}^{(i-1)}$: Retarded runoff

(F) Soil Moisture Storage

The water balance of the existing soil moisture, the infiltration, the real evapotranspiration, and the percolation gives the soil moisture storage. The formula used are as follows:

$$HSF = HIS + (FNPER \times AINFRE) - ETR_{i,1} \quad (18)$$
$$HSM = (HIS + HSF)/2.0 \quad (19)$$
$$FNPER = 1.0 - FPER \quad (20)$$

Where;

HSF:	Final soil moisture for the month
HIS:	Initial soil moisture for the month
FNPER:	Fraction of infiltration which does not percolate
HSM:	Mean soil moisture for the month

(G) Groundwater Storage

The groundwater storage can flow out as groundwater flow or as surface flow(base flow). The used formula are as follows:

$$VF = AASI + PERC + FSUBA_1 - QB - FSUBE_{i,1} \quad (21)$$
$$VM = (AASI + VF)/2.0 \quad (22)$$

Where;

AASI:	Initial groundwater storage
PERC:	Percolation
$FSUBA_1$:	Groundwater inflow for the sub-basin 1
QB:	Base flow
VM:	Mean groundwater storage
$FSUBE_{i,1}$:	Groundwater inflow during the month i and sub-basin 1
VF:	Final groundwater storage

(H) Surface Runoff

Surface runoff is a fraction of the difference between the available moisture for infiltration and the real infiltration. The used formula are as follows:

$$ESCD = PESC_1 \times ASUP \quad (23)$$
$$ESCURT^{(i)} = (1.0 - PESC_1) \times ASUP \quad (24)$$

Where;

$ESCD$: Runoff during the month

$ESCURT^{(i)}$: Retarded runoff

$PESC_1$: Fraction of surface storage that is a part of streamflow

(I) Base Flow

As mentioned before, base flow is a fraction of groundwater storage that flows out to the river. The formula are as follows:

$$QB = PQB_1 \times VM \qquad (25)$$

Where;

QB: Base flow

PQB_1: Fraction of groundwater storage that goes out as base flow

(J) Groundwater Outflow

This is the flow which goes out from the basin as groundwater flow. The formula are as follows:

$$FSUBE_{i,1} = PFSE_1 \times VM \qquad (26)$$

Where;

$FSUBE_{i,1}$: Groundwater outflow during the month **i** which goes out of sub-basin **1**.

$PFSE_1$: Fraction of groundwater storage that goes out as groundwater outflow.

$$PQB_1 + PFSE_1 \leq 1.0 \qquad (27)$$

(K) Streamflow

This is the flow which leaves the basin through the river and is the result of the surface runoff, the streamflow from the other basin, the retarded streamflow and the base flow. The formula involved are as follows:

$$ESCT_{i,1} = ESCD + ESCORR + QB \tag{28}$$

$$ESCORR = PESC_1 \times (ESCOTA + ESCORT^{(i-1)}) \tag{29}$$

$$ESCORT^{(i)} = (1.0 - PESC_1) \times (ESCOTA + ESCORT^{(i-1)}) \tag{30}$$

Where;

$ESCT_{i,1}$:	Total streamflow during the month **i** , supplied by the sub-basin **1**
ESCORR:	Runoff during the month
$ESCORT^{(i-1)}$:	Retarded runoff of month before
$ESCORT^{(i)}$:	Retarded runoff during the month **i**

5.3. Fitting of the Monthly Hydrological Model

The drainage areas involved in this study have some meteorological stations controlled by National and Regional Institutions. The information has been detailed in Chapter 3.

The development of water resources project depends on a good estimation of the water resources, in order to maximize its use for human benefits.

Along the basins, we do not find many streamflow gaging stations which have a continuous records permitting to fit the hydrological model. The following three streamflow gaging stations are finally selected for fitting of the model because they have some continuous records.

STATION	REGISTERED PERIOD
Carrizal river at Calceta	(1964 - 1980)
Chico river at Alajuela	(1970 - 1982)
Grande river at A.J. Mosquito	(1970 - 1980)

The evaporation data used for the fitting of the model were those recorded in Portoviejo Meteorological Station which gives evaporation data measured in a Class A. This station is located in the study area and the spatial variation of the evaporation is considered small.

The objective of the fitting process is to optimize some characteristics parameters, considering the precipitation and evaporation of the drainage area, as well as the recorded streamflow.

The parameters optimized by the monthly hydrological model in each drainage area to be calibrated are the following:

1. CINF: Infiltration capacity
2. HSN: Soil moisture storage
3. CT: Factor in order to convert the mean evaporation to potential evapotranspiration.
4. PQB: Fraction of groundwater storage that goes out as base flow
5. PFSE: Fraction of groundwater storage that goes out as groundwater flow.
6. PESC: Fraction of surface storage that leaves the sub-basin as streamflow during the month.
7. AIHS: Initial soil moisture capacity.
8. AIAS: Initial groundwater storage.
9. AISUP: Initial surface storage.

The precipitation stations used to fit the model were the following:

- DOS BOCAS in order to fit Carrizal river at Calceta
- CHAMOTETE in order to fit Chico river at Alajuela
- CHONE in order to fit Grande river at A.J. Mosquito

The results obtained for each basin are presented in Appendix 1 including the rainfall station used for the model fitting as well as the parameters optimized and a summary of the results for the considered period. It also shows the correlation coefficient between the observed and simulated discharges. The model makes the optimization of the parameters automatically. However, it is necessary to adjust some parameters to be consistent with the physical and hydrological characteristics of the drainage area.

In Figures 5.3.1 to 5.3.3, the fitting obtained in each site is shown, indicating a satisfactory fitting.

5.4. Long - Term Monthly Streamflow Generation

As can be seen in Section 5.3, out of the three drainage areas chosen for the model fitting, one is located in the Portoviejo river basin , and the other two in the Chone river system (one in the Carrizal river basin and the other in the Chone river basin). For that reason, the streamflow generation at the sites located in the Portoviejo river system has been done applying the parameters optimized and obtained through the fitting of the model in the Chico river at Alajuela. On the other hand, the generation at the sites located in the Chone river system has been done applying the parameters optimized in the Carrizal and the Grande rivers.

In Appendix 2, is given a detailed output of the model's streamflow generation in m3/s and MCM, which has been done for the following 12 sites.

LOCATION	DRAINAGE AREA (km^2)	
1. La Esperanza dam site	445.0	
2. Poza Honda dam site	170.0	
3. Santa Ana new diversion dam site	481.9	
4. La Estancilla diversion dam	769.6	
5. Chico river at La Cienega	347.2	
6. Portoviejo river at El Ceibal	1794.4	
(Chico river at Alajuela	183.0	for fitting)
(Crande river at A.J. Mosquito	187.2	for fitting)
(Carrizal river at Calceta	523.0	for fitting)
7. Portoviejo river (confluent with Chico river)	1190.0	
8. Chico river (confluent with Portoviejo river)	585.0	
9. Estuary of Portoviejo river	2060.0	
10. Carrizal river (confluent with Chone river)	1166.0	
11. Chone river (confluent with Carrizal river)	755.0	
12. Estuary of Chone river	2267.0	

It is important to mention that in order to carry out the streamflow generation in each drainage area, rainfall data at the precipitation stations were used which are influencing the area, considering the Thiessen Polygon defined in Figure 4.1.1.

The streamflow generated on the mentioned sites are shown in Tables 5.4.1 to 5.4.15

in m^3/s and Tables 5.4.16 to 5.4.30 in MCM.

6. SEDIMENT ANALYSIS IN RESERVOIRS

6.1. General

The Project involves three reservoirs, i.e. Daule Peripa, La Esperanza and Poza Honda reservoirs and the related facilities for their integrated transbasin. Two existing reservoirs, the Daule Peripa reservoir and the Poza Honda reservoir, have been built in 1987 and 1971, respectively, and La Esperanza reservoir is under construction at present and will be completed in 1996.

As is well known, all reservoirs created by dams on natural river courses are subject to some degree of sediment inflow and its deposition in a reservoir. It is broadly appreciated to take some provisions and guarantees of the reservoir functions during the useful life of a dam against the sedimentation problem.

In the project, the inlet and outlet facilities as well as the pumping station are planned to locate at upper reach of the reservoirs where the sedimentation problems are generally anticipated. For the design of the facilities, intake and outlet water levels should be defined in consideration of sediment deposit level analyzed in this study and countermeasures against sedimentation, if necessary, will also be studied based on the results of the sediment study.

A reservoir operation study is normally based on the area-storage curves with deposit of sedimentation after a useful life of reservoir. The modified area-storage curve obtained in the study should, therefore, be used for the integrated reservoir operation study including the three transbasin schemes.

6.2. Sediment Yield

In the design stage of the three dams, the sediment analysis had been conducted for the project life as summarized below:

Reservoir	Project Life (year)	Catchment Area (km^2)	Sediment Rate (m^3/km^2/year)	Sediment Yield (MCM)
Daule Peripa	50	4,200	1,238	260 1/
La Esperanza	100	445	1,500	64 2/
Poza Honda	100	170	743	13

1/ Based on Reservoir Operation Report of Daule-Peripa Dam Feasibility Study.

2/ Taking account of trap efficiency at 95%.

As far as Poza Honda reservoir is concerned, the bathymetric survey conducted from 1978 to 1985 were used during the Master Plan stage (1987-1990) to confirm the sediment rate after impounding the reservoir and a rate of sediment were estimated at 1,750 m^3/km^2/year, resulting in a sediment yield of 30 MCM in a useful life of 100 years. Based on the measured sediment rate of Poza Honda reservoir, La Esperanza reservoir sedimentation was designed at 1,500 m^3/km^2/year.

On the other hand, the sediment analysis for the reservoirs had been done in the Master Plan using a modified delivery ratio curve as recommended by the American Society of Civil Engineers, as shown below.

Estimation of Sediment Loads at Damsites (Master Plan)

Reservoir	Project Life (year)	Catchment Area (km^2)	Erosion Potential (ton/km^2/year)	Modified Delivery Ratio	Sediment Production (ton/km^2/year)	Total Sediment (Mil.ton)	Sediment Volume (MCM)
Daule-Peripa	50	4,200	-	-	-	-	260 (*)
La Esperanza	100	445	4,645	0.2787	1,295	69.15	53.19
Poza Honda	100	170	4,734	0.3596	1,702	36.17	27.83

(*) Based on Reservoir Operation Report of Daule-Peripa Dam Feasibility Study.

Source: PHIMA, Sediment Transport Report

However, if the upper delivery ratio curve recommended by the American Society of Civil Engineers is applied, then the total sediment volume for Poza Honda and La Esperanza reservoir will be 14 MCM and 29 MCM respectively for the project life. These results are in accordance with values registered mainly in the United States. Summary of sediment estimation is shown below.

Summary of Sediment Estimation

Reservoir	Project Life	Sediment (MCM)			
		Design	Bathymetric	Master Plan	ASCE
Daule Peripa	50	260	-	-	-
La Esperanza	100	64	-	53	29
Poza Honda	100	13	30	28	14

In this study, the maximum sediment rate of each reservoir is applied and the sedimentation after 25 years, 50 years and 100 years is studied.

This conservative approach is important for taking decision for the definition of inlet and outlet elevations of the transbasin structures, because in many cases reservoirs suffer from larger sedimentation than anticipated. The study cases are then summarized as follows.

	STUDIES CASES			
	Project Life			
Reservoir	100	50	25	12.5
Daule Peripa	-	260	130	65
La Esperanza	64	32 (*)	16	-
Poza Honda	30	13(**)	7.5	-

(*) Corresponding to 100 years of project life in accordance with the American Society of Civil Engineers Delivery Ratio and Potential Erosion obtained during the Master Plan.

(**) In agreement with Design Stage.

6.3. Reservoir Sediment Deposition

6.3.1 Sediment distribution within reservoirs

The procedure applied in this study covers the essential sedimentation characteristics to be considered in the design of dams and reservoirs and is related to the sedimentation processes in a reservoir that is quite complex because of the variation of the many influencing factors such as the hydrological fluctuations in water and sediment inflow, variation on grain size distribution, reservoir operation fluctuation and the size and shape of the reservoir.

The procedure used in this study represents a combination of state-of-the-art together with methods which are practical, technically sound, and sufficiently verified to fit the complexity of the problem. There are empirical methods such as the Area-Reduction Method in order to estimate the sediment distribution in a reservoir assuming the sediment yield that will be deposited from the bottom of the reservoirs during the useful life.

The used method was developed by Borland and Miller (1960) and revised by Lara in 1962 and is based on bathymetric surveys conducted in 30 reservoirs in USA. The method recognizes that the sediment distribution is dependent upon:

1. The manner in which the reservoir is operated
2. The texture and size of deposited sediment particles
3. Shape of the reservoir
4. Volume of sediment deposited in the reservoir.

The third one is the criteria that have been used in this study, because it has been adopted as the best one in order to predict the sediment distribution in a reservoir considering the design curves obtained empirically. In fact, the shape of the reservoir is defined by the depth to capacity relationship where "m" is the reciprocal of the slope of the depth versus capacity plotted on a logarithmic paper. The classification of reservoirs on this basis is as follows:

Reservoir Type	Classification	m
I	Lake	3.5 to 4.5
II	Flood plain-foothill	2.5 to 3.5
III	Hill	1.5 to 2.5
IV	Normally empty (Gorge)	1.0 to 1.5

Source: Reservoir Sedimentation by Strand and Pemberton

The reservoir sediment deposition evaluated for each reservoir by using the sediment yields is analyzed in the following tables.

