

*The Feasibility Study of the Flood Control Project for
the Lower Cagayan River in the Republic of the Philippines
Final Report
Supporting Report*

**ANNEX IV :
METEO-HYDROLOGY**

THE FEASIBILITY STUDY OF
THE FLOOD CONTROL PROJECT FOR THE LOWER CAGAYAN RIVER IN
THE REPUBLIC OF THE PHILIPPINES

FINAL REPORT

Volume III-1 SUPPORTING REPORT
ANNEX IV METEO-HYDROLOGY

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CHAPTER 1 GENERAL DESCRIPTION

1.1 Meteorology of Cagayan River Basin

The climate in the Cagayan river basin consists of two tropical monsoons, i.e. the Southwest Monsoon and the Northeast Monsoon. According to the climate classification by Philippine Atmospheric, the Geophysical and Astronomical Services Administration (PAGASA), climate in the Cagayan river basin falls under Type III. This climate type is characterized as not having very pronounced seasons with relatively dry weather condition from November to April while the remaining of the year is noted as wet weather.

Major storms that have struck the Cagayan river basin have resulted from typhoon and monsoon in the area. In the Cagayan river basin, typhoons normally strike during July to December with about 8 times a year on an average.

A primal portion of annual rainfall is, however, ascribed to the southwest monsoon. This monsoon is caused by thermal variations of the Asiatic mainland, and accompanies humid air mass to the Cagayan basin.

Seasonal extreme climate variability in the Philippines, including the Cagayan Basin, is associated with the El Niño phenomenon. Most recent El Niño phenomenon was observed in 1997-1998, according to PAGASA. In the past, El Niño occurred in 1972-73, 76-77, 82-83, 86-87, 91-94 according to the National Oceanic and Atmospheric Administration (NOAA) of US. As the records indicate, El Niño occurs almost every three years while the duration of phenomenon varies. As experienced in the past El Niño-related drought events, these adverse impacts will collectively cause to a certain extent disruption in the socio-economic well being of the country.

1.2 Hydrology of Cagayan River Basin

The feather-shaped Cagayan river basin, with its drainage area of 27,281 km², is bounded by the Sierra Madre Mountains in the east, the Cordillera Mountains in the west and the Caraballo Mountains in the South, as presented in the Location Map. The annual average rainfall in the basin is estimated to be 2,600 mm. It travels 520 km in the Cagayan Valley from the south to north in the northern part of Luzon Island. Since the Cagayan river takes route closer to the Sierra Madre Mountains, the right tributaries are generally of steep slope and small scale.

The major tributaries are the Magat river ($5,113 \text{ km}^2$), Ilagan river ($3,132 \text{ km}^2$), Siffu-Mallig river ($2,015 \text{ km}^2$), and Chico river ($4,551 \text{ km}^2$). The river bed slope is $1/8,680$ between the river mouth and Tuguegarao in the main river. Average runoff estimated for these basins in the Study are summarized as follows:

Tributary	Catchment (km^2)	Annual Average Runoff (m^3/s)
Upper Cagayan River	6,633	291.6
Magat River	5,113	262.6
Ilagan River	3,132	143.9
Siffu Mallig River	2,015	85.8
Chico River	4,551	251.4
Whole Basin	27,281	1,343.2

In the Cagayan river basin, typhoons usually strike during July to December about 8 times a year on an average. Floods occur during these typhoons which bring abundant rainfall to the basin. Major typhoons that have brought floods to the basin include typhoon Loleng in October 1998 and Rosing in November 1995. On the other hand recent droughts occurred at the end of 1997 to the beginning of 1998. According to PAGASA, the drought was estimated to be once in 50 years based on rainfall data.

1.3 Scope of Meteorological and Hydrological Study

The meteorological and hydrological analysis for the Cagayan river basin was conducted during the 1987 Master Plan Study in the mid-1980s. Approximately 15 years have passed since the analysis was conducted. Therefore, objectives of the meteorological and hydrological analysis in this JICA Study comprise of the following major items:

- (1) Collection of additional meteo-hydrological data after the 1987 Master Plan;
- (2) Review of meteo-hydrological data collected: i.e., rainfall, runoff records, sediment records and water quality records; and
- (3) Review of analysis on flood runoff, streamflow, water balance, sediment, riverbed fluctuation, and salinity intrusion based on the overall meteo-hydrological data collected including the additional data after the 1987 Master Plan.

Scope of each study is summarized below.

1.3.1 Observation Network

Hydrological data such as rainfall, discharge, and sediment runoff has been collected for the period after the 1987 Master Plan Study. Statistical analysis has been conducted to confirm the consistencies of the rainfall data collected during

the 1987 Master Plan Study period and additional rainfall data collected during the JICA Study.

1.3.2 Flood Runoff Analysis

Based on the hydrological data collected and reviewed, a flood runoff analysis was conducted. The analysis consists of the establishment of a river system model, rainfall analysis and flood runoff analysis. Owing to the fact that the probable rainfall has shown similar results between 1987 Master Plan and this JICA Study, the probable peak discharge obtained in the JICA Study showed the same results or slightly lower than that of the 1987 Master Plan. It is concluded that no changes will be made to the probable flood flow obtained during the 1987 Master Plan and all the calculated floods in the 1987 Master Plan will be adopted in the JICA Study as well.

1.3.3 Streamflow Analysis

A Tank Model was applied to simulate the long-term runoff of the basin. In the streamflow analysis, the Cagayan river basin was divided into 53 sub-basins and long-term runoff for each sub-basin determined.

1.3.4 Water Balance Analysis

Water demand and supply balance study consists of review of the municipal water demands, irrigation water demands and maintenance flow. Representative runoff of 1/5 return period was determined for the analysis. Water deficit was calculated for each base point and evaluation on the deficit is made for base points.

1.3.5 Sediment Analysis

Sediment yield estimated in the 1987 Master Plan Study was reviewed using additional data collected in this JICA Study. Estimated sediment runoff from the whole Cagayan River basin, i.e. 1.5 mm/year, is validated in the JICA Study as well. Sediment transport capacity determined in the 1987 Master Plan was also reviewed. Computed sediment transport capacity in the present river condition revealed no significant differences in the sediment transport capacity.

1.3.6 Riverbed Fluctuation Analysis

One dimensional riverbed fluctuation was applied to predict the riverbed fluctuation caused by the imbalance of sediment carrying capacity along the river course. Fluctuation depth was calculated from the difference of sediment

transport capacity between downstream and upstream river sections, suspended load between lifted and deposited in a river stretch, and extraction volume. A simulation model was validated and riverbed fluctuation, which may be caused by each of the three channel widening plan, was estimated.

1.3.7 Saline Water Intrusion

A salinity intrusion survey was conducted by DPWH Region 2 engineers and Hydrologist of the Study Team to investigate the saline water intrusion into the Cagayan River during the dry season. Twenty four hour continuous observations were conducted at the six monitoring stations established along the Cagayan River from its river mouth at every 5 km distance. During the survey, no salinity intrusion was detected. Saline water intrusion analysis was conducted to consider the intrusion length of saline water.

1.3.8 Flood Inundation Analysis

Flood inundation analysis was conducted to obtain inundation depth and inundation period for probable floods for the return period of 2-, 5-, 10-, 25-, 50-, and 100-years. Results of the analysis were applied to the flood damage analysis, which is described in ANNEX VI – FLOOD CONTROL.

1.3.9 Climatological Features of the Study Area

(1) Climate

The climate in the Cagayan river basin consists of two tropical monsoons, i.e. the Southwest Monsoon and the Northeast Monsoon. According to the climate classification by Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA), the climate in Cagayan river basin falls under Type III. This climate type is characterized by not very pronounced seasons with relatively dry weather condition from November to April while the remaining of the year is noted as wet weather condition as illustrated in Figure 1.3.1.

(2) Storms/Rainfall

Major storms, which struck the Cagayan river basin, resulted from typhoon and monsoon in the area. In Cagayan river basin, typhoons usually strike during July to December at the rate of about 8 times a year on an average.

A primal portion of annual rainfall is, however, ascribed to the southwest monsoon. This monsoon is caused by the thermal variations of the Asiatic mainland, and accompanies humid air mass to the Cagayan basin.

(3) Temperature

Air temperature in the Cagayan river basin is relatively low in the country due to its location at high latitudes. The hottest month is May or June, while the coldest month is January.

The monthly mean air temperature ranges from 23.1°C in January to 29.0°C in May, and the annual mean air temperature is 26.4°C at Tuguegarao as shown in Table 1.3.1.

(4) Relative Humidity

High relative humidity is observed in the basin ranging between 70% and 90%. At Tuguegarao, the monthly mean relative humidity varies from 69% in April/May to 82% in November/December and the annual mean relative humidity is 76% as shown in Table 1.3.1.

(5) Evaporation

Daily evaporation is measured by A-pan in the basin. Maximum evaporation is recorded in April and minimum is in December. An annual mean daily evaporation was recorded between 3.5 mm at Bontoc (EL. 855 m) and 5.9 mm at Alimanao (EL. 30 m) as shown in Table 1.3.1.

(6) Wind

Pervailing wind direction is south in May to September and north in October to April. Wind speed is about 10 km/hour at Aparri, 8 km/hour at Iguig and 6 km/hour at Tuguegarao throughout the year as shown in Table 1.3.1.

(7) Sunshine Duration

Annual mean daily sunshine duration is 5-6 hours in the basin. The longest duration is shown in April/May and the shortest in December. Daily sunshine duration ranges from 3.1 hours in December to 7.8 hours in April at Tuguegarao as shown in Table 1.3.1.

(8) Atmospheric Pressure

Monthly mean atmospheric pressure is relatively high in the dry season and low in rainy season. At Iguig, the monthly mean atmospheric pressure varies from 1,008 hpa in August to 1,018 hpa in February, as presented in Table 1.3.1.

CHAPTER 2 HYDROLOGICAL OBSERVATION SYSTEM

2.1 Observation Network

2.1.1 Meteorological Data Network

During the 1987 Master Plan Study, two climatological stations at Aparri and Tuguegarao maintained by PAGASA were considered as synoptic stations in the Cagayan river basin. In addition to the 2 synoptic stations, meteo-hydrological data from 13 meteorological stations were collected during the 1987 Master Plan Study. During this JICA Study, numbers of newly represented climatological stations maintained by other agencies have been added. Locations of the stations are shown in Figure 2.1.1.

2.1.2 Rainfall Data Network

Daily rainfall data were collected at 64 gauging stations during the 1987 Master Plan period. Additional data were collected from 6 newly established gauging stations. Hourly rainfall data are available for a relatively long period at Aparri and Tuguegarao during the 1987 Master Plan Study. However, since PAGASA commenced collection of rainfall data at every three hours, hourly rainfall data after the 1987 Master Plan are only available at Magat Damsite, Dantor, Halong, Buyoc, Dumayup (Baretbet) and Sto. Domingo. All of these stations are located to the upstream of Magat Dam and the data was collected by NIA Magat operations room. The location of the rainfall gauging stations is illustrated in Figure 2.1.1.

2.1.3 Water Level and Discharge Data Network

Daily mean water level and river runoff data were collected at 78 gauging stations. The locations are shown in Figure 2.1.2. Discharge measurement records were also collected at 50 stations. Flood hydrographs are observed at the Magat damsite, Matuno damsite, Palattao, Cabulay, Ibulao and Gabong gauges. Hourly rainfall records were also available from some of the flood hydrograph records at Magat and the Matuno damsites. Availability of hydrograph and hourly rainfall records are listed in Table 2.1.1.

2.1.4 Water Quality and Sediment Discharge Data Network

Locations of stations collecting sediment load observation record and water quality record are presented in Figure 2.1.2.

2.2 Available Data

2.2.1 Climatological Data

Availability of climatological data is summarized in Figure 2.2.1. As shown in the figure, relatively long periods of climatological records are available at Aparri, Tuguegarao and Iguig stations. These stations have observed rainfall, air temperature, relative humidity, sunshine duration, evaporation and wind velocity for more than 25 years. Other climatological stations also observe rainfall, air temperature, relative humidity, evaporation or sunshine duration. Almost all the stations are located in the lowland of the Basin except for Consuelo and Bontoc.

2.2.2 Rainfall Data

Among the daily rainfall data obtained from 70 gauging stations in the Cagayan basin, 22 gauging stations, as enlisted in 1987 Master Plan, have been excluded from further hydrological analyses due to fragmentary or very short period of data available. Duration of these available data is presented in Figure 2.2.2.

Reliability of data obtained for the remaining 48 stations were examined by the double mass curve method. Through this examination, the rainfall data at (3) Aggunetan and (32) Solano revealed as not reliable as shown in Figure 2.2.3. Therefore, daily rainfall data collected at the remaining 46 stations are used for further hydrological analysis. Among these 46 stations, Aparri, Tuao, Tuguegarao, Naneng, and Consuelo have operated over the observation period of 34 years from 1963 to 1998 as presented in Figure 2.2.2.

(1) Rainfall Features

A mean annual rainfall varies from under 2,000 mm in the plain of the basin to over 4,000 mm in the eastern mountainous area. Heavy rainfall in the eastern and western mountainous area is caused by the southwest monsoon with humid air mass. Figure 2.2.4 presents the isohyetal map of the Cagayan river basin, which was developed by the rainfall and runoff data obtained. From this map, a mean annual basin rainfall of the Cagayan river basin was estimated to be 2,600 mm.

Monthly rainfall pattern shows the rainy season from May to November as presented in Figure 2.2.4. In this rainy season, rainfall depth reaches about 80% of the annual rainfall. The maximum monthly rainfall appears in July or August when southwest monsoon is heaviest, and in November when typhoon becomes the most frequent in a year.

Observing the overall rainfall data collected, the maximum annual rainfall was 5,352 mm at Mt. Polis, Banaue in 1974 during the observed period of 1963 to 1980. The maximum daily rainfall was 732 mm at Consuelo on November 5, 1980.

(2) Analysis to confirm the consistency of rainfall data collected during the 1987 Master Plan and this JICA Study

Three sets of statistical analysis, i.e. 1) statistical parameters, 2) double mass curve slopes, and 3) probability distributions were made from the rainfall data collected during the 1987 Master Plan Study and the JICA Study to study the rainfall characteristics for these two study periods.

1) Analysis of Statistical Parameters

Analysis on the statistical parameters was made to confirm the consistencies of the rainfall data collected during the 1987 Master Plan Study period and additional rainfall data collected in the JICA Study. Standard deviation and coefficient of skewness on annual rainfall recorded at the following representative stations were determined.

Station	Standard Deviation (1987 M/P)	Standard Deviation (This JICA Study)	Skewness (1987 Master Plan)	Skewness (This JICA Study)
Aparri	490.9	533.5	-0.03	+0.01
Tuguegarao	415.9	413.7	0.46	0.48
Tuao	325.1	316.2	0.13	0.01

The standard deviation and skewness of Tuguegarao Station showed high consistencies between 1987 Master Plan study and the JICA Study. Therefore, it was considered that rainfall characteristics in the Cagayan river basin have not changed.

2) Analysis on Double Mass Curve – Comparison of the slopes

Double mass curves for some of the representative stations against the Tuguegarao Station, which presented the high consistencies by the statistical parameter method, were obtained as presented in Figure 2.2.3. The double mass curves do not indicate any major difference in rainfall data characteristics between the 1987 Master Plan Study period and its succeeding 15 years. For example, slope of the double mass curve obtained from linear regression for the Aparri Rainfall Station was 1.35 in the 1987 Master Plan Study whereas, including the additional rainfall records of 1986 to 1999, the slope was 1.31. The slopes of double mass curves are summarized in the following table:

Comparison of Double Mass Curve Slope Obtained from Linear Regression

Station	Slope of Double Mass Curve up to 1985	Slope of Double Mass Curve up to 1999
Aparri/Tuguegarao	1.35	1.31
Tuao/Tuguegarao	1.02	1.02
APC-Iguig/Tuguegarao	0.96	0.95
Batanes*/Tuguegarao	1.97	1.81
Ilagan/Tuguegarao	1.35	1.31

From the above consistency in rainfall data of Aparri, Tuguegarao, Tuao, Iguig and Ilagan was confirmed. However, rainfall data of Batanes clearly indicates inconsistencies. Therefore, Batanes was disregarded for further analysis.

3) Analysis on Probability Distributions

Normal distribution was examined to describe the annual rainfall at the above stations. However, as hydrological variables usually follow different distributions, probability distribution was also analyzed for the rainfall data collected during the 1987 Master Plan and the JICA Study in order to study difference in rainfall characteristics for the two study periods. With the annual 1-day maximum rainfall for each station in each observed year, probable rainfall for the return period of 1 to 200 years for the following stations were calculated by the Pearson Type III method because the method is flexible, among the methods considered, when applied to the non-symmetrical sample distribution, which is a common phenomenon in hydrological statistics. Listed below is the 100-year probable rainfall for the representative stations with relatively long records using Pearson Type III method:

100-year probable rainfall at representative stations

Station	Probable Rainfall (mm)	
	the 1987 Master Plan Study	this JICA Study
Aparri	566	520
Tuguegarao	434	447
Tuao	329	299

From the above probable rainfall analysis, it was concluded that consistencies for the rainfall data obtained during the 1987 Master Plan Study, i.e. 1960 to 1985, do not differ much from the additional rainfall data obtained during the JICA Study, i.e. 1986 to 1999. Results of 100-year probable rainfall for Aparri and Tuao showed a lower 100-year probable rainfall when annual maximum rainfall data from 1986 to 1999 were added to the previous period. Due to the differences in the probable rainfalls at representative stations, the

probable basin rainfall for the flood runoff analysis is re-computed in the following sub-chapter.

2.2.3 Water Level and Runoff Data

(1) Review of water level and runoff data

A list of streamflow gauging stations is presented in Figure 2.2.5. Among the daily mean water level and/or runoff data collected at 78 gauging stations in the 1987 Master Plan Study, the reliability of runoff data was examined for 40 station with more than 2-year period of data. The reliability of the selected data was studied by the double mass curve method as shown in Figure 2.2.6. Among the 40 stations. Therefore, the runoff data at the remaining 31 stations are selected for further analysis because 9 stations was considered inappropriate for the further analysis.

These runoff data from 31 stations are compared with the mean annual rainfall of the catchment area for each of the 31 stations to obtain annual runoff coefficients. Runoff coefficient represents relationship between runoff and rainfall for a given time period and is usually applied as a measure to obtain abstraction of these two parameters. Judging from the annual runoff coefficient calculated in Table 2.2.1, the following 8 stations have been disregarded:

- (5) Simay, (24) Abbot, (25) Pasonglao, (37) Casile, (38) Maligaya, (39) Munoz, (45) Caipilan, (57) Kamamasi.

Runoff coefficient of less than 0.50 or grater than 0.90 indicates that either rainfall data and/or runoff data are not reliable. Those data were, hence rejected. Overlapping the locations of the streamflow gauging stations indicated in Figure 2.1.2, and the locations of rainfall gauging stations in Figure 2.1.1, it is evident that the number of rainfall gauging stations in the catchment area at each streamflow gauging stations in very limited. Therefore, it is presumed that the obtained runoff coefficients have been somewhat erratic.

Thus, the daily runoff data of the following 23 stations are only used for further hydrological analysis:

- (7) Calaoagan, (10) Calantac, (12) Escolta, (18) Larion Alto, (19) Pinukpuk, (29) Antagan, (30) Ampawilen, (34) Taed, (40) Malalam, (41) Palattao, (42) Supang, (43) Minanga, (46) Dipalin, (47) Oscariz, (48) Dulao, (50) Hapid, (51) Camandag, (52) Pangal, (53) Panang, (54) Guinalvin, (55) Bante, (61) Bato, (62) Dippadiw

(2) Review of Sediment Runoff Data

Suspended sediment load is observed at 25 stations in the Cagayan river basin. Abundant samples of suspended sediment load were observed at: (6) Pasonglao, (13) Oscariz, (17) Lamut, (18) Hapid, (21) Bante, (25) Dippadiw, (41) Dakgan, and (42) Bagabag stations. Riverbed material observations were also conducted in the Cagayan River and its major tributaries such as Magat, Ilagan, Siffu-Mallig, Tuguegarao and Chico rivers. Detailed discussion on wash load is presented in Chapter 6 – Sediment Analysis.

(3) Tidal Level Data

Tide levels are observed at Aparri. Daily mean tidal level at Aparri is shown in Figure 2.2.7 and monthly mean level is given in Table 2.2.2. The maximum tide level was observed to be 1.4 m above sea level on July 17, 1964 and the minimum is 0.80 m below the sea level on September 18, 1959. The mean tide level of 4 years from 1960 to 1963 is 0.24 m above the mean sea level. No additional records of tidal level at Aparri were obtained in the JICA Study.

2.2.4 Sediment and Water Quality Records

A list of stations collecting sediment load observation records and water quality records is presented in Figure 2.2.8. For detail of a sediment analysis, refer to Chapter 6.

2.3 Establishment of Gauging Stations

During the First Works in the Philippines, pressure type automatic water level gauges and staff gauges were installed at 4 places along the Cagayan River to observe water level and measure river discharge and suspended load.

2.3.1 Locations

Water level gauges were installed, during the First Study in the Philippines, at Magapit, Nassiping, Iguig and Sta. Maria along the Cagayan River.

2.3.2 Type of Gauges

Two gauge types, pressure type automatic water level gauges and staff gauges, were provided for each station. A schematic profile of automatic water level gauges is presented in Figure 2.3.1.

2.4 Measurement of River Water Level and Runoff

2.4.1 Water Level

Measurement of river water level at the 4 automatic gauging stations has been continued. Figure 2.4.1 presents the water levels measured at the gauging stations. The figure shows that the Magapit gauging station tidal effect.

2.4.2 River Runoff

Discharge measurement at the gauging stations was undertaken at 4 times by the sub-contractor. A summary of the discharge measurement is shown in Table 2.4.1. To obtain water level – discharge relationship at each gauging stations, discharge measurement has been continued by the DPWH counterpart personnel.

2.4.3 Sediment Runoff

Suspended sediment loads were measured at the same time together with discharge measurements. A summary of these measurements is presented in Table 2.4.2. Grain size distribution of the sediment runoff measured was not recorded.

2.4.4 Water Quality

During the discharge/sediment measurement, water was also sampled to analyze water quality of the Cagayan River at each gauging stations. Monitored items were pH, Dissolved Oxygen (DO), Electro-conductivity (EC), Turbidity and BOD. All parameters except for BOD were measured on-site. Water was sent to a water quality laboratory for testing immediately after being sampled. Table 2.4.3 presents the result of water quality analysis.

CHAPTER 3 FLOOD RUNOFF ANALYSIS

3.1 Available Data

3.1.1 Rainfall Data

Hourly rainfall record were available at Aparri and Tuguegarao gauges in the 1987 Master Plan. These records were utilized to make a hourly distribution pattern. Storm records, which the means daily rainfall larger than 100 mm at both gauges, are shown in Figure 3.1.1.

In recent years, hourly storm/rainfall records are only measured upstream of the Magat dam at Sto. Domingo, Dumayup, Buyoc, Dantor, Halong and Magat damssite (Figure 3.1.1). In order to analyze the storms, happened after the Master Plan Study, these hourly rainfall records are examined.

3.1.2 Flood Runoff Data

Flood hydrographs at Magat damssite are available to establish a flood runoff simulation model. Refer to Table 2.1.1 and Figure 3.1.2.

3.2 Methodology

A flow chart for the flood runoff analysis is shown in Figure 3.2.1. The analysis consists of 3 sub-analysis, river system model establishment, rainfall analysis and flood runoff analysis.

3.3 River System Model

The basin division and the river system in the 1987 Master Plan Study were used in the JICA Study. These are shown in Figure 3.3.1 and Figure 3.3.2, respectively.

Nine points were determined principally as base points at the junctions of main river and major tributaries, Chico, Siffu, Ilagan, and Magat river. The location of each point and its upstream basin area are tabulated below.

Base Point	Location	Basin Area (km ²)	Distance from River mouth (km)
BP-1	Rivermouth of Cagayan River	27,281	0.0
BP-2	Cagayan River at junction of Chico River	21,473	51.6
BP-3	Cagayan River at junction of Siffu River	15,334	198.7
BP-4	Cagayan River at junction of Ilagan River	11,993	212.3
BP-5	Cagayan River at junction of Magat River	6,633	232.8
BP-6	Chico River at junction of Cagayan River	4,551	51.6
BP-7	Siffu River at junction of Cagayan River	2,015	198.7
BP-8	Ilagan River at junction of Cagayan River	3,132	212.3
BP-9	Magat River at junction of Cagayan River	5,113	232.8

Following 15 damsites identified in the 1987 MP are also taken as base points:

No.	Damsite Name	Catchment Area (km ²)	No.	Damsite Name	Catchment Area (km ²)
(1)	Casecnan	1,150	(9)	Ilagan No.1	1,350
(2)	Cagayan No.2	1,631	(10)	Disabungan	652
(3)	Cagayan No.1	2,324	(11)	Siffu No.1 (A)	656
(4)	Disuyon	477	(12)	Mallig No.2	362
(5)	Addalam (A)	864	(13)	Chico No.2	720
(6)	Alimit No.1 (A)	559	(14)	Chico No.4	1,410
(7)	Matuno No.1	550	(15)	Pinukpuk	856
(8)	Magat	4,143			

Sub-base points were determined at junctions of tributaries considering the river basin scale. The Cagayan river basin is, then, divided into 50 sub-basins at the selected base and sub-base points. Thirty river channels were prepared as basin elements, which affect flood runoff substantially.

Finally, the river system model was made assembling the base and sub-base points including the basin components of 50 sub-basins, 30 river channels and 15 damsites.

3.4 Rainfall Analysis

3.4.1 Rainfall Duration Time

The major storms recorded in Aparri and Tuguegarao show that rainfall duration is usually 4-day or less. The lag time of flood runoff is estimated at about 64 hours in the longest watercourse. The rainfall duration for the flood runoff analysis, at base points 1 to 9 is therefore decided to be 4 days. For the runoff analysis the duration is determined to be 1 day at damsites considering the lag time.

3.4.2 Mean Basin Probable Rainfall

As additional daily rainfall data were collected for 1985 to 1999, mean basin probable rainfall was re-estimated. The Thiessen polygon method was used to estimate the mean basin rainfall from point rainfall as shown in Table 3.4.1 and Figure 3.4.1. Although a deformed polygon appears in Figure 3.4.1 basin

rainfall is attested to be usable by comparing rainfalls of deformed and uniform polygons. Adjustment factor for mean basin evaluation is adopted to estimate the mean basin rainfall at the damsites as shown in Table 3.4.2. This adjustment factor was proposed in “Nationwide Flood Control Plan” conducted by JICA in 1982, and also adopted in the 1987 MP.

The mean probable basin rainfall is calculated from annual maximum basin rainfall by the Pearson Type III method. The calculated probable rainfalls at the base points are shown in Table 3.4.3.

3.4.3 Hourly Rainfall Distribution

A 1-day rainfall duration curve was developed using the hourly rainfall data at Aparri and Tuguegarao as well as additional data obtained during the Feasibility Study given in Figure 3.4.2. As shown, the Rt/Rd curve (rainfall rate and duration curve) did not differ much when compared between the 1987 Master Plan and this JICA Study. As in the Master Plan, the hourly rainfall distribution of probable 4-day rainfall is, consequently, estimated as shown in Figure 3.4.3. Comparison of the same figure with the 1987 Master Plan is presented as follows:

Volume ratio	1987 Master Plan	This JICA Study
1hr. rainfall/24hr.rainfall	20.14%	20.26%
6 hr. rainfall/24 hr. rainfall	65.90%	65.63%

The hourly rainfall distribution of the 1987 Master Plan and this JICA Study showed only a slight difference.

3.4.4 Areal Rainfall Distribution

There are not enough rainfall data covering the whole basin to examine the areal distribution pattern of storms. Therefore, the areal distribution of the probable rainfall is assumed to give the intensive rainfall to each of the basins of major tributaries. Then, 5 distribution types, including the rainfall period for 1995 to 1999, are introduced as given in Table 3.4.4. The distribution type of intensive rainfall in the Upper Cagayan basin is adopted to estimate the flood runoff in the main river because this type induces the largest runoff. Other distribution types are applied to estimate runoff for the respective tributaries.

3.5 Flood Runoff Analysis

3.5.1 Runoff from Sub-basin

Flood runoff from a sub-basin was estimated by applying the storage function on which the coefficients are based on the recorded storms, including the recent storms obtained during this JICA Study, at Magat damsite. The recorded storms at the Magat damsite are shown in Table 3.5.1.

Constant values used in the storage function of sub-basins were examined through trial and error. This examination was conducted by comparing the flood hydrographs recorded at the Magat damsite and estimated rainfall which was obtained by applying the Thiessen Polygon method in Figure 3.5.1.

Primary runoff coefficient (f_1) was estimated to be 0.5 and saturated rainfall (R_{sa}) was estimated to be 150 mm, based on the selected storms shown in Figure 3.5.2. The specific baseflow estimated with data at 23 stream gauging stations is 0.04 $m^3/sec/km^2$ which was obtained by linear regression of the 23 plots, as shown in Figure 3.5.3.

3.5.2 Re-calibration of the Flood Runoff Model

Calibration of the flood runoff model with the available runoff and rainfall data was obtained at the Magat damsite for the storms after 1977. Figure 3.5.4 presents the comparison of observed flood hydrograph at the Magat damsite and the calculated hydrograph from available hourly rainfall records. Hydrographs from 1992 storm Maring and 1998 monsoon are presented together with another 4 floods used for the calibration in the 1987 Master Plan.

As seen in this figure, observed and calculated hydrographs, including the newly collected data, agree with each other when the flood runoff model with the storage function coefficients, K and P, were used. Furthermore, Time lag, T, has been adjusted for both calculated and observed hydrographs to coincide at the peak flow. Therefore, it is concluded that the same coefficients of storage function K, and P used in the 1987 Master Plan will be applied for this JICA Study as well. On the other hand, adjusted time lag T will be applied for the flood distribution model. These coefficients are listed in Table 3.5.2.

3.5.3 Channel Flow

The values of the channel storage for each channel calculated under the present river conditions are shown in Table 3.5.3. Under the present river condition, non-uniform flow calculation was applied to channel No. 7, 8, 11, 12, 15, 16, 17,

18, 19, 20, 21, 22, 26, 27, 28, 29 and 30 while uniform flow calculation was used for the others. The lag time of channel flow in each channel estimated by Kraven formula is shown in Table 3.5.4.

3.5.4 Flood Regulation by Magat Reservoir

The flood operation for the Magat reservoir was performed by the constant-ratio/constant amount outflow method, which is studied by the project "Flood Forecasting and Warning System for Dam Operation Project (May 1984)". In this project, control starting point, constant ratio and constant amount outflow are proposed to be 1,600 m³/s, 0.4 and 3,000 m³/s, respectively.

3.5.5 Probable Flood Runoff Estimated

Based on the rainfall analysis presented above, the probable flood discharge was computed by the same method applied in the 1987 Master Plan. 100-year probable flood peak discharge at the base points and damsites are compared for the 1987 Master Plan and this JICA Study as given below.

Comparison of Flood Peak Discharge (100 year probable flood) at Base Points

Base Point	1987 MP (m ³ /sec)	this Study (m ³ /sec)	Remarks
BP-1	21,400	19,000	Mouth of Cagayan Main Stream
BP-2	21,000	18,400	Conf. of Cagayan and Chico (Nassiping)
BP-3	25,300	21,200	Conf of Cagayan and Siffu
BP-4	23,500	20,200	Conf of Cagayan and Ilagan
BP-5	14,700	13,600	Conf of Cagayan and Magat
BP-6	8,700	8,000	Chico River Mouth
BP-7	3,300	3,200	Siffu River Mouth
BP-8	9,400	8,200	Ilagan River Mouth
BP-9	10,600	9,900	Magat River Mouth

Comparison of Flood Peak Discharge (100 year probable flood) at Damsites

Damsite	1987MP (m ³ /sec)	this Study (m ³ /sec)	Damsite	1987 MP (m ³ /sec)	this Study (m ³ /sec)
Casecnan	20,700	18,900	Ilagan	8,950	7,300
Cagayan 2	19,400	17,300	Disabungan	7,600	7,300
Cagayan 1	17,200	17,000	Siffu No.1	1,950	1,900
Diduyon	7,500	6,200	Mallig No.2	1,100	1,100
Addalam	5,650	5,400	Chico No.2	3,550	3,500
Matuno	2,050	2,000	Chico No.4	4,500	4,500
Alimit	1,650	1,600	Pinukpuk	3,150	2,900

3.5.6 Determination of Probable Discharge for the Project

Owing to the fact that probable rainfall has shown similar results between 1987 Master Plan and this JICA Study, the probable peak discharge obtained in this JICA Study showed same results or slightly lower than that of the 1987 Master Plan.

At this point, it is recalled that peak discharges are calculated based on the limited number of rainfall data available in the area. Out of the 29 reliable gauging stations, a total of 10 gauging stations were used in the basin rainfall analysis to construct Thiessen Polygon during the 1987 Master Plan Study. On the other hand, in this JICA Study, only 6 gauging stations have been used because of the availability of rainfall data. Key rainfall gauging stations: Naneng, Bontoc and Nayon, which were utilized during the 1987 Master Plan Study, no longer conducts rainfall observation. Considering the very limited number of rainfall data available in this JICA Study, it cannot be judged that the probable flood peak discharge obtained in this JICA Study has higher accuracy than that obtained in the Master Plan Study.

Therefore, adopting a conservative side of the plan, it is concluded that no changes will be made to the probable flood flow obtained during the 1987 Master Plan and all the calculated flood in the 1987 Master Plan will be adopted in this JICA Study as well. Figure 3.5.5 presents the probable flood peak runoff distribution under the present river condition, whereas Figure 3.5.6 presents 100-yr probable flood hydrographs.

CHAPTER 4 STREAMFLOW ANALYSIS

4.1 Available Data

In the Cagayan river basin, 23 reliable runoff gauges exist or existed during the 1987 Master Plan as shown in Table 4.1.1. However, records at these gauges are fragmentary and the observation period is more or less 10 years, which is deemed to be insufficient to analyze available water for irrigation and domestic use.