Reservoir	Sediment Yield (MCM)	Table No.
Poza Honda	30	6.3.1 and 6.3.2
	13	6.3.3 and 6.3.4
	7.5	6.3.4 and 6.3.6
La Esperanza	64	6.3.7 and 6.3.8
	32	6.3.9 and 6.3.10
	16	6.3.11 and 6.3.12
Daule-Peripa	260	6.3.13 and 6.3.14
	130	6.3.15 and 6.3.16
	65	6.3.17 and 6.3.18

(1) From the corresponding Tables of each reservoirs, plot the depth in col.2 versus the original capacity in col.4 on logarithmic paper as shown in Figures 6.3.1 to 6.3.3. According to the classification presented before, each reservoir is classified into the following type.

RESERVOIR	TYPE
Poza Honda	III
La Esperanza	III
Daule-Peripa	II

(2) Compute col.5 by dividing the original depth represented by elevations in col.1, by the original total depth (H).

POZA HONDA H = 33.5 m.
LA ESPERANZA H = 43.0 m.
DAULE-PERIPA H = 69.0 m.

The depths of the reservoir are based on the High Water Level, the values of 106.5 m., 66.0 m and 85.0 m for Poza Honda, La Esperanza and Daule-Peripa, respectively.

(3) By using col.1, 3, 4, and 5 of Table 6.3.1, Table 6.3.2 is prepared and the col.2 and 6 are plotted as shown in Figures 6.3.4 to 6.3.6 obtained from reference 6.3 pag.785, in order to determine the elevation of sediment deposited at dams. The results are presented as follows:

Reservoir	Sediment Yield (MCM)	Relative Depth P = Po/H	New Reservoir Bottom * Above m.s.l.
Poza Honda	30.0	0.425 (Po=14.25)	87.25
	13.0	0.260 (Po= 8.71)	81.71
	7.5	0.080 (Po= 2.70)	75.70
La Esperanza	64.0	0.100 (Po= 4.30)	27.30
	32.0	0.052 (Po= 2.25)	25.25
	16.0	0.052 (Po= 2.25)	25.25
Daule-Peripa	260.0	0.070 (Po= 4.83)	21.83
	130.0	0.064 (Po= 4.42)	20.42
	65.0	0.030 (Po= 2.07)	18.07

* New Bottom Elevation=Po+Original Bottom Elevation

(4) From Figure H.8 pag. 783 of the reference 6.3, compute the relative area (col. 6 of Table 6.3.1) by using the corresponding curve according to the type of the reservoir. It can also be calculated by the formula giving in the mentioned reference, that are presented as follows:

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* New Botton Elevation = Po + Original Botton Elevation

Type I $a = 5.074\, p^{1.84}\, (1-p)^{0.35}$
Type II $a = 2.487\, p^{0.57}\, (1-p)^{0.45}$
Type III $a = 16.967\, p^{1.15}\, (1-p)^{2.32}$
Type IV $a = 1.486\, p^{-0.25}\, (1-p)^{1.34}$

where:

a = Relative sediment area
p = Relative depth of reservoir measured from the bottom

(5) Compute the K1 factor, dividing the original area at the new zero elevation by the relative area at that elevation.

(6) In Table 6.3.1, compute col.7 by multiplying each of the values in col.6 by the K1 factor.

(7) In Table 6.3.1, compute sediment volumes in col.8 with the Average End Area Method using areas from col.7.

(8) Accumulate values of col.8 to compute col.9. If the accumulated total sediment volume S1 does not agree with the design value of S, compute a new K as follows:

$$K_2 = K_1 \, (S / S_1)$$

and repeat from step 6.

(9) In the same Table 6.3.1, compute col.10 as the difference between col.3 and col.7.

(10) As step 9, compute col.11 with the differences between values in col.4 and 9.

New area capacity curves were drawn from data of col.10 and 11 and are presented in Figures 6.3.7 to 6.3.9 for Poza Honda, La Esperanza, and Daule-Peripa reservoirs respectively and considering in the same order a Sediment Yield of 13.0, 64.0, and 260.0 MCM.

6.3.2 Delta deposits

Another phenomenon of Reservoir Sediment Deposition is the distribution of sediment longitudinally and this has to receive a special attention because of the problem associated with this. In reality, the life of a reservoir is dependent upon the rate at which sediment is moved into it. A deposition profile in its extreme upstream portion is the formation of Delta Deposits. There are many consequences of these delta deposits related to the loss of the operational volume and the structures located at the end of reservoirs such as the Inlet and Outlet of the transbasin.

Sediments deposited in the delta are continually being reworked into the downstream storage area during low reservoir stage and during extreme flood discharges. Therefore, predicting the delta development within a reservoir is a complex problem because of the variables involved into the phenomenon such as operation of the reservoir, sizes of sediment and hydraulics.

The prediction of delta formation is as yet an empirical procedure based upon observed delta deposits in existing reservoirs and proposed by the U.S. Department of the Interior, Bureau of Reclamation(reference 6.2). A typical delta profile can be seen on the sketch of Figure 6.3.10 and it is defined by a Topset slope, Foreset slope, and a Pivot Point between the two slopes dependent on the reservoir operating level.

In general terms, the procedure followed in this study has been taken from reference 6.2. However, it is important to mention that the sediment deposition has been estimated by considering the distribution of the sediment evaluated in subsection 6.3.1.

With respect to La Esperanza reservoir, considering that the reservoir is mainly formed by two branches or systems (Carrizal River System and Barro River System), it was necessary to consider the sediment yield proportionally to drainage areas and in that way factors of 0.64 and 0.36 for Carrizal River and Barro River, respectively, was found. On the other hand, the cross sections considered along the river were taken from the National Topographic Maps, in the scale of 1:50,000 and 1:25,000. The sediment inflows considered were of 64.0 and 32.0 MCM and the results are presented in Figures 6.3.11 and 6.3.12 for Carrizal River System and Figures 6.3.13 and 6.3.14 for Barro River System.

With respect to Poza Honda Reservoir, the cross sections were taken from the bathymetric survey done in 1985 and making some corrections considering points with known elevation, in order to elaborate a longitudinal bed profile of the river before the building of the dam. The sediment inflows considered were of 30.0 and 13.0 MCM and the results are presented in Figures 6.3.15 and 6.3.16 respectively. Also, in those Figures can be seen the actual delta formation that we would be developed in Poza Honda reservoir during its operating years.

In case of the Conquillo river where the Conquillo tunnel inlet is located, sediment inflow of 11.0 MCM is estimated from a drainage area of 177 km^2 in 50 years, and the delta formation is drawn as shown in Figure 6.3.17.

According to the proposed method, the topset slope can be found by a statistical analysis of existing delta slopes which supports a value equal to one-half of the existing channel slope. This criteria was used with small modification of the topset slope, in order to fit the sediment distribution on the reservoir evaluated previously in 6.3.1.

On the other hand, the location of the pivot point between the topset and foreset slopes depends primarily on the operation of reservoirs and the foreset slopes is about 6.5 times the topset slope according to the Bureau of Reclamation Reservoir Resurveys. This criteria was also used with small modification in order to fit the sediment distribution by considering the bottom slope from the new zero bottom elevation estimated in 6.3.1.

In order to locate the pivot point, the mean level of reservoir water fluctuation is taken into account.

6.4 Remarks on Sediment Analysis

Before making the conclusion of the sedimentation study and in order to create a propitious feeling for taking decisions with respect to the location of the transbasin structures, it will be necessary to say that the concepts and theories which can be applied to the behavior of rivers and reservoirs are numerous. However, in many instances, especially in the field of this project, only empirical relationships have been developed and these are pertinent to situations involved in the range that originated the method.

As a matter of fact, predicting the response of reservoir sedimentation is a very complex task because of the large number of variables involved in the analysis, that are interrelated and can respond to changes in many influencing factors as was explained under Subsection 6.3.1. However, such a prediction is necessary and recognition of the limitations of the method is important for any engineering judgment based on the knowledge of the factors involved in the problem.

Now, it is important to refer to two important aspects involved in the study as follows:

1. The sediment yield
2. The reservoir operation

According to the sediment yields evaluated for Poza Honda and La Esperanza reservoir by using the rate of sediment computed from the bathymetric survey made in Poza Honda, the annual erosion rates will be 1.50 mm and 1.75 mm in La Esperanza and Poza Honda reservoir drainage areas, respectively, which seems very high compared with the arithmetic average of sediment-production rates for various groups of drainage areas in the United States as follows:

Watershed-size range, sq mi	No. of measurements	Average Annual Sediment-Production Rate, Acre-ft /sq mi
Under 10	650	3.80 (1830 m^3/km^2)
10 - 100	250	1.60 (770 m^3/km^2)
100 - 1000	123	1.01 (486 m^3/km^2)
Over - 1000	118	0.50 (240 m^3/km^2)

Source: Handbook of applied hydrology, V.T. Chow, 1964.

On the other hand, the sediment yields evaluated by using the upper bound of the American Society Curve referred above, correspond more reasonably to the sediment-production rates found in the United States and are almost the fifty percent (50 years) of those evaluated by the bathymetric surveys under the present study.

In view of the above and further considering the project life, it would be recommended for Poza Honda to use the sediment yield of 30 MCM and 13 MCM and their corresponding reservoir sedimentation distribution to locate the inlet and outlet structures of the transbasin.

According to the reservoir operation fluctuations, it is important to mention that the method applied in this study have considered that the reservoirs are going to have an annual regulation and this situation can move the delta into the reservoir, improving the conditions of the structure location at the upper end of the reservoirs. On the other hand, if by any reason the reservoir is not going to fluctuate much, then it would allow a typical delta formation.

Finally, it is important to carry out a reservoir survey periodically in order to know how the sediment deposition is developed within the reservoir and then to take some decisions or countermeasures, if necessary.

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TABLES

Table 3.1.1. Monthly Rainfall at Dos Bocas Station

(Unit : mm)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
1964	455.1	213.3	460.8	278.6	5.8	8.7	8.3	7.9	4.7	3.1	0.4	6.8	1,453.5
1965	194.2	266.3	564.2	312.8	328.9	30.3	6.7	2.3	0.5	0.0	0.0	137.8	1,844.0
1966	581.7	279.1	278.3	153.5	141.0	22.2	33.0	0.2	54.3	0.5	2.6	71.9	1,618.3
1967	753.7	458.4	186.6	51.8	103.3	0.5	0.0	0.2	3.0	6.7	0.9	22.3	1,587.4
1968	196.2	592.0	95.5	120.8	37.0	0.0	0.1	0.0	90.2	0.7	0.1	4.0	1,136.6
1969	239.1	122.3	470.8	183.7	345.4	33.9	0.5	5.7	0.0	13.2	43.0	12.3	1,469.9
1970	208.0	157.8	219.0	320.0	257.9	17.6	48.3	0.9	0.1	1.3	0.7	83.1	1,314.7
1971	159.9	331.9	604.1	73.1	22.8	13.5	3.0	1.4	41.7	1.5	1.5	45.5	1,299.9
1972	159.1	479.1	458.2	200.2	102.5	366.1	142.6	57.0	0.0	0.0	0.0	175.2	2,140.0
1973	541.7	80.5	449.3	218.9	252.9	47.2	4.6	5.6	0.0	1.7	0.0	47.3	1,649.7
1974	67.7	309.3	162.4	85.2	52.1	10.1	0.0	0.0	12.5	11.2	17.2	100.3	828.0
1975	443.6	630.0	436.6	120.1	29.0	2.4	12.8	2.7	32.5	47.4	3.0	143.0	1,903.1
1976	718.3	230.5	282.0	182.1	114.8	15.9	0.0	3.8	5.3	0.4	0.0	43.0	1,596.1
1977	405.0	370.0	501.0	88.0	38.5	0.0	0.0	1.6	19.1	7.4	0.0	48.5	1,479.1
1978	224.0	263.0	334.5	104.5	195.0	0.0	0.0	0.0	9.1	0.0	0.0	14.3	1,144.4
1979	325.8	209.9	169.4	219.9	199.9	30.5	10.0	0.0	9.7	4.0	0.0	1.8	1,180.9
1980	171.1	280.8	201.3	297.7	36.9	0.0	0.0	0.0	0.0	0.3	0.0	84.5	1,072.6
1981	135.6	533.8	288.4	270.5	0.0	0.0	43.0	0.0	0.0	5.0	5.0	88.9	1,370.2
1982	136.4	219.0	202.8	160.3	33.5	21.5	11.0	0.0	12.0	197.8	326.1	454.3	1,774.7
1983	493.7	381.6	659.1	477.5	375.2	294.5	421.2	227.4	161.7	13.4	10.2	87.5	3,603.0
1984	22.4	566.7	378.5	308.8	65.9	4.0	3.0	0.0	7.5	0.0	0.0	107.5	1,464.3
1985	127.1	214.6	291.9	176.9	12.4	23.8	0.0	0.0	0.0	0.0	0.0	155.2	1,001.9
1986	426.9	215.1	192.0	348.6	0.0	0.0	0.0	0.0	0.0	70.5	0.0	67.4	1,320.5
1987	341.3	727.8	555.8	497.9	203.4	0.0	0.0	50.4	0.0	0.0	0.0	79.4	2,456.0
1988	299.9	574.4	101.0	206.8	227.2	30.8	24.1	0.0	0.0	24.0	22.4	65.6	1,576.2
1989	542.8	423.3	144.9	365.5	35.2	30.4	0.0	0.0	23.0	10.6	0.0	72.0	1,647.7
1990	112.8	205.0	144.6	106.5	0.0	0.0	0.0	0.0	0.5	11.6	0.1	29.9	611.0
1991	204.0	316.0	335.9	152.8	43.4	77.7	1.4	5.9	0.2	1.5	0.0	59.0	1,197.8
1992	145.0	190.6	420.1	335.5	100.1	30.2	0.0	5.0	7.0	1.5	0.0	59.0	1,294.0
MAX	753.7	727.8	659.1	497.9	375.2	366.1	421.2	227.4	161.7	197.8	326.1	454.3	3,603.0
MEAN	304.6	339.4	330.7	221.3	115.9	38.3	26.7	13.0	17.1	15.0	14.9	81.6	1,518.5
MIN	22.4	80.5	95.5	51.8	0	0	0	0	0	0	0	1.8	611