On the other hand, in the 1987 Master Plan Study, some rainfall data are available for more than about 20 years at several gauges in the Cagayan river basin. Therefore, a long-term streamflow was generated by developing a runoff simulation model, which converts rainfall into runoff.

4.2 Methodology

The following procedure was applied in order to generate long-term naturalized runoff in the Cagayan river basin:

- a) Simulation of long term runoff at the selected runoff gauge by the runoff simulation model;
- b) Estimation of long term runoff in the sub-basin by applying the catchment and rainfall ratio of the gauge and the sub-basin to the simulated runoff; and
- c) Verification of the estimated long-term runoff.

In the above item a), the Cagayan River basin is divided into several basins considering its topography and climate. Thereafter, one runoff gauge was selected for each divided basin. The runoff simulation model was developed at each selected gauge. Tank Model was applied as the runoff simulation model because of the simplicity of structure and calculation, and easy simulation of rainfall-runoff relation. Tank Model simulation of long-term runoff at each selected gauge was conducted with long-term rainfall data.

Furthermore as noted in the item c) above, the estimated long-term runoff in basins is verified by comparing to the recorded gauge height and discharge, and/or existing study results. Instead of daily runoff, 10-day mean runoff was generated by the above procedure. General workflow of streamflow analysis is given in Figure 4.2.1. Theoretical background of Tank Model is discussed in Sub-Chapter 3.2.3 in Supporting Report of the 1987 Master Plan.

4.3 Simulation Model

4.3.1 Basin Division

The Cagayan river basin is divided into 6 basins taking account of the topography, river system and climate as shown in Figure 4.3.1. Divided basins are Upper Cagayan, Magat, Ilagan, Lower Cagayan, Upper Chico, and Lower Chico.

4.3.2 Selection of Gauge

Six Tank Models were prepared for the 6 basins mentioned above. Each model represents the streamflow characteristics of the corresponding basin. In order to develop 6 Tank Models, the same runoff gauges used during the 1987 Master Plan Study have been selected for this JICA Study as well, as shown in Table 4.1.1. Reliability of records at the selected runoff gauges was examined by the daily hydrograph and the double mass curve, as presented in the 1987 Master Plan Report.

The rain gauges selected during the 1987 Master Plan Study was selected for this JICA Study as well. The missing data were assumed on the basis of data at the surrounding gauges. The 10-day rainfall at the selected rain gauges is given in Table 4.3.1.

4.3.3 Tank Coefficients

The tank coefficients applied in the 1987 Master Plan Study have been applied in this JICA Study as well. The basin rainfall for the selected runoff gauge was derived from the isohyetal map shown in Figure 4.2.4. The rainfall ratio is shown in Table 4.3.2. The same rainfall ratio was applied both in the 1987 Master Plan and the Feasibility Study. Moreover, the same average evaporation record and the evaporation ratio were used both in the 1987 Master Plan and this JICA Study. Tank coefficients calibrated in the 1987 Master Plan are summarized in Figure 4.3.2. These coefficients were applied in this JICA Study.

4.3.4 Long Term Runoff at Gauge

A long term 10-day runoff was simulated at 6 selected runoff gauges for 22 years from 1985 to 1998 by applying the rainfall data in Table 4.3.1 to the corresponding Tank Model. Simulation results are shown in Table 4.3.2 and Table 4.3.3. As presented in Figure 4.3.4, simulated flow duration curves during the 1987 Master Plan Study and the same obtained during this JICA Study reveals similar curves at each gauge. Therefore, it has been concluded that the

long-term flow characteristics in the Cagayan River basin does not change significantly after 14-additional years of data is added.

4.4 Estimate of Runoff in Sub-basin

4.4.1 Basin Division

In the 1987 Master Plan Study, the Cagayan river basin was further divided into 53 sub-basins as shown in Figure 4.4.1. River system model based on the sub-basin division is presented in Figure 4.4.2. These sub-basin divisions are applied in this JICA Study as well.

4.4.2 Long Term Runoff in Sub-basin

The long term naturalized 10-day mean runoff for 1985 to 1998 years is estimated in each sub-basin by multiplying the simulated runoff at the gauge by the drainage area and annual rainfall ratios of the runoff gauge and the sub-basin, as conducted during the 1987 Master Plan. The annual rainfall for gauges and sub-basins was derived from the isohyetal map shown in Figure 2.2.4.

The drainage area and the annual rainfall are summarized for the runoff gauge and the sub-basin in Table 4.4.1. The calculation point is presented in Figure 4.4.2. Result of the runoff estimation is given in Tables 4.4.2. The average of the estimated runoff is summarized below.

Tributary	Catchment (km ²)	Annual Average(m ³ /s)	
		1987 MP	This JICA Study
Upper Cagayan River	6,633	291.6	289.3
Magat River	5,113	262.6	269.8
Ilagan River	3,132	143.9	147.1
Siffu Mallig River	2,015	85.8	88.2
Chico River	4,551	251.4	256.1
Whole Basin	27,281	1,343.2	1,371.6

Duration curves of estimated 10-day runoff for 1963 to 1998 are presented in Figure 4.4.3.

As for this JICA Study, additional 14-years data from 1985 to 1998 were applied to compare the long-term runoff at these gauges. Furthermore, the on-going construction activities at Casecnan Multi-purpose Irrigation and Power Project plans to divert Casecnan river flow of 900 MCM per year for irrigation purposes, with the revised catchment area of 520 km² at the damsite. As for this on-going project, the maintenance flow to the Cagayan River of 2.4 m³/sec is considered. In the water balance review presented in the following sub-chapter, results of the streamflow analysis was used to update the water balance review, including the Cagayan Diversion project.

CHAPTER 5 WATER BALANCE ANALYSIS

5.1 Basic Conditions of Water Balance Study

5.1.1 Balance Points and Basin Model

Water balance analysis was performed at the selected 48 balance points in the Cagayan river basin, considering the national irrigation system intakes, the municipal water supply intakes, the damsites, the estuary and confluence of the mainstream and the tributaries, as presented in Figure 5.1.1. The Cagayan river basin with the drainage area of 27,281 km² was divided into 48 sub-basins at the balance points for the purpose of this water balance analysis. The divided sub-basins are shown in Figure 5.1.2, and those drainage areas are listed in Table 5.1.1.

5.1.2 Runoff from Sub-basin

The naturalized river runoff from each of the divided 48 sub-basins was applied to the water balance analysis. This runoff was estimated by multiplying the basin area and the annual rainfall ratios to the generated runoff studied in the streamflow analysis. Table 5.1.1 shows the sub-basins for water balance analysis and the corresponding sub-basins for the streamflow analysis, and the area and the rainfall ratio.

The estimated runoff from the sub-basin is a 10-day mean naturalized one for 36 years from 1963 to 1998. As noted above, the Casecnan Multi-purpose Irrigation and Power Project plans to divert the Casecnan river flow of 900 MCM per year for irrigation purposes, with the revised catchment area of 520 km² at the damsite. As for this on-going project, the maintenance flow to the Casecnan River of 2.4 m³/sec was considered.

5.1.3 Maintenance Flow

In determining the river maintenance flow of a river, following aspects are considered to maintain the functions of river: a) navigation; b) fishing; c) picturesque scenery; d) salt water intrusion; e) clogging of river mouth; f) protection of riparian structures such as intake of irrigation system; g) protection of groundwater level; h) flora and fauna; and I) river water quality. As in the 1987 Master Plan Study, the specific discharge of 0.0046 m³/s/km² was applied to determine the maintenance flow at each base point. This specific discharge has been determined during the 1987 Master Plan Study from an average of the n-th lowest discharges during n-years at water level gauges over the basin.

5.1.4 Return Flow

Return flow from each sectoral water supply was assumed as follows:

- | | |
|------------------------------------|-------|
| a) Irrigation water supply | 30 % |
| b) Hydropower scheme | 100 % |
| c) Municipal water supply scheme | 40 % |

Return flow from communal irrigation system and the municipal water supply was assumed to return just downstream of the balance point where the demand water is taken. Return flow from the national irrigation system is returned as indicated in Figure 5.1.1.

5.1.5 Magat Dam

The effective storage volume of the Magat reservoir is 820 MCM according to the study report for “THE MASTER PLAN STUDY ON THE IMPROVEMENT PROJECT OF THE OPERATION AND MAINTENANCE OF MAGAT RIVER INTEGRATED IRRIGATION SYSTEM.” The evaporation from the reservoir surface and the seepage loss were assumed to amount 30 MCM a year, as stipulated in the report.

5.2 Water Demand

Water demand in the Cagayan river basin comprises the irrigation water demand and the municipal water demand. The irrigation water demand is composed of the demand for the national irrigation system and that for the communal irrigation system. The municipal water demand includes the domestic, service/public and industrial water demands. Review of these water demands was made and is discussed below.

5.2.1 Review of Municipal Water Demand

Based on the projected population up to the year 2020 as presented in the Socio-Economy section, the total water demand excluding agricultural sector has been reviewed. Projected water demand was reviewed by obtaining the unit water consumption for each municipality applied during the 1987 Master Plan study for the period of 1985 to 2005. Thereafter, the obtained units water consumption for each municipality was multiplied with the projected population for the year 2000 to 2020.

In projecting water source requirement, the following water losses applied during the 1987 Master Plan study have been applied in this JICA Study:

Year	2000	2005	2010	2015	2020
Loss Factor	1.54	1.48	1.43	1.38	1.33

Table 5.2.1 presents the water source requirement by municipality.

At this point, field surveys were conducted in order to compare the source water requirement estimated and the actual water supplied at municipality levels. According to the District Water Office in Tuguegarao, the current capacity of the water supply system of the city is 4,669,470 gal/day (17,674 m³/day). The projected water source requirement for the year 2000 was estimated at 17,569 m³/day for Tuguegarao as presented in Table 5.2.1. Therefore, it is noted that the water source requirement estimated for the year 2000 reflects the actual volume of municipal water produced.

As presented in Table 5.2.1, the projected total water source requirement for the year 2020 was estimated to be 978,651 m³/day for the study area.

5.2.2 Review of Irrigation Water Demand

Irrigation water demands have also been reviewed to reflect the current and future water demand in the sector. Table 5.2.2 summarizes the monthly mean water requirements of the system in the years 2000, 2005, 2010, 2015 and 2020.

5.3 Water Balance Analysis

The water demand and supply balance study was performed in order to

- a) determine theoretically whether there are enough river runoff to protect the intake of Magapit pumping station from salt water intrusion in low streamflow condition by projecting the water deficit under the present basin runoff and the future water demand conditions; and
- b) examine the required storage volumes of the deficit supply dams

The water deficit estimated is the balance of the representative runoff of 1/5 return period and future water demand, which is computed as a sum of the irrigation water requirement, municipal water requirement and the river maintenance flow. These future water requirements were determined by computing the deficit volume against the requirements for 2000, 2005, 2010, 2015 and 2020. As noted above, the present river runoff includes the water released from the existing Magat reservoir with the effective storage volume of 820 m³.

5.4 Projected Water Deficit

5.4.1 Determination of Representative Runoff of 1/5 Return Period

The naturalized 10-day runoff for the 137 base points used in the stream flow analysis has been obtained for the duration of 36 years from 1963 to 1998. The lowest reach of Cagayan river has been represented by the base point 137, which is the nearest base point from the Magapit intake along the mainstream of Cagayan River, as in Table 5.4.1. The representative runoff pattern for 1/5 return period has been obtained by selecting the 7th lowest annual average discharge obtained from the Table, which was determined to be the year 1994 flow pattern. Therefore, 1994 flow pattern obtained will be applied to determine projected water deficits in future years as well.

5.4.2 Deficit Calculation

The water deficit in the present basin runoff condition was estimated without the proposed dams but with the Magat dam. By applying the above obtained representative runoff pattern for 1/5 return period, water deficit against the demand conditions in 2000, 2005, 2010, 2015 and 2020 have been obtained, as presented in Table 5.4.2.

5.4.3 Deficit Evaluation

The followings are the evaluations of the deficits at each of the balance points. The deficit evaluated is that for the project demand in the year of 2005.

Balance Point 47

Balance point 47 is the intake site of the CIADP (Lower Cagayan). This balance point had no water deficiencies, when maintenance flow of $140 \text{ m}^3/\text{s}$ was considered. According to “the CAGAYAN INTEGRATED AGRICULTURAL DEVELOPMENT PROJECT, FEASIBILITY REPORT” by JICA/NIA, with the discharge of $140 \text{ m}^3/\text{s}$, salt water reaches up to El 3.5m at the pumping station, which is 1.0m lower than the intake sill of the Magapit station. Therefore, with the demand condition of 2020 at the return period of 1/5 years, the pumping station will not be affected by the saline water intrusion.

Balance Point 6

Balance Point 6 is the intake site of the Dabubu Irrigation Scheme. The water demand is composed of irrigation water requirement and the river maintenance flow of $0.6 \text{ m}^3/\text{s}$, which is obtained from the catchment area of 141 km^2 multiplied by the specific discharge discussed above. The maximum 10-day deficit of 2.40

m^3/s is relatively large which continues for 20 days and should be supplied by a certain supply dam.

Balance Point 8

The balance point 8 is an assembly of the intakes for the Gappal irrigation Scheme. The demand includes the irrigation water demand and the river maintenance flow of $0.6 \text{ m}^3/\text{s}$. Annual water deficit at this balance point is 6.51 million m^3 , which is not considered to be large. Therefore, the deficit at this point was judged not to be supplied.

Balance Point 11

This balance point is the intake site of the Matuno irrigation Scheme in Bayombong, Nueva Vizcaya. Water demand consists of the maintenance flow of $7.7 \text{ m}^3/\text{s}$ with heavy irrigation demand by 2020, together with municipal water supply of $0.35 \text{ m}^3/\text{s}$. Annual water deficit was estimated at 113 MCM. More than $10 \text{ m}^3/\text{s}$ of water deficit exists in March, May and June. The deficit water supply scheme is to be examined for this balance point.

Balance Point 13

Balance Point 13 represents the existing Magat dam. The water demand consists of the irrigation water requirement for Magat RIS and the municipal water requirement of $1.56 \text{ m}^3/\text{s}$. The annual deficit amounts to be 93.37 MCM, which indicates that the additional water supply dams, are expected in order to supplement the supply capacity of the Magat Dam.

Balance Point 21

This balance point is the site of the Chico No. 2 dam on the Chico river. Deficit of $0.16 \text{ m}^3/\text{s}$ was estimated for the duration of 10 days only. Therefore, the above deficit is not supplied.

Balance point 22

The balance point 22 is the site of Chico No. 4 dam. Only the maintenance flow of $6.5 \text{ m}^3/\text{s}$ is the demand at this point. Deficit of only $0.44 \text{ m}^3/\text{sec}$ was estimated for 10 days, therefore, the above deficit is not considered further.

Balance point 23

Balance point 23 is the intake site of Chico RIS. Water demand includes the irrigation water requirement and the river maintenance flow of $9.0 \text{ m}^3/\text{s}$. The probable annual deficit with return period of 1/5 year was estimated to be 61.75

MCM with the duration of more than 2 months. The deficit supply scheme is to be planned for the Chico RIS.

Balance point 29

Balance point 29 is the intake site of Siffu RIS. Annual deficit was estimated to be 68.96 MCM. The deficit supply scheme is to be planned for the Siffu RIS.

Balance point 30

The balance point 30 is the intake site of the Chico Mallig irrigation scheme and at the same time the Mallig No. 2 damsite. Water demand consists of irrigation water requirement and the maintenance flow of $1.7 \text{ m}^3/\text{s}$. Annual deficit was estimated to be 162 million m^3 . The water supply dam is necessary to be studied for the full development of the Chico Mallig irrigation scheme.

Balance point 31

Balance point 31 is the intake site of the Mallig RIS. The water requirements at this point are the irrigation water requirement and the maintenance flow of $2.1 \text{ m}^3/\text{s}$. Annual deficit was computed to be 18.45 million m^3 . A certain dam scheme is to be examined for this water deficit.

Balance point 32

This balance point is situated on the Siffu Mallig river just upstream of the junction with the main river. Water demand consists of municipal water of $0.83 \text{ m}^3/\text{sec}$ and the river maintenance flow of $9.3 \text{ m}^3/\text{s}$. The probable annual deficit was estimated to be 24.75 million m^3 . However, this deficit will be reduced by the additional return flow of the irrigation water supplied from a dam, which is studied on the Mallig River. Therefore, the additional water supply dam was not taken for the deficit supply at this point.

Balance point 33

The balance point 33 is the intake site of the Tumauini irrigation scheme. The water demand includes the irrigation water and the river maintenance flow of $0.8 \text{ m}^3/\text{s}$. The annual water deficit was estimated at 13.36 million m^3 . This deficit is considered to be large. Therefore a water supply scheme was examined for this Tumauini irrigation scheme.

Balance Point 34

The Balance point 34 is the intake site of the San Pablo-Cabagan irrigation scheme. Water requirements consist of the irrigation water demand and the maintenance flow of $0.6 \text{ m}^3/\text{s}$. The annual water deficit was estimated to be 1.45

MCM. The deficit only lasts for 10 days at $1.43 \text{ m}^3/\text{s}$. No deficit supply dam was considered at this time.

Balance Point 40

The Balance point 40 is the intake site of the Baggao Pared irrigation scheme. The water demands are the irrigation water demand and the river maintenance flow of $0.5 \text{ m}^3/\text{s}$. Annual water deficit was estimated to be 11.24 MCM. The volume is considered large and should require a water supply dam.

Balance point 42

Balance point 42 is the intake site of the Baggao Paranan irrigation scheme. Demands are irrigation water and the river maintenance flow of $0.3 \text{ m}^3/\text{s}$. The annual water deficit was estimated to be 31.54 million m^3 by the year 2020. A supply dam is to be planned.

Balance point 44

Balance point 44 is the intake site of Zinundungan irrigation scheme. Requirements at this point consist of the above irrigation water and river maintenance flow of $0.9 \text{ m}^3/\text{sec}$. The annual deficit was estimated to be 24 million m^3 . The deficit continues for more than 2 months with the maximum value of $4.17 \text{ m}^3/\text{sec}$. The deficit supply dam is examined for this irrigation scheme.

Balance point 45

Balance point 45 is the Dummon damsite with communal irrigation scheme requirement and the maintenance flow of $0.5 \text{ m}^3/\text{s}$. Annual deficit was estimated to be 11.85 in the year 2020. Dummon Dam is considered for additional water supply in the area.

Balance point 46

Balance point 46 is the intake site of the Dummon irrigation scheme. Demands include the irrigation water requirement and the river maintenance flow of $0.9 \text{ m}^3/\text{s}$.

5.4.4 Required Dam Development

According to the results of the deficit calculation and evaluation in the previous sections, the water deficit supply is required at the following 12 balance points:

Balance Point	Irrigation Scheme	Annual Deficit (mil. m ³)
6	Dabubu River IP	9
8	Gappal IP	7
11	Matuno IP	113
13	Magat RIS	93
23	Chico RIS	62
30	Chico Mallig IP	162
31	Mallig RIS	18
33	Tumauini IS	14
40	Baggao Pared IS	11
42	San Pablo-Cabagan	31
44	Zinundungan RIS	24
45	Dummon IP	12
46	Dummon RIS	33

As in the 1987 Master Plan Study, the following combinations of water deficit and supply dams were selected, considering the points and amounts of deficits and the available water supply dam candidates:

Deficit Supplied by Balance Point	Supply Dam
6 Dabubu River UP	Santo Niño
8 Gappal IP	Gappal (Sta. Maria, Calaocan, Colorado)
11 Matuno IP	Matuno No.1
13 Magat RIS	Matuno No.1, Alimit No.1, Siffu No.1
23, 30, 31 Chico RIS, Chico Mallig IP Mallig IP	Mallig No.2
33 Tumauini IS	San Vicente
40 Baggao Pared IS	Paranan
42 San Pablo-Cabagan	Paranan
44 Zinundungan RIS	Zinundungan
45 Dummon IP	Dummon
46 Dummon RIS	Dummon

CHAPTER 6 SEDIMENT ANALYSIS

6.1 Objective of Sediment Yield Analysis

Objective of sediment yield analysis is to review the sediment yield estimated in the 1987 Master Plan, by using additional data collected in the field. In the 1987 Master Plan, the sediment yield was estimated by the representative volume of the sediment yield from the entire Cagayan River Basin. In this review work, the validity of the sediment yield presented in the 1987 Master Plan, i.e. 1.5 mm/year, is discussed.

6.2 Available Data

In the 1987 Master Plan, suspended sediment records at 3 stations, i.e., Pasonglao (Chico River), Oscariz (Magat River) and Dippadiw (Cagayan River) were used to generate the sediment rating curves. There is no additional suspended sediment data at these 3 stations. However, there is some new sediment data at the Magat Reservoir and the Nagtipunan new gauging station. Review of the 1987 Master Plan has been conducted by the following consideration.

- Pasonglao (Chico River)

Suspended sediment measurement at this station ceased in the 1970's. There is no sediment measuring station near the abolished station today. The sediment rating curve presented in the 1987 Master Plan is used as it is.

- Oscariz (Magat River)

This station was located just downstream of the Magat damsite. Available sediment records at the site were those observed before dam construction. Therefore, the validity of annual sediment discharge can be reviewed using sedimentation record of Magat dam reservoir.

- Dippadiw (Cagayan River)

Although the sediment measurement at this station also ceased in early 1980's, there exists a new gauging station (Nagtipunan) approximately 10 km upstream of the Dippadiw station. Since there is no major confluence between Dippadiw and Nagtipunan, the flow characteristics of these two stations were judged to be similar. Therefore, the data taken at Nagtipunan was used in this review work.

As shown in Figure 6.2.1, the annual sediment volume of the Magat dam reservoir is about 1.6 mm/year until the year 1990, when the large scale earthquake

occurred. The reservoir sedimentation record before the earthquake in 1990 was presumed to correspond to the annual sediment data generated from the rating curve of Oscariz station, while the reservoir sedimentation record after the earthquake is unstable and cannot represent whole Cagayan Basin.

6.3 Methodology

In the 1987 Master Plan, following two methods were applied in order to estimate the sediment yield from the basin.

- a) Application of empirical formulas (the Tanaka formula and the Ishige formula)
- b) Application of sediment rating curve

As concluded in the 1987 Master Plan, empirical formulas such as the Tanaka Formula or the Ishige Formula, which are commonly applied in Japan, did not have enough validity to estimate the sediment yield from the Cagayan River Basin. Thus, these empirical formulas were not applied to the estimation in this review work, and the sediment yield was estimated by applying the sediment rating curve and sediment record of Magat dam reservoir.

6.4 Sediment Yield and Discharge

The sediment rating curve newly generated at Dippadiw (Nagtipunan) is shown in Figure 6.4.1 together with the estimated rating curves of the other 2 stations in the 1987 Master Plan.

A summary of above discussion is tabulated below. The runoff data of Guinalvin, selected in the 1987 Master Plan, was used for the estimation of the suspended load from the Cagayan River since no additional runoff data were available. The bed load was assumed to be 20 % of the estimated suspended load. This assumption was same as that in the 1987 Master Plan.

River Name	Stage*	Runoff Gauge	Suspended Load	Bed Load	Total Sediment
Chico River (Pasonglao)	1987 MP	Ampawilen	880	180	1,060
	RMP	Ampawilen	880	180	1,060
Magat River (Oscariz)	1987 MP	Oscariz	1,270	250	1,520
	RMP	(Magat Res. Data)	1,330	270	1,600
Cagayan River (Dippadiw and Nagtipunan)	1987 MP	Guinalvin	1,070	210	1,280
	RMP	Guinalvin	910	180	1,090

Unit : m³/km²/yr

* 1987 MP : the 1987 Master Plan
RMP : the Reviewed Master Plan (this JICA Study)

Comparing the above results, the estimated sediment runoff from whole of the Cagayan Basin in the 1987 Master Plan, i.e. 1.5 mm/year, remains to be valid. Therefore, the study results of other sectors based on this value, such as dam planning, are considered to be valid as well.

The total sediment volume shown above may contain wash load in some degree. A rough estimation of wash load is reported in the next section.

6.5 Sediment Balance

6.5.1 Sediment Transport

The annual sediment transport was reviewed at 26 points selected in the 1987 Master Plan. In order to estimate an annual sediment transport, the Einstein-Brown formula was applied, as in the 1987 Master Plan.

The specific gravity and the mean diameter of the riverbed material were determined to be 2.61 and 0.04 cm on the basis of the result of the riverbed material survey carried out in this JICA Study, along the Cagayan Mainstream from the junction with the Magat River to the river mouth. Ten day mean runoff simulated in streamflow analysis (refer to Chapter 4) was applied to the Einstein-Brown formula.

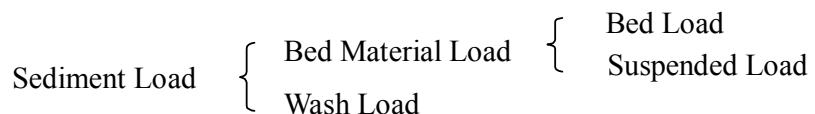
The computed annual sediment transport in the present river condition is shown in Figure 6.5.1. No significant change in annual sediment transport is observed from the figure.

As mentioned in subsection 6.4, the annual sediment yield from the entire Cagayan river basin was assumed to be 1.5 mm/year. The annual sediment transport presented in Figure 6.5.1 (solid lines and white dots) seems to be small comparing with this amount, considering that no serious aggradation of riverbed, except for upstream river channel of the Magat dam, has been reported during the field investigations conducted by the Study Team.

6.5.2 Estimation of Wash Load

An important factor for the explanation of above matter is dealing of wash load.

The form of sediment is generally classified as follows:



Only the bed material load (suspended load and bed load) can be estimated by the Einstein-Brown formula, while the sediment rating curve or reservoir sedimentation record contain some extent of wash load.

Therefore, it can be judged that the majority of the sediment, yielded from the basin, flows down to the ocean, i.e. Babuyan Channel, as wash load. It is said that the maximum diameter of wash load is around 0.1 mm, and wash load is not contained in the riverbed material significantly. Since no grain size distribution of the sediment in sampled river water, which contains both suspended load and wash load, was available, the rough estimation of wash load was made applying following formula:

$$Q_{WL} = \alpha Q_W^2$$

where, Q_{WL} : Discharge of wash load (m^3/sec)
 Q_W : Discharge of water (m^3/sec)
 α : Parameter

This formula is usually applied to the estimation of wash load in Japan. The parameter " α " varies between 4×10^{-8} and 6×10^{-6} . In this estimation, 3×10^{-7} was set as parameter " α " to make the total sediment yield (bed material load + wash load) from the upstream basin, i.e. No.22 point, around 1.5 mm/year.

The estimation result of wash load at each selected point is shown in Figure 6.5.1 (dotted lines and black dots) and summarized below.

Point	(1) Bed Material Load ($10^6 m^3/yr$)	(2) Wash Load ($10^6 m^3/yr$)	(3) = (1) + (2) Total Sediment Load ($10^6 m^3/yr$)	(4) = (2) / (3) Share of Wash Load to the Total Sediment Load
No.1 ~ No.4	7.79	22.89	30.68	74.6 %
No.5 ~ No.14	5.53	11.04	16.57	66.6 %
No.15	5.01	6.41	11.42	55.2 %
No.16	4.43	3.99	8.42	47.4 %
No.17 ~ No.22	6.87	0.90	7.77	11.6 %
No.23 (Chico)	5.48	0.85	6.33	13.4 %
No.24 (Siffu)	4.99	0.10	5.09	2.0 %
No.25 (Ilagan)	6.34	0.26	6.60	3.9 %
No.26 (Magat)	5.62	0.90	6.52	13.8 %

As shown in the table, the ratio of wash load to the total sediment load indicates a high value in the lower reaches of the Cagayan mainstream, while it is small in the upper reaches and in the tributaries. The ratio of wash load to the annual runoff volume of water is 0.05% at most, and that of the total sediment load to the annual water runoff ranges 0.05 to 0.07%.

CHAPTER 7 RIVERBED FLUCTUATION

7.1 Objectives of the Riverbed Fluctuation Analysis

The riverbed fluctuation analysis was carried out for evaluating the stability of present river stretch and for predicting the influence of narrow improvement (channel widening) and construction of cut-off channels on the variation of average riverbed of the Lower Cagayan River stretch.

Objectives of the riverbed fluctuation analysis are:

1. To examine the stability of the present river channel; and
2. To compare the extent of fluctuation in riverbed of 1) the natural condition, 2) the condition when the channel widening is implemented, and 3) the condition when three cut-off channels (Gabut, San Isidro and Tuguegarao; refer to ANNEX VI – FLOOD CONTROL) are implemented.

Results of this analysis would provide some important bases for determination of the channel widening or cut-off channel scheme.

Following 5 cases were considered as alternative channel widening or cut-off channel plans. Detailed description of these 5 cases is shown in ANNEX VI – FLOOD CONTROL.

Case-1 : Widening the river channel of Tupang site to 500 m

Case-2 : Widening the river channels of Tupang and Nassiping sites to 500 m

Case-3 : Widening the river channels of Tupang, Nassiping and Magapit sites to 500 m

Case-4 : Widening the river channels of Tupang, Nassiping and Magapit sites to 700 m

Case-5 : Construction of three cut-off channels (Gabut, San Isidro and Tuguegarao cut-off channels)

In addition to the 5 cases, the riverbed fluctuation for the case of “without project implementation” (natural condition; Case-0) was also simulated. The analysis was conducted for the river stretch between Cabagan, which is located approximately 160 km from the river mouth along the present Cagayan mainstream and Aparri at the river mouth.

The process of this analysis is divided into two stages, i.e. evaluation of the stability of the present river channels and evaluation of the influence on the future riverbed fluctuation by each scheme. General work flow is shown in Figure 7.1.1.

7.2 Available Data

As presented in Figure 7.1.1, the following data are used for the analysis:

- a. River cross section/profile data measured in 2000;
- b. River cross section/profile data of each channel widening/cut-off channel construction case (5 cases);
- c. Grain size distribution data measured in 2000;
- d. Flood runoff data;
- e. 10 day runoff data; and
- f. Water level data of the lowest river cross section (Aparri).

Due to the lack of streamflow record around the objective stretch, the input data “d” and “e” are generated from the result of flood runoff analysis (CHAPTER 3) and streamflow analysis (CHAPTER 4), respectively.

7.3 Methodology

One dimensional riverbed fluctuation model was applied to predict the riverbed fluctuation caused by the imbalance of sediment carrying capacity along the river course. This model was applied for the simplicity of the model itself in evaluating riverbed fluctuation changes introduced by new river structures or improvement works. Applicability of the model is widely validated by river planning in Japan.

Fluctuation depth was calculated based on the followings:

- 1) difference of sediment transport capacity between downstream and upstream river sections; and
- 2) extraction volume.

The following assumptions were made to the model in order to simplify the discussion on differences in results obtained for each case:

- No riverbed material is extracted from the objective river stretch; and
- Every river section can be eroded infinitely.

The reason why the second assumption was introduced is explained in the next subsection.

In order to examine the stability of the present channel, short-term and long-term riverbed fluctuation analyses are made on Case-0. After the evaluation of the stability, long-term riverbed fluctuation analysis was made on another 5 cases and the evaluation of the influence on the future riverbed change is made by comparing the outputs with those of natural condition (Case-0).

7.4 Result of Analysis

Simulation of the riverbed fluctuation for each of the following 6 cases has been conducted:

- Case-0 : Natural Condition (no changes);
- Case-1 : Widening the river channel of Tupang site to 500 m;
- Case-2 : Widening the river channels of Tupang and Nassiping sites to 500 m;
- Case-3 : Widening the river channels of Tupang, Nassiping and Magapit sites to 500 m;
- Case-4 : Widening the river channels of Tupang, Nassiping and Magapit sites to 700 m; and
- Case-5 : Construction of three cut-off channels (Gabut, San Isidro and Tuguegarao) in the stretch between Alcala and Tuguegarao.

7.4.1 Natural condition (Case-0)

Figure 7.4.1 shows the result of short-term riverbed fluctuation analysis together with the 2-year probable flood hydrograph applied to the analysis. The riverbed change after the occurrence of 2-year probable flood is within 30 cm.

The simulation results of long-term riverbed fluctuation under natural condition (Case-0) is shown in Figure 7.4.2. The average riverbed elevations after 5, 10, 25 and 50 years together with measured average riverbed in the year 2000 are depicted in this figure.

In the graphs shown below the riverbed profile of each section in Figure 7.4.2, the objective river stretch is divided into 4 parts as follows:

- 1) from Aparri (river mouth) to Magapit bridge (Lower part);
- 2) from Magapit bridge to the upstream end of Tupang site (Lower middle part);
- 3) from upstream end of Tupang site to the confluence of the Cagayan mainstream and the Tuguegarao river (Upper middle part); and
- 4) from the confluence of the Cagayan mainstream and the Tuguegarao river to Cabagan (Upper part).

The average riverbed elevation of each section changes on a large scale even in a short period such as 5 years after the year 2000. It is one of the characteristics of this analysis that the section with high riverbed elevation is strongly eroded (due to its large sediment transport capacity) and the eroded riverbed materials are easy to accumulate on the section with low riverbed elevation (due to its small sediment transport capacity). This phenomenon is caused by the assumption that every section can be eroded infinitely, while the section with high riverbed elevation, such as that located around 75 km from the river mouth, is presumed to

have a layer of a material with difficulty of erosion (such as rock layer). The section measured in 2000 must be a result of erosion and sedimentation of “super” long-term scale. In this analysis, the evaluation of the stability of the present riverbed condition and the influence of each implementation scheme was made based on this result for the following reasons;

- Reasonable estimation of changeable depth of each river cross section is almost impossible in view of present data availability.
- The assumption that every section can be eroded infinitely leads the simulation results to the safety side when discussing about the stability of the present riverbed condition.
- It is reasonable enough that the estimation of the influence of each implementation scheme itself on the riverbed fluctuation is made by comparing the riverbed profile of “without project” condition and “with project” condition of the same time.

As shown in Figure 7.4.2, the average riverbed elevation in each part (Lower, Lower middle, Upper middle and Upper) is stable enough, although slight aggradation of bed is recognized in Lower middle and Upper parts.

7.4.2 Influence of each channel widening case (Case-1 to Case-4) on the future riverbed condition

Figures 7.4.3 to 7.4.6 show the comparison of results of long-term riverbed fluctuation analysis between Case-0 (natural condition) and each channel widening case both after 10 and 50 years. The influence of channel widening scheme is spread to not only downstream reaches but also upstream in all cases.

In Case-1 (refer to Figure 7.4.3), channel widening at Tupang site causes riverbed degradation both in upper and lower reaches of the widening section, and the length of affected reaches is around 65 km after 50 years of the implementation. However, the influence does not reach any existing bridge sites such as Magapit, Buntun or Santa Maria. And since it does not reach the stretch around the river mouth, the tidal reaches of the Cagayan mainstream do not receive any ill effect such as river mouth clogging from this implementation.

In Case-2 (refer to Figure 7.4.4), the common features as in Case-1 are found, and affected reach spreads around 70 km after 50 years. Comparing results of this case with those of Case-1, it is clearly recognized that widening of the Nassiping site will not influence the fluctuation characteristics of upper reaches of the site including Tupang. The existing bridges are not affected by this implementation

alternative either. And the tidal sections retain their elevations at same levels as those of natural condition (Case-0).

In Case-3 (refer to Figure 7.4.5), the riverbed elevation of upstream reaches from Nassiping site is same as that of Case-2. Though the affected length of widening Magapit site is less than 20 km after 50 years from the implementation, the affected reaches contain the Magapit bridge site.

In Case-4 (refer to Figure 7.4.6), the riverbed condition takes much more different state from the another cases, and the length of affected reaches comes up to around 100 km after 50 years from the implementation. Although the Buntun and the Santa Maria bridges are saved from the affected reaches, the Magapit bridge is clearly located in it.

As mentioned above, if channel widening schemes of Case-3 or Case-4 are taken, the possibility of some ill effects on the Magapit bridge site should be examined carefully. Following table shows simulated average riverbed elevation of the section of Magapit bridge site.

Simulated Average Riverbed Elevation at the Section of Magapit Bridge Site

	Average Riverbed Elevation (EL m)		
	Case-0	Case-3	Case-4
At present ('00)	* -3.18	-3.18	* -3.18
After 5 years	-5.32	-3.81	-3.43
After 10 years	** -5.77	** -4.12	-3.70
After 25 years	-4.33	-2.93	** -4.13
After 50 years	-3.89	* -2.60	-3.34
<i>Amplitude (m)***</i>	2.59	1.52	0.95

* : Maximum elevation

** : Minimum elevation

*** : Difference between maximum and minimum elevations

Average riverbed elevation of this section goes down at first and comes up after reaching the minimum value in every case. According to the field reconnaissance made in this Study, rock layer was exposed to the ground surface around this site and the foundation of the piers of Magapit bridge is of course located on this layer. Therefore drastic degradation magnitude shown above must be just for reference, and actual amplitude seems to be much smaller. Though the amplitude value in the table has weak meaning in quantitative aspect, it becomes smaller if an alternative to widening the Magapit site is taken.

7.4.3 Influence of construction of 3 cut-off channels (Case-5) on the future riverbed condition

Figure 7.4.7 shows the comparison of simulation results between Case-0 and the case of 3 cut-off channel construction (Case-5). Degradation of the riverbed is

found in the upstream reaches of each cut-off channel, while aggradation is recognized in the downstream of them. Generally speaking, when a cut-off channel is constructed, the riverbed elevation of the upstream reaches of it tends to decline due to the increase of sediment transport capacity in the cut-off channel sections. On the other hand, that of the downstream reaches of it tends to rise because the downstream sections do not have enough sediment transport capacity compared with the cut-off channel sections. Though the results in Figure 7.4.8 show this tendency well, the difference of the riverbed elevation from the natural condition ranges within 1 m after 50 years. Moreover, the Magapit bridge and the Santa Maria bridge exist out of the affected reaches and the Buntun bridge is located at the part of riverbed aggradation. Therefore, the construction of 3 cut-off channels will not cause any serious scouring at the part of piers of each bridge.

CHAPTER 8 SALINE WATER INTRUSION

8.1 Objectives of the Saline Water Intrusion Analysis

The primary purpose of this study is to investigate the saline water intrusion into the Cagayan River during dry season, under the current condition, i.e. without improvement of the Cagayan River.

The objective of the survey is as follows:

- a) to determine the types of saline water intrusion; e.g. negligible saline wedge formation (saline wedge is formed only at the bottom of the river bed); moderate saline wedge formation; or strong saline wedge formation (i.e. chloride concentration is relatively large and does not vary regardless of the water depth); and
- b) to determine the distance of salinity intrusion from the Cagayan river mouth.

The following sections describe methods and results of the salinity intrusion survey conducted.

8.2 Available Data

During the 1987 Master Plan Study, field investigation was conducted on March 8 and 9, 1986. Electric conductivity of river water at variable water depth were measured together with temperatures of water and discharge at reference sections. Results of these investigations are presented in Table 8.2.1.

8.3 Methodology

Field observation of saline water intrusion was conducted on 24-hour basis to detect the actual intrusion length and type of wedge formed. Saline water intrusion analysis was made based on the hydraulic calculation to examine the intrusion length.

8.4 Field Observation and Measurement

On January 10 to 11, 2001, 24-hour continuous salinity intrusion survey was conducted by DPWH Region 2 engineers and the Hydrologist of the Study Team.

8.4.1 Observation Stations

The observation stations consist of six (6) stations with staff gauges along the Cagayan River from its river mouth at Aparri at every 5 km distance as follows:

River	Station No.	Location
Cagayan River	5+000	05 km from river mouth
	10+000	10 km from river mouth
	15+000	15 km from river mouth
	20+000	20 km from river mouth
	25+000	25 km from river mouth
	30+000	30 km from river mouth (upstream of Magapit Br)

8.4.2 Simultaneous Observations

The observations were carried out as follows:

(1) Observation Period

At the above six stations along the Cagayan River, 24-hour continuous observation was conducted. River water samples were simultaneously collected at the six observation stations. Date of the observation was determined by the date when the highest tidal level at Aparri in the month of January 2001 is predicted in “Predicted Tide and Current Tables 2001” published by NAMRIA.

(2) Observation Location

Water samples were taken at the location where the deepest water depth was determined from the results of cross-sectional survey conducted during the First Work in the Philippines. Samples were taken from the water surface, thereafter at an intervals of 1.0 meters towards the riverbed with the last sample taken at the riverbed. The sampling point was marked by a locally produced buoy.

(3) Sampling Equipment

Sampling equipment were made by utilizing locally available materials, since approximately 1,000 sampling bottles were required. Each sampling bottle was covered with plastic wrap with a rope and a weight attached in order to take water sample at a specific depth.

(4) Sampling Team

One DPWH Region II engineer and several locally hired assistants were assigned to each observation station with sampling equipment. Wrist watches of all engineers were synchronized with each other prior to their departure to each location.

(5) Temperature Measurement

After sampling, the temperature of the water sample was measured immediately with a thermometer.

(6) Salinity Measurement

After sampling, the water samples were transported immediately to a laboratory set out in the field. Salinity content was measured as a percent by water quality testing equipment. Results of measurement are presented in Table 8.2.1.

(7) Discharge Measurement

Discharge measurement was made by the DPWH Hydrologist Counterpart at the Magapit automatic water level gauging station with the use of a current meter. The measurement was made at every 4 hours at Magapit. Results of the measurement are presented in Table 8.4.1.

8.5 Saline Water Intrusion Analysis

A saline water intrusion analysis was conducted to estimate the intrusion length (the length of salt water wedge) and the shape of wedge.

8.5.1 Basic Formulas

The shape and length of the salt water wedge were estimated using following formulas (refer to Figure 8.5.1):

$$\eta \left(-\frac{1}{5} F_{d0}^{-2} \eta^4 + \frac{1}{4} F_{d0}^{-2} \eta^3 + \frac{1}{2} \eta - 1 \right) + 3F_{d0}^{2/3} \left(\frac{1}{4} - \frac{1}{10} F_{d0}^{2/3} \right) = \frac{\bar{f}_i}{2} \cdot \frac{x}{H} \quad (a)$$

$$L = \frac{H}{2 \bar{f}_i} \left(\frac{1}{5} F_{d0}^{-2} - 2 + 3F_{d0}^{2/3} - \frac{6}{5} F_{d0}^{4/3} \right) \quad (b)$$

Where,

H : Water depth at the tip of wedge (m)

$\eta (=h_1/H)$: Ratio of fresh water depth to total water depth

$F_{d0} (=U_0/(\epsilon g H)^{1/2})$: Density Froude number

\bar{f}_i : Average resistance factor along the wedge

h_1 : Depth of fresh water (m)

U_0 : Average current velocity at the tip of wedge (m/sec)

G : Acceleration of gravity ($=9.8 \text{ m/sec}^2$)

$\epsilon (= (\rho_2 - \rho_1)/\rho_2)$: Relative difference of density

ρ_1 : Density of fresh water

ρ_2 : Density of saline water

The use of the formulas are proposed in the following conditions:

- The salt water wedge is in steady state.
- The lower layer (saline water) has no current velocity.
- The density of lower layer has constant value.
- The cross-sections of tidal stretch are regarded as rectangular shape with uniform width and water depth.
- The riverbed gradient of tidal stretch is regarded as zero.

8.5.2 Procedure

Figure 8.5.2 shows the general procedure of the analysis.

8.5.3 Target Runoff and Parameters

Target runoffs (Q_t) were determined taking the results of low flow analysis (refer to Chapter 4) into account. Selected six target runoffs are tabulated below:

No.	Q_t (m ³ /sec)	Description
1.	137	Minimum 10-day runoff simulated from rainfall records from 1963 to 1998
2.	173	5-year probable drought runoff (10-day runoff)
3.	207	95 % dependable 10-day runoff
4.	416	75 % dependable 10-day runoff
5.	949	50 % dependable 10-day runoff
6.	1,606	Measured runoff in the field observation (January 10 ~ 11, 2001; refer to Table 8.2)

Applying basic formulas (a) and (b), the wedge shape and length under the conditions for each target runoff were calculated. The actual length of the wedge is of course affected by the geographical conditions of the stretch. Therefore, the actual wedge length for each target runoff was estimated by laying the deepest riverbed profile measured in 2000 on the calculated salt water wedge.

In applying basic formulas, following assumptions were introduced:

- Tidal level was set at EL. 0.71 m from the tidal level data at Aparri.
- Average current velocity of tidal stretch was estimated by non-uniform flow calculation.
- According to the longitudinal distribution of chloride concentration measured in the 1987 Master Plan, average resistance factor was set to 0.0037.
- The densities of fresh and saline water were set to 1.000 g/cm³ and 1.025 g/cm³ accordingly.
- Water depth at the tip of wedge (H) was set to 10 m for every target runoff considering the actual riverbed elevation and the results of non-uniform flow calculation.

8.6 Result of Analysis

Figure 8.6.1 shows the result of analysis. This figure indicates that the tip of salt water wedge for each target runoff cannot reach the Magapit Bridge due to the topographical barrier existing about 22 km upstream from the river mouth.

The wedge tip reaches only about 1 km from the river mouth for the runoff of 1,606 m³/sec, which was measured in the field observation conducted from January 10 to 11, 2001. This is consistent with the fact that no saline water intrusion was observed even at 5 km upstream point from the river mouth in the field observation.

Though it can be said that the saline water reaches around 22 km upstream from the river mouth at most in the present condition, careful examination of the length and shape of salt water wedge should be made when planning dams or dredging works. Because the former may become the cause of low flow reduction, and the latter may lower the topographic barriers.

CHAPTER 9 FLOOD INUNDATION ANALYSIS

9.1 Past Flood Events

Largest floods in recent years occurred in November 1973 by typhoon Openg, in November 1980 by typhoon Aring, and in October 1998 by typhoon Iliang. Inundation Area map of these floods are presented in Figure 9.1.1.

Flood marks of 1973 and 1980 have been surveyed during the 1987 Master Plan Study. Furthermore, flood marks of 1998 has been surveyed during the flood damage survey during this JICA Study, as discussed in Flood Control Section.

9.2 Methodology and Simulation Model

9.2.1 Applied Simulation Method

Flood inundation model simulates a wide-spread flooding in the lower Cagayan River from Cabagan to Aparri. As shown in Figure 9.1.1, the flood inundation area has been well defined due to the constricted flood plain of the lower Cagayan River. In the lower Cagayan River, instead of the areal distribution of the inundation area, it is the inundation depth and time which differs depending on the magnitude of the flood.

Considering above characteristics of the Cagayan river floods, one-dimensional non-uniform calculation method is applied to the analysis. The basic equation of this method is shown below:

$$-i + \frac{dH}{dx} + \frac{\alpha Q^2}{2g} \frac{d}{dx} \left(\frac{1}{A^2} \right) + \frac{n^2 Q^2}{R^{2/3} A^2} = 0$$

where,
i : riverbed slope
H : water depth
A : area of water section
Q : discharge
n : Manning's roughness coefficient

Behavior of the flood flow is hydraulically analyzed using above energy equation.

9.2.2 Available Data and Information for the Analysis

Following are the data and information applied for the analysis.

- Flood marks of past events
- River profile and cross-section data measured in the year 2000
- Flood hydrographs at 11 points along the Cagayan mainstream obtained by storage function method (refer to CHAPTER 3)

- DEM (Digital Elevation Model) data generated from aerial photograph and supplemental survey result obtained in the year 2000

The locations of river cross sections measured are shown in Figure 9.2.1 together with the location of the 11 points with calculated flood hydrographs.

9.2.3 Simulation Procedure

The flood inundation area in the lower Cagayan basin was divided into mesh of 1 km × 1 km grid cells using the newly developed topographic map in 2000. In order to express the spatial movement of flood flow in the inundation area, one-dimensional non-uniform flow calculation model was adopted. The model simulates the flood level propagation through divided mesh blocs by obtaining the flood level by non-uniform flow analysis at every reference point of the individual mesh.

For each mesh, average mesh elevation above mean sea level was obtained from digital elevation model (DEM) data developed from aerial photographs. Ground elevation with distance of every 10 m has been obtained. In other words, approximately 10,000 elevation data was used to obtain the average elevation of each mesh.

The maximum inundation depth for a mesh was calculated from the flood water depth obtained for the mesh minus the average elevation of the mesh. Similarly, the inundation time required for the flood damage study is the time required for the maximum inundation depth to dissipate completely from the mesh (refer to Figure 9.2.2).

General procedure of the analysis is illustrated in Figure 9.2.2.

9.2.4 Calibration

The parameters incorporated into the proposed inundation model were calibrated by use of flood marks obtained for selected flood records. Table 9.2.1 presents the flood marks obtained for the major flood which occurred in the area.

Calibration of the flood level of the model was conducted by developing floods that occurred by typhoon Openg in 1973 and Aring in 1980. Figure 9.2.3 presents the result of the calibration of the flood level and the flood marks of these two flood events. Simulated inundation duration was compared with the same obtained by the Flood Damage Survey conducted in the year 2000 by the sub-contracted works.

9.3 Result of Analysis

With the return period of 2, 5, 10, 25, 50 and 100 years, flood inundation analysis was made to obtain maximum inundation depth and inundation period for each mesh. Results for these six return periods are presented in Figure 9.3.1. The result of flood inundation analysis was applied to estimate flood damage, which is discussed in the Annex on Flood Control.

CHAPTER 10 HYDROLOGICAL ANALYSIS FOR FEASIBILITY STUDY

10.1 Calibration of Storage Function values (k and p) based on newly obtained topographic maps

Based on the new topographic maps obtained, calibration of storage function values, i.e. k and p, were obtained. The figures have been obtained by considering storage-function values of channels.

As presented by hydrographs in Figure 10.1.1, the newly-obtained storage-function values do not cause any significant difference to the peak as well as hydrograph patterns. Therefore, it was concluded that topographic conditions of the river do not vary much from the 1987 Master Plan period.

10.2 Change in Discharge due to Implementation of Feasibility Study Projects

Analysis was made to consider the change in discharge due to implementation of the feasibility study projects. Based on the cross sections which includes the planned short cut channels and diking works, several cases have been analyzed to consider the differences in discharge.

As presented in Figure 10.1.1 and the table below, the flood peak will increase by approximately 9.5% when short-cut channels and diking works are implemented:

Locations	Without projects	With projects	Increase in %
BP-1	15,700 m ³ /sec	17,196 m ³ /sec	9.53
BP-2	15,300 m ³ /sec	16,764 m ³ /sec	9.57
Stretch 1	15,900 m ³ /sec	17,451 m ³ /sec	9.76
Stretch 2	18,700 m ³ /sec	18,700 m ³ /sec	0.00

BP-1 : Aparri

BP-2 : Upstream of the confluence with the Chico River

Stretch 1 : River stretch between BP-1 and BP-2

Stretch 2 : River stretch between BP-2 and BP-3

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Annex IV: Meteo-Hydrology

Tables

Table 1.3.1 Summary of Meteorological Record (1/2)

Rainfall (mm)

Station	Period	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Amount
Aparri	1951-85	134.4	75.2	45.4	35.3	99.4	175.2	183.5	226.5	286.8	345.2	397.6	210.8	2,215.3
APC, Iguig	1981-99	27.6	16.1	18.7	42.5	153.0	161.0	225.2	267.1	232.5	346.8	180.0	133.1	1,803.6
Lal-lo	1972-84	125.0	56.1	29.5	55.5	162.3	145.9	171.2	275.0	197.7	310.3	349.1	197.2	2,074.8
Bitag Grande	1975-80	85.5	21.0	28.9	27.4	212.6	118.3	313.0	199.9	548.7	214.2	286.3	141.2	2,197.0
Tuao	1956-85	29.4	24.3	31.2	63.3	171.0	195.4	214.8	232.2	175.1	246.7	230.8	96.9	1,711.1
Tuguegarao	1949-85	18.7	14.5	30.2	49.1	113.1	155.2	195.5	234.5	202.2	248.5	276.4	94.7	1,632.6
Pinukpuk	1970-81	83.7	26.0	58.4	75.8	203.8	233.6	263.2	322.3	212.7	365.5	364.2	189.2	2,398.4
Naneng	1956-85	38.3	28.1	51.4	72.9	208.0	271.8	285.4	337.8	288.7	298.2	299.2	94.9	2,274.7
Guilguila	1963-80	122.7	56.1	61.7	77.0	215.4	321.8	329.1	284.7	312.9	318.5	375.9	237.2	2,713.0
Lubuagan	1969-78	62.6	32.8	65.2	51.2	147.7	224.6	213.1	236.5	210.8	237.2	275.0	155.4	1,912.1
Basao	1963-75	95.6	27.2	70.6	114.8	288.8	422.0	382.0	341.4	314.9	312.6	439.8	271.5	3,081.2
Ilagan	1965-84	59.1	20.9	32.3	62.6	155.4	172.8	144.7	186.0	172.2	291.1	315.9	191.1	1,804.1
Banga-an	1963-78	27.2	7.6	22.0	78.8	218.7	274.8	302.4	375.6	274.5	148.8	115.3	26.4	1,872.1
Bontoc	1963-85	17.9	11.9	46.6	127.6	263.8	294.5	390.5	267.9	302.8	204.8	152.5	54.4	2,135.2
Barlig	1963-85	134.4	41.0	92.9	95.2	309.7	402.6	394.7	411.6	372.1	407.8	499.5	326.3	3,487.8
Bauko	1963-80	6.5	7.5	43.8	169.1	284.5	304.8	371.0	421.4	313.4	188.7	67.9	54.4	2,233.0
Mt. Polis	1963-80	160.4	134.0	110.1	157.7	337.3	457.1	516.8	553.5	453.0	378.1	370.9	246.6	3,875.5
Mt. Data	1950-78	27.2	25.0	74.6	187.9	357.0	413.5	619.4	563.3	465.2	296.3	220.4	78.2	3,328.0
Lagawe	1968-82	176.0	88.5	65.2	190.1	171.3	265.0	362.0	319.9	341.4	331.6	394.3	146.3	2,851.6
Nayon	1968-80	63.4	25.5	69.9	89.5	217.2	200.4	207.8	243.6	220.4	240.2	185.7	99.3	1,862.9
Echague	1976-85	17.5	9.1	18.2	91.7	114.5	97.1	148.8	259.9	189.6	272.8	128.0	142.3	1,489.5
Diadi	1968-71	54.2	16.3	49.9	54.4	173.0	239.2	275.8	192.4	211.4	399.6	280.0	153.3	2,099.5
Barat	1968-80	23.8	10.1	35.8	90.0	226.7	224.8	271.4	323.1	302.7	337.8	156.4	104.9	2,107.5
Consuelo	1956-85	33.5	18.0	44.0	70.9	221.5	252.6	380.4	331.0	325.5	263.9	211.8	60.5	2,213.6
Gabong	1972-52	38.6	13.0	25.5	33.4	128.5	179.9	251.5	216.7	229.0	230.0	284.9	90.3	1,721.3
Dakgan	1972-82	18.4	11.3	29.8	23.1	134.5	158.8	234.2	176.5	216.5	273.1	274.6	68.9	1,619.7
Casiguran	1961-84	234.2	113.8	176.5	136.3	242.3	229.4	284.7	251.9	592.5	421.7	628.8	402.9	3,715.0
Wacal	1980-85	36.8	19.6	112.2	160.7	174.1	107.5	255.5	201.4	183.2	259.9	141.4	50.4	1,702.7
Banti	1980-85	33.7	12.4	17.9	71.4	102.7	86.6	133.0	169.9	224.6	177.9	78.9	34.7	1,143.7
Dippadiw	1980-83	185.8	19.7	53.2	27.2	190.1	59.7	245.8	239.2	181.1	249.7	458.1	299.5	2,209.1
San Francisco	1975-80	122.8	138.2	47.0	41.8	146.3	82.3	143.1	143.4	153.9	328.3	209.8	171.7	1,728.6
NIA Cabarrquigs	1982-85	54.2	7.7	52.0	95.5	170.3	185.8	96.0	187.8	124.2	159.2	121.0	117.5	1,371.2
Hapid	1976-85	15.4	21.7	42.8	115.2	222.5	167.9	209.4	173.7	241.4	213.4	109.4	29.9	1,562.7
Baretbet	1977-85	21.1	12.5	58.9	128.1	262.7	184.7	231.4	194.9	254.4	250.8	125.1	49.4	1,774.0
Baligatan	1976-85	29.4	10.7	37.6	98.7	206.8	177.0	234.2	213.1	231.0	202.9	160.2	50.9	1,652.5
Poblacion Lagawe	1976-85	44.9	37.5	62.7	117.9	240.1	183.3	284.8	267.4	230.1	250.7	136.3	64.3	1,920.0
Sto. Domingo	1976-85	28.6	14.6	29.7	115.3	113.9	161.7	193.5	157.3	232.7	245.3	116.3	44.8	1,453.7
Kasibu	1978-85	52.5	44.4	86.0	189.8	260.1	221.3	223.1	234.9	259.6	555.6	398.4	132.1	2,657.8
Kamamasi	1978-85	183.1	55.5	111.5	158.7	279.0	187.7	325.4	216.4	401.2	521.3	505.7	306.7	3,252.2
Alayan	1978-85	112.1	42.4	60.1	191.4	229.6	170.4	253.8	200.3	375.2	535.9	475.1	268.3	2,914.6
Packet	1979-84	45.4	30.5	75.2	126.2	261.3	171.9	259.5	187.3	335.8	231.5	277.7	201.8	2,204.1

Mean air temperature (°C)

Station	Period	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
Aparri	1951-85	23.1	23.8	25.3	27.1	28.3	28.5	28.3	27.9	27.6	26.8	25.4	23.8	26.3
Tuguegarao	1951-83	23.1	24.1	26.1	28.2	29.0	28.6	28.0	27.7	27.3	26.3	24.8	23.5	26.4
Echague	1981-84	21.5	22.7	24.5	26.1	26.9	27.6	26.8	26.6	26.3	25.3	24.2	22.2	25.1

Mean maximum air temperature (°C)

Station	Period	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
Echague	1980-97	27.1	29.4	32.3	34.5	34.9	34.4	33.2	33.3	32.2	31.5	29.5	27.2	31.6
APC, Iguig	1981-99	28.1	29.8	32.9	35.3	36.5	35.7	34.5	33.9	33.2	31.2	29.6	27.6	32.4
Aparri	1951-85	26.3	27.6	29.6	31.6	33.3	33.5	32.9	32.4	31.6	30.2	28.3	26.8	30.3
Tuguegarao	1951-83	29.2	31.2	33.8	35.9	36.8	35.7	34.9	34.2	33.6	32.2	30.1	28.8	33.0
Malasin	1976-80	27.2	27.4	30.2	32.8	32.9	31.9	31.5	31.3	30.9	29.0	27.0	26.0	29.8
San Isidro	1976-80	27.3	28.2	30.6	33.1	33.0	31.9	31.7	31.6	31.3	29.2	27.3	26.2	30.1
Lagawe	1981-84	29.1	29.0	28.9	28.8	29.7	30.2	29.7	29.9	29.7	29.7	29.6	28.4	29.4
Hapid	1981-84	23.7	24.6	25.7	27.3	28.5	28.2	27.7	26.8	28.2	26.7	25.5	23.0	26.3
Baretbet	1981-84	26.1	28.2	31.2	31.0	30.1	29.9	29.1	28.8	29.8	28.4	27.8	25.9	28.9
Consuelo	1981-84	25.5	28.7	30.3	30.9	31.7	31.1	29.2	27.6	28.6	27.4	27.1	24.8	28.6
Sto Domingo	1981-84	27.7	29.1	28.9	31.0	32.2	32.7	31.9	30.1	30.0	29.4	30.1	27.2	30.0

Table 1.3.1 Summary of Meteorological Record (2/2)

Mean minimum air temperature (°C)

Station	Period	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
Echague	1980-97	19.8	20.1	20.6	22.7	23.7	24.0	23.6	23.7	23.4	22.9	22.0	19.0	22.1
APC, Iguig	1981-99	20.0	20.2	21.3	23.0	24.1	24.5	24.0	24.2	23.8	23.1	22.2	20.4	22.6
Aparri	1961-99	20.4	20.6	22.0	23.5	24.4	24.8	24.7	24.5	24.2	23.7	22.8	21.2	23.1
Tuguegarao	1951-83	19.3	19.4	20.9	22.6	23.7	23.8	23.6	23.6	23.3	22.5	21.6	20.3	22.1
Malasin	1976-80	21.8	21.9	23.6	24.6	24.8	25.3	25.1	25.3	25.4	24.7	23.2	22.3	24.0
San Isidro	1976-80	21.3	21.1	23.0	24.9	25.4	25.7	25.6	25.5	24.6	24.1	22.8	21.6	23.8
Lagawe	1981-84	20.5	19.0	22.0	21.7	21.2	22.1	20.6	21.8	21.5	21.8	22.0	21.1	21.3
Hapid	1981-84	21.2	20.5	21.1	22.7	23.3	24.1	23.8	23.2	23.0	23.4	22.0	20.5	22.4
Baretbet	1981-84	21.7	23.1	23.3	24.3	24.5	24.4	24.2	24.8	25.0	24.0	23.8	22.5	23.8
Consuelo	1981-84	20.4	21.5	23.7	24.2	25.4	25.2	24.0	23.4	23.6	22.9	22.0	21.1	23.1
Sto Domingo	1981-84	19.6	20.1	19.5	20.2	22.2	22.0	21.2	20.4	20.1	18.7	19.1	18.9	20.2

Relative humidity (%)

Station	Period	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
APC, Iguig	1983-97	89	88	82	79	78	82	84	85	86	88	89	90	85
Aparri	1951-85	85	83	82	81	80	80	81	83	84	84	86	87	83
Tuguegarao	1949-99	80	76	73	69	69	72	74	76	77	79	82	82	76
Echague	1981-84	88	86	81	79	83	84	84	87	86	85	90	92	85
Malasin	1976-80	85	81	78	70	72	80	81	80	85	83	88	86	81
San Isidro	1976-80	86	82	78	74	73	80	82	81	83	86	90	88	82

Daily evaporation, A-pan (mm)

Station	Period	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
APC, Iguig	1980-99	2.8	4.1	5.8	6.6	6.5	6.0	5.1	4.7	4.3	3.5	2.7	2.3	4.5
Tuguegarao	1974-91	2.6	3.9	5.0	5.8	5.7	5.1	4.8	4.0	3.4	3.2	2.6	2.1	4.0
Alimano reservoir	1957-67	4.9	5.5	6.6	7.8	7.5	6.4	6.0	5.5	5.8	5.3	4.5	4.4	5.9
Talictic (Baligatan)	1957-84	3.7	4.6	6.0	7.3	7.1	6.1	5.6	5.1	5.1	4.6	3.7	3.3	5.2
Bontoc	1969-74	3.9	4.4	4.2	4.3	3.0	3.5	2.5	3.1	3.6	3.2	2.9	3.0	3.5
Echague	1977-97	2.6	3.2	5.0	5.3	5.3	4.8	4.8	4.1	3.9	3.4	2.5	2.3	3.9
Lagawe	1980-82	3.9	3.7	4.3	5.4	5.7	4.8	4.9	5.7	4.9	6.4	5.5	3.9	4.9
Consuelo	1980-84	3.5	4.6	5.2	6.0	6.1	5.4	5.1	3.7	4.7	3.3	3.3	3.1	4.5
Sto Domingo	1979-84	4.3	5.3	6.3	7.3	6.3	6.4	5.8	5.6	6.0	5.3	4.7	4.7	5.7
Baretbet	1980-84	3.4	3.3	5.7	6.2	6.2	5.8	5.6	5.3	5.0	4.3	3.6	3.2	4.8
Wacal	1980-84	3.0	4.2	5.2	5.6	5.8	6.6	5.7	5.4	4.8	4.7	3.5	3.0	4.8
Malasin	1976-80	3.5	4.4	6.2	8.3	7.5	6.2	6.0	5.5	4.3	3.8	3.1	2.6	5.1
San Isidro	1976-80	3.5	4.4	5.8	7.3	7.1	6.4	6.1	5.4	4.9	3.8	3.1	2.6	5.0

Wind speed (km/hr)

Station	Period	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
Aparri	1951-85	12.0	10.0	10.0	10.0	8.0	8.0	9.0	8.0	8.0	11.0	14.0	12.0	10.0
APC, Iguig	1983-96	8.0	8.0	8.8	8.1	8.0	7.6	7.7	5.9	6.2	7.6	7.8	7.7	7.6
Tuguegarao	1958-99	5.4	5.0	5.7	6.4	5.7	5.8	5.5	4.5	4.5	5.9	5.4	5.6	5.5

Daily sunshine duration (hr)

Station	Period	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
Tuguegarao	1978-99	4.3	5.9	7.1	7.8	7.4	7.3	6.6	5.7	5.6	4.8	3.8	3.1	5.8
Echague	1981-97	3.3	5.0	6.2	6.9	7.0	6.5	6.0	5.2	5.1	4.2	3.4	2.5	5.1

Mean Monthly Atmospheric Pressure (hpa)

Station	Period	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
Tuguegarao	1984-99	1,008	1,001	1,004	1,002	1,002	1,000	1,004	1,001	1,007	1,000	1,001	1,008	1,003
APC, Iguig	1984-99	1,017	1,018	1,017	1,013	1,011	1,009	1,009	1,008	1,009	1,012	1,014	1,017	1,013

Table 2.1.1 Storm Records in the Cagayan River Basin

Tropical Cyclone/Monsoon Rain			Flood Hydrograph		Hourly Rainfall	Remarks
Code	Name	Period	Availability	Peak (m ³ /s)	Availability	
(1) Magat damsite (C.A. = 4,143 km²)						
T6718	Welming	Nov. 1 - 5 '67	x	8,281	x	
T6811	Nitang	Sep. 24 - 29 '68	x	1,790	x	
T6905	Elang	Jul. 24 - 27 '69	x	1,242	x	
T7013	Pitang	Sep. 8 - 12 '70	x	9,540	x	
T7311	Narsing	Oct. 12 - 16 '73	x	6,128	x	
T7416	Tering	Oct. 14 - 17 '74	x	5,658	x	
T7604	Didang	May 15 - 26 '76	x	4,900	x	
T7717	Uding	Nov. 10 - 17 '77	x	1,449	o	
T7810	MIDING	Aug. 23 - 26 '78	o	3,060	o	
T7818	WELING	Sep. 26 - 30 '78	o	3,100	o	
T7822	Kading	Oct. 25 - 27 '78	o	7,906	o	
TS7922	Krising	Dec. 21 - 24 '79	o	2,537	x	
T8011	Nitang	Jul. 18 - 22 '80	x	3,101	o	
T8012	Osang	Jul. 22 - 27 '80	o	1,650	x	
TS8019	Yoning	Oct. 28 - 30 '80	x	3,297	o	
T8020	Aring	Nov. 1 - 7 '80	o	7,637	o	
TS8105	Elang	Jul. 3 - 5 '81	o	3,996	o	
T8120	Anding	Nov. 21 - 27 '81	o	5,440	o	
TS8410	Maring	Aug. 28 - Sept. 5 '84	o	2,140	o	
TD8415	Seniang	Oct. 28 - Nov. 3 '84	o	4,440	o	
TS8510	Miling	Sept. 2 - 11 '85	o	3,192	o	
T8516	Tasing	Oct. 18 - 26 '85	o	6,300	o	
	Reming	29-Oct-84	x	4,259	x	
	Saling	19-Oct-85	x	7,634	x	
	Ruping	20-Oct-86	x	1,706	x	
	Weling	11-Nov-86	x	2,154	x	
	Toyang	21-Oct-88	x	5,293	x	
	Yoning	8-Nov-88	x	2,678	x	
	Tasing	19-Oct-89	x	8,671	x	
	Pasing	16-Oct-90	x	2,349	x	
	Maring	21-Sep-92	o	2,444	o	
	Kadiang	5-Oct-93	o	8,527	o	
	Husing	2-Nov-93	o	7,079	o	
	Monang	7-Dec-93	x	784	o	
	Oneng	16-Dec-93	x	1,326	o	
	Mameng	1-Oct-95	o	5,713	o	
	Neneng	Oct 8-12, '95	x	2,567	o	
	Rosing	Nov. 3-8, '95	o	5,918	o	
	Monsoon	Dec. 24-28, 1995	o	3,442	o	
	Ulpiang	14-Nov-96	x	1,005	x	
	Iliang	15-Oct-98	o	2,797	o	
	Loleng	24-Oct-98	o	6,976	o	
	Norming	12-Dec-98	x	843	o	
(2) Matuno damsite (C.A. = 550 km²)						
T8011	Nitang	Jul. 18 - 22 '80	o	852	o	2 hrs. rainfall
(3) Palattao G/S (C.A. = 6,626 km²)						
		Nov. 22 - 23 '61	o	5,978	x	
		Nov. 6 - 7 '62	o	4,786	x	
		Jun. 27 - 28 '63	o	3,290	x	
(4) Cabulay G/S (C.A. = 196 km²)						
		Sept. 18 - 19 '65	o	105	x	
(5) Ibulaao G/S (C.A. = 606 km²)						
		Sept. 23 - '71	o	445	x	
(6) Gabong G/S (C.A. = 586 km²)						
		Jul. 19 - 25 '80	o	441	x	