Table 3.1.2 Monthly Rainfall at Chone Station

(Unit : mm)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
1964	215.8	148.3	359.0	372.9	4.7	15.7	10.3	5.2	9.7	6.3	6.8	5.8	1,160.5
1965	123.2	160.6	346.1	339.6	101.3	75.0	59.5	26.3	7.1	23.4	10.2	37.0	1,309.3
1966	312.5	373.0	288.2	113.2	67.4	36.7	8.2	27.8	39.1	30.2	10.8	34.7	1,341.8
1967	408.1	411.5	87.6	50.1	54.3	8.5	9.9	3.9	39.0	3.8	0.0	6.4	1,083.1
1968	114.8	117.8	109.2	94.5	15.2	21.0	4.0	0.0	4.7	11.5	0.7	5.1	498.5
1969	142.0	59.2	251.4	169.5	115.6	145.8	80.0	3.0	2.4	1.4	21.9	12.6	1,004.8
1970	158.2	107.6	244.2	357.9	85.4	36.8	14.1	10.2	6.0	18.2	28.1	28.1	1,094.8
1971	71.6	238.0	629.0	60.2	18.2	18.0	0.0	4.1	14.3	26.2	2.0	24.3	1,105.9
1972	42.7	342.7	285.5	127.8	54.4	321.4	63.5	110.4	0.4	11.2	5.9	204.0	1,569.9
1973	290.5	115.0	352.7	194.6	148.9	26.6	32.9	7.1	18.0	7.2	4.1	33.7	1,231.3
1974	82.3	481.2	44.9	193.1	26.9	26.4	2.2	0.5	11.7	4.3	12.9	86.7	973.1
1975	410.8	424.5	516.5	221.6	7.9	55.6	20.0	5.7	8.0	11.2	4.7	75.2	1,761.7
1976	450.7	307.8	327.1	260.1	156.5	218.0	12.8	2.0	9.1	1.8	2.0	67.0	1,814.9
1977	407.4	486.9	354.6	145.1	0.0	23.3	0.0	2.8	13.5	6.3	0.2	33.8	1,473.9
1978	228.1	285.5	228.2	62.7	79.5	8.6	7.0	4.7	1.1	28.8	0.0	12.6	946.8
1979	169.2	247.9	123.6	85.4	22.0	68.5	0.0	0.9	15.0	4.4	1.0	0.9	738.8
1980	169.8	243.8	342.8	210.9	75.1	13.0	0.0	2.0	0.4	7.8	2.9	31.2	1,099.7
1981	162.9	291.2	229.8	229.8	1.4	5.8	15.6	6.3	10.8	4.6	1.1	25.0	984.3
1982	155.5	83.0	150.1	85.9	54.4	14.2	3.0	0.0	8.2	240.9	215.8	391.3	1,402.3
1983	548.7	593.0	541.5	284.1	681.6	395.3	310.1	133.8	114.5	9.2	8.5	62.8	3,683.1
1984	15.7	377.0	428.8	239.7	20.8	31.2	5.0	2.5	9.1	6.8	2.2	141.6	1,280.4
1985	124.4	234.1	153.1	108.0	38.4	9.0	6.3	7.1	4.4	3.0	3.6	92.6	784.0
1986	388.6	117.4	201.2	270.2	21.6	2.3	2.4	7.4	19.0	31.1	5.3	92.8	1,159.3
1987	216.3	652.6	380.0	504.1	124.1	2.2	14.4	68.3	14.3	9.7	6.6	58.7	2,051.3
1988	189.9	270.6	50.0	123.4	76.5	27.1	10.2	14.3	8.5	6.0	7.6	21.9	806.0
1989	319.9	434.3	145.1	244.7	60.2	31.0	7.7	4.1	11.5	22.1	0.9	29.3	1,310.8
1990	130.4	178.1	207.2	232.4	7.8	11.8	2.5	0.1	0.4	3.4	1.0	24.3	799.4
1991	103.8	253.3	127.4	69.6	13.1	15.2	3.5	5.0	0.3	0.6	12.5	32.9	637.2
1992	210.4	180.1	253.0	278.7	175.8	13.1	17.2	2.6	3.8	3.5	0.4	14.9	1,153.5
MAX	548.7	652.6	629.0	504.1	681.6	395.3	310.1	133.8	114.5	240.9	215.8	391.3	3,683.1
MEAN	219.5	283.3	267.5	197.6	79.6	57.8	24.9	16.1	13.9	18.8	13.1	58.2	1,250.4
MIN	15.7	59.2	44.9	50.1	0.0	2.2	0.0	0.0	0.3	0.6	0.0	0.9	498.5

Table 3.1.3 Monthly Rainfall at Portoviejo Station

(Unit : mm)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
1964	59.7	46.8	205.0	69.1	5.1	8.3	0.0	0.5	0.0	4.4	0.6	0.9	400.4
1965	29.2	53.3	136.0	67.2	46.8	47.6	15.3	2.7	0.2	0.4	2.2	3.2	404.1
1966	78.0	94.2	112.5	68.0	18.9	7.0	3.1	8.3	8.2	1.7	1.8	10.5	412.2
1967	184.9	164.9	28.2	6.4	11.6	0.3	2.8	0.0	1.0	0.1	0.0	1.0	401.2
1968	56.9	66.0	21.9	34.0	0.5	1.7	0.0	1.0	0.9	0.0	1.0	2.1	186.0
1969	146.6	17.4	97.6	79.0	83.2	50.4	17.0	0.2	0.1	0.3	4.1	7.2	503.1
1970	46.2	52.5	118.8	84.5	65.5	3.1	0.3	0.2	2.0	0.1	1.3	7.9	382.4
1971	30.8	133.1	219.5	8.1	0.0	6.6	0.1	0.1	3.3	1.3	2.8	1.3	407.0
1972	75.8	199.6	245.7	81.1	2.7	84.1	20.5	6.3	3.6	1.6	0.7	18.3	740.0
1973	183.1	177.1	55.1	68.8	29.7	4.6	1.8	1.8	2.9	0.0	0.8	4.1	529.8
1974	24.1	114.7	54.6	50.1	13.3	5.4	0.6	0.1	1.8	4.4	5.8	24.2	299.1
1975	213.9	247.5	166.2	63.0	3.2	3.8	0.4	0.6	14.7	19.2	0.7	24.6	757.8
1976	202.4	121.2	124.5	65.8	44.9	19.2	7.6	0.0	2.9	0.2	2.0	8.8	599.5
1977	36.2	126.2	143.7	107.9	0.0	6.0	0.0	0.1	8.9	0.3	0.0	15.5	444.8
1978	52.8	73.6	58.8	122.2	11.5	0.0	4.4	0.0	0.4	0.0	0.0	1.1	324.8
1979	37.9	145.2	20.5	20.9	9.9	4.0	1.0	1.0	1.1	0.0	0.0	0.0	241.5
1980	39.1	33.1	90.7	54.4	12.8	2.2	0.0	0.0	0.1	0.3	0.9	0.4	234.0
1981	50.2	95.7	41.0	18.4	0.0	0.0	0.0	0.2	0.6	2.3	0.2	8.4	217.0
1982	20.0	7.3	28.9	6.5	9.7	2.6	0.0	0.0	1.1	35.2	98.3	116.7	326.3
1983	264.3	125.0	205.0	254.7	271.5	338.9	231.6	23.4	46.8	1.7	0.7	25.6	1,789.2
1984	1.7	202.4	116.5	31.6	29.5	2.9	0.6	0.0	0.0	0.1	8.5	120.1	513.9
1985	40.3	78.0	95.9	35.1	42.6	1.6	0.0	0.0	0.0	0.3	0.0	17.1	310.9
1986	283.9	44.2	75.7	80.0	3.7	0.0	0.7	0.0	0.0	3.5	0.0	3.8	495.5
1987	70.6	333.3	138.3	95.7	23.3	0.0	0.8	16.5	1.5	0.1	2.4	2.8	685.3
1988	51.1	96.1	30.0	66.5	23.8	0.0	0.8	0.2	12.2	0.0	1.3	6.8	288.8
1989	245.4	162.0	189.1	60.5	1.4	1.3	0.1	0.0	6.1	0.9	0.0	0.0	666.8
1990	32.2	76.3	59.3	38.8	0.9	1.7	0.0	0.0	0.0	0.0	0.1	8.8	218.1
1991	57.4	96.1	28.4	34.1	17.0	0.1	0.0	0.2	1.9	0.0	3.2	18.8	257.2
1992	107.1	139.1	295.0	235.7	145.8	9.4	0.5	0.0	0.0	0.0	0.0	8.8	941.4
MAX	283.9	333.3	295.0	254.7	271.5	338.9	231.6	23.4	46.8	35.2	98.3	120.1	1,789.2
MEAN	93.9	114.5	110.4	69.2	32.0	21.1	10.7	2.2	4.2	2.7	4.8	16.2	482.0
MIN	1.7	7.3	20.5	6.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	186.0

Table 3.1.4 Monthly Rainfall at Rocafuerte Station (INAMHI)

(Unit : mm)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
1964	33.6	55.0	191.9	66.4	5.6	0.0	1.1	0.0	0.0	0.0	0.0	0.0	353.6
1965	12.4	54.4	131.1	81.0	29.5	36.6	2.4	2.0	1.0	3.6	0.0	1.9	355.9
1966	104.8	122.5	79.2	31.3	19.7	1.4	0.0	0.0	5.8	0.0	1.2	0.6	366.5
1967	80.6	184.3	81.7	22.0	12.3	0.0	2.8	0.0	3.2	0.0	0.0	0.5	387.4
1968	66.1	79.2	9.5	4.2	0.0	1.6	4.0	0.0	2.3	0.0	0.0	42.7	209.6
1969	110.5	14.5	96.1	22.7	27.1	9.4	0.0	0.0	0.0	0.0	1.8	3.4	285.5
1970	72.2	32.9	35.0	81.9	86.4	2.3	1.2	0.0	0.2	0.0	1.2	3.6	316.9
1971	24.9	81.7	230.0	11.6	0.0	6.2	0.0	0.4	0.8	0.2	0.0	1.2	357.0
1972	22.4	157.3	169.8	110.9	4.3	70.6	0.9	3.2	0.0	0.0	0.0	20.5	559.9
1973	149.3	115.0	55.4	39.7	19.1	1.5	0.0	0.0	0.0	0.0	0.0	0.0	380.0
1974	25.2	84.9	78.7	32.9	9.7	4.7	0.0	0.0	2.0	0.0	0.0	30.0	268.1
1975	182.3	261.1	133.1	48.4	4.5	7.5	0.5	1.5	4.0	9.0	1.5	5.6	659.0
1976	176.7	201.4	176.3	82.0	33.1	11.6	0.0	0.0	10.6	0.0	0.0	12.5	704.2
1977	94.7	111.7	183.4	80.5	0.5	9.2	0.0	0.0	4.0	0.0	0.0	0.0	484.0
1978	46.9	94.0	59.9	2.3	2.2	0.0	0.5	0.0	2.5	0.0	0.0	0.0	208.3
1979	50.1	129.6	23.2	11.5	4.9	0.6	0.0	0.0	8.1	0.2	0.0	0.0	228.2
1980	41.2	83.9	62.7	42.6	13.0	2.8	0.0	0.0	0.0	0.2	8.2	0.3	254.9
1981	64.2	147.5	31.2	12.5	0.0	0.0	0.0	0.0	0.0	1.5	0.6	2.5	260.0
1982	26.2	4.0	15.9	9.7	7.8	6.2	0.8	0.0	0.7	27.2	49.5	60.8	208.8
1983	273.0	185.2	170.1	188.9	337.4	196.9	235.0	13.7	52.8	1.1	1.9	33.0	1,689.0
1984	0.0	303.1	131.3	12.6	8.2	5.6	0.0	0.2	0.0	0.0	3.1	143.6	607.7
1985	42.8	62.2	10.6	10.4	63.7	0.3	0.0	1.0	0.0	0.0	0.0	17.3	208.3
1986	180.0	5.3	17.9	94.5	1.7	0.0	0.0	0.0	0.0	3.9	0.0	0.0	303.3
1987	0.0	257.0	122.7	49.9	38.6	0.0	1.0	9.4	0.0	0.0	3.0	8.2	489.8
1988	32.8	60.3	38.1	31.9	24.6	0.0	0.0	0.0	1.2	0.0	0.0	3.5	192.4
1989	119.9	228.3	126.0	31.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	506.3
1990	10.2	76.3	20.6	13.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	17.9	138.2
1991	45.4	46.4	31.0	30.5	5.4	0.0	0.0	0.0	0.0	0.0	2.2	6.4	167.3
1992	70.9	130.9	284.2	212.2	89.8	0.0	0.0	0.0	0.0	0.0	0.0	1.0	789.0
MAX	273.0	303.1	284.2	212.2	337.4	196.9	235.0	13.7	52.8	27.2	49.5	143.6	1,689.0
MEAN	74.5	116.2	96.4	50.7	29.3	12.9	8.6	1.1	3.4	1.6	2.6	14.4	411.7
MIN	0.0	4.0	9.5	2.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	138.2