Table 2.2.1 Preliminary Estimation of Runoff Coefficient at 31 Gauges

Station Number	Station Name	Name of River	Catchment Area (km2)	Annual Runoff Coefficient				Remarks
				Period	Runoff (mm)	Rainfall (mm)	Coefficient	
5	Simay	Zinundungan	189	65 - '71	2,421	2,268	1.07	x
7	Calaogan	Dummon	308	68 - '71	2,019	2,710	0.75	
10	Calantac	Paret	907	63 - '64	3,221	4,110	0.78	
12	Escolta	Matalag	655	65 - '71	1,656	2,430	0.68	
18	Larion Alto	Tuguegarao	655	65 - '71	3,067	4,000	0.77	
19	Pinukpuk	Saltan	856	65 - '71	1,740	2,500	0.70	
24	Abbot	Chico	3,349	63 - '64	3,287	2,770	1.19	x
25	Pasonglao	Chico	1,987	66 - '69	2,676	2,960	0.90	x
29	Antagan	Tumauini	170	65 - '71	3,405	4,330	0.79	
30	Ampawilen	Chico	751	65 - '71	2,639	3,400	0.78	
34	Taed	Chico	391	65 - '71	2,511	3,300	0.76	
37	Casile	Casile	195	66 - '69	457	1,800	0.25	x
38	Maligaya	Mallig	563	68 - '71	1,070	2,260	0.47	x
39	Munoz	Siffu	686	66 - '69	1,049	2,220	0.47	x
40	Malalam	Ilagan	3,123	63 - '64	2,496	3,170	0.79	
41	Palattao	Cagayan	6,626	65 - '71	1,594	2,370	0.67	
42	Supang	Sabangan	57	65 - '71	2,464	3,200	0.77	
43	Minanga	Ilagan	1,565	66 - '69	1,646	2,580	0.64	
45	Caipilan	Taotao	430	61 - '62	381	1,800	0.21	x
46	Dipalin	Disabungan	198	66 - '69	1,640	2,770	0.59	
47	Oscariz	Magat	4,150	63 - '64	1,534	2,250	0.68	
48	Dulao	Alimit	573	68 - '71	2,244	2,900	0.77	
50	Hapid	Ibulao	606	66 - '69	2,672	3,350	0.80	
51	Camandag	Cadaclan	261	'69	1,196	2,400	0.50	
52	Pangal	Cagayan	4,244	65 - '71	2,188	2,750	0.80	
53	Panang	Cagayan	2,392	61 - '62	1,707	2,880	0.59	
54	Guinalvin	Addalam	921	65 - '71	1,676	2,400	0.70	
55	Bante	Matuno	558	63 - '64	2,701	3,200	0.84	
57	Kamamasi	Diduyon	462	79 - '80	846	2,700	0.31	x
61	Bato	Magat	1,649	65 - '71	1,377	2,710	0.51	
62	Dippadiw	Cagayan	2,380	68 - '71	2,435	2,850	0.85	

Remarks with x sings: Data disregarded, as detail described in Section 2.2

Table 2.2.2 Tidal Level at Aparri

Daily Mean Tidal Level:

Unit: Meter above sea level

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
1960	0.14	0.16	0.20	0.18	0.16	0.31	0.28	0.36	0.23	0.35	0.29	0.24	0.24
1961	0.03	0.04	0.16	0.16	0.22	0.16	0.37	0.31	0.34	0.34	0.30	0.17	0.22
1962	0.16	0.19	0.19	0.20	0.21	0.28	0.32	0.38	0.39	-	-	0.21	0.25
1963	0.20	0.16	0.18	0.18	0.15	0.29	0.32	0.33	0.25	0.31	0.17	0.26	0.23

Mean = 0.24

Daily Maximum Tidal Level:

Unit: Meter above sea level

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
1960	0.56	0.56	0.53	0.71	0.54	0.83	0.66	0.94	0.72	0.70	0.74	0.79	0.83
1961	0.50	0.54	0.66	0.66	0.68	0.90	0.72	1.05	0.74	0.72	0.88	0.76	1.05
1962	0.60	0.64	0.62	0.75	0.74	0.80	0.78	0.78	0.88	-	-	0.75	0.88
1963	0.70	0.62	0.74	0.71	0.61	0.90	0.89	0.82	0.79	0.83	0.67	0.64	0.90

Max = 1.05

Daily Minimum Tidal Level

Unit: Meter above sea level

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
1960	-0.48	-0.52	-0.44	-0.42	-0.42	-0.25	-0.34	-0.38	-0.40	-0.38	-0.34	-0.32	-0.52
1961	-0.44	-0.34	-0.34	-0.42	-0.31	-0.34	-0.28	-0.24	-0.22	-0.26	-0.33	-0.39	-0.44
1962	-0.32	-0.24	-0.28	-0.32	-0.32	-0.28	-0.26	-0.18	-0.28	-	-	-0.36	-0.36
1963	-0.35	-0.42	-0.41	-0.31	-0.41	-0.37	-0.39	-0.39	-0.36	-0.39	-0.39	-0.33	-0.42

Min = -0.52

Table 2.4.1 Summary of Discharge Measurement

Station	Date of observation	Time of observation	Gauge Height (m)		Discharge
			start	end	
Magapit	5-Jun-00	1325-1500	1.64	1.55	1,415.64
	9-Jun-00	1030-1215	1.71	1.85	978.84
	9-Jun-00	1330-1500	1.98	1.94	851.93
	12-Jun-00	0815-0930	1.66	1.54	1,146.78
Nassiping					
	6-Jun-00	1400-1800	3.88	3.89	419.42
	7-Jun-00	0900-1100	3.92	3.93	479.04
	9-Jun-00	0725-0900	3.72	3.80	412.00
Iguig	12-Jun-00	1030-1210	3.30	3.30	411.33
	7-Jun-00	0615-0745	2.23	2.23	380.85
	8-Jun-00	1400-1600	2.23	2.23	312.92
Sta. Maria	10-Jun-00	1400-1600	2.30	2.30	324.59
	12-Jun-00	1400-1600	2.33	2.33	384.28
	7-Jun-00	1530-1800	2.53	2.53	361.92
	8-Jun-00	0920-1130	2.56	2.56	368.38
	10-Jun-00	1015-1145	2.57	2.62	377.86
	11-Jun-00	1300-1500	2.58	2.54	365.89

Table 2.4.2 Summary of Sediment Discharge Measurement

Station	Date of observation	Gauge Ht. (meter)	Discharge (m ³ /s)	Mean Sed. conc.(ppm)	Sed. Disch. Disch (kg/s)
Magapit	5-Jun-00	1.60	1,415.64	50.58	35.73
	9-Jun-00	1.78	978.84	22.92	22.43
	9-Jun-00	1.96	851.93	18.82	16.03
	12-Jun-00	1.60	1,146.78	75.77	86.89
Nassiping					
	6-Jun-00	3.88	419.42	68.02	28.53
	7-Jun-00	3.92	479.04	44.88	21.50
	9-Jun-00	3.76	412.00	44.55	18.35
Iguig	12-Jun-00	3.30	411.33	52.25	21.49
	7-Jun-00	2.23	380.85	33.25	12.66
	8-Jun-00	2.23	312.92	41.13	12.87
Sta. Maria	10-Jun-00	2.30	324.59	43.57	14.14
	12-Jun-00	2.33	384.28	45.08	17.32
	7-Jun-00	2.53	361.92	43.33	15.68
	8-Jun-00	2.55	368.38	42.67	16.39
	10-Jun-00	2.57	377.86	55.75	21.07
	11-Jun-00	2.58	365.89	76.58	27.94

Table 2.4.3 Result of Water Quality Analysis

Station: Magapit Gauging Station

Date	Code	pH (ppm)	Temp. (°C)	DO (ppm)	EC (us/cm)	Turbidity (ppm)	BOD (mg/l)
5-Jun-00	MQ1-1	6.9	30.1	8.1	238	86	*
	MQ1-2	7.0	30.7	7.6	235	90	17
9-Jun-00	M2V1-T	7.0	29.5	7.6	240	50	1.3
	M2V1-B	7.1	29.3	8.0	238	55	1.8
9-Jun-00	M3V1-T	6.9	30.6	7.7	228	69	4.3
	M3V1-B	7.0	31.0	7.2	225	82	1.3
12-Jun-00	M4V1-T	6.6	29.3	6.8	220	176	28
	M4V1-B	6.7	29.0	5.8	222	184	9

Station: Nassiping Gauging Station

Date	Code	pH (ppm)	Temp. (°C)	DO (ppm)	EC (us/cm)	Turbidity (ppm)	BOD (mg/l)
6-Jun-00	NQ1-1	6.9	30.9	7.4	230	75	*
	NQ1-2	7.0	30.0	7.9	228	72	*
7-Jun-00	NQ2-1	7.0	29.8	7.0	230	46	*
	NQ2-2	7.6	29.5	7.5	226	54	*
9-Jun-00	NQ3-1	7.6	29.0	6.5	220	45	4
	NQ3-2	7.9	29.1	6.6	220	39	5
12-Jun-00	NQ4-1	6.9	29.9	7.9	225	47	6
	NQ4-2	7.2	28.7	8.1	225	65	16

Station: Iguig Gauging Station

Date	Code	pH (ppm)	Temp. (°C)	DO (ppm)	EC (us/cm)	Turbidity (ppm)	BOD (mg/l)
7-Jun-00	IQ1-1	7.3	28.9	6.9	225	95	14
	IQ1-2	7.8	29.2	6.8	224	90	*
8-Jun-00	IQ2-1	7.3	29.8	7.2	213	48	2.2
	IQ2-2	7.9	30.0	7.8	215	52	1.4
10-Jun-00	IQ3-1	7.8	29.9	7.9	230	42	23
	IQ3-2	7.6	29.0	7.5	225	38	14
12-Jun-00	IQ4-1	7.8	31.0	6.7	225	112	18
	IQ4-2	7.5	29.9	6.9	223	108	20

Station: Sta. Maria Gauging Station

Date	Code	pH (ppm)	Temp. (°C)	DO (ppm)	EC (us/cm)	Turbidity (ppm)	BOD (mg/l)
7-Jun-00	SQ1-1	7.0	29.8	6.9	220	72	14
	SQ1-2	6.9	29.0	6.6	220	70	*
8-Jun-00	SQ2-1	7.0	28.8	6.7	225	49	<1.0
	SQ2-2	7.0	29.5	7.1	225	54	<1.0
10-Jun-00	SQ3-1	8.1	31.4	7.0	225	62	8
	SQ3-2	7.6	29.8	7.2	220	49	10
12-Jun-00	SQ4-1	7.9	29.0	7.8	220	65	9
	SQ4-2	7.7	29.1	6.9	218	65	11

*:BOD value of more than 28 mg/l. Data rejected for further analysis.

Table 3.4.1 Thiessen Weight for Base Point Basin (1/3)

Case 1 (Period 1956 - 1963, 1985 - 1996)

Basin	Rainfall Gauging Station									
	Aparri	Tuao	Tuguegarao	Naneng	Ilagan	Bontoc	Nayon	Echague	Consuelo	Dakgan
Casecnan	-	-	-	-	-	-	-	-	1.00	-
Cagayan No.2	-	-	-	-	-	-	-	-	1.00	-
Cagayan No.1	-	-	-	-	-	-	-	-	1.00	-
Diduyon	-	-	-	-	-	-	-	-	1.00	-
Addalam (A)	-	-	-	-	-	-	-	-	1.00	-
Matuno No.1	-	-	-	-	-	-	-	-	1.00	-
Alimit No.1 (A)	-	-	-	1.00	-	-	-	-	-	-
Magat	-	-	-	0.27	-	-	-	-	0.73	-
Ilagan No.1	-	-	0.64	-	-	-	-	-	0.36	-
Disabungan	-	-	1.00	-	-	-	-	-	-	-
Siffu No.1 (A)	-	-	-	1.00	-	-	-	-	-	-
Mallig No.2	-	-	-	1.00	-	-	-	-	-	-
Chico No.2	-	-	-	1.00	-	-	-	-	-	-
Chico No.4	-	-	-	1.00	-	-	-	-	-	-
Pinukpuk	-	0.23	-	0.77	-	-	-	-	-	-
Base Point No.1	0.04	0.09	0.29	0.28	-	-	-	-	0.30	-
Base Point No.2	-	0.02	0.36	0.22	-	-	-	-	0.40	-
Base Point No.3	-	-	0.23	0.21	-	-	-	-	0.56	-
Base Point No.4	-	-	0.06	0.27	-	-	-	-	0.67	-
Base Point No.5	-	-	0.09	0.16	-	-	-	-	0.75	-
Base Point No.6	-	0.36	0.02	0.62	-	-	-	-	-	-
Base Point No.7	-	-	0.23	0.77	-	-	-	-	-	-
Base Point No.8	-	-	0.85	-	-	-	-	-	0.15	-
Base Point No.9	-	-	0.02	0.38	-	-	-	-	0.60	-

Case 2 (Period 1964 - 1967)

Basin	Rainfall Gauging Station									
	Aparri	Tuao	Tuguegarao	Naneng	Ilagan	Bontoc	Nayon	Echague	Consuelo	Dakgan
Casecnan	-	-	-	-	-	-	1.00	-	-	-
Cagayan No.2	-	-	-	-	-	-	1.00	-	-	-
Cagayan No.1	-	-	-	-	-	-	1.00	-	-	-
Diduyon	-	-	-	-	-	-	1.00	-	-	-
Addalam (A)	-	-	-	-	-	-	1.00	-	-	-
Matuno No.1	-	-	-	-	-	-	1.00	-	-	-
Alimit No.1 (A)	-	-	-	-	-	-	1.00	-	-	-
Magat	-	-	-	-	-	-	1.00	-	-	-
Ilagan No.1	-	-	0.78	-	-	-	0.22	-	-	-
Disabungan	-	-	1.00	-	-	-	-	-	-	-
Siffu No.1 (A)	-	-	-	0.72	-	-	0.28	-	-	-
Mallig No.2	-	-	-	1.00	-	-	-	-	-	-
Chico No.2	-	-	-	-	-	-	1.00	-	-	-
Chico No.4	-	-	-	0.31	-	-	0.69	-	-	-
Pinukpuk	-	0.23	-	-	0.77	-	-	-	-	-
Base Point No.1	0.09	0.30	0.14	-	0.43	-	-	-	-	-
Base Point No.2	-	0.02	0.38	0.10	-	0.50	-	-	-	-
Base Point No.3	-	-	0.26	0.05	-	0.69	-	-	-	-
Base Point No.4	-	-	0.08	0.07	-	0.85	-	-	-	-
Base Point No.5	-	-	0.09	0.06	-	0.85	-	-	-	-
Base Point No.6	-	0.36	0.01	0.38	-	0.25	-	-	-	-
Base Point No.7	-	-	0.23	0.68	-	0.09	-	-	-	-
Base Point No.8	-	-	0.91	-	-	0.09	-	-	-	-
Base Point No.9	-	-	0.02	0.09	-	0.89	-	-	-	-

Table 3.4.1 Thiessen Weight for Base Point Basin (2/3)

Case 3 (Period 1968 - 1976)

Basin	Rainfall Gauging Station									
	Aparri	Tuao	Tuguegarao	Naneng	Ilagan	Bontoc	Nayon	Echague	Consuelo	Dakgan
Casecnan	-	-	-	-	-	-	-	-	1.00	-
Cagayan No.2	-	-	-	-	-	-	-	-	1.00	-
Cagayan No.1	-	-	-	-	-	-	0.23	-	0.77	-
Diduyon	-	-	-	-	-	-	0.21	-	0.79	-
Addalam (A)	-	-	-	-	-	-	0.51	-	0.49	-
Matuno No.1	-	-	-	-	-	-	0.83	-	0.17	-
Alimit No.1 (A)	-	-	-	-	-	0.28	0.72	-	-	-
Magat	-	-	-	-	-	0.07	0.66	-	0.27	-
Ilagan No.1	-	-	-	-	1.00	-	-	-	-	-
Disabungan	-	-	-	-	1.00	-	-	-	-	-
Siffu No.1 (A)	-	-	-	0.66	0.06	0.25	0.03	-	-	-
Mallig No.2	-	-	-	1.00	-	-	-	-	-	-
Chico No.2	-	-	-	-	-	1.00	-	-	-	-
Chico No.4	-	-	-	0.31	-	0.69	-	-	-	-
Pinukpuk	-	0.23	-	0.77	-	-	-	-	-	-
Base Point No.1	0.03	0.09	0.12	0.10	0.26	0.06	0.22	-	0.12	-
Base Point No.2	-	0.01	0.15	0.04	0.34	0.02	0.28	-	0.16	-
Base Point No.3	-	-	-	-	0.37	0.02	0.39	-	0.22	-
Base Point No.4	-	-	-	-	0.20	0.03	0.49	-	0.28	-
Base Point No.5	-	-	-	-	0.26	-	0.40	-	0.34	-
Base Point No.6	-	0.36	0.02	0.38	-	0.24	-	-	-	-
Base Point No.7	-	-	0.20	0.47	0.42	0.08	0.01	-	-	-
Base Point No.8	-	-	-	-	1.00	-	-	-	-	-
Base Point No.9	-	-	-	0.01	0.08	0.06	0.63	-	0.22	-

Case 4 (Period 1977 - 1984)

Basin	Rainfall Gauging Station									
	Aparri	Tuao	Tuguegarao	Naneng	Ilagan	Bontoc	Nayon	Echague	Consuelo	Dakgan
Casecnan	-	-	-	-	-	-	-	-	0.19	0.81
Cagayan No.2	-	-	-	-	-	-	-	-	0.13	0.87
Cagayan No.1	-	-	-	-	-	-	-	0.01	0.09	0.90
Diduyon	-	-	-	-	-	-	0.04	-	0.12	0.84
Addalam (A)	-	-	-	-	-	-	0.01	0.12	0.07	0.79
Matuno No.1	-	-	-	-	-	-	0.83	-	0.17	-
Alimit No.1 (A)	-	-	-	-	-	0.28	0.72	-	-	-
Magat	-	-	-	-	-	0.07	0.65	-	0.27	0.01
Ilagan No.1	-	-	-	-	0.05	-	-	0.95	-	-
Disabungan	-	-	-	-	1.00	-	-	-	-	-
Siffu No.1 (A)	-	-	-	0.66	0.06	0.25	0.03	-	-	-
Mallig No.2	-	-	-	1.00	-	-	-	-	-	-
Chico No.2	-	-	-	-	-	1.00	-	-	-	-
Chico No.4	-	-	-	0.31	-	0.69	-	-	-	-
Pinukpuk	-	0.23	-	0.77	-	-	-	-	-	-
Base Point No.1	0.03	0.09	0.12	0.10	0.15	0.06	0.11	0.18	0.05	0.11
Base Point No.2	-	0.01	0.14	0.04	0.20	0.02	0.14	0.23	0.07	0.14
Base Point No.3	-	-	-	-	0.18	0.02	0.20	0.32	0.09	0.19
Base Point No.4	-	-	-	-	0.06	0.02	0.25	0.30	0.12	0.25
Base Point No.5	-	-	-	-	0.04	-	0.02	0.46	0.04	0.44
Base Point No.6	-	0.35	0.02	0.38	-	0.25	-	-	-	-
Base Point No.7	-	-	0.20	0.47	0.41	0.07	0.01	-	-	-
Base Point No.8	-	-	-	0.59	-	-	0.41	-	-	-
Base Point No.9	-	-	0.01	0.04	0.06	0.58	0.09	0.22	-	-

Table 3.4.1 Thiessen Weight for Base Point Basin (3/3)

Case 5 (Period 1985 - 1999)

Basin	Rainfall Gauging Station									
	Aparri	Tuao	Tuguegarao	Naneng	Ilagan	Bontoc	Nayon	Echague	Consuelo	Dakgan
Casecnan									1.00	
Cagayan No.2								0.24	0.76	
Cagayan No.1								0.47	0.53	
Diduyon								0.25	0.75	
Addalam (A)								0.55	0.45	
Matuno No.1									1.00	
Alimit No.1 (A)								1.00		
Magat								0.46	0.54	
Ilagan No.1					0.14			0.86		
Disabungan					1.00					
Siffu No.1 (A)	0.04				0.53			0.43		
Mallig No.2	0.32	0.54			0.14					
Chico No.2	0.31							0.58	0.11	
Chico No.4	0.65							0.30	0.06	
Pinukpuk	1.00									
Base Point No.1	0.04	0.17	0.14		0.18			0.34	0.14	
Base Point No.2	0.00	0.02	0.16		0.23			0.41	0.18	
Base Point No.3					0.20			0.55	0.25	
Base Point No.4					0.08			0.60	0.32	
Base Point No.5					0.07			0.70	0.23	
Base Point No.6		0.78	0.07					0.13	0.02	
Base Point No.7		0.07	0.18		0.62			0.14		
Base Point No.8					0.64			0.36		
Base Point No.9					0.05			0.51	0.44	

Table 3.4.2 Adjustment Factor for Basin Mean Elevation

Dam Basin	Rainfall Gauging Station									
	Aparri	Tuao	Tuguegarao	Naneng	Ilagan	Bontoc	Nayon	Echague	Consuelo	Dakgan
Casecnan	1.52	1.48	1.50	1.15	1.47	0.85	1.22	1.45	1.00	1.14
Cagayan No. 2	1.47	1.44	1.45	1.11	1.42	0.82	1.18	1.41	0.96	1.11
Cagayan No. 1	1.44	1.41	1.42	1.09	1.40	0.81	1.16	1.38	0.94	1.08
Diduyon	1.55	1.52	1.53	1.17	1.50	0.87	1.25	1.48	1.10	1.27
Addalam (A)	1.27	1.25	1.26	0.96	1.24	0.72	1.03	1.22	0.91	1.04
Matuno No. 1	1.50	1.46	1.48	1.13	1.45	0.84	1.21	1.43	1.07	1.22
Alimit No. 1 (A)	1.27	1.25	1.26	0.96	1.24	0.72	1.03	1.22	0.91	1.04
Magat	1.22	1.20	1.21	0.92	1.19	0.69	0.99	1.17	0.87	1.00
Ilagan No. 1	1.25	1.22	1.23	0.94	1.21	0.70	1.01	1.20	0.89	1.02
Disabungan	1.17	1.14	1.15	0.88	1.13	0.66	0.94	1.12	0.83	0.95
Siffu No. 1 (A)	1.17	1.15	1.16	0.89	1.14	0.66	0.95	1.12	0.84	0.96
Mallig No. 2	1.18	1.16	1.17	0.89	1.15	0.66	0.95	1.13	0.84	0.97
Chico No. 2	1.81	1.77	1.79	1.37	1.76	1.02	1.46	1.73	1.29	1.48
Chico No. 4	1.52	1.49	1.51	1.15	0.15	0.86	1.23	1.46	1.09	1.25
Pinukpuk	1.29	1.26	1.28	0.97	1.25	0.73	1.04	1.24	0.92	1.06

Table 3.4.3 Probable Rainfall in the Base Point Basin

		Unit: mm									
		Basin	1/2*	1/5	1/10	1/25	1/50	1/100	1/200	1/1000	1/10000
1 - Day Rainfall	Casecnan	133	209	277	360	440	520	600	820	1,200	
	Cagayan No. 2	122	200	270	360	420	505	590	800	1,100	
	Cagayan No. 1	116	184	247	330	400	470	550	780	1,080	
	Diduyon	127	201	268	360	430	520	700	850	1,300	
	Addalam (A)	102	156	201	271	333	405	488	733	1,261	
	Matuno No. 1	117	152	174	202	222	242	261	307	373	
	Alimit No. 1 (A)	100	141	168	203	230	257	284	349	450	
	Magat	89	119	139	158	164	200	218	261	324	
	Ilagan No. 1	132	186	223	273	312	352	394	498	669	
	Disabungan	141	206	254	319	371	426	484	633	887	
	Siffu No. 1 (A)	81	123	153	194	226	259	293	379	519	
	Mallig No. 2	90	141	180	234	277	324	375	507	741	
	Chico No. 2	131	190	237	303	359	421	489	677	1,036	
	Chico No. 4	110	160	195	240	275	311	348	439	581	
	Pinukpuk	104	155	191	238	275	312	351	448	603	
4 - Day Rainfall	Base Point No. 1	157	205	236	274	302	329				
	Base Point No. 2	158	212	246	289	321	352				
	Base Point No. 3	164	221	258	304	338	372				
	Base Point No. 4	169	233	277	333	376	420				
	Base Point No. 5	178	250	303	373	430	489				
	Base Point No. 6	173	231	269	317	352	386				
	Base Point No. 7	167	223	260	305	338	371				
	Base Point No. 8	188	255	298	354	395	436				
	Base Point No. 9	162	221	261	311	349	388				

Note: *1: Probability

Table 3.4.4 Areal Rainfall Distribution

All Cagayan River Basin

	km ²	1/2	1/5	1/10	1/25	1/50	1/100
BP-1	27,281	157	205	236	274	302	329
BP-2	21,473	158	212	246	289	321	352
BP-3	15,334	164	221	258	304	338	372
BP-4	11,993	169	233	277	333	376	420
BP-5	6,633	178	250	303	373	430	489
BP-6	4,551	173	231	269	317	352	386
BP-7	2,015	167	223	260	305	338	371
BP-8	3,132	188	255	298	354	395	436
BP-9	5,113	162	221	261	311	349	388

Intensive rainfall in Upper Cagayan basin

	km ²	1/2	1/5	1/10	1/25	1/50	1/100
U	6,633	178	250	303	373	430	489
BP-4	5,360	158	212	245	284	310	334
BP-3	3,341	148	177	189	197	199	200
BP-2	6,139	143	188	217	253	279	303
BP-1	5,808	153	183	200	219	231	243

27,281

Intensive rainfall in Magat basin

	km ²	1/2	1/5	1/10	1/25	1/50	1/100
M	5,113	162	221	261	311	349	388
BP-4	6,880	174	242	289	350	396	444
BP-3	3,341	148	177	189	197	199	200
BP-2	6,139	143	188	217	253	279	303
BP-1	5,808	153	183	200	219	231	243

27,281

Intensive rainfall in Ilagan basin

	km ²	1/2	1/5	1/10	1/25	1/50	1/100
I	3,132	188	255	298	354	395	436
BP-3	12,202	158	212	247	291	323	355
BP-2	6,139	143	188	217	253	279	305
BP-1	5,808	153	183	200	219	231	243

27,281

Intensive rainfall in Siffu basin

	km ²	1/2	1/5	1/10	1/25	1/50	1/100
S	2,015	167	223	260	305	338	371
BP-2	19,458	157	210	245	288	319	350
BP-1	5,808	153	183	200	219	231	243

27,281

Intensive rainfall in Chico basin

	km ²	1/2	1/5	1/10	1/25	1/50	1/100
C	4,551	173	231	269	317	352	386
BP-1	22,730	154	200	230	266	292	318

27,281

Table 3.5.1 Runoff Coefficient of the Selected Storms at Magat Damsite

	No./Date	Storm	Rainfall			Runoff			Coefficient			
			3-hr Max (mm)	24-hr Max (mm)	Total (3-day) (mm)	1-hr Max (m ³ /s)	Total (3-day) (mm)	Direct Runoff (mm)	Peak	Total	Direct	
1	T7717	Uding	38.0	81.0	125.1	1,440	52.7	43.3	0.03	0.42	0.35	*
2	T7810	Miding	32.9	96.5	135.3	3,060	87.7	78.3	0.08	0.65	0.58	*
3	T7818	Weling	26.1	66.2	89.1	3,100	100.1	90.7	0.10	1.12	1.02	
4	T7822	Kading	95.2	193.8	203.9	7,906	125.3	115.9	0.07	0.61	0.57	*
5	T8011	Nitang	42.0	55.0	55.5	3,101	69.0	59.6	0.06	1.24	1.07	
6	T8019	Yoning	55.7	87.8	141.8	3,297	64.5	55.1	0.05	0.45	0.39	*
7	T8020	Aring	83.0	244.2	284.9	7,637	220.9	211.5	0.08	0.78	0.74	
8	TS8105	Elang	73.4	130.1	132.9	3,996	73.3	63.9	0.05	0.55	0.48	
9	T8120	Anding	45.2	101.5	114.4	5,440	110.1	100.7	0.10	0.96	0.88	
10	TS8410	Maring	23.1	62.7	115.6	2,140	56.3	46.9	0.08	0.49	0.41	*
11	TD8415	Seniang	28.3	67.7	102.9	4,440	100.3	90.4	0.14	0.97	0.88	
12	TS8510	Miling	24.8	52.1	86.0	3,192	58.0	48.6	0.11	0.67	0.57	
13	T8516	Tasing	38.8	86.4	113.5	6,300	113.1	103.7	0.14	1.00	0.91	
14	21-Sep-92	Maring	27.2	69.9	100.0	2,444	69.6	60.2	0.08	0.70	0.60	*
15	5-Oct-93	Kadiang	60.1	136.0	232.2	8,527	188.9	179.5	0.12	0.81	0.77	
16	2-Nov-93	Husing	44.0	98.3	102.2	7,079	114.3	104.9	0.14	1.12	1.03	
17	1-Oct-95	Mameng	63.9	93.2	109.7	5,713	99.6	90.2	0.08	0.91	0.82	
18	Nov. 3-8, '95	Rosing	51.6	98.2	139.2	5,918	123.3	113.9	0.10	0.89	0.82	
19	Dec. 24-28, 1995	Monsoon	35.3	78.4	122.9	3,442	89.4	80.0	0.08	0.73	0.65	
20	15-Oct-98	Iliang	9.0	21.4	37.7	2,797	62.8	53.4	0.27	1.67	1.42	
21	24-Oct-98	Loleng	91.6	232.6	306.9	6,976	185.6	176.2	0.07	0.60	0.57	
22	18-Dec-98	Monsoon	31.2	54.9	74.7	2,276	48.2	38.8	0.06	0.65	0.52	
23	3-Nov-99	Monsoon	66.8	179.2	203.1	5,290	87.2	77.8	0.07	0.43	0.38	

Note: * Storm selected for simulation study.

The others are not selected due to unreliability of runoff coefficient value and unreliable response between hourly rainfall and runoff data.