Table 3.1.5 Monthly Rainfall at Calceta Station

(Unit : mm)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
1964	114.4	213.7	392.4	267.7	5.9	9.7	5.4	9.1	0.7	4.0	4.9	10.4	1,038.3
1965	134.8	111.8	469.8	234.3	78.2	54.6	56.1	1.3	6.9	31.7	5.1	27.1	1,211.7
1966	239.5	257.3	216.5	110.9	71.0	29.3	5.4	20.5	8.8	16.2	3.3	15.8	994.5
1967	393.9	267.7	78.9	38.9	18.2	5.0	7.4	0.7	46.4	0.0	0.0	1.7	858.8
1968	67.6	88.0	54.1	128.2	12.9	9.0	1.7	1.4	24.6	6.4	0.0	3.4	397.3
1969	198.3	32.6	211.4	175.4	114.7	96.2	12.2	0.6	0.0	0.4	8.3	14.8	864.9
1970	138.5	130.3	175.8	399.8	55.9	46.9	7.1	0.7	3.1	4.2	6.5	13.1	981.9
1971	81.4	246.6	554.8	58.7	10.4	13.6	1.2	0.6	6.8	14.3	6.1	12.5	1,007.0
1972	113.8	259.4	193.8	174.0	40.3	208.6	26.6	51.6	4.7	7.1	14.7	84.0	1,178.6
1973	252.3	217.6	180.2	98.1	128.0	23.0	24.1	3.5	8.5	2.5	1.6	7.4	946.8
1974	67.4	328.3	119.8	94.5	16.0	13.0	3.1	0.0	8.7	0.5	66.9	84.3	802.5
1975	398.3	397.2	479.1	206.2	11.4	9.9	8.0	1.8	2.2	16.6	2.9	102.6	1,636.2
1976	138.8	214.8	556.7	198.9	106.2	116.8	57.4	10.6	8.1	1.4	0.0	26.3	1,436.0
1977	310.9	267.5	257.1	140.3	0.5	18.1	1.5	0.0	14.4	2.1	0.0	24.7	1,037.1
1978	209.5	280.5	178.0	18.9	79.4	0.0	9.9	0.0	10.0	1.3	0.0	1.7	789.2
1979	127.1	216.9	118.2	80.2	59.0	10.0	0.0	0.0	1.4	3.3	0.0	0.0	616.1
1980	75.5	192.9	291.3	189.0	46.5	4.5	0.0	0.0	0.0	0.0	0.0	62.3	862.0
1981	65.4	278.5	263.0	191.7	0.0	3.2	9.7	0.5	3.7	1.2	2.4	6.5	825.8
1982	60.8	143.7	118.0	186.7	16.5	5.8	7.3	0.0	26.3	76.8	127.7	230.7	1,000.3
1983	497.6	365.0	270.9	331.7	357.7	336.6	485.5	85.2	118.2	0.0	7.3	79.4	2,935.1
1984	3.6	304.9	354.4	59.7	4.9	11.6	0.0	2.5	5.5	3.9	3.6	150.6	905.2
1985	132.9	176.6	120.8	122.3	24.0	7.1	5.5	0.0	0.0	0.0	0.0	71.0	660.2
1986	173.5 *	256.9 *	270.4 *	162.3 *	60.8 *	53.0 *	40.6 *	10.1 *	14.6 *	9.0 *	14.6 *	60.8 *	1,126.6
1987	237.1 *	351.1 *	369.6 *	221.8 *	83.2 *	72.4 *	55.4 *	13.9 *	20.0 *	12.3 *	20.0 *	83.2 *	1,540.0
1988	123.2 *	182.4 *	192.0 *	115.2 *	43.2 *	37.6 *	28.8 *	7.2 *	10.4 *	6.4 *	10.4 *	43.2 *	800.0
1989	200.2 *	296.4 *	312.0 *	187.2 *	70.2 *	61.1 *	46.8 *	11.7 *	16.9 *	10.4 *	16.9 *	70.2 *	1,300.0
1990	84.7 *	125.4 *	132.0 *	79.2 *	29.7 *	25.8 *	19.8 *	4.9 *	7.2 *	4.4 *	7.2 *	29.7 *	550.0
1991	92.4	136.8	144.0	86.4	32.4	28.2	21.6	5.4	7.8	4.8	7.8	32.4	600.0
1992	154.0	228.0	240.0	144.0	54.0	47.0	36.0	9.0	13.0	8.0	13.0	54.0	1,000.0
MAX	497.6	397.2	556.7	399.8	357.7	336.6	485.5	85.2	118.2	76.8	127.7	230.7	2,935.1
MEAN	168.5	226.5	252.2	155.2	56.2	46.8	33.9	8.7	13.8	8.6	12.1	48.4	1,031.1
MIN	3.6	32.6	54.1	18.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	397.3

* Estimated Monthly Values

Table 3.1.6 Monthly Rainfall at Chamotete - Jesús María Station

(Unit : mm)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
1964	120.1 *	89.2 *	383.7 *	226.3 *	0.0 *	4.5 *	0.4 *	5.9 *	0.0 *	0.0 *	1.3 *	0.0 *	831.4
1965	111.7 *	147.6 *	488.4 *	216.7 *	267.0 *	22.1 *	0.0 *	2.0 *	0.0 *	0.0 *	1.0 *	97.0 *	1,353.5
1966	569.8 *	161.7 *	199.0 *	96.8 *	110.2 *	15.5 *	18.9 *	0.5 *	57.4 *	0.0 *	2.3 *	38.6 *	1,270.7
1967	773.1 *	359.4 *	106.2 *	15.0 *	78.7 *	0.0 *	0.0 *	0.5 *	0.0 *	0.4 *	1.5 *	0.0 *	1,334.8
1968	114.1 *	506.7 *	14.0 *	62.9 *	23.4 *	0.0 *	0.0 *	0.0 *	105.6 *	0.0 *	1.2 *	0.0 *	827.9
1969	164.8 *	50.0 *	393.9 *	128.0 *	280.8 *	25.0 *	0.0 *	4.4 *	0.0 *	6.2 *	20.1 *	0.0 *	1,073.2
1970	148.0	139.9	252.1	324.7	87.2	84.3	5.5	0.0	1.2	2.4	6.5	18.7	1,070.5
1971	96.6	243.0	518.2	72.6	6.7	39.3	4.0	0.7	3.6	6.2	6.7	13.9	1,011.5
1972	99.4	192.3	424.4	130.5	115.8	283.1	18.6	44.6	59.8	8.8	29.0	166.8	1,573.1
1973	401.3	339.9	415.3	166.2	179.2	46.0	10.3	4.6	10.7	2.2	0.9	29.8	1,606.4
1974	40.7	419.8	112.7	72.6	6.7	38.5	1.1	0.0	7.3	3.0	9.6	57.2	769.2
1975	519.6	455.7	355.7	191.1	34.1	34.0	9.2	2.4	5.6	31.6	3.1	45.7	1,687.8
1976	529.7	375.3	411.0	324.4	194.2	124.5	32.8	5.3	3.7	0.0	1.4	45.4	2,047.7
1977	278.0	318.4	343.7	180.0	11.7	16.4	0.0	0.6	5.6	2.2	0.0	60.7	1,217.3
1978	177.4	232.6	203.1	79.8	80.7	3.0	0.4	0.0	0.4	0.3	0.0	4.8	782.5
1979	124.7	192.4	189.8	109.6	38.9	27.6	7.1	0.0	3.6	4.4	10.7	10.7	719.5
1980	65.4	131.2	247.5	305.3	112.4	4.6	0.0	1.6	0.0	0.0	6.6	4.6	879.2
1981	100.0	430.6	139.1	195.8	103.9	2.2	9.7	1.6	1.0	0.0	0.0	23.8	1,007.7
1982	128.5	88.3	159.8	39.5	42.9	3.4	27.7	0.0	12.0	186.9	179.4	456.4	1,324.8
1983	413.7	421.0	427.3	527.4	353.7	238.8	381.5	187.4	241.7	1.1	3.8	24.3	3,221.7
1984	235.2	594.6	461.7	75.9	14.0	3.4	1.3	1.6	18.0	0.0	0.0	81.6	1,487.3
1985	97.3	182.3	265.1	239.2	57.0	56.2	1.4	0.4	1.3	0.4	0.0	65.7	966.3
1986	602.9	119.3	73.9	200.3	16.3	5.9	13.0	0.7	0.9	20.9	1.4	29.2	1,084.7
1987	276.0	584.9	262.3	461.8	155.5	5.6	8.0	53.0	4.3	9.0	13.7	49.8	1,883.9
1988	152.8	368.0	94.7	287.8	114.9	5.5	5.5	4.4	10.3	0.0	23.1	40.7	1,107.7
1989	702.4	396.3	264.0	253.7	30.7	13.7	3.8	0.9	32.3	12.5	0.6	25.4	1,736.3
1990	87.4	99.1	254.9	241.9	2.1	0.0	5.2	0.0	0.2	0.2	0.0	58.1	749.1
1991	166.0	171.9	339.0	102.2	83.5	38.3	0.0	2.8	1.1	0.0	17.5	27.8	950.1
1992	453.3	378.4	656.8	424.2	413.0	78.0	3.3	1.8	0.6	1.0	0.4	34.7	2,445.5
MAX	773.1	594.6	656.8	527.4	413.0	283.1	381.5	187.4	241.7	186.9	179.4	456.4	3,221.7
MEAN	267.2	282.4	291.6	198.4	104.0	42.0	19.6	11.3	20.3	10.3	11.8	52.1	1,311.1
MIN	40.7	50.0	14.0	15.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	719.5

□ * Corrected Values Through Double Mass Curve

Table 3.1.7 Monthly Rainfall at Santa Ana Station

(Unit : mm)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
1964	110.8	43.4	319.0	226.5	6.0	10.7	3.7	0.0	0.0	0.0	0.0	4.6	724.7
1965	39.3	89.0	376.0	147.0	73.4	61.0	32.6	0.0	21.6	2.8	0.0	7.6	850.3
1966	185.4	146.4	141.0	40.9	2.8	7.6	0.0	2.8	15.2	1.8	10.8	3.8	558.5
1967	329.2	319.4	111.2	24.4	23.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	807.8
1968	96.2	75.8	31.8	32.4	0.0	0.0	0.0	0.0	7.4	0.0	0.7	5.9	250.2
1969	121.8	69.5	168.5	272.0	200.9	74.3	20.5	2.9	1.7	0.8	68.5	32.4	1,033.8
1970	102.4	114.0	152.8	222.3	93.2	19.8	6.3	0.6	1.5	0.4	1.1	5.5	719.9
1971	80.2	199.0	349.1	35.5	3.0	34.0	0.0	0.3	10.9	3.2	10.5	14.6	740.3
1972	119.9	208.5	219.3	97.9	37.1	211.3	63.5	31.9	0.6	8.2	3.1	53.8	1,055.1
1973	175.9	166.3	260.3	197.0	107.8	92.9	3.6	0.0	5.1	0.0	0.0	13.6	1,022.5
1974	27.4	191.9	112.2	65.7	28.0	22.8	0.0	0.0	0.0	3.4	0.0	52.8	504.2
1975	319.0	330.6	332.4	164.4	5.6	40.6	5.6	0.0	20.6	1.3	6.5	39.9	1,266.5
1976	320.1	304.2	210.6	162.9	72.5	170.6	36.0	10.1	1.8	0.0	0.0	74.0	1,362.8
1977	120.3	213.0	227.6	104.0	16.0	66.8	0.0	0.0	54.0	0.0	0.0	33.5	835.2
1978	132.8	137.0	198.1	28.7	81.5	51.9	13.0	2.9	8.3	1.3	6.5	21.2	683.2
1979	68.6	164.7	101.4	112.8	52.0	18.3	0.0	0.0	0.0	0.0	0.0	0.0	517.8
1980	91.4	63.8	140.4	121.8	121.7	2.8	0.0	0.0	0.0	0.0	9.0	1.7	552.6
1981	45.0	198.3	236.2	140.1	6.7	0.0	4.8	0.0	0.0	0.0	0.0	2.9	634.0
1982	56.7	26.0	80.9	43.2	55.1	0.0	1.5	0.0	4.3	67.6	83.8	257.7	676.8
1983	387.9	320.2	342.5	280.1	463.5	243.5	222.2	78.8	84.4	0.0	0.0	28.0	2,451.1
1984	11.4	222.1	292.1	43.5	8.3	12.3	0.0	0.0	0.0	0.0	0.0	136.6	726.3
1985	90.5 *	122.3 *	154.0 *	110.2 *	27.2 *	19.8 *	0.0 *	4.8 *	3.2 *	0.0 *	4.6 *	59.3 *	595.9
1986	319.7 *	117.2 *	154.1 *	128.9 *	52.2 *	3.5 *	3.0 *	0.0 *	3.4 *	9.4 *	0.0 *	0.8 *	792.2
1987	235.9 *	235.0 *	191.9 *	208.7 *	150.4 *	3.1 *	0.0 *	88.8 *	10.8 *	0.0 *	0.0 *	17.2 *	1,141.8
1988	143.7 *	199.6 *	146.6 *	143.7 *	85.8 *	6.3 *	0.0 *	0.6 *	7.4 *	0.0 *	18.7 *	39.0 *	791.4
1989	154.1 *	220.1 *	251.5 *	138.3 *	87.0 *	73.4 *	26.2 *	9.4 *	13.6 *	10.5 *	8.4 *	55.6 *	1,048.1
1990	58.3 *	83.3 *	95.1 *	52.3 *	32.9 *	27.8 *	9.9 *	3.6 *	5.2 *	3.9 *	3.2 *	21.0 *	396.5
1991	60.3	86.2	98.5	54.2	34.1	28.7	10.3	3.7	5.3	4.1	3.3	21.7	410.4
1992	161.7	131.0	264.0	145.2	91.3	77.0	27.5	9.9	14.3	11.0	8.8	58.3	1,000.0
MAX	387.9	330.6	376.0	280.1	463.5	243.5	222.2	88.8	84.4	67.6	83.8	257.7	2,451.1
MEAN	143.6	165.4	198.6	122.2	69.6	47.6	16.9	8.7	10.4	4.5	8.5	36.7	832.8
MIN	11.4	26.0	31.8	24.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	250.2