Table 3.5.2 Storage Function of Subbasin

Basin No.	A (km ²)	L (km)	I	K	P	Tl (hr)
1	1,150	92.1	1/20	27.5	0.416	3.8
2	481	25.0	1/90	21.6	0.504	0.6
3	733	37.5	1/50	25.7	0.439	1.2
4	298	35.0	1/260	15.7	0.646	1.1
5	351	62.5	1/330	14.6	0.684	2.4
6	142	30.0	1/740	11.5	0.827	0.9
7	477	42.5	1/200	17.0	0.608	1.4
8	387	56.0	1/40	27.5	0.416	2.1
9	264	22.5	1/560	12.5	0.774	0.5
10	1,106	45.0	1/1730	8.9	1.009	1.6
11	1,051	65.0	1/1040	10.4	0.895	2.5
12	620	55.0	1/1000	10.5	0.887	2.0
13	292	26.0	1/190	17.2	0.601	0.7
14	550	44.0	1/80	22.3	0.490	1.5
15	1,228	41.0	1/90	21.6	0.504	1.4
16	559	45.0	1/390	13.9	0.711	1.6
17	266	53.0	1/80	22.3	0.490	1.9
18	970	57.0	1/240	16.1	0.634	2.1
19	247	42.5	1/480	13.1	0.747	1.4
20	876	112.0	1/560	12.5	0.774	4.7
21	474	30.0	1/390	13.9	0.711	0.9
22	215	82.0	1/190	17.2	0.601	3.3
23	652	50.0	1/220	16.5	0.622	1.8
24	915	38.0	1/680	11.8	0.810	1.2
25	652	48.0	1/120	19.8	0.539	1.7
26	915	63.0	1/120	19.8	0.539	2.4
27	209	35.0	1/150	18.5	0.568	1.1
28	656	48.0	1/150	18.5	0.568	1.7
29	408	88.0	1/1910	8.6	1.033	3.6
30	362	51.0	1/150	18.5	0.568	1.8
31	589	82.0	1/1390	9.5	0.956	3.3
32	964	55.0	1/220	16.5	0.622	2.0
33	327	39.0	1/120	19.8	0.539	1.3
34	92	19.0	1/3940	6.9	1.225	0.3
35	657	74.0	1/70	23.3	0.475	3.0
36	1,042	76.5	1/5000	6.5	1.295	3.0
37	969	70.0	1/140	18.9	0.559	2.7
38	73	13.5	1/5000	6.5	1.295	0.1
39	386	26.0	1/70	23.3	0.475	0.7
40	334	42.5	1/90	21.6	0.504	1.4
41	157	25.0	1/30	30.0	0.389	0.6
42	533	36.0	1/40	27.5	0.416	1.1
43	372	44.0	1/70	23.3	0.475	1.5
44	612	53.5	1/230	16.3	0.628	2.0
45	856	58.0	1/60	24.4	0.458	2.2
46	1,301	70.0	1/120	19.8	0.539	2.7
47	169	30.0	1/240	16.1	0.634	0.9
48	417	19.0	1/350	14.4	0.693	0.3
49	393	69.0	1/480	13.1	0.747	2.7
50	278	29.5	1/5670	6.2	1.334	0.8

Notes:

A; Catchment Area (km^2)

A; Catchment Area (km²)
L; River Length (km)

I; Basin Slope

K, P; Storage Function constants

Tl: Lag Time (hr)

Table 3.5.3 Relationship of Discharge and Channel Storage (1/2)

(Present River Condition - 1987 M/P Stage)

Table 3.5.3 Relationship of Discharge and Channel Storage (2/2)

(Present River Condition - 1987 M/P Stage)

**Table 3.5.4 Storage Function of Channel
(Present River Condition)**

Basin No.	L (km)	I	K	P	Tl (hr)
1	25.0	1/330	219,326	0.609	3.3
2	31.0	1/560	230,267	0.605	4.1
3	19.3	1/790	289,468	0.604	2.6
4	17.2	1/980	259,378	0.603	2.3
5	56.0	1/40	41,381	0.858	4.4
6	22.5	1/560	15,555	0.869	3.0
7	45.0	1/1,730	93,167	0.809	6.0
8	58.0	1/2,900	288,697	0.778	7.7
9	45.0	1/390	271,501	0.607	6.0
10	42.5	1/480	359,465	0.604	5.6
11	63.5	1/870	67,277	0.927	8.4
12	20.5	1/6,410	123,116	0.789	2.7
13	14.0	1/260	123,121	0.573	1.9
14	38.0	1/680	616,550	0.497	5.0
15	40.0	1/2,470	191,428	0.697	5.3
16	18.5	1/3,850	18,399	0.945	2.4
17	88.0	1/1,910	1,677	1.535	11.6
18	82.0	1/1,390	704	1.617	10.8
19	35.5	1/3,940	73,394	0.917	4.7
20	19.0	1/19,000	43,943	0.936	2.5
21	76.5	1/5,000	159,425	0.901	10.1
22	13.5	1/5,000	155,281	0.711	1.8
23	20.0	1/110	86,227	0.625	1.9
24	20.0	1/120	34,295	0.706	1.9
25	25.5	1/120	79,330	0.648	2.4
26	53.5	1/230	57,719	0.836	7.1
27	61.0	1/1,030	271,743	0.783	8.1
28	10.0	1/50,000	60,304	0.815	1.3
29	11.5	1/19,170	82,668	0.784	1.5
30	29.5	1/5,670	900,264	0.626	3.9

Notes:

L; River Length (km)

I; River Slope

K,P; Storage Function

Tl; Lag Time (hr)

Table 4.1.1 Selection of Runoff Gauge for Tank Model

Basin	/1 Runoff Gauge	Stream	Drainage Area (km2)	Selection	Reason for Selection
Basin 1 (Upper Cagayan)	Palattao	Cagayan	6,626		.appropriate
	Pangal	Cagayan	4,244		.drainage area
	Guinalvin	Cagayan	2,392		.long record period
	Dippadiw	Addalam	921	Selected	
		Cagayan	2,380		
Basin 2 (Magat)	Oscariz	Magat	4,150		.appropriate
	Dulao	Alimit	573	Selected	.drainage area
	Hapid	Ibulao	606		.less missing
	Camandag	Cadaclan	261		
	Bante	Matuno	558		
	Bato	Magat	1,649		
Basin 3 (Ilagan)	Malalam	Ilagan	3,123		.appropriate
	Minanga	Ilagan	1,565	Selected	.drainage area
	Dipalin	Disabungan	198		
Basin 4 (Lower Cagaran)	Calaoagan	Dummon	308		.appropriate
	Calantac	Paret	907		.drainage area
	Larion Alto	Tuguegarao	655	Selected	.long record period
	Antagan	Tumauini	170		
Basin 5 (Upper Chico)	Ampawilen	Chico	751	Selected	.appropriate
	Taed	Chico	391		.drainage area
	Supang	Sabanga	57		.less missing
Basin 6 (Lower Chico)	Escolta	Matalag	655		.less missing
	Pinukpuk	Saltan	856	Selected	

Note; /1: Runoffs at these gauges are examined by double mass curve and runoff coefficient, and judged to be reliable.

Table 4.3.1 10-DAY RAINFALL (1985 - 1998) (1/5)

* STATION ----- TUAO													
* DISTRICT ----- CAGAYAN													
* REGION ----- REGION II													
	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	
85	F	7.4	0.5	0.0	5.4	4.1	112.3	43.7	171.6	170.0	12.5	35.0	18.9
	M	1.6	0.8	10.7	18.5	0.0	35.1	29.8	45.8	57.2	79.1	14.0	18.1
	L	0.5	54.4	24.7	103.0	16.1	137.2	20.1	198.5	37.8	177.1	134.9	30.7
86	F	5.1	58.7	5.9	3.8	5.8	3.6	275.7	289.7	100.1	128.5	162.9	53.4
	M	1.0	14.1	25.9	0.0	40.0	34.3	32.0	93.9	2.5	157.1	101.4	3.7
	L	45.2	9.0	0.3	0.0	36.6	19.1	61.4	7.0	50.1	88.7	80.6	49.8
87	F	10.7	10.9	0.0	6.3	1.0	82.9	0.8	14.0	87.7	2.3	0.0	27.6
	M	1.3	0.0	0.0	10.9	46.1	161.0	37.4	124.5	45.5	0.0	58.0	33.9
	L	12.4	2.8	19.6	0.0	56.7	56.1	43.9	0.0	40.4	62.8	13.2	28.8
88	F	22.6	17.0	18.8	79.3	55.2	43.5	44.0	140.2	1.0	63.8	72.0	6.8
	M	35.7	151.7	0.0	88.4	17.1	87.0	101.1	105.4	77.0	162.4	84.0	3.8
	L	31.0	7.0	0.0	8.6	89.8	24.7	20.1	25.3	42.9	35.7	6.5	70.0
89	F	2.8	2.3	5.4	8.9	60.0	16.7	22.1	69.8	228.4	92.0	64.3	4.9
	M	30.0	5.6	21.3	0.0	26.2	61.0	141.9	142.3	83.1	61.9	11.0	4.4
	L	35.6	68.1	46.8	0.0	80.2	39.6	73.5	47.9	70.6	5.9	31.2	0.3
90	F	0.0	4.8	2.3	6.1	13.4	108.0	37.4	20.8	29.7	15.3	24.1	70.6
	M	8.3	0.0	0.5	33.0	7.9	37.2	58.2	60.5	161.9	126.0	72.2	53.5
	L	14.2	5.9	42.7	46.7	138.0	284.2	59.5	338.3	0.0	12.2	9.0	21.4
91	F	0.0	42.5	0.0	38.1	0.0	2.5	94.0	32.6	7.6	5.6	5.4	19.7
	M	2.5	3.4	3.4	0.3	36.4	6.4	90.9	263.0	44.8	0.0	51.3	36.5
	L	12.7	12.3	18.0	19.8	17.3	28.7	97.3	192.2	22.4	230.0	60.2	3.8
92	F	6.2	0.0	0.0	14.0	0.0	118.2	33.8	102.4	105.0	124.6	31.8	17.0
	M	30.9	0.0	2.5	15.2	61.2	20.8	88.9	39.9	181.8	115.2	53.5	22.7
	L	10.5	1.8	0.0	9.7	110.4	7.8	26.4	75.3	131.6	72.1	32.5	10.0
93	F	2.3	14.9	0.8	6.3	15.2	82.4	98	45	130.7	237.5	42.2	38.3
	M	1.1	11.6	3.7	105.3	22.7	122.8	34.4	106.3	122.8	3.6	2.0	127.9
	L	12.5	0.8	32.8	0.3	25.9	92.3	117.1	54.6	4.0	95.2	125.3	32.3
94	F	52.9	2.3	0.5	28.3	62.5	21.9	233.0	102.2	304.8	36.1	24.7	0.0
	M	14.1	3.3	6.9	15.0	58.2	155.7	11.6	3.6	6.8	84.7	8.1	3.9
	L	26.7	0.5	25.9	25.2	47.9	54.4	64.5	114.5	9.4	26.1	12.3	5.4
95	F	13.6	16.1	0.3	0.0	50.7	35.8	101.8	36.9	18.9	57.2	103.4	28.3
	M	0.7	0.0	0.0	0.0	95.0	23.7	50.1	5.1	302.4	5.6	109.0	54.4
	L	1.0	0.0	0.0	0.0	11.3	76.2	104.3	161.4	19.7	114.4	4.1	215.4
96	F	3.6	4.9	24.7	31.3	68.4	5.6	35.6	96.2	144.8	49.1	68.8	17.6
	M	4.3	4.8	1.0	94.8	91.3	20.0	38.9	105.7	78.1	253.1	149.0	24.1
	L	17.3	13.1	0.0	21.1	75.4	32.9	205.6	30.5	27.5	42.2	16.5	3.3
97	F	12.2	0.0	18.5	48.0	66.5	51.4	48.2	3.3	37.2	43.3	158.6	79.6
	M	11.7	15.2	4.1	19.4	14.7	77.5	45.4	19.9	8.6	202.9	25.0	2.5
	L	6.7	1.0	65.1	5.8	175.2	62.0	33.1	27.2	59.0	12.7	2.8	0.3
98	F	0.3	0.3	0.0	0.3	0.0	84.9	116.9	131.6	85.3	59.5	27.6	31.5
	M	0.0	0.0	0.0	78.1	51.3	30.1	69.9	50.0	175.1	278.1	63.9	172.2
	L	7.7	2.8	0.0	53.3	139.2	36.8	41.0	114.2	15.8	93.6	52.9	61.3

Table 4.3.1 10-DAY RAINFALL (1985 - 1998) (2/5)

* STATION ----- BONTOC													
* DISTRICT ----- MOUNTAIN													
* REGION ----- REGION I													
	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	
1985	F	0.0	74.2	0.0	66.4	138.4	100.0	25.8	113.9	176.8	56.4	32.0	44.6
	M	0.0	0.0	72.7	93.0	0.0	33.7	98.6	85.0	88.4	114.1	71.6	2.9
	L	0.0	58.0	12.3	143.5	17.4	440.8	86.4	282.6	95.7	257.8	125.4	19.1
1986	F	2.6	24.1	7.9	32.0	3.1	46.4	364.0	637.6	107.1	161.3	87.6	110.3
	M	1.3	5.2	21.2	0.0	23.1	56.6	49.0	215.8	16.8	265.4	141.8	4.2
	L	55.5	5.5	3.9	0.0	74.0	47.2	90.5	68.4	40.7	375.8	178.1	90.2
1987	F	6.9	8.1	0.0	1.0	0.0	86.5	3.8	2.6	176.2	4.2	0.0	64.5
	M	0.5	0.0	0.0	37.5	41.6	106.0	22.7	94.4	33.8	0.0	133.2	101.4
	L	6.0	0.0	8.4	0.0	134.5	18.9	74.9	27.0	55.9	207.2	23.6	25.7
1988	F	27.3	11.3	36.7	63.5	42.7	18.1	5.0	65.0	17.0	214.4	88.4	2.1
	M	30.9	69.5	0.0	34.6	6.3	56.9	185.5	80.8	69.2	111.7	221.6	0.0
	L	55.6	4.5	0.8	3.9	150.0	18.9	110.1	12.3	43.3	128.8	1.8	141.2
1989	F	1.8	0.7	10.2	8.9	23.6	29.6	80.5	119.3	301.1	176.0	105.4	5.8
	M	100.1	9.2	23.6	0.0	66.1	70.0	392.6	166.5	122.2	91.5	21.4	11.1
	L	32.3	29.9	102.5	0.0	60.1	77.1	44.6	9.7	68.4	55.1	26.8	1.0
1990	F	1.3	10.0	5.8	14.4	34.6	38.6	36.5	24.4	19.1	77.6	31.5	158.1
	M	9.7	0.0	3.1	8.7	5.0	263.0	9.2	53.8	83.1	224.0	97.6	27.0
	L	23.1	0.0	0.0	0.3	94.4	263.6	124.8	320.7	24.1	6.0	30.9	6.3
1991	F	6.6	25.7	0.0	25.4	6.0	0.0	27.3	409.8	5.0	2.1	69.8	13.9
	M	3.1	0.3	12.1	32.3	71.9	32.8	238.8	95.5	87.9	0.5	129.8	8.9
	L	27.5	3.5	81.3	31.6	0.0	10.2	39.9	112.0	3.7	394.4	32.3	0.5
1992	F	3.4	0.3	0.0	11.5	0.0	93.1	38.8	47.6	61.1	100.7	35.7	3.4
	M	31.1	1.0	0.0	7.6	83.7	0.0	194.5	75.0	512.7	194.1	85.2	13.4
	L	1.8	0.0	0.0	0.0	141.9	33.0	60.6	10.9	40.4	170.7	16.5	0.0
1993	F	1.3	10.8	0.0	2.6	58.2	11.3	19.7	128.8	227.1	117.9	2.6	120.1
	M	9.4	4.2	28.3	0.5	0.0	103.3	169.6	154.2	223.4	83.9	155.3	70.2
	L	4.5	0.0	0.0	0.0	23.6	91.5	25.7	91.4	244.8	117.8	61.4	28.8
1994	F	39.1	8.4	10.0	11.8	18.4	7.9	132.6	78.4	411.2	91.8	25.7	0.0
	M	3.8	0.0	0.8	24.4	9.8	69.2	55.6	77.5	17.7	65.8	25.0	3.9
	L	4.1	2.0	31.5	24.4	10.2	153.2	236.4	61.9	2.1	28.8	0.0	4.5
1995	F	0.7	0.3	0.0	0.0	51.7	11.5	114.1	100.1	137.4	59.7	18.6	38.7
	M	3.7	0.0	0.0	0.0	103.7	0.0	38.8	112.8	77.8	214.0	85.5	247.8
	L	2.5	0.0	0.0	0.5	45.5	55.1	215.1	76.8	57.0	180.2	5.1	8.7
1996	F	2.9	0.5	1.3	15.1	120.1	31.2	29.2	78.2	327.7	195.1	196.2	0.0
	M	11.4	4.7	0.0	45.6	121.0	59.8	492.8	97.0	130.6	444.3	175.5	14.2
	L	25.7	13.8	1.6	79.5	75.3	15.2	38.6	18.9	141.4	66.6	42.0	6.8
1997	F	3.7	6.6	0.0	8.1	0.0	0.7	48.0	20.6	19.1	31.7	3.4	1.2
	M	1.0	7.5	0.7	24.0	140.3	17.3	22.4	83.4	17.6	579.1	18.1	0.9
	L	0.0	8.7	43.0	136.0	52.7	149.5	19.7	160.6	143.7	371.8	63.5	0.0
1998	F	1.6	2.1	0.0	49.8	21.1	43.5	21.1	26.2	180.0	404.7	117.0	249.7
	M	3.7	3.9	0.5	1.0	51.5	36.2	31.7	196.0	67.8	190.7	115.7	205.6
	L	1.3	0.0	0.0	0.0	127.1	81.8	103.2	134.0	78.0	7.1	120.4	80.4

Table 4.3.1 10-DAY RAINFALL (1985 - 1998) (3/5)

Table 4.3.1 10-DAY RAINFALL (1985 - 1998) (4/5)

* STATION -----		Nayon											
* DISTRICT -----		IFUGAO											
* REGION -----		REGION II											
		JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
985	F	8.7	0.0	0.0	3.7	7.8	76.0	39.8	132.5	146.4	46.7	26.5	36.9
	M	0.2	0.7	9.6	38.5	0.0	119.5	31.5	36.3	73.2	94.5	59.3	2.4
	L	0.0	0.4	9.8	80.6	20.0	186.9	3.3	209.2	79.3	213.6	103.9	15.9
986	F	2.2	20.0	6.5	26.5	2.6	38.5	301.6	528.2	88.8	133.6	72.6	91.4
	M	1.1	4.3	17.6	0.0	19.1	46.9	40.6	178.8	13.9	219.9	117.4	3.5
	L	46.0	4.6	3.3	0.0	61.3	39.1	75.0	56.7	33.7	311.4	147.5	74.7
987	F	5.8	6.7	0.0	0.9	0.0	71.7	3.2	2.2	146.0	3.5	0.0	53.5
	M	0.4	0.0	0.0	31.1	34.4	87.8	18.8	78.2	28.0	0.0	110.4	84.0
	L	5.0	0.0	7.0	0.0	111.5	15.6	62.0	22.4	46.3	171.7	19.6	21.3
988	F	22.6	9.3	30.4	52.6	35.4	15.0	4.1	53.9	14.1	177.6	73.2	1.7
	M	25.6	57.6	0.0	28.7	5.2	47.1	153.7	66.9	57.4	92.6	183.6	0.0
	L	46.1	3.7	0.7	3.3	124.3	15.6	91.3	10.2	35.9	106.7	1.5	117.0
989	F	1.5	0.5	8.5	7.4	19.6	24.6	66.7	98.9	249.4	145.8	87.3	4.8
	M	82.9	7.6	19.6	0.0	54.8	58.0	325.3	138.0	101.3	75.8	17.7	9.2
	L	26.7	24.8	85.0	0.0	49.8	63.9	36.9	8.0	56.7	45.6	22.2	0.9
990	F	1.1	8.3	4.8	12.0	28.7	31.9	30.2	20.2	15.9	64.3	26.1	131.0
	M	8.0	0.0	2.6	7.2	4.1	217.9	7.6	44.5	68.9	185.6	80.8	22.4
	L	19.1	0.0	0.0	0.2	78.2	218.4	103.4	265.7	20.0	5.0	25.6	5.2
991	F	5.4	21.3	0.0	21.1	5.0	0.0	22.6	339.5	4.1	1.7	57.8	11.5
	M	2.6	0.2	10.0	26.7	59.5	27.2	197.8	79.1	72.8	0.4	107.6	7.4
	L	22.8	2.9	67.4	26.2	0.0	8.5	33.0	92.8	3.0	326.8	26.7	0.4
992	F	2.8	0.2	0.0	9.6	0.0	77.1	32.2	39.4	50.6	83.4	29.6	2.8
	M	25.7	0.9	0.0	6.3	69.3	0.0	161.1	62.1	424.8	160.8	70.6	11.1
	L	1.5	0.0	0.0	0.0	117.5	27.4	50.2	9.0	33.5	141.4	13.7	0.0
993	F	1.1	11.3	0.0	2.2	48.2	11.3	16.3	151.7	325.7	90.2	19.3	99.3
	M	7.8	1.1	23.5	0.4	0.0	136.2	140.5	82.8	47.6	64.7	129.1	54.6
	L	3.7	0.0	0.0	0.0	19.6	23.2	21.3	75.7	202.8	96.7	31.1	23.5
994	F	32.4	7.0	8.3	9.8	15.2	6.5	109.8	65.0	340.7	76.0	21.3	0.0
	M	3.2	0.0	0.7	20.2	8.1	57.4	46.1	64.2	14.7	54.5	20.8	3.3
	L	3.4	1.6	26.1	20.2	8.5	126.9	195.9	51.3	1.7	23.9	0.0	3.7
995	F	0.5	0.2	0.0	0.0	42.8	9.6	94.5	82.9	113.9	49.4	15.4	32.0
	M	3.0	0.0	0.0	0.0	85.9	0.0	32.2	93.4	64.4	177.3	70.8	205.3
	L	2.1	0.0	0.0	0.4	37.7	45.6	178.2	63.7	47.3	149.3	4.2	7.2
996	F	2.4	0.4	1.1	12.5	99.5	25.9	24.2	64.7	271.5	161.7	162.5	0.0
	M	9.5	3.9	0.0	37.8	100.3	49.5	408.3	80.4	108.2	368.1	145.4	11.7
	L	21.3	11.4	1.3	65.8	62.4	12.6	31.9	15.6	117.1	55.2	34.8	5.6
997	F	3.0	5.4	0.0	6.7	0.0	0.5	39.8	17.1	15.9	26.3	2.8	1.0
	M	0.9	6.2	0.5	19.9	116.2	14.3	18.6	69.1	14.6	479.8	15.0	0.8
	L	0.0	7.2	35.6	112.7	43.7	123.8	16.3	133.1	119.1	308.0	52.6	0.0
998	F	1.3	1.7	0.0	41.3	17.5	36.1	17.5	21.7	149.2	335.3	96.9	206.9
	M	3.0	3.3	0.4	0.9	42.7	30.0	26.3	162.4	56.2	158.0	95.8	170.3
	L	1.1	0.0	0.0	0.0	105.3	67.8	85.5	111.0	64.6	5.9	99.7	66.6

Table 4.3.1 10-DAY RAINFALL (1985 - 1998) (5/5)

* STATION ----- ILAGAN														
* DISTRICT ----- ISABELA														
* REGION ----- REGION II														
			JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
1985	F	6.2	5.7	0.0	33.9	23.8	150.3	36.8	170.1	145.1	59.1	49.8	67.3	
	M	5.2	0.0	37.5	63.1	0.0	68.2	63.1	6.1	84.2	89.8	79.3	1.2	
	L	3.6	11.6	46.5	57.6	20.1	97.4	32.2	31.3	118.4	185.3	68.9	15.3	
1986	F	7.6	35.1	7.9	1.3	13.7	83.9	281.8	365.7	41.5	66.2	174.3	49.4	
	M	6.0	3.0	25.2	0.0	40.2	12.4	32.4	134.8	34.8	116.6	177.1	27.8	
	L	62.4	3.9	19.2	0.0	5.2	0.4	12.6	27.1	6.9	230.2	47.1	68.7	
1987	F	24.8	6.2	0.0	181.0	0.0	43.4	16.2	13.2	61.5	0.0	8.8	67.0	
	M	6.6	1.6	0.0	105.1	8.1	77.0	70.9	100.8	51.2	1.6	105.8	78.1	
	L	36.6	0.0	0.0	0.0	77.2	16.5	81.0	12.2	33.6	98.9	57.3	71.6	
1988	F	21.1	3.9	37.5	42.8	1.6	5.6	17.0	79.4	8.0	165.6	104.6	6.8	
	M	23.7	209.1	0.0	36.4	8.7	6.6	160.0	128.0	48.2	364.4	54.0	2.6	
	L	6.8	59.2	1.2	46.4	28.3	105.1	69.0	5.8	48.6	76.0	16.2	123.8	
1989	F	8.6	5.6	39.6	34.4	71.4	41.6	32.7	22.6	216.9	70.4	34.0	1.9	
	M	37.0	1.6	22.4	0.0	69.8	42.8	180.5	132.4	104.7	84.5	11.1	14.4	
	L	58.6	58.4	129.1	0.0	0.8	56.6	11.4	17.1	27.0	95.1	113.6	1.0	
1990	F	1.8	14.6	2.7	7.4	14.7	64.8	7.3	15.5	24.6	80.7	37.5	51.8	
	M	10.0	0.0	0.0	35.7	43.7	72.7	116.2	32.8	86.0	161.9	105.1	99.4	
	L	15.9	0.0	0.0	9.2	165.2	120.9	38.5	150.1	19.5	7.2	29.7	21.8	
1991	F	42.1	20.0	0.0	140.5	43.7	2.2	11.2	72.8	59.9	31.1	23.5	32.4	
	M	2.1	0.0	1.1	12.0	0.0	8.8	81.9	348.7	21.9	7.5	41.8	15.1	
	L	32.1	14.0	0.0	14.7	0.0	9.8	135.9	61.0	22.4	151.8	46.7	23.6	
1992	F	45.1	30.1	0.0	12.4	24.5	86.9	31.8	57.4	10.1	41.0	45.0	35.7	
	M	20.4	0.0	0.6	3.5	126.0	0.0	166.0	13.0	291.7	236.0	232.0	18.4	
	L	1.3	1.4	0.0	2.1	183.5	12.1	41.8	221.5	117.6	86.2	13.9	4.3	
1993	F	1.5	4.0	2.4	15.5	0.0	134.4	30.4	67.4	75.9	205.8	10.0	115.5	
	M	5.5	5.1	20.4	40.4	0.0	9.8	13.4	103.3	150.5	28.2	94.7	231.6	
	L	13.8	2.3	0.0	0.0	1.2	220.1	86.0	67.2	62.3	100.9	184.5	88.9	
1994	F	46.9	8.3	6.0	11.5	54.0	26.4	83.1	101.4	167.1	67.2	43.7	3.0	
	M	8.9	2.5	11.2	5.8	67.4	68.1	26.6	33.0	117.6	116.0	36.2	5.6	
	L	22.2	6.5	15.2	6.5	14.0	94.8	37.7	125.0	18.4	20.0	63.1	6.6	
1995	F	49.7	12.0	0.0	4.1	110.0	44.1	101.0	67.6	74.0	122.1	141.7	144.7	
	M	9.6	0.0	0.0	0.0	95.1	36.8	5.7	23.9	125.6	24.7	83.1	111.0	
	L	1.6	1.9	0.0	0.0	90.3	10.6	204.6	29.0	69.3	274.0	3.4	283.0	
1996	F	6.7	6.4	7.4	31.8	44.1	3.0	26.6	61.8	158.2	87.7	164.1	40.8	
	M	5.4	11.6	0.0	19.6	80.0	5.1	17.4	116.1	21.9	293.9	195.2	10.3	
	L	41.7	6.0	0.0	2.5	20.9	38.5	197.3	45.2	29.3	102.2	79.4	5.9	
1997	F	19.1	14.5	50.8	19.0	15.6	19.3	105.1	90.6	102.9	57.7	123.8	57.7	
	M	4.7	50.5	0.0	19.9	24.2	254.4	38.2	14.0	28.6	135.0	71.8	1.5	
	L	7.6	5.9	66.9	22.2	61.9	19.0	13.6	28.3	15.3	45.0	0.0	11.2	
1998	F	3.2	46.0	0.0	0.0	0.0	30.2	40.6	257.4	67.2	4.6	17.2	123.2	
	M	7.6	0.3	0.0	125.5	55.0	27.9	62.5	102.7	143.7	57.2	172.6	326.8	
	L	12.0	26.4	1.2	0.0	88.0	14.4	24.6	25.8	71.1	169.9	47.0	141.1	
1999	F	43.7	12.5	39.2	60.1	85.0	93.8	87.4	29.9	103.2	91.8	353.8	322.5	
	M	97.8	16.3	16.5	36.1	15.2	77.1	43.0	91.1	43.0	132.4	13.8	173.9	
	L	18.6	5.9	33.4	10.4	178.4	104.6	30.3	23.9	117.7	68.2	88.3	77.0	

Table 4.3.2 Conditions and Results of Tank Coefficient Calibration (1987 MP)

	Basin 1 (Upper Cagayan)	Basin 2 (Magat)	Basin 3 (Ilagan)	Basin 4 (Lower Cagayan)	Basin 5 (Upper Chico)	Basin 6 (Lower Chico)
Runoff Gauge	Guinalvin	Dulao	Minanga	Larion Alto	Ampawilen	Pinukpuk
Raingauge	Ilagan	Nayon	Ilagan	Tuguegarao	Bontoc	Tuao
Drainage Area (km ²)	921	573	1,565	655	751	856
Calibration Period	1965 71, 74	1968 70	1966, 68 69	1957 73	1963 76	1968 71
Rainfall Ratio	1.35	1.60	1.20	2.20	1.40	1.70
Evaporation Ratio	0.7	0.7	0.7	0.7	0.6	0.7
Rainfall (mm)	2,808	2,845	2,153	3,707	3,379	2,913
Loss (mm)	1,255	1,221	1,152	1,244	1,037	1,143
Estimated Runoff (mm)	1,553	1,624	1,001	2,463	2,342	1,770
Observed Runoff (mm)	1,686	1,497	915	2,427	2,383	1,890

Notes: Ration of basin rainfall to rainfall at applied gauge.
 Ratio of evapotranspiration to evaporation by A-pan.

Table 4.3.3 Simulated 10-day Mean Runoff (1/6)

Station : Pinukpuk (C.A. = 856km ²)													(Unit : m ³ /sec)
		Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
1963	(F)	23.3	12.7	10.8	9.3	8.9	38.1	171.1	54.5	60.3	20.0	11.4	71.2
	(M)	19.3	14.5	9.6	9.2	10.4	116.3	141.1	27.0	23.2	16.7	10.3	120.8
	(L)	12.6	15.4	8.6	9.0	7.9	151.2	33.3	24.7	22.9	12.6	9.6	38.6
1964	(F)	17.6	8.7	53.5	7.6	7.3	66.0	13.9	146.4	79.3	123.4	173.0	158.9
	(M)	12.7	8.2	8.8	7.5	7.2	71.5	13.8	105.0	88.1	79.2	389.2	128.0
	(L)	9.0	9.0	7.0	7.4	35.5	52.9	54.2	81.7	108.1	74.7	332.4	90.6
1965	(F)	44.5	27.2	14.7	10.2	157.3	78.6	24.7	89.5	186.2	27.3	59.7	19.8
	(M)	39.4	20.0	12.6	10.0	46.1	94.1	157.7	72.2	78.0	47.1	19.6	16.9
	(L)	29.0	20.6	10.0	7.3	70.0	46.1	170.4	81.3	56.2	18.8	22.9	14.5
1966	(F)	13.3	10.2	9.8	9.3	86.0	98.0	58.8	31.4	55.5	23.7	93.7	125.2
	(M)	12.1	10.1	9.6	7.9	101.3	56.1	75.9	98.8	59.7	56.4	118.0	77.3
	(L)	9.8	12.4	8.6	106.6	165.3	57.5	94.2	103.0	25.0	74.7	296.7	89.9
1967	(F)	36.7	16.1	11.8	79.1	10.7	95.0	90.4	86.3	77.6	205.4	119.7	52.6
	(M)	29.1	14.6	10.6	12.9	15.0	18.6	27.0	121.9	89.0	242.8	70.9	27.1
	(L)	20.1	16.5	9.5	16.1	36.1	169.4	79.9	103.8	77.8	84.6	38.5	20.2
1968	(F)	22.6	13.6	10.8	10.3	10.2	52.1	43.5	139.9	77.6	64.3	20.6	11.9
	(M)	17.9	12.2	10.6	10.1	9.8	48.2	16.7	260.4	31.2	34.5	14.8	10.8
	(L)	13.5	12.2	9.5	31.3	34.9	34.5	32.8	109.0	173.7	24.8	13.1	8.7
1969	(F)	9.4	8.9	8.5	8.2	7.8	75.5	92.6	109.0	81.1	104.8	19.4	55.0
	(M)	9.2	8.8	8.4	8.0	36.2	38.8	45.9	32.2	78.7	54.2	51.5	23.6
	(L)	8.3	10.8	7.5	7.9	9.3	9.7	248.3	22.5	64.2	20.7	69.9	19.2
1970	(F)	49.9	10.7	8.1	7.7	9.6	69.5	10.6	85.8	71.0	71.4	159.4	79.6
	(M)	16.7	9.1	7.9	7.6	123.8	22.0	15.4	58.8	75.1	106.4	164.3	101.6
	(L)	10.9	10.2	7.9	7.5	88.0	14.5	30.2	95.6	53.2	147.9	111.8	51.6
1971	(F)	32.9	15.3	12.0	8.8	31.8	94.4	44.0	23.0	63.5	232.6	118.2	159.7
	(M)	25.5	18.0	12.1	8.7	11.5	45.2	136.1	63.4	61.1	154.7	93.6	129.0
	(L)	17.4	17.6	9.3	8.6	8.2	17.7	62.4	17.0	49.7	88.6	267.1	70.6
1972	(F)	70.8	18.8	12.2	9.9	38.8	41.8	79.8	92.2	32.4	19.2	38.6	38.6
	(M)	32.5	14.9	12.8	32.1	53.6	17.1	96.6	133.8	25.8	13.3	11.9	12.9
	(L)	23.9	15.3	10.4	10.0	52.0	19.8	88.6	65.2	24.9	11.0	38.8	9.7
1973	(F)	10.3	8.6	8.2	7.9	7.5	58.3	70.1	91.2	134.5	168.4	103.3	177.8
	(M)	10.0	8.5	8.1	7.8	8.0	141.6	50.1	74.2	77.7	296.1	126.4	86.1
	(L)	8.3	10.5	7.3	7.6	6.7	67.3	44.7	164.0	56.7	126.6	349.1	42.6
1974	(F)	37.2	17.6	12.1	10.1	70.6	63.1	10.5	37.3	15.0	174.4	259.9	65.4
	(M)	28.2	15.5	10.5	9.9	43.0	18.0	11.0	105.3	64.1	118.9	200.4	124.0
	(L)	21.6	17.5	9.3	42.1	63.1	14.2	8.8	44.9	117.7	181.5	95.1	70.0
1975	(F)	35.0	19.5	12.0	11.9	72.5	84.5	91.8	69.5	61.1	19.6	95.9	23.5
	(M)	28.4	15.2	10.5	9.9	44.4	147.3	70.3	44.1	47.5	62.1	55.0	44.1
	(L)	23.9	17.4	9.3	9.7	63.7	63.8	21.2	153.9	20.8	213.6	27.4	66.8
1976	(F)	48.7	13.5	10.5	9.4	9.0	71.6	85.9	69.2	47.9	86.8	98.4	78.8
	(M)	21.5	12.0	9.9	9.3	13.0	78.0	23.8	62.8	68.8	24.5	133.8	32.6
	(L)	16.7	11.9	8.9	9.1	112.3	108.5	91.5	106.2	26.4	71.9	104.1	23.7
1977	(F)	22.0	13.5	9.7	9.1	8.7	38.9	21.1	170.2	73.3	32.5	18.1	17.0
	(M)	20.7	12.4	9.4	9.0	8.6	79.0	21.2	65.5	123.9	25.0	77.4	12.8
	(L)	16.0	14.2	8.4	8.8	47.9	82.0	142.7	29.4	115.9	16.8	22.6	10.9
1978	(F)	11.1	8.6	8.2	7.8	7.5	49.9	11.2	84.6	167.2	186.2	70.3	47.2
	(M)	10.2	8.5	8.1	7.7	10.2	49.8	118.1	100.2	108.6	114.8	78.4	59.2
	(L)	8.1	10.4	7.2	7.6	62.4	16.9	65.9	217.7	105.8	128.1	32.0	23.3
1979	(F)	19.8	14.2	9.2	8.8	8.4	11.2	69.3	43.5	64.7	86.7	101.5	21.1
	(M)	14.5	11.7	9.0	8.6	49.6	8.4	62.0	15.8	45.1	103.2	87.0	19.1
	(L)	11.6	13.0	8.1	8.5	45.8	8.3	72.4	9.0	14.2	21.4	51.8	64.3
1980	(F)	19.8	10.2	7.7	7.3	7.0	38.5	90.7	24.3	89.7	19.8	224.1	34.8
	(M)	15.6	9.6	7.5	7.2	169.2	12.8	92.6	24.1	57.6	16.9	123.4	68.3
	(L)	12.4	9.1	6.7	7.1	66.8	35.8	91.8	84.5	21.5	258.4	43.2	25.1
1981	(F)	22.1	12.0	8.4	8.0	7.6	191.6	44.4	57.9	22.6	91.1	162.3	27.7
	(M)	18.0	10.4	8.2	7.9	58.8	120.4	103.1	139.0	115.8	60.9	83.2	21.5
	(L)	12.2	11.5	7.4	9.4	74.9	31.7	23.8	42.5	47.0	92.7	70.0	15.3
1982	(F)	14.3	9.4	8.5	9.8	9.2	103.1	77.7	19.0	120.1	21.5	22.6	77.1
	(M)	12.1	8.8	8.3	8.0	72.8	24.1	54.1	18.7	76.0	143.6	87.5	59.7
	(L)	9.9	10.7	7.5	48.8	120.4	65.9	19.0	93.8	49.8	43.8	111.8	48.0
1983	(F)	21.7	13.0	8.6	8.3	7.9	7.5	7.2	97.4	72.3	97.6	54.9	100.9
	(M)	51.4	11.4	8.5	8.1	9.8	32.7	8.8	59.0	69.9	62.9	21.3	67.6
	(L)	17.1	12.6	8.0	8.0	7.0	7.8	72.2	37.0	45.6	88.1	44.4	93.4
1984	(F)	28.1	10.7	7.5	7.2	96.0	54.4	110.4	83.6	86.5	21.8	71.9	84.0
	(M)	20.7	9.4	7.4	63.5	21.4	105.4	70.6	25.6	31.3	22.6	78.8	25.2
	(L)	13.6	9.3	6.6	69.3	100.3	161.3	29.3	225.1	25.9	118.6	50.7	17.9
1985	(F)	15.4	9.5	8.5	8.1	9.2	69.3	59.5	131.2	182.8	30.3	83.3	61.0
	(M)	12.2	8.7	8.3	7.9	7.6	37.1	21.8	74.1	107.5	73.8	32.3	29.1
	(L)	10.0	43.8	7.4	60.4	6.8	102.9	15.7	152.2	67.7	141.4	122.4	25.7
1986	(F)	21.6	57.2	11.8	8.8	8.4	8.1	194.3	234.0	96.1	112.5	168.0	89.3
	(M)	16.4	18.7	11.4	8.7	9.7	8.8	82.8	150.5	30.5	155.6	140.3	35.5
	(L)	18.6	19.3	9.0	8.5	9.5	7.8	60.9	53.0	51.2	109.7	116.4	54.5
1987	(F)	27.7	14.8	10.1	9.4	9.0	61.9	20.7	15.8	70.3	16.2	11.0	15.2
	(M)	21.4	13.1	9.7	9.2	11.3	129.9	20.8	92.2	52.9	11.0	40.7	35.8
	(L)	16.2	14.8	8.7	9.1	33.5	78.5	34.8	17.5	43.4	36.9	13.2	15.4
1988	(F)	16.7	15.2	17.9	44.2	35.2	41.2	41.5	115.3	20.8	60.3	79.7	22.1
	(M)	37.5	117.3	11.1	65.6	11.9	68.7	81.3	113.6	59.0	138.1	91.3	17.6
	(L)	16.2	47.3	8.2	12.6	51.4	20.4	20.1	49.0	47.4	65.3	28.3	50.5
1989	(F)	16.8	12.9	11.1	9.9	30.6	11.8	12.8	74.1	193.1	106.0	65.0	19.9
	(M)	18.2	10.8	10.5	8.2	9.4	42.1	103.6	126.4	128.9	85.9	25.9	16.1
	(L)	33.0	58.9	12.2	8.1	45.9	32.5	73.1	67.9	99.1	27.8	25.6	11.2
1990	(F)	11.1	8.7	8.1	7.8	7.7	96.9	99.9	27.4	115.1	32.5	30.1	69.9
	(M)	10.3	8.4	8.0	7.7	7.3	51.1	75.8	58.3	163.1	109.9	75.7	65.8
	(L)	9.0	10.3	9.0	10.9	7.7	219.5	60.4	241.7	60.4	30.6	25.9	24.3
1991	(F)	20.0	16.4	10.2	9.7	8.4	8.0	60.3	47.9	80.5	23.6	62.4	26.7
	(M)	14.8	12.6	9.0	8.6	9.							