* Estimated Monthly Values

Table 3.1.8 Monthly Rainfall at Boyacá Station

(Unit : mm)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
1964	152.2 *	185.4 *	193.7 *	124.0 *	65.1 *	51.0 *	36.0 *	22.7 *	2.6 *	8.5 *	8.0 *	0.8 *	850.0
1965	112.6	143.6	255.7	215.6	72.0	41.4	12.7	13.6	15.6	15.6	23.3	11.1	932.8
1966	160.1	166.4	274.2	92.9	49.0	18.8	12.6	22.6	10.3	23.0	4.9	18.7	853.5
1967	219.4	283.3	43.9	41.5	101.3	9.2	9.9	5.0	11.5	5.0	0.0	3.3	733.3
1968	114.1	290.2	78.7	101.2	4.0	31.2	0.7	4.6	4.2	5.3	0.0	4.7	638.9
1969	67.2	37.3	222.1	135.2	90.8	49.4	19.7	3.8	2.3	1.5	17.3	13.7	660.3
1970	158.1	80.6	194.2	353.6	71.2	13.8	12.5	4.7	16.9	16.5	10.4	15.1	947.6
1971	53.4	218.5	280.8	24.3	5.8	46.0	8.8	5.7	9.2	25.7	0.0	12.0	690.2
1972	61.3	224.7	217.5	120.8	23.9	172.3	28.4	14.5	25.5	6.6	6.2	71.4	973.1
1973	259.8	177.9	192.6	127.8	106.0	16.9	19.7	12.2	10.8	11.2	3.1	6.1	944.1
1974	99.0	281.4	77.6	95.3	23.1	8.9	7.8	2.3	10.4	6.9	5.0	46.4	664.1
1975	376.6	412.8	346.8	121.4	8.2	9.9	25.0	7.0	4.5	3.2	6.4	27.4	1,349.2
1976	316.4	129.1	135.3	127.3	89.1	44.3	9.0	8.6	6.4	0.0	5.0	21.4	891.9
1977	191.2	267.0	214.6	122.6	2.3	122.2	28.4	9.7	32.9	46.6	0.3	11.1	1,048.9
1978	196.5	171.9	121.0	28.5	13.7	1.1	8.9	4.1	23.4	41.7	7.5	32.6	650.9
1979	106.0	261.8	64.9	53.7	9.9	25.3	1.3	10.2	19.1	8.2	1.5	35.0	596.9
1980	62.8	160.8	214.7	64.3	69.8	9.1	1.9	5.6	0.6	5.3	9.7	11.0	615.6
1981	150.7	191.7	190.9	120.3	0.2	2.5	18.2	23.8	75.3	5.2	4.6	32.6	816.0
1982	90.1	41.6	203.0	60.8	25.8	11.3	1.9	0.0	4.4	71.1	132.2	106.2	748.4
1983	244.6	208.2	425.4	391.1	441.3	162.0	246.2	73.6	86.0	12.1	18.1	26.8	2,335.4
1984	147.9	282.7	191.4	118.3	56.6	41.8	26.1	12.2	21.7	17.4	13.9	40.0	970.0
1985	168.6	208.2	218.1	134.9	64.4	47.6	29.7	13.9	24.8	19.8	15.9	45.6	991.5
1986	65.8	81.3	85.2	52.6	25.2	18.6	11.6	5.4	9.7	7.8	6.2	17.8	387.2
1987	248.4	306.8	321.4	198.7	94.9	70.1	43.8	20.5	36.5	29.2	23.4	67.2	1,460.9
1988	124.8	154.2	161.6	99.9	47.7	35.2	22.0	10.3	18.4	14.7	11.8	33.8	734.4
1989	120.4	148.7	155.8	96.3	46.0	34.0	21.2	9.9	17.7	14.2	11.3	32.6	706.1
1990	103.9	128.3	134.4	83.1	39.7	29.3	18.3	8.5	15.3	12.2	9.8	28.1	610.9
1991	109.2	134.9	141.4	87.4	41.8	30.8	19.3	9.0	16.1	12.9	10.3	29.6	642.7
1992	170.0	210.0	220.0	136.0	65.0	48.0	30.0	14.0	25.0	20.0	16.0	46.0	1,000.0
MAX	376.6	412.8	425.4	391.1	441.3	172.3	246.2	73.6	86.0	71.1	132.2	106.2	2,335.4
MEAN	153.5	192.7	192.3	121.7	60.5	41.4	25.2	12.3	19.2	16.1	13.2	29.2	877.5
MIN	53.4	37.3	43.9	24.3	0.2	1.1	0.7	0.0	0.6	0.0	0.0	0.8	387.2

* Corrected Values Through Double Mass Curve

Table 3.2.1 Monthly Evaporation Class A Land Pan at Portoviejo Station

(Unit : mm)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
1964	146.7	128.3	90.4	98.2	160.9	113.0	115.6	143.6	151.6	137.3	148.1	198.5	1,632.2
1965	184.8	157.3	132.5	112.8	138.7	137.0	140.4	155.7	142.2	151.9	146.8	185.1	1,785.2
1966	132.0	77.5	84.1	101.8	106.6	96.9	114.1	106.2	128.8	137.4	142.8	153.7	1,381.9
1967	95.7	64.9	84.0	137.2	122.0	93.7	112.4	138.8	121.5	132.8	136.5	146.0	1,385.5
1968	142.6	145.6	186.1	181.3	157.7	124.9	139.5	140.7	146.8	150.9	147.3	196.9	1,860.3
1969	144.2	147.9	143.7	124.7	111.7	92.6	130.7	148.7	152.2	158.0	152.0	165.5	1,671.9
1970	152.2	132.0	168.9	121.9	121.5	106.0	129.6	149.7	162.9	169.5	149.4	158.0	1,721.6
1971	141.7	112.0	109.3	127.9	138.1	104.7	122.9	144.4	146.9	139.1	127.7	130.6	1,545.3
1972	123.5	93.7	119.2	127.6	131.2	90.5	101.6	119.4	132.1	145.3	138.6	122.1	1,444.8
1973	94.3	82.0	129.4	132.1	129.6	98.8	113.7	134.8	132.0	139.3	141.2	129.9	1,457.1
1974	147.4	111.7	145.9	130.9	150.1	110.9	121.6	181.2	139.1	149.9	149.4	119.4	1,657.5
1975	99.7	76.9	126.0	108.4	117.7	94.5	93.8	116.7	118.6	142.9	133.1	142.4	1,370.7
1976	83.1	100.0	122.1	122.6	122.2	114.3	123.9	118.6	138.5	142.2	124.6	144.9	1,457.0
1977	118.3	118.5	137.6	137.1	164.1	121.6	128.7	145.4	187.7	153.7	153.3	141.6	1,707.6
1978	119.7	101.4	139.3	137.2	135.2	114.9	138.3	160.2	168.3	169.9	158.7	161.9	1,705.0
1979	125.3	125.3	145.9	126.9	138.2	110.5	140.6	153.2	141.6	154.6	154.4	153.7	1,670.2
1980	146.9	133.8	135.8	140.8	136.0	124.0	159.0	152.9	167.9	155.7	158.1	158.3	1,769.2
1981	148.3	100.0	140.9	138.3	159.5	154.1	131.6	146.2	149.7	155.4	149.6	157.3	1,730.9
1982	152.4	147.7	163.5	163.3	144.4	139.3	152.5	198.8	194.2	142.6	136.4	118.9	1,854.0
1983	104.4	108.9	143.6	130.0	125.5	119.2	113.0	123.0	99.4	107.4	106.4	124.3	1,405.1
1984	169.0	122.2	108.6	139.5	123.5	107.9	116.0	124.3	149.4	155.3	128.5	97.8	1,542.0
1985	118.6	125.8	136.1	144.2	150.8	123.7	130.9	152.8	155.2	162.2	158.0	130.4	1,688.7
1986	89.4	133.5	145.8	125.9	127.1	132.0	138.4	166.5	160.0	135.0	135.4	157.6	1,646.6
1987	117.8	88.2	144.1	126.5	118.7	119.5	109.2	123.3	131.5	131.9	161.1	147.8	1,519.6
1988	142.8	110.3	142.2	133.9	127.1	112.2	126.1	142.1	136.8	140.6	131.5	147.9	1,593.5
1989	110.0	101.4	118.3	129.1	125.2	96.4	110.1	150.0	137.1	141.7	156.3	154.3	1,529.9
1990	151.6	113.8	152.4	137.1	157.9	131.7	148.8	173.4	175.1	169.8	168.8	171.5	1,851.9
1991	150.1	105.0	162.0	179.4	165.8	155.8	192.0	155.9	182.4	163.8	148.4	150.1	1,910.7
1992	110.9	104.3	121.7	116.2	117.4	103.1	108.1	120.6	121.8	140.5	142.1	166.5	1,473.2
MAX	184.8	157.3	186.1	181.3	165.8	155.8	192.0	198.8	194.2	169.9	168.8	198.5	1,910.7
MEAN	129.8	112.8	133.8	132.2	135.3	115.3	127.7	144.4	147.3	147.5	144.3	149.4	1,619.6
MIN	83.1	64.9	84	98.2	106.6	90.5	93.8	106.2	99.4	107.4	106.4	97.8	1370.7

Table 3.3.1 Obsevation of Streamflow
(Carrizal River at Calceta)

(Unidad: m3/s)

AÑO	ENE	FEB	MAR	ABR	MAY	JUN	JUL	AGO	SEP	OCT	NOV	DIC	ANUAL
1964	5.45	23.66	54.63	69.42	6.60	1.25	0.70	0.40	0.25	0.20	0.20	0.10	162.86
1965	0.60	14.67	66.11	77.01	43.19	18.42	5.48	1.20	0.65	0.45	0.40	0.20	228.38
1966	12.48	64.64	53.59	28.56	8.21	2.53	0.90	0.55	0.40	0.50	0.20	0.20	172.76
1967	60.00	94.73	47.13	9.98	5.31	2.83	2.20	1.70	1.30	2.20	0.80	0.13	228.31
1968	2.23	5.36	5.40	4.40	28.50	59.08	35.91	23.00	7.20	2.50	1.10	0.84	175.52
1969	1.80	1.20	27.80	36.70	52.50	36.37	4.09	2.60	0.80	0.30	0.20	0.45	164.81
1970	0.30	11.70	17.20	78.40	28.90	4.80	2.40	1.50	0.70	0.50	0.40	0.30	147.10
1971	1.60	31.00	108.70	30.10	3.50	2.40	1.60	0.80	0.70	0.50	0.30	0.50	181.70
1972	2.00	31.70	62.60	42.71	6.70	61.90	34.10	5.70	5.00	4.80	4.20	0.20	261.61
1973	53.50	78.40	51.80	63.00	44.30	8.50	3.00	2.80	2.70	2.70	2.60	6.10	317.40
1974	2.70	14.90	24.30	1.70	2.70	1.20	1.00	0.80	0.50	0.30	0.20	2.70	53.00
1975	24.20	77.50	88.00	45.20	5.90	3.20	1.80	1.20	1.00	0.60	0.40	0.20	249.20
1976	26.70	45.80	65.80	43.10	36.30	11.90	6.00	2.50	1.30	0.70	0.70	0.40	241.20
1977	10.70	33.80	50.00	12.20	3.70	1.80	1.30	0.90	0.30	0.30	0.20	0.40	115.60
1978	2.40	12.50	20.60	8.80	7.70	1.90	0.90	0.50	0.30	0.30	0.20	0.20	56.30
1979	1.60	5.50	6.90	9.80	1.70	1.20	0.50	0.20	0.10	0.10	0.10	0.60	28.30
1980	0.10	3.20	5.20	23.60	3.70	1.30	0.30	0.30	0.20	0.10	0.10	0.10	38.20
MAX	60.00	94.73	108.70	78.40	52.50	61.90	35.91	23.00	7.20	4.80	4.20	6.10	317.40
MEDIA	12.26	32.25	44.46	34.39	17.02	12.98	6.01	2.74	1.38	1.00	0.72	0.80	166.01
MIN	0.10	1.20	5.20	1.70	1.70	1.20	0.30	0.20	0.10	0.10	0.10	0.10	28.30

Table 3.3.2 Obsevation of Streamflow
(Chico River at Alajuela)

(Unidad: m3/s)

AÑO	ENE	FEB	MAR	ABR	MAY	JUN	JUL	AGO	SEP	OCT	NOV	DIC	ANUAL
1970	0.90	1.40	2.20	7.60	3.10	1.50	0.30	0.10	0.00	0.00	0.00	0.00	17.10
1971	0.10	2.60	14.60	2.30	0.50	0.30	0.20	0.10	0.00	0.00	0.00	0.00	20.70
1972	0.10	2.30	0.20	4.40	0.50	7.10	2.60	1.20	0.80	0.70	0.60	0.00	20.50
1973	6.70	11.60	11.90	10.80	8.10	4.90	3.40	2.80	2.50	2.30	2.10	1.40	68.50
1974	2.00	0.00	0.00	0.00	2.70	2.10	1.80	1.50	1.30	1.10	1.00	2.00	15.50
1975	8.20	21.50	12.00	6.50	2.00	3.30	2.00	2.50	3.50	3.50	3.30	0.30	68.60
1976	6.40	14.70	14.80	13.70	13.70	8.20	6.70	5.70	5.40	4.70	4.80	3.30	102.10
1977	5.90	10.90	14.90	10.80	6.10	5.30	4.70	4.40	4.00	3.50	3.80	4.70	79.00
1978	1.40	1.00	1.00	0.40	0.10	0.00	0.00	0.00	0.00	0.00	0.00	3.80	7.70
1979	0.00	1.80	1.60	1.60	0.70	0.20	0.10	0.00	0.00	0.00	0.00	0.00	6.00
1980	0.00	0.00	0.00	2.50	1.10	0.40	0.10	0.00	0.00	0.00	0.00	0.00	4.10
1981	0.00	4.00	4.80	4.50	0.70	0.30	0.10	0.00	0.00	0.00	0.00	0.00	14.40
1982	0.00	0.80	4.80	4.50	3.20	1.10	0.90	0.40	0.10	1.60	2.80	0.00	20.20
MAX	8.20	21.50	14.90	13.70	13.70	8.20	6.70	5.70	5.40	4.70	4.80	4.70	102.10
MEDIA	2.44	5.58	6.37	5.35	3.27	2.67	1.76	1.44	1.35	1.34	1.42	1.19	34.18
MIN	0.00	0.00	0.00	0.00	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.10

Table 3.3.3 Obsevation of Streamflow
(Grande River at A.J. Mosquito)

(Unit:m3/s)

AÑO	ENE	FEB	MAR	ABR	MAY	JUN	JUL	AGO	SEP	OCT	NOV	DIC	ANUAL
1970	0.60	9.60	34.10	5.70	1.70	1.30	1.10	0.90	0.80	0.70	0.70	1.10 *	58.30
1971	1.00	4.00	17.50	12.60	3.60	11.40	5.80	0.90	0.50	0.40	0.20	0.70	58.60
1972	11.40	12.70	12.80	14.20	9.00	2.10	1.60	1.10	0.80	0.20	0.60	1.20	67.70
1973	0.50	8.30	5.60	0.70	0.60	0.30	0.20	0.20	0.10	0.10	0.10	0.50	17.20
1974	10.10	22.80	26.50	17.30	1.60	0.00	0.00	0.00	0.00	0.00	0.00	0.30	78.60
1975	11.40	16.20	15.80	11.30	10.50	3.20	0.00	0.00	0.00	0.00	0.00	0.00	68.40
1976	5.00	10.20	18.50	1.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.10	36.30
1977	0.80	6.00	7.20	3.00	0.50	0.30	0.20	0.10	0.10	0.10	0.10	0.10	18.50
1978	0.30	3.00	0.50	10.60	3.20	0.90	0.20	0.10	0.10	0.10	0.10	0.10	19.20
1979	0.30	16.00	10.50	1.80	1.80	0.20	0.10	0.00	0.00	0.30 *	0.40 *	0.20	31.60
1980	0.40	2.20	3.40	4.20	3.10	2.00	1.00	0.60	0.40	2.00	3.50	4.30	27.10
MAX	11.40	22.80	34.10	17.30	10.50	11.40	5.80	1.10	0.80	2.00	3.50	4.30	78.60
MEDIA	3.80	10.09	13.85	7.54	3.24	1.97	0.93	0.35	0.25	0.35	0.52	0.87	43.77
MIN	0.30	2.20	0.50	0.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	17.20

* ESTIMATED VALUES

Table 5.4.1 Estimated Long-term Runoff in m^3/sec for Chico River in Alajuela

(Unit : m3/s)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN
1964	1.44	1.12	6.60	6.75	2.01	1.54	1.32	1.17	1.07	0.92	0.84	0.72	2.13
1965	0.67	1.04	8.85	7.57	7.54	2.66	1.69	1.50	1.37	1.18	1.08	0.94	3.01
1966	9.83	8.02	6.19	3.76	3.02	2.28	1.94	1.72	1.58	1.35	1.24	1.06	3.50
1967	14.73	18.07	9.42	3.43	2.43	1.97	1.69	1.50	1.38	1.18	1.08	0.93	4.82
1968	0.86	8.83	2.26	1.35	1.03	0.93	0.80	0.71	0.68	0.56	0.51	0.44	1.58
1969	0.54	0.43	4.91	3.04	5.20	2.02	1.46	1.30	1.19	1.02	0.93	0.80	1.90
1970	0.82	1.23	3.03	6.63	2.98	2.10	1.47	1.30	1.19	1.02	0.94	0.81	1.96
1971	0.74	2.36	11.53	5.04	1.76	1.50	1.26	1.12	1.02	0.88	0.80	0.69	2.39
1972	0.64	1.52	8.23	4.63	2.80	5.72	2.39	1.97	1.81	1.51	1.38	1.48	2.84
1973	7.31	11.43	13.76	9.30	6.65	3.56	2.64	2.34	2.14	1.84	1.68	1.44	5.34
1974	1.28	6.10	3.38	2.05	1.47	1.36	1.16	1.03	0.94	0.81	0.74	0.64	1.75
1975	7.82	15.95	14.48	10.41	3.96	2.50	2.04	1.81	1.66	1.42	1.30	1.12	5.37
1976	8.50	13.55	14.92	14.53	10.03	6.21	3.17	2.57	2.35	2.02	1.85	1.59	6.77
1977	2.86	7.48	9.34	6.92	2.70	2.20	1.88	1.67	1.53	1.31	1.20	1.04	3.34
1978	1.33	3.47	3.72	2.13	1.65	1.32	1.13	1.01	0.92	0.79	0.72	0.62	1.57
1979	0.61	1.57	2.24	1.58	0.91	0.78	0.67	0.59	0.54	0.46	0.43	0.37	0.90
1980	0.33	0.50	2.27	5.55	2.68	1.18	0.99	0.87	0.80	0.69	0.63	0.54	1.42
1981	0.50	6.69	3.89	3.75	2.27	1.46	1.25	1.10	1.01	0.87	0.80	0.68	2.02
1982	0.69	0.73	1.08	0.52	0.42	0.37	0.31	0.28	0.26	0.50	1.41	8.80	1.28
1983	12.60	16.85	16.85	21.30	18.34	14.40	15.36	10.93	10.27	4.33	3.46	2.97	12.31
1984	3.62	15.69	17.92	9.61	3.94	3.04	2.60	2.31	2.11	1.81	1.66	1.44	5.48
1985	1.36	2.19	4.26	5.18	2.29	1.78	1.44	1.27	1.17	1.00	0.92	0.79	1.97
1986	10.43	6.97	2.59	3.53	1.71	1.50	1.29	1.14	1.05	0.90	0.82	0.71	2.72
1987	1.89	14.88	11.07	15.76	9.62	3.52	2.28	2.04	1.84	1.58	1.45	1.25	5.60
1988	1.34	6.41	3.03	5.60	3.39	2.05	1.73	1.54	1.41	1.21	1.11	0.95	2.48
1989	12.71	17.26	12.59	11.04	4.09	2.45	2.05	1.82	1.67	1.43	1.31	1.12	5.80
1990	1.02	1.10	2.72	4.34	1.39	1.17	1.00	0.89	0.81	0.70	0.64	0.55	1.36
1991	0.79	1.73	5.69	2.65	1.52	1.12	0.93	0.82	0.75	0.65	0.59	0.51	1.48
1992	5.30	11.26	20.14	20.52	19.42	10.59	3.85	2.63	2.40	2.06	1.89	1.62	8.47
MAX	14.73	18.07	20.14	21.30	19.42	14.40	15.36	10.93	10.27	4.33	3.46	8.80	12.31
MEAN	3.88	7.05	7.83	6.84	4.39	2.87	2.13	1.76	1.62	1.24	1.15	1.26	3.50
MIN	0.33	0.43	1.08	0.52	0.42	0.37	0.31	0.28	0.26	0.46	0.43	0.37	0.90

Table 5.4.2 Estimated Long-term Runoff in m^3/sec for Grande River in A. J. Mosquito

(Unit : ms/s)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN
1964	12.99	9.61	15.31	19.31	4.08	1.29	0.94	0.77	0.65	0.51	0.43	0.34	5.52
1965	0.42	1.68	10.06	14.62	5.71	1.81	0.66	0.29	0.22	0.17	0.15	0.12	2.99
1966	4.30	15.32	14.14	7.04	2.25	0.79	0.44	0.37	0.32	0.25	0.20	0.17	3.80
1967	8.37	19.31	7.28	1.90	0.79	0.42	0.33	0.27	0.23	0.18	0.15	0.12	3.28
1968	0.21	0.68	0.75	0.59	0.06	0.04	0.03	0.03	0.02	0.02	0.01	0.01	0.20
1969	0.24	0.15	3.80	4.47	2.64	3.46	1.50	0.32	0.26	0.21	0.18	0.14	1.45
1970	0.54	0.89	4.88	12.94	4.43	0.82	0.25	0.19	0.16	0.13	0.11	0.09	2.12
1971	0.12	3.30	23.52	8.07	0.94	0.26	0.19	0.15	0.13	0.10	0.09	0.07	3.08
1972	0.06	6.41	10.70	5.58	1.24	9.93	2.98	2.29	0.45	0.35	0.29	1.35	3.47
1973	8.35	5.11	12.82	9.37	5.68	1.04	0.50	0.34	0.29	0.23	0.19	0.15	3.67
1974	0.19	14.30	3.05	4.94	0.60	0.24	0.16	0.13	0.11	0.09	0.07	0.11	2.00
1975	10.02	20.28	25.15	15.85	2.79	1.05	0.44	0.33	0.28	0.22	0.18	0.17	6.40
1976	11.55	15.00	15.35	13.39	7.68	8.52	1.16	0.42	0.35	0.28	0.24	0.20	6.18
1977	8.92	22.42	18.68	9.47	0.87	0.33	0.24	0.19	0.16	0.13	0.11	0.09	5.13
1978	1.76	9.39	8.81	2.22	1.00	0.24	0.18	0.15	0.12	0.10	0.08	0.07	2.01
1979	0.57	5.74	2.98	1.28	0.20	0.28	0.10	0.08	0.07	0.05	0.05	0.04	0.95
1980	0.44	5.06	11.88	9.39	2.59	0.31	0.18	0.15	0.12	0.10	0.08	0.07	2.53
1981	0.60	8.00	8.39	8.75	0.70	0.20	0.16	0.13	0.11	0.09	0.07	0.06	2.27
1982	0.48	0.45	1.39	0.67	0.19	0.03	0.02	0.02	0.01	1.54	5.27	14.15	2.02
1983	24.69	34.19	30.88	20.58	32.40	26.34	19.28	9.38	4.91	0.77	0.48	0.47	17.03
1984	0.31	7.69	17.30	13.22	2.22	0.57	0.32	0.26	0.22	0.17	0.15	0.37	3.57
1985	1.02	5.73	4.17	2.21	0.41	0.18	0.14	0.12	0.10	0.08	0.07	0.10	1.19
1986	9.26	5.26	5.79	9.58	1.35	0.28	0.22	0.18	0.15	0.12	0.10	0.15	2.70
1987	2.54	26.99	21.61	26.23	11.26	1.49	0.38	0.44	0.24	0.19	0.16	0.14	7.64
1988	1.37	7.69	1.46	1.74	0.79	0.21	0.13	0.10	0.09	0.07	0.06	0.05	1.15
1989	4.16	18.02	8.61	9.88	2.50	0.60	0.31	0.25	0.21	0.17	0.14	0.11	3.75
1990	0.36	2.41	4.87	7.34	0.58	0.17	0.13	0.10	0.09	0.07	0.06	0.05	1.35
1991	0.14	4.49	2.77	0.76	0.11	0.09	0.07	0.06	0.05	0.04	0.03	0.03	0.72
1992	1.39	4.01	8.07	11.17	7.67	1.06	0.36	0.27	0.23	0.18	0.15	0.12	2.89
MAX	24.69	34.19	30.88	26.23	32.40	26.34	19.28	9.38	4.91	1.54	5.27	14.15	17.03
MEAN	3.98	9.64	10.50	8.71	3.58	2.14	1.10	0.61	0.36	0.23	0.32	0.66	3.48
MIN	0.06	0.15	0.75	0.59	0.06	0.03	0.02	0.02	0.01	0.02	0.01	0.01	0.20