Table 4.3.3 Simulated 10-day Mean Runoff (2/6)

Station : Ampawilen (C.A. = 751km ²)													(Unit : m ³ /sec)
	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	
1963	(F)	19.7	12.5	8.1	6.0	5.8	92.5	154.7	99.3	74.7	22.9	12.5	15.1
	(M)	16.5	11.2	6.4	5.9	72.9	60.5	159.2	96.0	63.0	19.1	12.7	51.7
	(L)	12.6	12.5	5.5	5.9	51.8	124.8	102.9	72.2	63.3	13.9	51.7	61.4
1964	(F)	14.3	8.9	5.4	5.2	45.1	75.4	76.6	200.0	123.1	148.4	61.1	62.2
	(M)	12.6	7.3	5.3	5.2	29.4	97.6	77.4	149.4	101.6	68.8	90.3	149.9
	(L)	9.0	6.7	4.8	5.1	68.6	128.4	71.0	74.6	65.5	24.6	155.5	54.6
1965	(F)	26.3	17.1	10.1	10.4	80.3	90.4	56.1	71.7	66.4	20.7	16.7	10.3
	(M)	23.5	13.7	8.4	8.3	72.9	77.1	130.4	88.4	23.4	18.3	14.3	10.5
	(L)	19.0	14.8	7.3	7.9	72.7	22.2	193.8	57.9	54.7	42.4	12.0	8.7
1966	(F)	8.9	5.4	5.1	4.9	52.4	96.2	19.4	152.8	68.2	16.4	17.8	141.8
	(M)	7.7	5.2	5.1	4.9	91.0	20.3	47.9	107.0	21.0	18.5	48.4	50.7
	(L)	5.9	6.5	4.5	5.5	105.7	46.7	60.2	70.1	17.9	59.2	201.7	20.2
1967	(F)	19.2	10.9	6.9	4.7	4.7	70.8	17.5	178.8	145.6	159.9	218.9	33.0
	(M)	16.5	9.4	5.2	4.6	50.9	41.9	63.9	143.1	134.8	223.3	81.2	28.2
	(L)	12.7	10.2	4.3	8.8	6.7	114.1	257.6	187.3	204.6	72.4	37.7	21.7
1968	(F)	20.2	12.9	9.2	8.2	44.0	72.2	98.1	125.7	171.7	142.8	32.6	23.7
	(M)	16.8	11.3	9.4	9.1	121.7	151.2	126.9	175.0	141.2	73.1	27.7	20.8
	(L)	13.7	10.7	32.3	68.1	60.3	180.8	163.6	119.4	294.4	34.3	28.4	15.9
1969	(F)	14.8	10.4	6.0	8.3	41.6	130.1	88.9	207.2	81.4	73.3	23.0	20.9
	(M)	13.5	8.7	6.0	47.8	67.5	91.0	88.3	119.3	70.5	29.1	20.4	17.9
	(L)	11.1	9.3	5.4	6.4	75.4	44.4	467.4	88.4	66.6	23.6	60.4	15.1
1970	(F)	64.3	11.4	8.1	7.1	109.5	123.9	23.9	69.3	96.1	139.4	117.8	55.6
	(M)	16.3	10.3	6.3	6.1	107.2	128.3	72.1	134.5	191.5	142.2	89.8	31.0
	(L)	12.8	11.4	31.3	68.3	96.9	60.2	68.0	109.7	106.1	141.0	34.6	23.6
1971	(F)	26.1	15.6	12.2	10.3	7.5	35.4	50.8	74.9	86.8	224.7	55.8	25.3
	(M)	22.1	17.6	11.2	9.1	7.3	50.2	142.7	82.1	66.0	105.9	52.5	22.7
	(L)	17.0	18.0	11.0	8.1	32.8	32.7	131.4	92.3	132.5	53.9	81.5	20.1
1972	(F)	19.5	12.1	7.6	5.7	99.6	142.5	93.0	90.4	29.3	25.7	16.7	11.5
	(M)	16.9	10.9	6.2	63.9	68.4	73.7	260.5	73.5	26.1	22.2	14.3	10.7
	(L)	13.9	10.4	5.5	59.0	105.3	62.5	182.0	57.4	101.7	16.5	12.1	8.8
1973	(F)	8.3	5.5	5.3	5.2	119.5	51.1	68.1	61.0	138.4	170.1	31.8	56.3
	(M)	7.0	5.5	5.3	5.1	126.9	17.5	63.1	78.0	86.0	200.3	29.5	24.8
	(L)	5.2	6.7	4.7	30.2	75.6	55.9	42.7	71.6	67.1	68.4	139.2	19.7
1974	(F)	18.3	11.4	7.2	34.6	49.9	152.3	18.0	80.6	72.0	80.4	235.2	32.2
	(M)	15.2	10.4	5.5	9.4	14.3	46.7	62.3	133.9	25.8	237.2	98.0	74.9
	(L)	12.8	11.3	4.7	114.3	62.0	16.2	77.3	125.5	90.0	185.6	60.4	26.8
1975	(F)	25.6	15.6	11.0	35.1	118.0	78.8	60.0	73.7	138.6	55.4	24.0	15.6
	(M)	21.5	12.9	9.4	7.2	53.2	73.3	92.8	56.4	99.3	50.0	18.9	14.8
	(L)	17.5	14.6	7.0	6.1	46.3	15.1	71.3	83.3	24.7	39.3	16.7	13.3
1976	(F)	13.0	7.9	5.0	28.6	5.5	43.8	130.6	49.0	65.5	129.6	23.0	17.6
	(M)	10.8	6.4	5.0	7.6	6.0	139.2	50.7	22.1	107.7	88.5	56.0	16.1
	(L)	8.3	5.8	7.9	5.2	119.6	202.2	74.1	54.0	85.3	22.6	19.7	12.3
1977	(F)	11.1	8.0	4.8	5.7	4.5	41.2	101.4	129.0	56.9	63.6	20.1	19.4
	(M)	10.2	6.5	4.7	40.4	4.4	45.5	97.0	49.6	254.9	26.3	118.4	16.8
	(L)	8.4	6.7	4.2	4.7	35.8	66.6	100.1	54.2	117.1	20.2	24.0	12.5
1978	(F)	11.0	6.7	4.4	4.3	8.5	8.6	120.8	17.8	83.7	52.8	12.8	9.9
	(M)	9.4	5.2	4.3	32.3	5.2	94.2	66.3	14.5	110.4	19.2	45.5	9.3
	(L)	7.5	5.5	4.1	5.7	36.8	42.4	90.8	10.8	173.7	14.5	12.1	7.2
1979	(F)	7.2	4.3	3.8	3.7	50.4	105.2	15.3	45.8	12.2	13.2	13.5	11.1
	(M)	6.3	3.9	3.8	3.7	46.5	34.8	66.7	13.2	11.5	57.8	36.5	11.9
	(L)	5.1	4.8	3.4	78.2	10.4	42.5	53.8	9.6	11.7	12.6	43.1	13.1
1980	(F)	10.3	6.7	4.2	3.3	5.4	16.7	80.3	89.8	47.2	23.2	156.4	23.2
	(M)	8.9	5.9	3.4	3.3	157.8	11.8	85.2	78.6	71.9	46.8	84.7	20.4
	(L)	7.7	5.0	3.0	3.2	112.6	8.7	196.0	75.2	55.4	153.4	26.6	15.6
1981	(F)	14.6	8.3	3.8	3.6	3.8	168.9	80.2	44.4	39.4	50.0	128.5	17.5
	(M)	11.9	6.6	3.7	3.6	109.7	131.7	47.1	54.2	114.3	16.4	49.5	14.9
	(L)	8.6	6.7	3.3	3.5	89.4	68.4	18.1	49.3	20.4	53.0	55.8	11.4
1982	(F)	9.8	5.6	3.7	6.1	6.3	9.3	57.2	60.5	126.3	23.9	50.8	43.2
	(M)	8.2	4.4	3.7	33.3	27.8	78.4	10.2	84.4	65.0	77.6	49.4	17.5
	(L)	6.5	4.7	4.1	3.8	7.6	51.3	38.7	14.7	137.4	17.0	16.5	14.3
1983	(F)	13.4	7.9	5.9	3.5	3.4	8.4	9.0	92.7	20.0	50.9	12.3	7.7
	(M)	12.4	7.5	4.2	3.5	3.4	38.9	59.5	73.6	42.1	13.8	11.5	6.5
	(L)	9.4	8.4	3.2	3.4	53.3	7.4	138.2	54.1	14.7	14.9	10.0	5.3
1984	(F)	4.6	3.2	3.1	3.6	35.8	40.9	42.8	72.0	73.8	18.6	20.7	71.7
	(M)	4.4	3.2	51.5	8.5	6.7	11.9	13.7	16.2	60.2	15.6	49.4	15.7
	(L)	3.0	3.5	6.3	51.8	49.7	10.5	37.0	229.2	22.4	96.8	16.7	12.4
1985	(F)	10.7	36.7	6.1	10.3	100.1	54.6	94.4	91.5	166.7	69.0	84.1	67.9
	(M)	8.2	6.7	32.3	59.0	13.9	15.1	86.6	79.2	108.0	94.9	76.9	26.9
	(L)	6.5	36.6	5.5	91.2	11.0	271.4	69.0	174.9	95.3	170.2	106.2	22.3
1986	(F)	21.7	19.2	11.0	8.4	4.5	8.1	224.5	401.6	110.8	120.2	154.6	132.6
	(M)	18.1	15.4	10.3	6.5	4.4	36.3	90.6	253.4	37.6	202.0	146.5	43.5
	(L)	19.1	17.2	8.1	4.6	25.5	10.5	69.0	112.9	54.8	266.6	165.8	85.1
1987	(F)	36.1	23.5	13.7	7.7	5.5	62.3	10.3	9.2	111.5	13.4	17.9	52.6
	(M)	31.5	19.4	11.6	7.5	5.5	72.4	9.6	50.4	48.8	10.6	96.6	77.6
	(L)	24.8	20.3	9.0	6.1	65.1	13.1	33.3	11.0	43.9	108.6	42.8	19.6
1988	(F)	20.6	15.5	14.2	11.7	8.2	11.6	8.0	60.3	13.6	143.5	88.3	23.2
	(M)	20.5	48.1	11.4	11.1	7.3	38.1	102.7	62.2	42.8	108.4	162.5	19.8
	(L)	48.2	16.1	7.8	8.1	69.4	9.7	79.9	13.5	17.3	98.7	55.0	83.0
1989	(F)	21.1	17.5	12.6	11.9	6.8	8.6	54.6	99.3	203.2	137.6	91.9	24.4
	(M)	76.2	14.9	11.6	8.9	10.4	41.8	243.6	129.6	137.5	102.8	31.6	22.0
	(L)	39.6	17.6	49.6	7.3	34.5	48.8	86.3	25.2	87.1	63.4	29.5	17.5
1990	(F)	16.0	11.8	7.4	5.0	4.8	8.3	76.9	21.6	72.8	65.8	25.5	113.0
	(M)	14.1	10.2	5.8	4.9	4.8	159.7	18.7	48.9	72.9	155.2	80.4	55.2
	(L)	12.0	11.1	4.6	4.9	36.6	196.7	74.1	184.4	24.7	47.4	46.3	19.3
1991	(F)	19.0	14.1	8.8	7.6	6.7	4.7	4.5	253.6	24.0	17.1	113.7	23.4
	(M)	16.0	12.2	7.6	7.6	30.7	4.7	132.0	69.1	13.6			

Table 4.3.3 Simulated 10-day Mean Runoff (3/6)

Station : Larion Alto (C.A. = 655km ²)													(Unit : m ³ /sec)
	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	
1963	(F)	24.8	12.9	8.8	5.3	5.1	5.0	33.7	33.0	51.1	21.5	11.5	101.3
	(M)	21.2	11.3	7.4	5.2	5.1	64.0	112.9	18.8	102.7	18.2	8.5	118.8
	(L)	15.3	12.6	5.6	5.2	4.6	94.1	52.2	13.9	76.4	13.6	8.1	38.4
1964	(F)	17.8	7.9	24.8	4.4	4.2	45.8	25.1	252.3	102.7	129.6	143.9	199.8
	(M)	14.3	7.2	6.7	4.3	4.2	46.4	55.8	159.3	48.7	80.2	377.3	143.3
	(L)	9.7	28.1	4.9	4.3	25.8	31.8	63.6	68.2	73.1	65.9	402.1	70.8
1965	(F)	52.7	35.7	19.1	11.4	7.7	11.9	13.4	59.0	121.7	30.5	88.4	21.0
	(M)	45.9	29.2	14.7	9.5	6.3	51.0	260.8	73.3	48.4	73.1	27.9	18.9
	(L)	37.4	30.2	12.2	8.3	59.5	44.1	116.4	48.7	100.7	23.7	38.7	14.7
1966	(F)	12.7	8.8	6.6	5.2	98.1	94.6	37.1	79.2	56.8	20.0	88.5	167.1
	(M)	10.3	7.5	5.3	6.4	63.9	51.7	94.9	113.0	46.7	40.8	118.4	105.4
	(L)	8.6	9.1	7.6	4.9	140.2	58.9	71.6	115.8	23.9	86.2	349.8	130.6
1967	(F)	66.5	27.2	14.2	154.1	12.1	48.7	71.5	64.2	116.7	234.6	137.6	39.5
	(M)	39.2	22.3	12.0	51.2	14.0	12.6	23.6	128.2	74.0	332.9	83.7	33.5
	(L)	30.5	22.7	9.2	17.2	26.8	214.2	39.0	188.9	35.9	118.1	46.2	26.3
1968	(F)	25.2	13.8	10.1	6.0	8.4	55.7	30.5	148.6	79.2	107.7	28.0	17.2
	(M)	20.8	12.5	8.5	5.9	5.8	57.0	77.4	263.0	35.5	56.0	24.7	14.0
	(L)	15.3	12.4	6.3	27.9	6.3	52.5	88.9	123.4	231.0	30.8	21.0	10.4
1969	(F)	10.6	6.9	5.4	25.3	5.0	99.7	92.8	112.7	72.4	86.9	20.8	50.7
	(M)	9.4	5.8	5.3	5.2	5.8	41.8	48.6	45.5	74.1	28.5	117.5	44.3
	(L)	7.4	6.8	4.8	5.1	27.7	10.8	241.4	43.5	75.3	22.2	66.6	19.7
1970	(F)	42.9	11.5	7.8	11.5	63.2	58.0	11.3	37.9	47.4	60.4	207.4	104.8
	(M)	18.6	9.4	6.3	8.1	46.7	17.2	111.4	42.6	50.4	109.5	132.2	131.6
	(L)	13.9	10.7	7.15	7.7	33.6	12.4	35.7	57.4	70.9	205.7	115.7	54.9
1971	(F)	35.4	20.5	12.7	7.9	7.8	58.8	44.6	48.0	20.8	253.6	201.6	259.1
	(M)	29.7	35.6	11.2	6.9	23.8	49.6	160.1	51.9	95.9	184.4	221.8	170.1
	(L)	21.9	21.6	8.8	5.3	7.2	11.8	73.4	17.4	97.6	155.1	441.8	104.2
1972	(F)	104.4	43.7	25.3	15.5	15.5	63.1	64.2	70.1	97.2	24.8	49.4	36.8
	(M)	56.2	37.3	24.7	14.5	69.3	19.4	65.1	75.5	30.6	20.2	17.9	16.5
	(L)	47.4	34.5	18.3	13.2	28.4	65.8	77.4	84.9	64.9	18.1	49.5	13.4
1973	(F)	13.1	9.2	6.0	5.8	21.3	8.0	28.3	70.1	57.3	120.3	91.0	217.5
	(M)	10.4	7.9	5.9	5.7	32.8	70.7	35.9	57.6	45.1	244.9	185.4	102.8
	(L)	8.9	8.7	5.6	5.7	6.0	46.8	11.9	100.4	21.6	122.3	463.0	51.4
1974	(F)	47.5	27.3	14.1	9.5	36.4	78.6	14.6	36.0	15.2	186.5	310.4	73.6
	(M)	39.5	22.1	12.6	8.2	9.3	28.8	13.8	55.8	78.6	133.4	237.8	115.5
	(L)	30.2	22.7	9.7	10.0	9.4	15.6	11.1	33.1	124.8	183.0	110.4	76.3
1975	(F)	41.4	23.1	13.0	9.7	25.9	31.5	16.6	82.7	60.3	149.6	91.0	27.2
	(M)	34.8	18.5	11.7	7.9	8.7	62.4	12.3	43.9	47.5	117.8	65.7	59.2
	(L)	26.0	18.8	10.3	6.3	42.8	39.6	7.9	86.5	17.7	174.9	30.4	71.2
1976	(F)	41.2	15.1	8.7	32.5	5.2	36.3	19.8	57.9	20.6	47.0	135.2	30.4
	(M)	22.7	11.4	7.5	7.0	8.1	85.9	14.6	46.1	82.2	20.9	146.1	50.6
	(L)	17.7	11.2	8.3	5.7	85.1	79.9	59.8	74.9	23.0	112.3	72.0	24.0
1977	(F)	22.2	12.2	7.3	4.8	4.6	39.9	28.4	135.2	139.7	101.1	34.2	27.3
	(M)	18.6	9.7	5.9	4.7	4.6	35.6	36.1	81.4	269.7	63.0	105.1	23.2
	(L)	14.6	11.1	4.4	4.7	33.8	26.3	177.7	54.6	177.5	32.4	51.1	18.8
1978	(F)	16.7	9.8	6.4	4.6	4.5	53.2	5.9	120.3	117.2	105.2	95.4	57.0
	(M)	13.2	8.8	5.7	7.4	4.4	9.5	62.8	67.8	132.9	78.0	142.7	71.3
	(L)	9.9	9.7	4.3	19.8	70.6	8.8	60.8	193.5	124.3	134.6	63.0	29.4
1979	(F)	26.8	16.2	9.8	5.3	4.6	11.6	137.4	38.3	42.8	137.8	121.5	23.8
	(M)	22.1	13.4	8.1	4.7	48.8	9.4	80.9	47.2	34.5	122.4	79.5	20.0
	(L)	17.0	13.6	5.9	5.4	45.9	7.9	59.2	15.4	30.4	40.8	45.6	51.5
1980	(F)	18.8	9.0	7.0	5.3	4.2	6.9	77.7	78.8	44.9	42.4	206.6	49.3
	(M)	15.2	10.2	5.6	5.0	83.9	4.5	184.1	86.8	63.5	20.8	121.0	70.4
	(L)	10.5	9.1	25.2	4.2	28.8	4.3	139.9	43.8	23.6	192.2	62.1	28.1
1981	(F)	25.3	12.9	7.7	4.3	4.2	102.9	23.5	123.5	21.0	74.8	185.9	34.2
	(M)	21.0	10.2	6.5	4.3	38.1	124.6	18.9	109.7	123.9	75.9	83.9	28.2
	(L)	15.2	11.7	4.6	5.0	83.0	60.4	12.7	47.5	43.2	106.4	88.0	21.7
1982	(F)	19.8	10.0	6.8	4.9	4.2	40.9	8.1	50.0	75.0	20.4	44.1	102.9
	(M)	16.3	9.3	5.4	24.2	56.8	9.1	7.3	37.7	60.3	138.5	110.5	50.1
	(L)	11.7	10.3	3.9	4.4	39.2	9.7	7.7	60.3	65.7	43.2	111.9	26.3
1983	(F)	26.2	16.7	8.4	5.4	3.9	3.8	3.6	51.8	108.7	115.3	46.9	17.6
	(M)	55.1	12.8	7.2	4.0	5.5	5.1	3.6	25.2	32.3	81.3	21.4	14.4
	(L)	19.1	12.1	6.0	3.9	5.1	3.8	4.0	5.8	28.2	104.9	42.4	9.9
1984	(F)	7.9	4.4	3.3	3.2	43.7	31.9	90.7	99.8	122.5	28.1	59.6	94.1
	(M)	6.5	3.4	3.3	19.9	9.6	35.9	48.8	57.3	39.9	22.7	64.0	27.6
	(L)	5.1	3.7	2.9	41.0	71.9	89.5	45.3	292.6	32.2	130.3	40.5	19.9
1985	(F)	19.0	8.9	5.3	3.6	5.8	38.1	69.7	89.4	149.8	68.9	87.3	70.9
	(M)	15.0	7.9	4.5	5.3	3.6	80.8	41.7	52.0	103.1	92.0	79.1	31.4
	(L)	10.3	8.5	3.4	46.7	3.2	142.0	14.2	139.4	92.6	161.5	105.2	25.5
1986	(F)	23.4	18.8	9.8	7.7	4.1	23.1	199.8	376.5	120.4	119.0	163.1	140.0
	(M)	18.9	15.3	9.3	6.2	4.0	28.3	90.4	253.5	64.6	196.6	153.6	71.4
	(L)	34.1	15.8	7.3	4.6	24.2	25.6	70.8	124.0	56.8	258.6	170.2	84.1
1987	(F)	44.7	26.8	14.2	9.2	6.0	61.5	13.3	11.3	105.9	17.0	39.0	54.1
	(M)	37.4	21.7	12.5	9.4	7.2	71.8	12.0	50.1	52.0	13.1	87.5	77.4
	(L)	28.8	22.2	10.0	7.6	61.3	17.9	34.6	14.3	46.9	103.5	44.7	39.7
1988	(F)	23.0	17.7	16.7	9.2	25.9	8.3	62.3	17.0	128.9	91.0	29.9	
	(M)	35.0	46.0	12.2	10.8	7.2	32.7	96.6	63.8	44.0	105.8	159.0	24.9
	(L)	39.6	18.0	7.9	7.9	64.9	11.1	78.4	18.2	36.5	98.6	63.5	82.4
1989	(F)	27.3	21.5	14.7	14.2	7.9	10.7	54.7	103.2	189.2	139.1	96.2	
	(M)	76.5	17.9	13.5	9.9	27.6	39.7	229.0	130.8	138.7	108.6	55.8	25.8
	(L)	43.3	22.4	49.3	8.3	27.7	48.2	91.4	49.4	70.5	34.8	19.5	
1990	(F)	17.5	12.8	8.5	5.3	5.5	23.9	82.4	43.0	78.7	62.7	44.9	110.2
	(M)	15.3	10.8	7.1	5.2	5.1	142.8	26.5	45.3	77.4	148.5	75.4	59.7
	(L)	13.1	12.2	5.1	5.2	35.0	186.4	75.4	173.4	44.3	53.4	48.8	24.2
1991	(F)	22.8	17.4	9.5	10.0	7.6	5.9	239.2	45.8	21.8	117.2	31.8	
	(M)	18.8	13.7	8.5	10.0	31.0	6.2	123.6	134.0	6			

Table 4.3.3 Simulated 10-day Mean Runoff (4/6)

Station : Minanga (C.A. = 1,565km ²)													(Unit : m ³ /sec)
	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	
1963	(F)	38.3	31.1	26.9	19.3	15.4	194.3	160.8	92.3	84.7	43.9	117.0	
	(M)	34.9	32.0	23.2	17.2	15.1	185.9	112.0	94.2	96.7	41.4	140.5	
	(L)	29.9	39.2	19.9	15.6	44.3	180.9	83.9	174.6	134.6	46.5	45.6	43.9
1964	(F)	42.3	32.9	30.6	22.3	17.3	80.4	90.9	115.8	85.9	157.3	153.1	153.0
	(M)	39.4	31.3	29.1	20.7	16.9	82.5	77.0	41.3	134.8	84.5	417.2	231.0
	(L)	33.0	39.8	23.0	17.9	93.0	107.2	115.3	37.3	154.2	95.5	290.1	112.0
1965	(F)	66.4	46.3	32.0	20.6	18.9	20.9	128.5	30.7	102.9	26.5	104.9	28.2
	(M)	60.0	40.7	28.1	19.5	18.6	18.5	165.3	35.5	31.9	87.7	29.0	32.0
	(L)	48.2	44.8	22.1	19.2	16.7	82.2	28.7	29.0	30.4	24.7	31.0	30.2
1966	(F)	27.5	19.8	15.4	14.8	101.5	58.0	62.5	26.6	20.7	21.7	74.4	198.2
	(M)	24.3	17.2	15.2	14.5	18.9	80.1	24.5	22.2	19.9	54.8	160.0	122.0
	(L)	19.5	19.9	13.6	14.3	67.7	28.4	23.2	19.8	17.1	23.4	356.5	225.4
1967	(F)	107.1	44.4	32.1	23.8	17.5	20.3	88.0	65.8	117.1	119.4	84.6	25.8
	(M)	51.8	41.3	27.3	21.9	15.2	16.4	23.9	26.6	28.0	31.9	28.4	24.1
	(L)	43.9	45.2	21.6	21.1	13.6	87.2	63.8	24.9	27.0	24.8	26.6	20.4
1968	(F)	19.4	15.3	12.9	12.3	16.9	154.3	21.6	110.0	32.3	34.5	27.8	24.5
	(M)	18.3	13.3	12.7	12.1	12.5	84.5	58.9	206.4	77.7	66.6	25.4	72.3
	(L)	15.1	14.5	11.4	17.4	10.5	68.1	21.3	69.3	121.8	28.4	30.4	23.6
1969	(F)	24.7	17.1	12.0	11.5	11.0	48.4	10.6	76.9	76.6	188.3	23.2	135.8
	(M)	22.9	14.6	11.9	11.3	10.8	13.1	10.0	91.7	18.6	88.8	130.5	134.9
	(L)	17.1	15.7	10.6	11.2	44.6	11.1	9.0	46.4	20.8	24.2	151.3	121.9
1970	(F)	112.1	32.8	23.9	15.6	12.6	10.9	13.8	87.6	22.9	162.4	154.5	200.9
	(M)	38.9	27.6	19.4	13.1	11.2	55.2	13.8	81.0	100.3	137.2	134.1	194.7
	(L)	32.1	32.5	16.0	10.0	49.2	12.2	17.5	26.5	167.6	113.9		81.8
1971	(F)	102.1	40.3	31.0	27.7	22.2	82.0	87.5	73.0	107.0	290.6	203.1	393.5
	(M)	46.7	39.8	143.2	22.8	82.6	177.6	181.4	109.7	243.2	274.8	271.3	248.1
	(L)	41.4	44.7	30.3	19.3	19.8	79.5	77.2	114.5	98.3	212.2	412.9	199.5
1972	(F)	199.0	75.7	53.4	40.8	40.6	51.4	109.3	40.6	37.4	33.7	31.6	72.5
	(M)	88.5	68.9	46.3	86.2	128.8	44.4	44.5	37.8	35.0	31.6	28.5	32.8
	(L)	76.3	68.1	38.1	76.4	153.6	95.5	36.6	33.4	34.2	26.7	125.0	26.9
1973	(F)	26.7	21.8	20.6	19.7	18.9	179.5	33.4	89.8	33.8	89.0	150.1	248.6
	(M)	25.2	21.3	20.3	19.4	18.6	123.7	30.6	126.7	91.6	239.6	261.4	118.8
	(L)	21.6	26.2	18.2	19.1	16.6	111.1	77.7	32.7	32.9	108.3	384.2	59.7
1974	(F)	59.5	46.9	31.6	21.9	19.0	146.1	18.8	18.1	20.0	257.9	343.7	111.0
	(M)	52.7	41.4	28.5	19.6	55.7	26.1	64.3	71.4	25.6	304.9	242.3	239.3
	(L)	45.3	46.0	22.4	19.3	17.0	22.0	17.0	66.5	338.0	131.0		144.1
1975	(F)	71.5	55.4	39.0	27.0	19.7	20.8	23.2	29.4	22.9	19.9	86.8	110.6
	(M)	63.4	51.5	33.6	23.0	19.4	21.6	22.6	23.7	60.3	96.8	29.3	90.0
	(L)	56.1	57.1	27.7	21.5	63.7	61.3	26.3	21.0	134.6	26.4	104.1	
1976	(F)	99.1	29.3	19.9	16.3	14.8	81.5	26.3	177.6	26.7	69.8	146.2	135.0
	(M)	34.6	24.6	19.3	16.0	15.5	22.5	22.5	35.1	117.4	27.9	219.2	190.5
	(L)	29.5	24.4	14.9	15.0	121.0	100.5	25.6	26.0	30.3	76.5	289.8	89.6
1977	(F)	51.2	43.6	28.7	20.0	15.6	17.0	14.4	48.8	13.9	22.9	16.0	23.1
	(M)	50.9	38.9	25.6	16.4	15.4	15.0	14.2	14.0	73.6	20.6	153.5	21.4
	(L)	43.0	43.2	20.1	15.9	88.9	14.8	12.9	12.6	105.5	15.9	28.9	17.6
1978	(F)	16.2	11.8	11.3	10.8	10.3	10.5	9.4	64.0	106.4	76.2	67.3	33.9
	(M)	15.0	11.6	11.1	10.6	10.2	9.8	9.3	14.0	99.3	26.4	170.0	36.8
	(L)	11.6	14.3	9.9	10.4	53.9	9.6	8.3	100.7	98.9	146.5	83.3	84.1
1979	(F)	31.9	19.0	13.2	10.2	9.8	136.0	111.3	81.6	204.3	106.9	85.3	32.7
	(M)	27.8	17.2	10.6	10.1	12.6	25.0	164.5	112.2	125.2	40.8	36.8	37.5
	(L)	21.0	19.3	9.4	12.1	150.6	61.1	178.8	38.2	43.4	34.3	34.7	29.2
1980	(F)	30.0	21.3	16.7	12.8	12.2	12.1	11.2	12.6	15.0	17.1	272.9	67.6
	(M)	27.5	19.8	13.6	12.6	12.0	11.5	15.9	11.9	13.1	12.6	122.5	114.2
	(L)	22.9	19.8	11.8	12.4	16.1	11.4	16.4	9.9	158.8	68.3	33.2	
1981	(F)	32.5	23.5	14.4	10.6	10.2	74.8	20.5	64.0	23.6	24.2	149.7	34.9
	(M)	30.7	19.1	11.6	10.5	10.0	78.4	114.1	86.5	67.0	24.2	86.8	32.3
	(L)	25.8	21.6	9.8	10.3	9.0	15.8	17.7	21.3	60.2	133.6	80.3	26.9
1982	(F)	27.2	17.2	10.8	10.3	9.9	9.4	9.8	8.7	106.2	15.5	22.0	75.8
	(M)	22.9	15.4	10.7	10.2	9.7	43.4	9.6	11.5	87.0	21.6	80.5	28.2
	(L)	17.7	16.4	9.5	10.0	8.8	13.1	8.0	58.8	18.0	18.9	24.3	
1983	(F)	58.1	16.7	11.2	8.5	8.1	8.9	7.5	7.2	7.2	94.0	59.3	13.8
	(M)	57.8	14.4	8.8	8.4	12.1	8.8	7.4	7.1	6.8	13.3	50.3	12.4
	(L)	19.2	16.4	7.8	8.2	40.0	8.1	6.6	7.8	61.0	70.2	16.6	9.3
1984	(F)	9.2	6.7	6.2	6.0	79.2	15.7	124.6	98.4	27.5	19.1	93.8	82.6
	(M)	9.0	6.4	6.2	55.2	17.9	15.0	23.0	26.7	24.1	82.6	32.4	28.5
	(L)	7.6	7.0	5.8	9.6	91.7	133.6	102.5	84.0	19.8	258.4	29.1	
1985	(F)	26.0	16.2	9.8	9.4	10.6	94.6	18.9	133.2	116.8	81.0	98.6	89.4
	(M)	22.8	14.1	9.6	10.6	8.9	63.2	53.5	22.2	95.5	94.5	98.7	35.9
	(L)	17.2	16.0	8.6	13.3	7.7	78.1	15.9	19.2	117.5	158.4		30.1
1986	(F)	29.1	26.9	17.6	11.3	10.7	43.8	203.3	285.4	38.3	34.5	214.7	92.6
	(M)	25.3	23.2	16.5	11.0	10.6	10.4	74.9	193.2	35.3	116.9	219.5	49.2
	(L)	25.8	24.8	13.2	10.9	9.5	10.0	17.3	71.8	31.6	198.4	120.0	84.4
1987	(F)	44.9	35.1	22.6	122.6	16.5	16.9	14.9	17.7	22.7	19.4	17.6	72.0
	(M)	41.3	29.9	19.1	103.2	14.8	60.8	19.1	73.8	25.5	15.8	84.7	83.5
	(L)	35.4	32.1	14.2	21.6	15.4	15.9	16.6	61.0	17.6	23.0	60.7	74.2
1988	(F)	26.9	19.7	30.5	18.7	15.5	11.6	12.0	74.6	21.5	144.0	44.7	40.0
	(M)	25.8	160.4	25.1	17.9	12.8	11.4	114.9	115.1	21.0	332.4	98.3	35.2
	(L)	21.6	104.8	17.8	17.5	10.8	61.3	66.9	22.1	23.0	151.8	43.3	100.1
1989	(F)	35.2	31.4	27.5	28.2	21.2	17.3	17.3	22.6	181.3	84.9	41.2	35.2
	(M)	35.0	26.5	25.1	23.4	56.7	17.0	142.9	105.7	137.0	94.7	35.3	33.1
	(L)	36.6	89.6	19.3	16.1	18.9	22.0	23.0	39.2	95.4	109.5		26.5
1990	(F)	25.2	19.9	13.9	13.3	12.7	68.3	22.4	23.6	28.8	73.8	33.1	72.1
	(M)	22.5	17.4	13.7	13.1	12.5	63.0	90.2	22.6	83.8	148.6	107.8	106.0
	(L)	19.1	19.1	12.2	12.9	99.5	101.0	24.5	105.6	26.8	29.7	36.3	32.4
1991	(F)	36.9	27.9	18.7	87.5	12.8	11.						