Table 5.4.3 Estimated Long-term Runoff in m^3/sec for Carrizal River in Calceta

(Unit : m3/s)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN
1964	25.36	27.26	52.28	49.46	18.31	8.49	4.03	1.77	0.79	0.33	0.14	0.06	15.69
1965	0.95	10.91	51.34	51.77	50.80	22.21	8.68	4.33	1.93	0.80	0.36	0.56	17.05
1966	37.40	42.97	42.12	31.91	23.49	11.35	6.60	3.24	1.83	0.67	0.30	0.27	16.85
1967	52.92	71.59	46.53	23.56	15.62	7.65	3.56	1.53	0.68	0.28	0.12	0.05	18.67
1968	1.35	45.69	22.14	15.68	7.02	3.55	1.49	0.64	0.55	0.12	0.05	0.02	8.19
1969	2.05	3.02	36.67	30.35	42.31	19.38	8.48	4.27	1.91	0.80	0.39	0.15	12.48
1970	1.99	5.02	13.95	32.17	34.40	14.23	8.60	4.43	1.98	0.82	0.37	0.24	9.85
1971	1.46	20.45	61.28	33.18	12.91	6.85	3.20	1.38	0.69	0.25	0.11	0.07	11.82
1972	1.05	34.11	53.77	42.06	23.82	42.86	29.01	15.03	7.62	3.38	1.50	3.00	21.43
1973	42.46	25.69	50.20	41.33	37.91	18.09	8.29	4.18	1.88	0.78	0.35	0.17	19.28
1974	0.16	10.44	11.93	9.74	6.23	3.31	1.42	0.61	0.27	0.11	0.05	0.19	3.71
1975	22.41	73.06	70.84	42.54	17.52	8.50	4.22	1.90	0.94	0.52	0.16	1.20	20.32
1976	56.05	47.11	44.29	34.80	21.59	9.96	4.99	2.17	0.96	0.40	0.18	0.09	18.55
1977	13.85	39.16	60.80	33.30	13.59	6.43	2.84	1.21	0.55	0.22	0.10	0.05	14.34
1978	2.61	16.18	33.16	21.04	22.35	8.96	4.45	1.93	0.86	0.35	0.16	0.07	9.34
1979	5.81	14.86	16.58	23.84	24.30	11.27	5.77	2.63	1.17	0.48	0.21	0.09	8.92
1980	0.67	11.24	16.54	31.93	13.14	6.42	2.88	1.23	0.55	0.23	0.10	0.09	7.09
1981	0.74	39.46	38.55	40.75	13.43	6.28	3.05	1.28	0.57	0.24	0.10	0.14	12.05
1982	0.89	7.36	13.51	15.56	7.23	3.99	1.76	0.75	0.34	1.78	18.46	45.88	9.79
1983	65.52	71.07	90.03	87.54	72.24	60.31	63.99	47.88	34.68	13.56	7.50	5.53	51.65
1984	2.80	46.35	51.70	51.71	24.82	10.04	5.16	2.28	1.01	0.42	0.18	0.29	16.40
1985	1.16	8.98	24.47	23.70	8.78	4.89	2.18	0.93	0.41	0.17	0.08	0.46	6.35
1986	23.81	28.38	25.42	41.25	14.19	7.02	3.14	1.35	0.60	0.33	0.11	0.11	12.14
1987	10.98	76.13	83.12	86.34	55.10	21.91	8.89	5.52	2.77	1.15	0.51	0.37	29.40
1988	9.13	55.46	29.67	29.23	29.59	13.23	7.10	3.47	1.54	0.66	0.30	0.22	14.97
1989	30.86	54.97	33.83	47.91	20.06	10.32	5.29	2.33	1.06	0.43	0.19	0.15	17.28
1990	0.51	5.50	7.59	8.52	4.09	1.91	0.79	0.34	0.15	0.06	0.03	0.01	2.46
1991	1.29	18.06	33.34	25.09	10.25	7.38	3.38	1.46	0.65	0.27	0.12	0.07	8.45
1992	0.75	5.36	34.54	45.44	25.69	12.08	6.15	2.80	1.25	0.52	0.23	0.14	11.25
MAX	65.52	76.13	90.03	87.54	72.24	60.31	63.99	47.88	34.68	13.56	18.46	45.88	51.65
MEAN	14.38	31.58	39.66	36.27	23.13	12.72	7.57	4.24	2.42	1.04	1.12	2.06	14.68
MIN	0.16	3.02	7.59	8.52	4.09	1.91	0.79	0.34	0.15	0.06	0.03	0.01	2.46

Table 5.4.4 Estimated Long-term Runoff in m^3/sec at Proposed La Esperanza Damsite

Table

(Unit : m3/s)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN
1964	21.57	23.19	44.48	42.09	15.58	7.23	3.43	1.51	0.67	0.28	0.12	0.05	13.35
1965	0.81	9.28	43.68	44.05	43.22	18.90	7.38	3.68	1.65	0.68	0.30	0.48	14.51
1966	31.83	36.56	35.84	27.15	19.99	9.66	5.62	2.76	1.56	0.57	0.25	0.23	14.34
1967	45.03	60.91	39.59	20.04	13.29	6.51	3.03	1.30	0.58	0.24	0.11	0.05	15.89
1968	1.15	38.87	18.84	13.34	5.97	3.02	1.27	0.54	0.47	0.10	0.04	0.02	6.97
1969	1.75	2.57	31.20	25.82	36.00	16.49	7.21	3.63	1.62	0.68	0.33	0.13	10.62
1970	1.69	4.27	11.87	27.38	29.27	12.11	7.32	3.77	1.69	0.70	0.31	0.20	8.38
1971	1.24	17.40	52.14	28.23	10.98	5.83	2.72	1.17	0.59	0.22	0.10	0.06	10.06
1972	0.89	29.03	45.75	35.79	20.27	36.47	24.68	12.79	6.49	2.88	1.28	2.55	18.24
1973	36.13	21.85	42.71	35.17	32.26	15.40	7.05	3.56	1.60	0.66	0.29	0.14	16.40
1974	0.14	8.88	10.15	8.28	5.30	2.82	1.20	0.52	0.23	0.10	0.04	0.16	3.15
1975	19.07	62.16	60.27	36.20	14.91	7.23	3.59	1.62	0.80	0.44	0.14	1.02	17.29
1976	47.69	40.09	37.69	29.61	18.37	8.47	4.24	1.85	0.82	0.34	0.15	0.08	15.78
1977	11.78	33.32	51.73	28.33	11.57	5.47	2.41	1.03	0.47	0.19	0.08	0.05	12.20
1978	2.22	13.77	28.21	17.91	19.02	7.63	3.79	1.64	0.73	0.30	0.13	0.06	7.95
1979	4.94	12.65	14.11	20.28	20.67	9.59	4.91	2.24	0.99	0.41	0.18	0.07	7.59
1980	0.57	9.56	14.08	27.17	11.18	5.46	2.45	1.05	0.47	0.19	0.09	0.08	6.03
1981	0.63	33.58	32.80	34.67	11.42	5.34	2.59	1.09	0.48	0.20	0.09	0.12	10.25
1982	0.76	6.26	11.49	13.24	6.15	3.39	1.49	0.64	0.29	1.51	15.71	39.04	8.33
1983	55.75	60.47	76.61	74.48	61.47	51.31	54.45	40.74	29.51	11.54	6.38	4.70	43.95
1984	2.38	39.44	43.99	44.00	21.11	8.54	4.39	1.94	0.86	0.36	0.16	0.25	13.95
1985	0.99	7.64	20.82	20.17	7.47	4.16	1.85	0.79	0.35	0.15	0.07	0.40	5.41
1986	20.26	24.15	21.63	35.09	12.08	5.97	2.67	1.15	0.51	0.28	0.09	0.10	10.33
1987	9.34	64.78	70.72	73.46	46.88	18.64	7.57	4.70	2.35	0.98	0.44	0.31	25.01
1988	7.77	47.19	25.24	24.87	25.17	11.26	6.04	2.95	1.31	0.56	0.25	0.18	12.73
1989	26.26	46.77	28.79	40.76	17.07	8.78	4.50	1.98	0.90	0.37	0.16	0.13	14.71
1990	0.44	4.68	6.46	7.25	3.48	1.62	0.67	0.29	0.13	0.05	0.02	0.01	2.09
1991	1.10	15.36	28.37	21.35	8.72	6.28	2.88	1.25	0.55	0.23	0.10	0.06	7.19
1992	0.64	4.56	29.39	38.66	21.86	10.27	5.23	2.38	1.06	0.44	0.20	0.12	9.57
MAX.	55.75	64.78	76.61	74.48	61.47	51.31	54.45	40.74	29.51	11.54	15.71	39.04	43.95
MEAN	12.24	26.87	33.75	30.86	19.68	10.82	6.44	3.61	2.06	0.88	0.95	1.75	12.49
MIN.	0.14	2.57	6.46	7.25	3.48	1.62	0.67	0.29	0.13	0.05	0.02	0.01	2.09

Table 5.4.5 Estimated Long-term Runoff in m^3/sec at Poza Honda Damsite

(Unit: m3/s)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN
1964	1.34	1.04	6.13	6.27	1.87	1.43	1.23	1.09	1.00	0.86	0.78	0.67	1.98
1965	0.62	0.96	8.22	7.03	7.01	2.47	1.57	1.39	1.27	1.09	1.00	0.88	2.79
1966	9.13	7.45	5.75	3.49	2.81	2.11	1.80	1.60	1.47	1.25	1.15	0.99	3.25
1967	13.69	16.79	8.75	3.19	2.26	1.83	1.57	1.39	1.28	1.10	1.01	0.86	4.48
1968	0.80	8.20	2.10	1.26	0.95	0.87	0.74	0.66	0.63	0.52	0.48	0.41	1.47
1969	0.50	0.40	4.56	2.82	4.83	1.88	1.36	1.20	1.10	0.95	0.87	0.74	1.77
1970	0.76	1.14	2.81	6.16	2.76	1.95	1.37	1.21	1.11	0.95	0.87	0.75	1.82
1971	0.69	2.20	10.71	4.68	1.64	1.39	1.17	1.04	0.95	0.82	0.75	0.64	2.22
1972	0.60	1.41	7.65	4.30	2.60	5.31	2.22	1.83	1.68	1.40	1.28	1.38	2.64
1973	6.79	10.61	12.79	8.64	6.17	3.31	2.46	2.17	1.99	1.71	1.56	1.34	4.96
1974	1.19	5.66	3.14	1.90	1.37	1.26	1.07	0.95	0.87	0.75	0.69	0.59	1.62
1975	7.27	14.81	13.45	9.67	3.68	2.32	1.90	1.68	1.54	1.32	1.21	1.04	4.99
1976	7.90	12.59	13.86	13.49	9.32	5.77	2.94	2.39	2.18	1.87	1.72	1.48	6.29
1977	2.66	6.95	8.68	6.43	2.50	2.05	1.75	1.55	1.42	1.22	1.12	0.96	3.11
1978	1.24	3.23	3.46	1.98	1.53	1.23	1.05	0.93	0.86	0.73	0.67	0.58	1.46
1979	0.56	1.46	2.08	1.47	0.84	0.73	0.62	0.55	0.50	0.43	0.40	0.34	0.83
1980	0.31	0.46	2.11	5.15	2.49	1.10	0.92	0.81	0.74	0.64	0.59	0.50	1.32
1981	0.47	6.21	3.62	3.49	2.11	1.35	1.16	1.03	0.94	0.81	0.74	0.63	1.88
1982	0.64	0.68	1.00	0.48	0.39	0.34	0.29	0.26	0.24	0.47	1.31	8.17	1.19
1983	11.71	15.65	15.65	19.79	17.03	13.38	14.27	10.15	9.54	4.02	3.21	2.76	11.43
1984	3.37	14.58	16.64	8.93	3.66	2.82	2.42	2.14	1.96	1.68	1.54	1.34	5.09
1985	1.26	2.03	3.96	4.81	2.13	1.65	1.33	1.18	1.08	0.93	0.85	0.74	1.83
1986	9.69	6.48	2.40	3.28	1.59	1.39	1.20	1.06	0.97	0.83	0.76	0.66	2.53
1987	1.76	13.82	10.28	14.64	8.93	3.27	2.12	1.90	1.71	1.47	1.34	1.16	5.20
1988	1.25	5.95	2.82	5.21	3.15	1.90	1.61	1.43	1.31	1.12	1.03	0.88	2.31
1989	11.81	16.03	11.69	10.25	3.80	2.27	1.90	1.69	1.55	1.33	1.22	1.04	5.38
1990	0.95	1.02	2.53	4.03	1.29	1.08	0.93	0.83	0.76	0.65	0.59	0.51	1.26
1991	0.74	1.61	5.29	2.46	1.41	1.04	0.86	0.76	0.70	0.60	0.55	0.47	1.37
1992	4.92	10.46	18.71	19.06	18.04	9.83	3.58	2.44	2.23	1.91	1.75	1.50	7.87
MAX	**13.69**	**16.79**	**18.71**	**19.79**	**18.04**	**13.38**	**14.27**	**10.15**	**9.54**	**4.02**	**3.21**	**8.17**	**11.43**
MEAN	**3.61**	**6.55**	7.27	**6.36**	**4.07**	2.67	**1.98**	**1.63**	**1.50**	**1.15**	**1.07**	**1.17**	**3.25**
MIN	**0.31**	**0.40**	**1.00**	**0.48**	**0.39**	**0.34**	**0.29**	**0.26**	**0.24**	**0.43**	**0.40**	**0.34**	**0.83**

Table 5.4.6 Estimated Long-term Runoff in m^3/sec at Santa Ana New Diversion Damsite

(Units: m3/s)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN
1964	3.65	2.55	15.46	16.63	5.04	3.91	3.35	2.97	2.72	2.34	2.14	1.84	5.22
1965	1.67	2.20	19.75	16.41	13.71	5.67	4.06	3.59	3.29	2.82	2.59	2.23	6.50
1966	16.18	14.70	12.01	7.51	5.98	4.95	4.24	3.75	3.45	2.95	2.71	2.32	6.73
1967	28.17	39.67	20.62	7.59	5.43	4.62	3.96	3.51	3.22	2.76	2.53	2.17	10.35
1968	2.00	13.30	3.29	2.49	2.00	1.83	1.57	1.39	1.29	1.09	1.00	0.86	2.68
1969	1.06	0.89	8.65	8.08	12.15	5.17	3.65	3.22	2.95	2.53	2.32	1.99	4.39
1970	2.02	2.85	6.15	13.88	6.52	4.42	3.31	2.93	2.69	2.31	2.11	1.81	4.25
1971	1.67	5.20	25.83	10.24	3.95	3.48	2.94	2.61	2.39	2.05	1.88	1.61	5.32
1972	1.53	4.14	17.46	9.52	5.54	12.17	5.58	4.61	4.17	3.53	3.24	3.10	6.22
1973	12.81	21.97	28.24	20.12	13.84	8.48	6.41	5.67	5.19	4.46	4.08	3.50	11.23
1974	3.11	11.12	6.71	4.51	3.36	3.08	2.63	2.34	2.14	1.84	1.68	1.45	3.66
1975	16.03	35.88	34.25	24.37	8.88	6.11	5.04	4.46	4.09	3.51	3.22	2.76	12.38
1976	17.64	30.95	32.24	30.24	19.10	13.53	7.67	6.41	5.87	5.04	4.62	3.97	14.77
1977	5.86	15.16	19.76	13.84	6.14	5.33	4.54	4.03	3.69	3.17	2.90	2.50	7.24
1978	2.99	6.99	8.57	4.55	3.69	2.97	2.54	2.25	2.06	1.77	1.62	1.39	3.45
1979	1.33	3.36	4.27	3.36	1.92	1.62	1.37	1.22	1.12	0.96	0.88	0.75	1.85
1980	0.69	0.96	4.02	9.41	5.12	2.43	2.05	1.81	1.66	1.43	1.31	1.12	2.67
1981	1.03	11.59	9.08	8.30	4.40	3.17	2.72	2.41	2.21	1.90	1.74	1.49	4.17
1982	1.42	1.44	1.83	1.06	0.87	0.76	0.65	0.58	0.53	0.78	2.05	17.19	2.43
1983	29.06	38.98	39.54	47.44	45.55	36.24	35.96	23.67	20.37	9.78	8.51	7.31	28.53
1984	7.35	29.40	37.22	18.12	8.35	7.11	6.10	5.41	4.96	4.25	3.90	3.40	11.30
1985	3.25	4.91	8.67	9.85	4.57	3.74	3.11	2.76	2.53	2.17	1.99	1.71	4.11
1986	20.94	13.91	6.29	7.89	4.13	3.60	3.09	2.74	2.51	2.15	1.97	1.69	5.91
1987	4.19	29.89	22.59	31.72	19.50	7.51	5.53	5.00	4.49	3.85	3.53	3.03	11.74
1988	3.20	12.87	7.11	11.46	7.18	4.71	4.01	3.56	3.26	2.80	2.56	2.21	5.41
1989	21.29	33.10	26.11	22.06	8.95	6.11	5.08	4.50	4.13	3.54	3.24	2.79	11.74
1990	2.53	2.69	4.91	6.77	2.72	2.39	2.05	1.82	1.66	1.43	1.31	1.13	2.62
1991	1.36	2.70	8.72	3.93	2.37	1.86	1.55	1.38	1.26	1.08	0.99	0.85	2.34
1992	8.21	19.35	38.54	38.74	35.19	17.93	7.62	6.15	5.63	4.83	4.43	3.80	15.87
MAX	29.06	39.67	39.54	47.44	45.55	36.24	35.96	23.67	20.37	9.78	8.51	17.19	28.53
MEAN	7.66	14.23	16.48	14.14	9.18	6.38	4.91	4.03	3.64	2.87	2.66	2.83	7.42
MIN	0.69	0.89	1.83	1.06	0.87	0.76	0.65	0.58	0.53	0.78	0.88	0.75	1.85

Table 5.4.7 Estimated Long-term Runoff in m^3/sec for Carrizal River in La Estancilla

(Unit : m3/s)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN
1964	20.03	31.04	59.06	66.91	40.25	25.89	15.17	8.64	4.90	2.54	1.38	0.69	23.04
1965	1.13	8.84	49.77	62.93	65.44	44.77	26.92	16.33	9.59	5.09	2.81	1.73	24.61
1966	30.99	49.12	53.92	49.24	39.75	27.65	17.95	11.06	6.86	3.67	2.05	1.16	24.45
1967	45.71	78.29	64.63	46.17	32.80	21.92	12.87	7.35	4.18	2.17	1.18	0.60	26.49
1968	1.24	35.41	27.71	25.39	16.52	10.84	6.17	3.46	2.13	1.06	0.57	0.29	10.90
1969	1.92	2.85	31.72	37.25	49.86	36.64	23.03	14.35	8.56	4.59	2.58	1.32	17.89
1970	2.23	5.12	13.94	36.78	41.94	29.01	19.96	12.92	7.89	4.29	2.41	1.30	14.82
1971	1.68	17.85	62.69	50.42	30.55	20.34	11.92	6.78	3.90	2.01	1.09	0.56	17.48
1972	1.11	29.32	54.83	56.62	41.24	56.01	45.10	32.09	21.62	12.58	7.38	5.76	30.31
1973	38.52	37.85	57.49	57.09	54.47	37.87	23.76	14.62	8.68	4.64	2.58	1.33	28.24
1974	0.78	10.53	13.76	14.45	11.38	8.10	4.79	2.75	1.56	0.81	0.45	0.39	5.81
1975	21.38	73.47	87.91	72.07	43.22	27.52	16.20	9.25	5.32	2.87	1.54	1.68	30.20
1976	45.71	56.15	63.90	57.56	42.05	28.14	17.18	9.97	5.66	2.93	1.59	0.82	27.64
1977	12.82	39.95	65.88	53.53	32.49	20.88	11.90	6.66	3.74	1.92	1.04	0.53	20.95
1978	2.61	16.59	34.38	29.95	30.88	21.07	13.12	7.74	4.49	2.36	1.30	0.66	13.76
1979	4.53	14.60	19.09	27.93	30.84	22.69	14.82	9.06	5.37	2.87	1.59	0.81	12.85
1980	0.88	9.48	19.09	35.85	24.18	16.58	9.88	5.66	3.23	1.68	0.91	0.50	10.66
1981	0.80	33.49	44.08	52.63	30.62	19.77	11.52	6.50	3.67	1.90	1.03	0.58	17.22
1982	0.89	6.01	12.61	18.98	13.50	9.69	5.80	3.34	1.91	2.21	14.97	44.31	11.19
1983	75.88	95.02	110.82	119.48	19.03	99.27	98.67	79.97	64.04	37.64	24.53	16.01	70.03
1984	9.72	45.36	61.34	66.52	44.86	28.94	17.43	10.13	5.82	3.04	1.66	1.09	24.66
1985	1.68	9.20	23.88	29.38	18.92	13.06	7.68	4.39	2.49	1.29	0.70	0.67	9.45
1986	18.86	32.68	35.37	50.48	30.97	20.65	12.08	6.82	3.84	2.04	1.09	0.61	17.96
1987	9.75	70.32	94.24	109.30	86.18	54.89	32.06	19.93	12.06	6.51	3.64	2.03	41.74
1988	8.20	49.46	41.64	42.44	41.09	28.89	18.85	11.68	6.96	3.74	2.08	1.14	21.35
1989	25.02	57.43	50.38	62.84	40.80	27.82	17.20	10.08	5.81	3.03	1.65	0.91	25.25
1990	0.88	4.94	8.20	10.70	7.92	5.35	3.06	1.72	0.97	0.50	0.27	0.14	3.72
1991	1.04	14.34	32.17	32.67	21.56	16.18	9.96	5.89	3.42	1.80	0.99	0.52	11.71
1992	0.96	5.88	32.82	50.53	39.45	27.76	17.70	10.65	6.23	3.29	1.82	0.97	16.51
MAX	75.88	95.02	110.82	119.48	86.18	99.27	98.67	79.97	64.04	37.64	24.53	44.31	70.03
MEAN	13.34	32.43	45.77	49.18	35.27	27.87	18.72	12.06	7.76	4.31	3.00	3.07	21.06
MIN	0.78	2.85	8.20	10.70	7.92	5.35	3.06	1.72	0.97	0.50	0.27	0.14	3.72

Table 5.4.8 Estimated Long-term Runoff in m^3/sec at Proposed La Ciénega Diversion Damsite

(Unit : m3/s)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN
1964	1.72	1.72	8.26	9.64	5.16	4.18	3.37	2.86	2.56	2.16	1.96	1.68	3.77
1965	1.52	1.88	10.54	10.97	11.45	7.05	5.11	4.14	3.56	2.93	2.61	2.22	5.33
1966	11.58	12.12	10.55	8.24	6.76	5.61	4.64	4.03	3.65	3.12	2.85	2.45	6.30
1967	17.82	25.82	17.22	10.43	7.56	6.02	4.72	3.94	3.46	2.89	2.61	2.22	8.73
1968	2.00	10.46	4.93	3.78	2.89	2.47	2.03	1.75	1.60	1.34	1.23	1.05	2.96
1969	1.12	1.01	5.73	4.82	7.36	4.69	3.63	3.09	2.76	2.33	2.12	1.82	3.37
1970	1.72	2.15	4.10	8.58	5.64	4.60	3.57	3.05	2.73	2.32	2.11	1.81	3.53
1971	1.64	3.41	14.48	9.11	5.35	4.34	3.42	2.86	2.52	2.11	1.91	1.62	4.40
1972	1.47	2.57	10.73	8.06	5.84	8.84	5.61	4.70	4.19	3.50	3.17	2.98	5.14
1973	9.45	16.26	19.82	16.42	13.08	9.51	7.29	6.05	5.31	4.43	3.99	3.40	9.58
1974	3.00	8.13	5.90	4.69	3.68	3.28	2.76	2.42	2.21	1.90	1.74	1.51	3.44
1975	9.56	21.61	22.11	18.74	10.95	8.11	6.14	5.00	4.32	3.56	3.18	2.69	9.66
1976	10.85	18.75	22.07	23.34	18.55	14.05	9.57	7.53	6.39	5.20	4.60	3.86	12.06
1977	4.78	10.25	13.45	12.02	7.39	6.10	4.93	4.20	3.75	3.17	2.89	2.47	6.28
1978	2.60	4.99	5.58	4.43	3.61	3.11	2.63	2.32	2.12	1.82	1.67	1.45	3.03
1979	1.34	2.46	3.14	2.75	2.03	1.79	1.50	1.32	1.21	1.04	0.95	0.82	1.70
1980	0.74	0.89	2.75	6.71	4.56	3.15	2.50	2.10	1.86	1.57	1.42	1.21	2.46
1981	1.10	7.75	5.87	6.06	4.56	3.59	2.94	2.53	2.27	1.93	1.76	1.51	3.49
1982	1.42	1.47	1.67	1.23	1.01	0.89	0.75	0.66	0.60	0.79	1.83	10.42	1.90
1983	17.33	24.67	26.26	33.55	31.94	28.75	28.67	22.62	20.66	12.91	10.35	8.19	22.16
1984	7.78	21.58	26.40	18.80	11.76	9.33	7.34	6.12	5.39	4.51	4.07	3.48	10.55
1985	3.17	4.05	6.21	7.73	5.12	4.32	3.53	3.06	2.77	2.36	2.16	1.86	3.86
1986	12.97	11.25	6.45	6.91	4.60	3.91	3.20	2.76	2.48	2.11	1.93	1.66	5.02
1987	2.73	18.75	16.92	23.42	17.46	10.69	7.61	6.04	5.08	4.11	3.62	3.04	9.96
1988	2.89	8.31	5.56	8.36	6.41	5.00	4.12	3.57	3.23	2.76	2.52	2.17	4.58
1989	15.52	24.28	20.89	19.60	11.33	8.27	6.27	5.09	4.38	3.60	3.22	2.72	10.43
1990	2.41	2.48	3.93	5.99	3.45	2.95	2.44	2.12	1.92	1.64	1.50	1.29	2.68
1991	1.45	2.56	6.83	4.72	3.44	2.80	2.26	1.93	1.73	1.47	1.34	1.15	2.64
1992	6.19	14.49	27.27	31.66	31.96	22.57	13.16	9.51	7.63	5.93	5.07	4.14	14.97
MAX	17.82	25.82	27.27	33.55	31.96	28.75	28.67	22.62	20.66	12.91	10.35	10.42	22.16
MEAN	5.44	9.87	11.57	11.41	8.79	6.90	5.37	4.39	3.87	3.09	2.77	2.65	6.34
MIN	0.74	0.89	1.67	1.23	1.01	0.89	0.75	0.66	0.60	0.79	0.95	0.82	1.70