Table 4.3.3 Simulated 10-day Mean Runoff (5/6)

Station : Guinalvin (C.A. = 921 km ²)													(Unit : m ³ /sec)
		Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
1963	(F)	31.0	21.0	15.8	11.3	7.9	9.0	150.3	127.4	58.5	55.6	24.0	79.3
	(M)	25.3	43.4	13.4	10.3	7.8	160.1	77.4	86.7	66.7	69.1	21.8	102.1
	(L)	20.7	26.8	11.5	8.6	39.2	141.7	60.5	136.8	102.3	47.4	49.4	25.3
1964	(F)	24.4	15.7	15.4	10.9	8.9	61.7	68.1	87.0	57.0	117.0	116.8	94.5
	(M)	20.5	15.5	14.0	10.3	8.7	63.6	56.8	27.0	103.5	53.3	339.6	173.1
	(L)	16.4	52.1	11.5	9.0	80.8	84.6	91.7	44.2	116.9	69.7	207.3	68.8
1965	(F)	37.9	20.8	14.8	9.6	9.3	35.5	103.0	19.0	78.2	12.8	85.9	16.7
	(M)	31.7	18.0	13.0	9.5	9.2	9.5	130.1	44.9	18.4	71.3	15.8	41.7
	(L)	23.5	20.9	10.2	9.4	9.1	66.4	18.2	16.8	16.5	12.4	19.2	17.5
1966	(F)	14.4	9.7	8.0	7.7	88.9	44.6	41.1	18.7	11.7	38.8	50.0	137.2
	(M)	11.6	8.5	7.9	7.6	13.1	64.3	15.3	12.6	11.7	36.7	128.3	80.5
	(L)	9.9	10.1	7.1	7.5	56.1	38.8	16.0	12.9	9.7	35.5	291.2	178.4
1967	(F)	65.6	24.4	15.2	15.3	9.4	42.9	68.5	50.5	98.3	98.8	69.8	16.0
	(M)	32.3	22.0	13.6	11.2	8.3	10.1	16.4	18.3	18.0	20.8	18.0	13.0
	(L)	25.5	22.5	10.6	10.8	8.0	70.2	51.2	17.5	17.1	13.8	14.4	10.8
1968	(F)	10.4	8.4	7.0	6.7	10.7	135.4	15.8	92.5	21.7	22.2	14.7	12.2
	(M)	10.0	7.2	6.9	6.7	6.9	62.5	47.9	168.8	60.4	48.4	13.1	54.6
	(L)	8.1	7.8	6.2	39.8	5.8	51.5	15.5	43.2	96.5	16.1	44.7	14.2
1969	(F)	14.6	8.7	6.5	6.3	6.0	40.4	6.1	69.0	62.3	161.2	13.2	101.1
	(M)	11.7	7.5	9.2	6.2	6.0	10.2	5.6	75.2	12.6	61.7	110.8	100.6
	(L)	9.0	8.2	5.7	6.1	41.1	6.4	5.1	34.4	15.8	15.4	118.6	90.8
1970	(F)	80.6	17.5	11.8	8.2	6.5	5.8	10.6	78.6	17.1	135.4	114.5	157.9
	(M)	23.5	13.4	10.1	7.1	5.9	49.8	10.1	64.8	85.4	104.3	97.9	145.2
	(L)	17.6	15.8	8.2	35.5	5.3	40.3	7.6	11.8	18.8	131.8	81.9	33.3
1971	(F)	80.5	21.8	15.2	13.2	37.0	65.8	65.2	51.0	77.0	233.7	143.9	290.4
	(M)	27.3	24.6	118.4	11.4	60.7	145.2	146.3	84.4	195.0	205.6	204.8	163.3
	(L)	26.0	23.6	16.8	9.5	12.2	52.3	50.6	87.0	59.1	152.9	320.9	135.8
1972	(F)	135.4	38.6	22.8	21.5	22.4	29.9	80.1	23.6	23.0	20.7	19.9	49.0
	(M)	50.5	33.7	20.7	64.8	100.4	23.3	24.1	19.1	18.7	16.5	14.9	18.5
	(L)	42.8	31.1	17.5	52.0	117.4	73.6	18.0	18.6	20.1	13.7	104.1	13.6
1973	(F)	13.7	11.1	10.2	9.8	9.5	157.3	22.3	68.5	19.4	71.8	111.8	172.4
	(M)	12.7	10.4	10.1	9.7	9.4	92.9	19.0	98.9	72.9	195.7	206.1	68.5
	(L)	10.9	12.9	9.0	9.6	9.1	83.3	62.9	20.7	18.0	71.5	301.9	35.3
1974	(F)	32.5	23.7	15.5	10.7	9.6	125.7	9.8	9.5	13.8	213.4	257.2	73.1
	(M)	26.7	19.4	13.7	9.8	49.1	13.7	16.8	54.3	60.7	44.8	238.8	186.3
	(L)	24.7	21.4	10.8	9.7	8.8	11.6	8.8	8.8	44.3	263.1	81.1	96.6
1975	(F)	42.3	28.7	18.0	12.9	9.7	13.1	15.6	17.9	14.6	10.5	59.9	91.7
	(M)	35.2	26.0	16.3	11.1	12.0	14.9	12.9	12.7	51.4	81.7	17.1	65.7
	(L)	32.4	27.1	13.1	10.5	55.2	51.3	42.8	11.5	107.9	14.1	76.8	
1976	(F)	72.0	15.3	10.1	12.0	9.2	61.6	18.3	140.3	14.6	52.5	116.7	85.4
	(M)	21.4	12.2	10.2	8.9	12.0	16.2	12.9	21.9	98.7	15.2	173.1	143.7
	(L)	16.2	12.7	7.9	8.0	107.3	83.0	41.9	14.7	19.1	63.2	226.4	56.1
1977	(F)	30.8	24.3	14.2	10.0	8.1	9.4	7.6	44.7	9.6	16.2	8.9	15.6
	(M)	31.4	20.1	12.8	8.3	8.0	7.8	9.4	7.7	66.7	13.6	132.3	12.1
	(L)	26.4	20.9	9.9	8.2	7.7	7.9	9.0	7.8	86.9	8.8	19.2	9.5
1978	(F)	8.9	6.6	6.4	6.1	5.9	6.4	5.6	58.3	84.9	57.0	25.3	21.4
	(M)	8.1	6.5	6.3	6.1	6.8	5.8	5.5	11.3	77.5	19.0	146.5	44.9
	(L)	6.3	8.0	5.6	6.0	51.2	5.6	5.0	87.1	77.1	122.2	57.5	58.8
1979	(F)	18.3	9.8	6.8	5.7	5.5	104.3	90.7	51.2	167.2	80.1	66.7	18.0
	(M)	14.0	8.5	5.8	5.6	31.7	17.4	132.3	85.6	87.8	24.6	22.1	48.6
	(L)	9.9	9.8	5.2	29.7	124.5	46.5	140.7	25.4	27.4	18.8	21.1	15.7
1980	(F)	15.4	10.8	8.5	6.5	6.3	6.1	7.3	7.1	35.0	36.1	220.0	56.1
	(M)	13.1	9.9	7.0	8.2	6.2	6.0	37.5	6.6	8.2	6.5	80.0	91.1
	(L)	10.9	9.8	6.0	6.4	37.1	6.0	10.8	5.4	6.2	133.8	26.8	21.5
1981	(F)	19.0	11.2	7.1	5.6	5.4	67.8	37.4	52.4	16.5	16.4	115.7	22.9
	(M)	17.9	9.7	5.8	5.5	8.2	64.6	88.3	69.3	55.1	16.8	59.1	21.1
	(L)	14.0	10.7	5.1	5.4	4.8	12.2	11.0	14.5	46.0	112.7	57.9	15.2
1982	(F)	14.8	8.6	5.6	5.4	5.2	5.1	5.7	7.1	86.9	8.7	14.7	60.4
	(M)	11.1	7.8	5.5	5.4	6.2	40.2	5.7	29.8	67.0	41.8	65.4	39.9
	(L)	8.9	8.5	5.0	6.6	7.1	10.4	4.4	45.6	11.2	11.7	16.5	
1983	(F)	40.5	7.8	5.5	5.8	4.4	4.9	4.2	4.0	5.8	79.0	46.0	7.5
	(M)	42.1	7.4	4.7	4.5	33.8	5.0	4.9	4.0	4.0	10.5	38.9	6.6
	(L)	9.8	7.9	4.2	4.5	28.5	4.6	3.7	7.5	56.3	10.5	58.6	5.3
1984	(F)	5.3	4.0	3.6	3.5	70.5	10.5	98.2	75.1	18.3	11.3	55.5	67.3
	(M)	6.3	3.7	5.9	52.2	35.8	9.4	15.3	17.2	13.3	70.5	20.5	16.8
	(L)	4.4	4.1	6.2	8.8	70.5	116.2	83.9	67.4	9.6	216.0	16.1	17.2
1985	(F)	14.0	8.2	4.9	5.8	6.6	84.6	14.0	113.9	98.0	58.0	67.2	64.4
	(M)	11.3	6.9	5.1	10.0	4.7	49.4	43.9	15.2	72.6	71.9	20.5	
	(L)	8.3	8.0	6.3	35.3	4.0	63.3	10.8	12.3	91.6	127.0	65.4	16.1
1986	(F)	14.4	14.4	8.3	5.5	5.3	39.8	177.4	244.2	28.0	45.9	161.9	61.0
	(M)	11.5	10.5	7.9	5.4	5.3	5.2	49.8	143.1	25.2	86.9	164.2	30.2
	(L)	35.0	11.9	6.5	5.3	4.7	5.0	10.7	27.2	19.0	158.1	77.4	61.0
1987	(F)	26.6	17.3	10.5	105.8	7.8	9.6	7.2	9.2	15.4	9.2	8.5	53.7
	(M)	21.9	13.5	8.9	79.4	6.8	47.7	35.2	59.7	41.6	7.6	69.0	63.2
	(L)	19.5	15.4	6.6	6.6	11.5	30.1	8.6	43.7	9.6	13.4	51.0	48.8
1988	(F)	17.1	9.3	19.3	9.3	7.9	5.7	6.6	57.7	11.8	114.4	103.2	22.4
	(M)	15.7	135.9	13.1	9.0	6.7	5.7	98.9	92.5	13.9	271.6	66.3	18.0
	(L)	11.3	73.7	8.4	10.4	5.7	54.7	50.5	14.2	35.1	102.7	26.5	80.0
1989	(F)	19.5	15.8	14.4	16.9	33.7	9.1	9.9	12.9	150.0	62.4	25.8	19.8
	(M)	20.6	12.0	11.9	11.0	39.1	10.3	118.7	87.1	101.2	70.7	20.5	17.8
	(L)	46.9	47.1	72.7	9.3	33.2	13.8	14.3	25.1	71.4	86.5	12.8	
1990	(F)	11.7	9.8	6.8	6.5	6.3	52.1	14.2	14.1	19.1	58.2	21.3	53.1
	(M)	11.0	8.5	6.7	6.5	6.9	48.8	73.3	13.6	66.1	120.0	85.3	81.4
	(L)	9.5	9.3	6.0	6.4	89.1	82.0	16.8	90.7	16.6	18.7	23.1	20.1
1991	(F)	23.5	14.9	9.4	7.1	7.3	6.1	5.9	58.0	60.0	17.8	20.9	20.9
	(M)	17.3	11.5	7.9	8.3	6.2	6.0	40.6	243.7	22.0	14.3	42.2	17.5
	(L)	15.7	13.6	6.0	6.7	5.6	6.0	77.9	19.1</				

Table 4.3.3 Simulated 10-day Mean Runoff (6/6)

Station : Dulao (C.A. = 573km ²)													(Unit : m ³ /sec)
		Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
1963	(F)	13.7	11.2	9.7	7.3	5.3	6.4	105.9	85.2	47.8	42.6	16.4	54.2
	(M)	11.9	27.5	8.6	6.7	5.2	103.7	61.0	63.4	48.0	48.6	15.1	70.3
	(L)	10.3	15.5	7.5	5.4	26.0	100.1	45.0	92.1	69.3	35.0	35.4	32.3
1964	(F)	15.4	11.3	11.1	7.7	6.2	45.8	49.9	62.1	38.5	82.1	78.6	77.0
	(M)	13.5	11.2	10.0	7.3	6.1	46.3	42.0	38.5	68.7	43.0	219.5	116.9
	(L)	11.4	35.6	8.0	6.4	52.6	59.1	62.1	28.3	80.5	48.6	152.1	53.8
1965	(F)	24.4	23.2	15.6	11.1	11.7	45.8	35.8	42.3	43.1	14.9	13.9	11.5
	(M)	69.3	19.5	13.1	10.5	28.0	37.5	47.0	38.4	15.6	34.0	11.5	12.4
	(L)	55.7	22.2	11.0	11.1	10.6	33.1	79.9	13.9	63.1	11.5	11.2	25.7
1966	(F)	10.2	7.9	8.1	5.8	26.6	42.7	31.2	45.8	11.8	8.3	40.8	85.4
	(M)	9.2	7.3	6.7	5.3	31.1	48.5	10.9	36.5	10.4	7.6	66.4	46.2
	(L)	7.7	10.3	5.5	5.3	63.0	31.8	11.1	50.9	8.7	6.6	142.5	62.1
1967	(F)	48.3	14.6	10.4	7.8	6.2	36.2	34.7	48.6	60.1	84.3	89.0	42.8
	(M)	50.2	13.5	8.5	7.5	6.9	8.7	10.9	51.0	65.2	83.0	41.9	17.1
	(L)	15.6	14.9	6.8	7.5	7.4	51.3	69.8	59.1	52.9	17.1	17.2	28.7
1968	(F)	13.2	8.5	8.2	4.7	78.5	60.8	64.8	107.8	97.1	37.6	16.6	12.1
	(M)	11.2	7.4	6.2	4.6	12.1	46.6	16.5	123.5	22.7	20.1	14.9	11.4
	(L)	8.5	7.3	4.6	136.3	24.4	103.7	84.0	84.4	21.8	16.4	13.8	8.8
1969	(F)	8.9	7.1	4.9	4.7	4.5	6.4	5.2	4.7	39.8	45.4	5.5	8.4
	(M)	8.5	6.2	5.3	4.6	61.2	29.2	4.6	4.5	5.8	8.6	4.9	31.8
	(L)	7.0	6.8	4.3	4.6	6.0	5.4	26.0	33.7	29.4	6.3	40.2	53.9
1970	(F)	104.2	8.7	39.2	5.5	3.6	76.0	5.2	9.1	27.3	29.5	61.2	123.8
	(M)	45.2	6.8	6.4	4.5	3.6	54.6	7.5	7.1	85.0	143.2	59.9	100.1
	(L)	9.6	7.4	5.4	3.6	5.3	7.0	46.8	46.3	36.8	88.6	105.4	34.6
1971	(F)	53.6	13.7	11.2	8.4	42.5	13.8	54.0	39.9	105.6	172.0	50.9	57.7
	(M)	18.9	11.4	42.2	7.4	150.9	35.5	91.7	13.8	63.4	87.1	37.1	51.5
	(L)	14.6	46.9	9.8	6.0	48.1	12.8	90.7	58.6	66.1	41.7	117.6	51.1
1972	(F)	52.6	16.5	10.3	9.3	8.0	33.8	52.6	66.3	52.2	12.6	46.1	9.5
	(M)	18.9	14.2	9.5	9.3	58.5	9.4	61.8	119.7	16.9	10.5	11.1	8.3
	(L)	41.6	13.8	7.7	7.4	50.8	8.7	37.5	38.7	13.7	8.5	11.7	6.8
1973	(F)	6.8	6.7	4.7	4.5	4.4	4.6	31.0	26.5	95.7	76.6	36.8	40.0
	(M)	6.0	5.2	4.6	4.5	38.1	69.2	7.2	90.0	35.7	96.0	15.8	16.9
	(L)	4.8	5.9	21.5	4.4	23.9	47.7	7.8	152.4	38.9	55.3	109.6	13.1
1974	(F)	13.2	11.0	7.6	4.4	4.3	23.9	38.0	6.2	41.8	8.6	90.6	35.4
	(M)	13.5	9.3	6.4	6.4	4.2	74.8	24.5	34.7	7.4	86.2	43.1	78.8
	(L)	12.3	10.3	5.1	4.4	3.8	34.4	7.0	8.0	50.8	119.6	60.2	30.6
1975	(F)	15.7	13.5	8.4	5.4	5.3	30.1	6.5	7.3	53.2	6.4	45.4	28.7
	(M)	62.9	11.2	7.6	4.2	4.0	4.8	26.7	5.2	9.5	38.8	27.0	69.4
	(L)	36.9	12.1	6.2	4.1	6.0	4.2	6.0	6.7	7.3	9.0	8.4	35.4
1976	(F)	9.4	5.5	54.9	39.5	53.0	89.2	41.7	68.6	54.4	82.0	18.0	15.2
	(M)	7.9	5.1	24.5	5.3	29.1	13.8	12.4	65.0	113.4	53.0	36.0	36.3
	(L)	5.6	5.2	4.4	4.2	135.3	76.3	44.1	37.0	82.4	17.3	16.2	11.8
1977	(F)	12.2	11.5	7.5	8.1	4.4	31.1	34.8	91.0	36.3	14.2	12.1	13.7
	(M)	12.4	10.2	6.9	5.7	4.0	38.3	41.5	39.2	60.9	13.8	89.5	11.3
	(L)	12.3	11.0	5.5	4.5	95.6	24.8	51.0	39.1	30.4	9.9	45.8	8.8
1978	(F)	8.2	5.5	4.5	3.8	4.0	46.4	5.9	9.2	61.6	80.4	95.6	17.3
	(M)	7.0	4.8	4.2	3.7	3.6	43.5	29.6	8.1	78.1	67.2	38.9	15.7
	(L)	5.8	6.7	3.5	37.9	43.5	8.2	42.4	102.3	84.3	108.9	17.1	33.5
1979	(F)	15.1	9.1	6.6	4.0	4.5	110.8	44.6	63.9	42.7	107.7	41.6	16.8
	(M)	12.6	7.9	5.6	3.9	66.4	44.7	37.6	47.9	43.0	69.7	48.3	14.2
	(L)	10.1	8.8	4.6	45.6	45.3	64.0	52.1	12.6	76.8	16.5	52.0	13.4
1980	(F)	12.2	7.9	6.7	7.2	5.6	8.1	8.3	55.5	26.9	34.4	158.8	17.0
	(M)	10.3	7.6	5.9	38.6	46.1	6.1	60.2	12.0	63.1	40.3	69.6	18.4
	(L)	7.7	7.8	57.7	6.9	53.9	5.8	43.5	33.3	42.3	119.2	35.0	13.8
1981	(F)	13.5	9.8	7.1	4.2	23.6	107.4	99.4	81.5	86.1	20.2	68.3	19.2
	(M)	11.7	8.3	6.0	5.4	62.8	79.5	147.7	57.6	77.9	19.5	42.4	16.5
	(L)	9.5	10.0	4.3	87.6	138.0	76.1	70.1	18.1	54.2	105.6	58.7	13.6
1982	(F)	13.1	9.4	7.2	46.1	13.9	64.2	38.4	47.6	77.3	15.6	31.7	14.6
	(M)	11.9	8.3	7.0	67.9	30.9	51.0	72.1	15.7	55.6	40.6	14.5	12.5
	(L)	9.4	9.3	57.8	58.4	117.5	40.5	50.8	81.0	36.7	12.9	30.6	10.6
1983	(F)	10.6	8.4	5.7	5.1	4.9	4.7	4.6	30.6	6.0	49.3	33.9	8.1
	(M)	10.9	7.6	5.2	5.0	6.2	6.7	6.6	24.9	6.1	51.3	11.3	7.2
	(L)	8.8	8.4	4.6	4.9	4.4	4.7	5.7	7.5	70.6	91.5	9.7	5.7
1984	(F)	5.7	4.0	3.9	3.8	103.0	39.3	62.2	45.6	13.9	12.2	38.0	32.0
	(M)	5.0	4.0	42.6	32.2	47.8	54.5	62.5	43.6	30.5	45.5	13.0	10.9
	(L)	4.1	4.4	4.3	40.8	54.8	12.8	54.3	57.4	12.5	98.3	11.9	8.5
1985	(F)	8.3	5.5	3.9	3.8	3.9	26.5	45.2	60.1	100.9	41.2	54.5	43.1
	(M)	7.2	4.7	3.8	4.0	3.6	55.5	11.3	32.4	66.4	58.0	48.4	15.6
	(L)	5.9	5.0	3.5	30.5	3.2	98.1	7.4	94.7	58.2	108.4	13.0	13.0
1986	(F)	12.5	11.2	7.3	5.4	3.9	6.4	145.4	263.0	73.7	82.4	106.6	89.1
	(M)	10.6	9.3	6.8	4.1	3.8	25.0	62.1	172.8	23.1	134.1	98.7	27.8
	(L)	11.1	10.0	5.1	3.9	5.4	6.8	45.6	78.2	22.0	177.2	110.5	56.0
1987	(F)	23.6	15.8	10.4	6.6	4.9	40.3	6.7	6.2	71.4	8.6	11.2	34.2
	(M)	20.5	13.4	9.0	6.4	5.0	47.0	6.1	34.3	32.3	6.8	63.0	50.6
	(L)	16.4	14.5	7.2	5.3	40.5	8.7	8.2	7.3	28.1	70.3	28.6	12.1
1988	(F)	12.7	9.9	8.9	7.5	5.5	6.6	5.0	39.2	8.2	88.7	58.2	14.2
	(M)	12.5	29.2	7.0	6.8	4.6	8.4	66.0	39.8	10.8	70.6	106.5	12.3
	(L)	29.8	10.3	5.6	5.5	43.5	6.6	52.0	8.3	26.0	64.6	37.6	53.5
1989	(F)	13.4	11.5	8.4	7.6	4.7	5.4	33.9	65.4	131.7	89.7	59.4	15.5
	(M)	48.8	10.2	7.6	6.4	6.5	23.9	158.2	84.6	91.6	67.8	19.5	14.0
	(L)	13.5	12.4	31.3	5.1	20.0	29.5	58.8	15.1	57.8	41.2	18.2	11.0
1990	(F)	10.3	8.1	5.4	4.3	4.1	5.7	53.1	13.1	49.4	41.1	15.8	79.4
	(M)	9.1	7.2	4.5	4.2	4.1	102.4	11.9	29.7	47.5	100.5	51.2	39.1
	(L)	7.9	8.0	3.9	4.2	23.4	130.0	46.7	119.0	15.2	31.8	16.5	12.7
1991	(F)	12.4	9.5	6.3	5.5	4.5	4.0	3.9	166.1	15.1	10.5	77.8	14.8
	(M)	10.6	8.0	5.6	5.4	6.7	4.0	85.0	89.2	44.0	8.5	77.4	13.0
	(L)	9.1	9.3	21.5	5.2	4.0	3.9	32.0	63.8	12.5	138.4	39.6	10.1
1992	(F)	9.5	7.0	4.2	3.8								

Table 4.4.1 Rainfall Data for Streamflow Analysis

Sub-basin	Basin	Drainage area (km2)	Basin rainfall (mm)	Sub-basin	Basin	Drainage area (km2)	Basin rainfall (mm)
1	1	1,150	3,300	19	2	266	2,070
2	1	481	3,600	20	2	970	1,910
3	1	733	3,400	21	3	247	2,100
4	1	298	2,900	22	3	876	2,500
5	1	351	2,800	23	3	474	2,300
6	1	142	2,300	24	3	215	2,400
7	1	477	2,750	25	3	652	3,800
8	1	387	2,650	26	3	915	3,900
9	1	193	2,500	27	4	209	2,960
10	1	264	2,150	28	2	656	2,850
11	1	1,106	2,080	29	2	408	1,820
12	1	1,051	2,060	30	2	362	2,500
13	2	620	2,500	31	2	589	1,820
14	2	292	3,100	32	4	225	3,530
15	2	550	3,500	33	4	739	2,180
16	2	1,228	2,500	34	4	327	3,690
17	2	628	4,000	35	4	92	2,250
18	2	559	3,000	36	4	657	3,880

Sub-basin	Basin	Drainage area (km2)	Basin rainfall (mm)
37	6	1,042	2,000
38	4	969	3,100
39	6	73	2,100
40	5	386	3,100
41	5	334	3,500
42	5	157	2,950
43	5	533	2,950
44	5	372	3,340
45	5	612	2,200
46	6	856	3,090
47	6	366	1,900
48	6	775	2,900
49	6	160	1,900
50	6	169	2,080
51	4	417	2,000
52	6	393	2,500
53	6	278	2,300

Notes: /1 ; 1 = Upper Cagayan,
2 = Magat,
3 = Ilagan,
4 = Lower Cagayan
5 = Upper Chico,
6 = Lower Chico

/2 ; Basin rainfall is assumed
on the basis of the isohyetal
map for the period
from 1963 to 1978.

Basin	Runoff Gauge	Drainage area (km2)	Basin rainfall (mm)
1. Upper Cagayan	Guinalvin	921	2,700
2. Magat	Dulao	573	3,000
3. Ilagan	Minanga	1,565	2,400
4. Lower Cagayan	Larion Alto	655	3,880
5. Upper Chico	Ampawilen	751	3,270
6. Lower Chico	Pinukpuk	856	3,090

Table 4.4.2 Mean Monthly Runoff

point	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Mean
1	35.5	25.8	17.2	20.5	37.2	61.2	61.4	77.9	79.0	114.4	127.0	95.6	62.7
2	16.2	11.8	7.8	9.4	17.0	27.9	28.0	35.5	36.0	52.2	57.9	43.6	28.6
3	23.3	16.9	11.3	13.5	24.4	40.2	40.3	51.1	51.9	75.1	83.4	62.8	41.2
4	8.1	5.9	3.9	4.7	8.5	13.9	14.0	17.7	18.0	26.0	28.9	21.8	14.3
5	9.2	6.7	4.4	5.3	9.6	15.9	15.9	20.2	20.5	29.6	32.9	24.8	16.2
6	3.1	2.2	1.5	1.8	3.2	5.3	5.3	6.7	6.8	9.8	10.9	8.2	5.4
7	12.3	8.9	5.9	7.1	12.9	21.2	21.2	26.9	27.3	39.5	43.9	33.0	21.7
8	9.6	7.0	4.6	5.6	10.1	16.5	16.6	21.0	21.3	30.9	34.3	25.8	17.0
9	4.5	3.3	2.2	2.6	4.7	7.8	7.8	9.9	10.0	14.5	16.1	12.2	8.0
10	5.3	3.9	2.6	3.1	5.6	9.2	9.2	11.6	11.8	17.1	19.0	14.3	9.4
11	21.5	15.6	10.4	12.5	22.6	37.1	37.2	47.2	47.9	69.3	77.0	57.9	38.0
12	20.3	14.7	9.8	11.7	21.2	34.9	35.0	44.4	45.1	65.3	72.4	54.5	35.8
13	14.7	9.2	8.5	10.3	22.9	30.5	38.0	45.4	48.2	55.4	44.9	29.2	29.8
14	8.6	5.4	5.0	6.0	13.4	17.8	22.2	26.5	28.1	32.3	26.2	17.1	17.4
15	18.3	11.5	10.6	12.8	28.5	37.9	47.1	56.4	59.8	68.8	55.7	36.3	37.0
16	29.1	18.3	16.9	20.5	45.4	60.5	75.2	89.9	95.4	109.7	88.9	57.9	59.0
17	23.8	15.0	13.8	16.8	37.2	49.5	61.5	73.6	78.1	89.8	72.7	47.4	48.3
18	15.9	10.0	9.2	11.2	24.8	33.0	41.1	49.1	52.1	59.9	48.5	31.6	32.2
19	5.2	3.3	3.0	3.7	8.1	10.9	13.5	16.1	17.1	19.7	15.9	10.4	10.6
20	17.6	11.0	10.2	12.4	27.4	36.5	45.4	54.3	57.6	66.2	53.6	35.0	35.6
21	5.4	4.2	2.9	2.8	4.2	7.0	7.1	9.1	9.4	13.3	15.5	12.1	7.8
22	22.9	17.7	12.1	11.9	17.7	29.6	29.9	38.5	39.5	56.2	65.4	51.2	32.7
23	11.4	8.8	6.0	5.9	8.8	14.7	14.9	19.1	19.7	28.0	32.6	25.5	16.3
24	5.4	4.2	2.9	2.8	4.2	7.0	7.0	9.1	9.3	13.2	15.4	12.1	7.7
25	25.9	20.0	13.7	13.5	20.0	33.5	33.8	43.5	44.7	63.6	74.0	58.0	37.0
26	37.3	28.9	19.8	19.4	28.8	48.2	48.7	62.7	64.4	91.6	106.6	83.5	53.3
27	6.0	3.7	2.4	2.8	6.4	10.2	15.1	20.4	20.2	26.0	25.5	14.7	12.8
28	17.7	11.1	10.3	12.5	27.7	36.8	45.8	54.8	58.1	66.8	54.1	35.3	35.9
29	7.0	4.4	4.1	5.0	11.0	14.6	18.2	21.8	23.1	26.5	21.5	14.0	14.3
30	8.6	5.4	5.0	6.0	13.4	17.8	22.2	26.5	28.1	32.3	26.2	17.1	17.4
31	10.2	6.4	5.9	7.2	15.9	21.1	26.3	31.4	33.3	38.3	31.0	20.2	20.6
32	7.7	4.7	3.1	3.5	8.2	13.1	19.4	26.1	26.0	33.4	32.7	18.9	16.4
33	15.5	9.6	6.3	7.2	16.6	26.6	39.3	53.0	52.6	67.8	66.4	38.3	33.3
34	11.6	7.2	4.8	5.4	12.4	19.9	29.5	39.7	39.4	50.8	49.8	28.7	24.9
35	2.0	1.2	0.8	0.9	2.1	3.4	5.1	6.8	6.8	8.7	8.5	4.9	4.3
36	24.6	15.2	10.0	11.3	26.3	42.1	62.2	83.9	83.3	107.3	105.1	60.7	52.7
37	16.1	11.9	7.8	13.3	29.6	45.5	51.1	65.5	61.7	68.4	67.6	40.8	40.0
38	28.9	17.9	11.8	13.4	30.9	49.6	73.3	98.8	98.2	126.4	123.9	71.5	62.1
39	1.2	0.9	0.6	1.0	2.2	3.3	3.8	4.8	4.5	5.0	5.0	3.0	2.9
40	7.9	5.5	4.1	7.7	20.8	28.2	40.5	42.4	43.9	43.9	31.3	18.0	24.5
41	7.8	5.4	4.0	7.5	20.4	27.5	39.6	41.4	42.9	42.9	30.5	17.5	23.9
42	3.1	2.1	1.6	3.0	8.1	10.9	15.7	16.4	17.0	17.0	12.1	7.0	9.5
43	10.4	7.2	5.3	10.1	27.4	37.0	53.2	55.7	57.7	57.7	41.1	23.6	32.2
44	8.2	5.7	4.2	8.0	21.6	29.3	42.1	44.0	45.6	45.6	32.5	18.6	25.5
45	8.9	6.2	4.6	8.7	23.5	31.7	45.6	47.7	49.4	49.4	35.2	20.2	27.6
46	20.5	15.1	9.9	16.9	37.6	57.8	64.9	83.2	78.3	86.8	85.8	51.8	50.7
47	5.4	4.0	2.6	4.4	9.9	15.2	17.1	21.9	20.6	22.8	22.6	13.6	13.3
48	17.4	12.8	8.4	14.3	31.9	49.1	55.2	70.7	66.5	73.8	72.9	44.1	43.1
49	2.4	1.7	1.1	1.9	4.3	6.6	7.5	9.6	9.0	10.0	9.9	6.0	5.8
50	2.7	2.0	1.3	2.2	5.0	7.7	8.6	11.1	10.4	11.5	11.4	6.9	6.7
51	8.0	5.0	3.3	3.7	8.6	13.8	20.4	27.4	27.3	35.1	34.4	19.8	17.2
52	7.6	5.6	3.7	6.3	14.0	21.5	24.1	30.9	29.1	32.2	31.9	19.3	18.8
53	4.9	3.6	2.4	4.1	9.1	14.0	15.7	20.1	18.9	21.0	20.7	12.5	12.3
101	51.7	37.5	25.0	29.9	54.2	89.2	89.5	113.4	115.0	166.6	184.9	139.2	91.3
102	75.1	54.5	36.3	43.4	78.7	129.4	129.8	164.5	166.9	241.7	268.3	201.9	132.5
103	92.4	67.0	44.6	53.4	96.8	159.1	159.7	202.4	205.4	297.4	330.0	248.5	163.1
104	21.9	15.9	10.6	12.7	22.9	37.7	37.8	48.0	48.7	70.5	78.2	58.9	38.6
105	26.4	19.2	12.8	15.3	27.7	45.5	45.6	57.9	58.7	85.0	94.3	71.0	46.6
106	121.8	88.4	58.9	70.4	127.6	209.9	210.6	267.0	270.9	392.2	435.3	327.7	215.1
107	148.7	107.9	71.9	86.0	155.8	256.2	257.0	325.9	330.6	478.7	531.2	399.9	262.5
108	23.3	14.6	13.5	16.4	36.3	48.4	60.1	71.9	76.3	87.7	71.1	46.3	47.2
109	41.6	26.1	24.1	29.2	64.8	86.3	107.3	128.3	136.1	156.5	126.8	82.6	84.2
110	94.6	59.3	54.8	66.5	147.4	196.3	244.0	291.9	309.6	356.0	288.4	187.9	191.4
111	110.5	69.3	64.1	77.7	172.2	229.4	285.1	341.0	361.8	415.9	336.9	219.6	223.6
112	115.7	72.6	67.1	81.3	180.4	240.2	298.5	357.1	378.9	435.6	352.8	230.0	234.2
113	133.3	83.6	77.3	93.7	207.8	276.7	343.9	414.1	436.5	501.8	406.5	264.9	269.8
114	302.3	206.2	159.0	191.4	384.8	567.8	636.0	781.7	812.1	1,045.7	1,010.1	719.4	568.0
115	34.3	26.5	18.2	17.9	26.5	44.3	44.7	57.6	59.2	84.2	98.0	76.7	49.0
116	65.6	50.8	34.8	34.2	50.7	84.7	85.6	110.2	113.2	161.0	187.4	146.8	93.7
117	103.0	79.6	54.6	53.6	79.5	132.9	134.3	172.9	177.7	252.6	294.0	230.3	147.1
118	410.6	290.0	216.4	247.9	468.5	707.8	777.3	963.7	999.1	1,311.6	1,319.7	961.8	722.9
119	24.8	15.6	14.4	17.4	38.7	51.5	64.0	76.5	81.2	93.3	75.6	49.3	50.2
120	18.8	11.8	10.9	13.2	29.3	39.0	48.4	57.9	61.4	70.6	57.2	37.3	38.0
121	43.6	27.3	25.3	30.6	67.9	90.4	112.4	134.4	142.6	164.0	132.8	86.6	88.2
122	460.2	321.0	244.1	281.2	542.8	808.4	904.8	1,118.5	1,162.0	1,501.6	1,478.0	1,063.1	823.8
123	467.8	325.8	247.2	284.8	551.0	821.5	924.2	1,144.6	1,187.9	1,535.0	1,510.8	1,082.0	840.2
124	495.0	342.6	258.3	297.3	580.0	868.0	993.0	1,237.3	1,280.0	1,653.6	1,627.0	1,149.0	898.4
125	521.5	359.0	269.2	309.6	608.4	913.5	1,060.3	1,328.0	1,370.1	1,769.6	1,740.6	1,214.6	955.4
126	566.6	388.8	288.8	336.2	668.9	1,008.6	1,184.8	1,492.4	1,529.9	1,964.4	1,932.1	1,327.0	1,057.4
127	15.7	10.8	8.0	15.2	41.2	55.7	80.1	83.8	86.8	86.8	61.8	35.5	48.5
128	18.8	13.0	9.6	18.2	49.3	66.6	95.8	100.2	103.8	103.8	73.9	42.5	58.0
129	29.2	20.2	14.9	28.3	76.7	103.7	149.0	156.0	161.5	161.5	115.0	66.1	90.2
130	37.5	25.9	19.1	36.3	98.3	133.0	191.1	200.0	207.0	207.1	147.5	84.7	115.6
131	66.9	47.1	33.6	61.9	159.3	222.4	301.6	330.9	334.7	343.3	268.5	156.8	193.9
132	89.6	63.9	44.6	80.6	201.1	286.7	373.8	423.4	421.8	439.9	364.0	214.4	250.3
133	92.0	65.7	45.7	82.6	205.4	293.3	381.3	433.0	430.8	449.8	373.8	220.4	256.1
134	659.8	455.4	335.1	419.7	876.5	1,305.3	1,569.8	1,930.2	1,96				

Table 5.1.1 Sub-basins for Water Balance Study and Streamflow Analysis

Serial No.	Subbasin	Drainage Area (km ²)	/1			/2			/2		
			Sub-basin	Area Ratio	Rainfall Ratio	Sub-basin	Area Ratio	Rainfall Ratio	Sub-basin	Area Ratio	Rainfall Ratio
1	UC-1	1,150									
2	UC-2	481	17								
3	UC-3	733	17								
4	UC-4	477	17								
5	UC-5	387	8								
6	UC-6A	141	4	141/298	3250/2900						
7	UC-6B	843	4	157/298	2585/2900	5			6		
8	UC-7	1,370	10								
9	UC-8A	122	17	122/1051	2170/2060						
10	UC-8B	929	17	929/1051	2045/2060						
11	UC-9	247	21								
12	M-1	1,143	13						16	231/1228	
13	M-2	550	15						19		
14	M-3	1,891	16	997/1228		17					
15	M-4	559	18								
16	M-5	970	20								
17	I-1	1,350	22			23					
18	I-2	215	24								
19	I-3	652	25								
20	I-4	915	26								
21	S-1	656	28								
22	S-2	7	29	7/408							
23	S-3	362	30								
24	S-4	100	31	100/589							
25	S-5	890	29	401/408		31	489/589				
26	C-1	720	40			41					
27	C-2	690	42			43					
28	C-3	541	44			45	169/612	2540/2200			
29	C-4	856	46			47	20/366	2100/1900	49		
30	C-5	463	45	443/612	2070/2200						
31	C-6	1,281	47	346/366	1890/1900	48					
32	LC-1	209	27								
33	LC-2	170	17	170/225	4025/3530						
34	LC-3	129	34	129/327	4290/3690						
35	LC-4A	445	36	445/657	4200/3880						
36	LC-4B	212	36	212/657	3210/3880						
37	LC-5	1,219	32	55/225	2000/3530	33	135/1042		34	198/327	3300/3690
38	LC-6	193	37	193/1042	2200/2000						
39	LC-7	567	37	567/1042	1930/2000						
40	LC-8	111	38	111/969	4030/3100						
41	LC-9A	64	38	64/969	3500/3100						
42	LC-9B	6	38	6/969	3500/3100						
43	LC-10	1,008	38	788/969	2935/3100	37	147/1042		39		
44	LC-11	161	32	161/393	2900/2500						
45	LC-12A	112	51	112/417	2100/2000						
46	LC-12B	88	51	88/417	2100/2000						
47	LC-13	618	50			51	217/417	1910/2000	52	232/393	2220/2500
48	LC-14	278	53								

Note: /1; Subbasin for water balance study (UC = Upper Cagayan, M = Magat, I = Ilagan, S = Siffu-Mallig, C = Chico, LC = Lower Cagayan)
/2; Subbasin for streamflow analysis

Table 5.2.1 Projected Source Water Requirement by Municipality (1/2)

Province	Municipality	2000		2005		2010		2015		2020	
		water req't (m ³ /day)	population (capita)								
Quirino	Aglipay	764	9,714	977	11,009	1,180	12,276	1,585	13,437	2,137	14,515
Quirino	Cabarrrogis	1,234	10,967	1,598	12,430	1,993	13,860	2,973	15,170	4,224	16,388
Quirino	Ditfun	1,986	17,330	2,691	19,642	3,545	21,901	5,750	23,973	8,852	25,897
Quirino	Maddela	1,298	13,771	1,716	15,608	2,182	17,404	3,290	19,050	4,844	20,579
Quirino	Saguday	1,848	5,240	2,741	5,939	4,035	6,622	7,702	7,249	11,589	7,831
Aurora	Casigran	174	2,644	211	2,958	235	3,246	257	3,530	281	3,785
Aurora	Dilasag	270	4,089	327	4,574	362	5,020	398	5,459	435	5,854
Aurora	Danalongan	76	1,148	93	1,285	103	1,410	113	1,533	122	1,644
Aurora	Dipaculao	144	2,185	175	2,445	194	2,683	213	2,918	232	3,128
Block 1	Total	7,794	67,087	10,528	75,890	13,828	84,422	22,283	92,319	32,715	99,621
N. Vizcaya	Ambagio	702	10,635	841	11,766	928	12,836	1,007	13,777	1,081	14,595
N. Vizcaya	Aritao	3,356	32,686	4,431	36,163	5,686	39,451	8,910	42,341	13,262	44,855
N. Vizcaya	Dupax del Norte	2,405	24,827	3,145	27,468	3,979	29,966	6,072	32,161	8,884	34,070
N. Vizcaya	Dupax del Sur	951	14,437	1,142	15,972	1,260	17,425	1,366	18,701	1,468	19,811
N. Vizcaya	Kayapa	598	9,067	717	10,031	791	10,944	857	11,745	922	12,443
N. Vizcaya	Santa Fe	918	6,934	1,236	7,671	1,626	8,369	2,680	8,982	4,025	9,515
N. Vizcaya	Alfonso Castañeda	115	1,745	138	1,931	151	2,106	165	2,261	177	2,395
Block 2	Total	9,043	100,332	11,649	111,002	14,423	121,097	21,056	129,969	29,820	137,684
N. Vizcaya	Bagabag	3,794	31,709	5,224	35,081	7,087	38,271	12,154	41,075	19,309	43,513
N. Vizcaya	Bambang	5,646	41,459	7,752	45,868	10,487	53,706	18,013	59,491	28,268	56,894
N. Vizcaya	Bayombong	8,916	51,932	12,509	57,455	17,382	67,272	31,191	74,518	49,113	71,265
N. Vizcaya	Diadi	1,301	13,981	1,626	15,468	1,939	18,111	2,660	20,062	3,516	19,186
N. Vizcaya	Lasib	1,940	29,436	2,327	32,566	2,569	35,528	2,784	38,131	2,994	40,394
N. Vizcaya	Quezon	1,031	15,635	1,236	17,298	1,365	18,871	1,478	20,253	1,591	21,456
N. Vizcaya	Solano	6,123	52,639	8,285	58,236	10,990	63,533	18,234	68,187	28,187	72,235
N. Vizcaya	Villaverde	993	15,060	1,191	16,661	1,314	18,177	1,423	19,508	1,532	20,666
Block 3	Total	29,745	251,851	40,151	278,634	53,131	313,468	87,938	341,225	134,511	345,610
Isabela	Echague	6,130	62,963	8,038	69,350	10,202	75,050	15,682	79,675	23,009	83,417
Isabela	Jones	3,664	38,897	4,817	42,843	6,135	46,364	9,466	49,221	14,023	51,533
Isabela	San Agustin	1,676	20,039	2,106	22,072	2,511	23,886	3,408	25,358	4,533	26,549
Isabela	San Isidro	1,187	17,999	1,416	19,825	1,551	21,455	1,664	22,777	1,768	23,847
Block 4	Total	12,657	139,898	16,378	154,090	20,400	166,755	30,220	177,031	43,332	185,346
Isabela	Cordon	2,517	34,176	3,069	37,643	3,490	40,737	4,210	43,247	5,046	45,278
Isabela	Ramon	3,875	40,261	4,910	44,345	1,883	47,990	8,497	50,948	11,554	53,341
Isabela	Santiago	13,154	110,559	17,415	121,775	22,447	131,784	35,847	139,905	33,014	146,476
Block 5	Total	19,546	184,996	25,393	203,763	27,820	220,510	48,554	234,099	69,615	245,095
Isabela	Alicia	6,670	59,088	8,547	65,083	10,578	70,432	15,843	74,772	22,168	78,284
Isabela	Angadan	3,559	37,187	4,586	40,959	5,687	44,326	8,403	47,057	11,882	49,268
Isabela	San Guillermo	1,936	14,031	2,598	15,454	3,413	16,725	5,653	17,755	8,519	18,589
Block 6	Total	12,164	110,307	15,731	121,497	19,678	131,483	29,899	139,585	42,568	146,142
Isabela	Benito Solive	2,593	23,207	3,400	25,562	4,323	27,663	6,734	29,367	9,801	30,747
Isabela	Dinapigui	116	1,764	137	1,943	148	2,102	167	2,232	177	2,337
Isabela	Divilican	135	2,036	161	2,243	175	2,427	188	2,577	201	2,698
Isabela	Ilagan	12,213	105,971	16,123	116,721	20,653	126,315	32,534	134,099	47,504	140,398
Isabela	Palanan	293	4,429	347	4,879	381	5,280	411	5,605	436	5,868
Isabela	San Mariano	4,738	39,095	6,208	43,061	7,892	46,601	12,355	49,472	17,846	51,796
Block 7	Total	20,088	176,504	26,375	194,409	33,572	210,388	52,389	223,353	75,965	233,844
Isabela	Cauayan	11,836	103,979	15,359	114,527	19,302	123,940	29,600	131,578	42,332	137,758
Isabela	Naguítian	3,750	27,227	5,189	29,989	7,066	32,454	12,257	34,454	19,279	36,073
Isabela	Reinal Mercedes	2,640	19,989	3,544	22,016	4,657	23,826	7,688	25,294	11,599	26,482
Block 8	Total	18,226	151,195	24,093	166,533	31,025	180,220	49,544	191,326	73,210	200,313
Isabela	Aurora	2,851	29,603	3,660	32,606	4,513	35,286	6,614	37,460	9,264	39,220
Isabela	Burgos	1,410	21,375	1,683	23,544	1,842	25,479	1,974	27,049	2,099	28,320
Isabela	Cabatuan	2,543	31,918	3,173	35,156	3,744	38,046	4,944	40,390	6,456	42,288
Isabela	Luna	1,644	14,871	2,143	16,380	2,717	17,726	4,210	18,819	6,110	19,703
Isabela	San manuel	3,943	28,640	5,198	31,545	6,687	34,138	10,761	36,242	15,791	37,944
Isabela	San mateo	5,743	54,819	7,464	60,381	9,374	65,343	14,258	69,370	20,453	72,629
Block 9	Total	18,133	181,227	23,321	199,612	28,877	216,018	42,760	229,330	60,173	240,102
Ifugao	Banaue	3,357	37,108	2,627	41,024	3,179	44,797	4,476	48,283	6,091	51,429
Ifugao	Hunguduan	1,420	21,516	1,701	23,788	1,877	25,976	2,044	27,997	2,210	29,822
Ifugao	Kiangan	1,222	15,133	1,521	16,730	1,795	18,269	2,370	19,691	3,082	20,974
Ifugao	Lagawe	1,884	16,682	2,463	18,444	3,136	20,140	4,905	21,707	7,176	23,122
Ifugao	Lamut	1,955	19,127	2,505	21,146	3,101	23,091	4,602	24,888	6,478	26,510
Ifugao	Mayoyao	2,027	27,655	2,495	30,575	2,886	33,387	3,596	35,985	4,484	38,330
Ifugao	Potia	1,998	30,296	2,393	33,495	2,645	36,576	2,879	39,422	3,111	41,991
Block 10	Total	13,863	167,515	15,705	185,203	18,618	202,236	24,872	217,973	32,632	232,179
Mt. Province	Barlig	540	8,194	635	8,897	691	9,571	743	10,190	795	10,732
Mt. Province	Bauko	1,067	16,182	1,257	17,571	1,366	18,902	1,469	20,123	1,571	21,195
Mt. Province	Bontoc	2,548	22,355	3,291	24,273	4,163	26,111	6,531	27,799	9,593	29,279
Mt. Province	Natonin	650	9,860	765	10,706	833	11,517	896	12,261	957	12,914
Mt. Province	Paraceles	1,149	17,405	1,350	18,899	1,469	20,330	1,580	21,644	1,690	22,797
Mt. Province	Sabangan	622	9,435	732	10,244	797	11,020	857	11,732	916	12,357
Mt. Province	Sadanga	381	5,781	448	6,277	488	6,752	525	7,189	561	7,572
Mt. Province	Sagada	522	7,931	616	8,611	669	9,263	720	9,862	770	10,387
Block 11	Total	7,478	97,143	9,094	105,478	10,476	113,466	13,323	120,801	16,853	127,233
Isabela	Gamu	3,070	25,541	4,023	28,132	5,126	30,444	8,052	32,320	11,712	33,839
Isabela	Mallig	3,430	26,191	4,575	28,848	5,964	31,219	9,736	33,143	14,550	34,699
Isabela	Quizon	2,850	19,765	3,840	21,770	5,072	23,560	8,477	25,012	12,827	26,186
Isabela	Roxas	1,355	20,554	1,619	22,639	1,771	24,500	1,898	26,010	2,019	27,231
Block 12	Total	17,647	142,749	23,370	157,230	30,162	170,153	48,381	180,638	71,545	189,123

Table 5.2.1 Projected Source Water Requirement by Municipality (2/2)

Province	Municipality	2000		2005		2010		2015		2020	
		water req't (m ³ /day)	population (capita)								
Isabela	Magsaysay	1,935	24,471	2,405	26,953	2,817	29,169	3,666	30,966	4,712	32,421
Isabela	Santo Tomas	2,020	22,539	2,611	24,825	3,246	26,866	4,783	28,521	6,837	29,861
Isabela	Tumauini	4,180	51,106	5,220	56,290	6,170	60,917	8,214	64,671	10,744	67,709
Block 13	Total	8,135	98,115	10,236	108,069	12,233	116,951	16,663	124,158	22,292	129,990
Isabela	Cabagan	3,058	39,329	3,801	43,318	4,455	46,879	5,790	49,768	7,468	52,105
Isabela	Maconacon	202	3,057	241	3,367	263	3,644	282	3,868	300	4,050
Isabela	San Pablo	857	12,984	1,022	14,301	1,119	15,476	1,200	16,430	1,275	17,202
Isabela	Santa Maria	1,439	21,835	1,720	24,050	1,881	26,027	2,017	27,631	2,144	28,929
Block 14	Total	5,557	77,205	6,783	85,037	7,719	92,026	9,290	97,697	11,187	102,286
K. Apayao	Lubuagan	1,567	10,994	2,210	12,022	3,087	12,929	5,570	13,654	9,070	14,238
K. Apayao	Pasil	654	9,925	776	10,853	843	11,672	900	12,327	953	12,854
K. Apayao	Rizal	892	13,522	1,057	14,787	1,150	15,902	1,226	16,794	1,298	17,513
K. Apayao	Tabuk	9,927	70,546	13,653	77,143	18,531	82,960	32,195	87,614	50,716	91,364
K. Apayao	Tanudan	822	12,489	975	13,657	1,063	14,687	1,133	15,511	1,199	16,175
K. Apayao	Tinglayan	996	15,097	1,180	16,509	1,283	17,754	1,369	18,750	1,450	19,553
Block 15	Total	14,859	132,574	19,850	144,971	25,957	155,903	42,392	164,650	64,686	171,696
K. Apayao	Balbaran	860	13,043	1,019	14,263	1,109	15,339	1,182	16,199	1,253	16,893
K. Apayao	Conner	1,086	15,011	1,265	16,453	1,349	17,696	1,418	18,660	1,478	19,414
K. Apayao	Flora	41	632	50	693	54	745	57	786	61	818
K. Apayao	Kabugao	39	601	48	659	52	708	54	747	58	777
K. Apayao	Pinukpuk	1,688	25,613	2,002	28,008	2,177	30,120	2,323	31,809	2,459	33,171
Block 16	Total	3,714	54,900	4,383	60,075	4,741	64,609	5,034	68,202	5,308	71,072
Cagayan	Tuguegarao	17,569	117,656	22,749	127,378	28,971	136,414	46,632	144,284	67,915	150,773
Block 17	Total	17,569	117,656	22,749	127,378	28,971	136,414	46,632	144,284	67,915	150,773
Cagayan	Amulung	3,135	41,396	3,769	44,817	4,262	47,996	5,202	50,765	6,285	53,049
Cagayan	Enrile	4,202	31,517	5,380	34,121	6,743	36,542	10,538	38,650	15,078	40,388
Cagayan	Iguig	1,971	20,948	2,442	22,679	2,905	24,288	4,050	25,689	5,410	26,845
Cagayan	Penablanche	1,558	23,621	1,828	25,573	1,979	27,387	2,114	28,967	2,243	30,270
Cagayan	Solana	5,326	66,186	6,428	71,654	7,335	76,738	9,236	81,165	11,392	84,815
Block 18	Total	16,193	183,668	19,847	198,845	23,225	212,951	31,140	225,237	40,408	235,367
Cagayan	Piat	1,892	19,163	2,333	20,746	2,767	22,218	3,859	23,500	5,121	24,557
Cagayan	Rizal	1,005	15,246	1,179	16,506	1,278	17,677	1,365	18,697	1,449	19,538
Cagayan	Santo Niño	1,967	18,697	2,470	20,241	3,002	21,677	4,385	22,928	6,036	23,959
Cagayan	Tuao	4,124	54,054	4,949	58,521	5,586	62,672	6,807	66,288	8,189	69,269
Block 19	Total	8,989	107,160	10,931	116,014	12,633	124,244	16,416	131,412	20,795	137,323
Cagayan	Alcala	3,416	35,135	4,273	38,038	5,152	40,737	7,370	43,087	10,053	45,025
Cagayan	Alicapan	1,275	12,927	1,542	13,995	1,786	14,988	2,395	15,853	3,052	16,566
Cagayan	Aparri	3,439	31,695	4,364	34,313	5,370	36,748	8,009	38,868	11,181	40,616
Cagayan	Baggao	4,156	41,177	5,198	44,579	6,276	47,742	9,027	50,496	12,298	52,767
Cagayan	Camalaniugan	2,258	18,241	2,891	19,748	3,616	21,149	5,592	22,369	7,969	23,375
Cagayan	Gattaran	2,883	32,793	3,570	35,502	4,230	38,021	5,795	40,215	7,692	42,023
Cagayan	Lal-lo	1,033	9,539	1,292	10,327	1,562	11,060	2,266	11,698	3,085	12,224
Cagayan	Lasam	2,680	26,613	3,343	28,812	4,019	30,856	5,746	32,636	7,789	34,104
Block 20	Total	21,140	208,119	26,473	225,315	32,011	241,300	46,200	255,220	63,120	266,700
GRAND TOTAL (m ³ /day)		282,540	2,844,176	363,039	3,125,557	449,500	3,383,886	684,985	3,603,526	978,651	3,787,934

Table 5.2.2 Future Irrigation Water Demand (1/5, Year 2000)

Name of System	Area Code/ Base Point N	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	(unit: m ³ /s)
I. Upper Cagayan Basin														
CISs	UC-3	0.52	0.64	0.70	0.40	0.37	1.28	1.38	0.73	0.85	0.25	0.00	0.24	
CIPs	UC-3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
CISs	UC-4	0.40	0.49	0.53	0.30	0.14	0.44	0.48	0.25	0.29	0.09	0.00	0.18	
CISs	UC-5	0.15	0.19	0.20	0.12	0.11	0.37	0.40	0.21	0.25	0.07	0.00	0.07	
Addalam RIP	outlet-5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
CISs	UC-6B	0.47	0.54	0.72	0.38	0.38	1.27	1.90	1.36	1.12	0.26	0.00	0.19	
Dabubu IP	6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
CIPs	UC-6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
CISs	UC-7	0.85	0.99	1.31	0.70	0.70	2.30	3.44	2.47	2.04	0.48	0.00	0.35	
CIPs	UC-7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Gappal IS/IP	8	0.33	0.41	0.48	0.05	0.40	0.29	0.36	0.23	0.09	0.06	0.02	0.28	
CIPs	UC-8B	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
CIPs	UC-9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Lulutan IP	15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Sub total		2.72	3.26	3.94	1.95	2.10	5.95	7.96	5.25	4.64	1.21	0.02	1.31	
II. Magat Basin														
CISs	M-1	8.52	10.50	11.80	6.87	2.96	9.47	10.52	8.03	7.63	2.61	0.00	3.91	
CIPs	M-1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Matuno (Manam.)	10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Matuno (Bayom.)	11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
CISs	M-2	0.12	0.15	0.17	0.10	0.05	0.19	0.25	0.19	0.19	0.05	0.00	0.06	
CISs	M-3	11.54	20.21	16.66	9.19	4.86	16.73	22.00	20.17	14.59	4.94	0.00	5.47	
CIPs	M-3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Magat RIIS	13	64.03	72.07	14.56	31.68	100.36	70.42	86.44	37.03	0.00	0.00	45.28	36.50	
CISs	M-4	1.12	1.36	1.66	1.03	0.55	1.83	2.42	2.08	1.70	0.56	0.00	0.51	
CISs	M-5	0.06	0.08	0.10	0.06	0.03	0.10	0.13	0.11	0.09	0.03	0.00	0.03	
Sub total		85.39	104.37	44.95	48.93	108.81	98.74	121.76	67.61	24.20	8.19	45.28	46.48	
III. Ilagan Basin														
Ilagan IP	18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Tumauini (Ila.)	18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
CISs	I-3	0.06	0.07	0.09	0.05	0.05	0.17	0.25	0.18	0.15	0.03	0.00	0.03	
CISs	I-4	0.18	0.21	0.28	0.15	0.15	0.49	0.73	0.52	0.43	0.10	0.00	0.07	
CIPs	I-4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Sub total		0.24	0.28	0.37	0.20	0.20	0.66	0.98	0.70	0.58	0.13	0.00	0.10	
IV. Siffu, Malling Basin														
CISs	S-1	0.91	1.10	1.34	0.83	0.30	0.89	1.17	1.01	0.83	0.27	0.00	0.41	
Siffu RIS	29	13.68	15.97	16.70	5.50	5.22	14.90	16.90	8.22	7.42	4.79	3.43	11.79	
CISs	S-3	0.12	0.15	0.18	0.11	0.07	0.22	0.28	0.25	0.21	0.07	0.00	0.05	
Malling RIS	31	1.36	1.78	0.84	0.00	1.11	3.25	3.10	2.66	0.92	0.00	0.35	1.03	
CISs	S-5	0.27	0.34	0.42	0.24	0.21	0.73	1.13	0.87	0.64	0.19	0.00	0.11	
CIPs	S-5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Sub total		16.34	19.34	19.48	6.68	6.91	19.99	22.58	13.01	10.02	5.32	3.78	13.39	
V. Chico Basin														
CISs	C-1	2.30	2.55	2.32	1.01	0.42	1.23	0.76	0.68	0.76	0.35	0.00	0.99	
CISs	C-2	1.00	1.17	1.10	0.56	0.44	1.24	0.87	0.74	0.86	0.25	0.00	0.42	
CISs	C-3	0.50	0.58	0.54	0.28	0.21	0.58	0.41	0.35	0.40	0.12	0.00	0.21	
Chico RIS	23	8.67	9.81	11.06	1.76	0.00	0.00	4.36	7.19	10.80	8.25	6.55	7.35	
Chico Malig IP	30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
CISs	C-4	0.44	0.52	0.63	0.37	0.25	0.87	1.17	0.88	0.72	0.21	0.00	0.18	
CISs	C-5	0.50	0.59	0.71	0.42	0.28	0.99	1.34	1.01	0.83	0.24	0.00	0.20	
Chico RIS(West)	25	1.66	1.93	2.18	0.33	0.00	0.00	0.59	0.99	1.54	1.21	0.98	0.98	
CISs	C-6	1.56	1.89	2.29	1.29	0.62	1.98	2.67	2.07	1.77	0.52	0.00	0.64	
CIPs	C-6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Sub total		16.63	19.04	20.83	6.02	2.22	6.89	12.17	13.91	17.68	11.15	7.53	10.97	
VI. Lower Cagayan Basin														
CISs	LC-1	0.13	0.16	0.20	0.12	0.10	0.35	0.54	0.42	0.31	0.09	0.00	0.05	
CIPs	LC-1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Tumauini IS	33	1.32	1.72	1.99	0.30	1.70	1.51	1.73	1.46	1.24	0.15	0.85	0.72	
S/Pab.Caba. IS	34	0.03	0.04	0.04	0.00	0.04	0.04	0.03	0.03	0.03	0.00	0.02	0.02	
Pinacanauan RIS	35	0.28	0.33	0.37	0.06	0.29	0.28	0.26	0.22	0.21	0.02	0.16	0.19	
CISs	LC-5	1.12	1.33	1.60	0.94	0.81	2.99	4.03	3.03	2.49	0.72	0.00	0.46	
CIPs	LC-5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Tuguegarao PIS	36	0.13	0.19	0.21	0.05	0.10	0.08	0.10	0.06	0.04	0.03	0.02	0.09	
Solana PIS	37	1.10	1.33	1.49	0.23	0.00	0.00	0.00	0.00	0.00	0.00	0.65	0.75	
A/Amul. West PIP	37	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
CISs	LC-6	0.30	0.36	0.44	0.26	0.13	0.42	0.57	0.43	0.35	0.10	0.00	0.13	
CIPs	LC-6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
IAAPIS(Iguig)	38	0.40	0.48	0.54	0.09	0.43	0.41	0.39	0.33	0.31	0.04	0.24	0.27	
CISs	LC-7	0.34	0.40	0.49	0.29	0.14	0.47	0.64	0.48	0.39	0.11	0.00	0.14	
IAAPIS(A/Amulu)	39	1.15	1.38	1.55	0.24	1.16	1.13	1.09	0.90	0.85	0.10	0.68	0.78	
Baggao IS(Pared)	40	0.58	0.70	0.79	0.12	0.61	0.60	0.57	0.48	0.45	0.05	0.35	0.40	
Baggao IS(Paranan)	42	0.79	0.95	1.07	0.17	1.13	1.10	1.06	0.88	0.83	0.10	0.47	0.54	
CISs	LC-10	1.38	1.63	1.97	1.16	0.58	1.93	2.61	1.96	1.61	0.47	0.00	0.56	
CIPs	LC-10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
CISs	LC-11	0.05	0.06	0.07	0.04	0.02	0.07	0.09	0.07	0.06	0.02	0.00	0.02	
Zinundungan RIS	44	2.46	3.07	3.47	0.51	2.51	2.34	2.32	2.00	1.96	0.24	1.57	1.64	
Zinun. Exten.	44	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Dumuman RIS	46	1.04	1.64	2.01	0.33	1.75	1.65	1.71	1.41	1.04	0.12	0.82	0.64	
CIPs	LC-12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
CISs	LC-13	0.70	0.97	1.29	0.81	0.41	1.32	1.91	1.45	0.93	0.26	0.00	0.31	
CIPs	LC-13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Magapit PIS(L/Caga.)	47	0.05	0.08	0.10	0.02	0.38	0.36	0.37	0.30	0.23	0.03	0.04	0.03	
CISs	LC-14	0.41	0.57	0.75	0.47	0.24	0.77	1.11	0.85	0.54	0.15	0.00	0.18	
CIPs	LC-14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Sub total		13.76	17.39	20.44	6.21	12.53	17.82	21.13	16.76	13.87	2.80	5.87	7.92	
TOTAL		135.08	163.68	110.01	69.99	132.77	150.05	186.58	117.24	70.99	28.80	62.48	80.17	

Table 5.2.2 Future Irrigation Water Demand (2/5, Year 2005)

Name of System	Area Code/ Base Point N	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
I. Upper Cagayan Basin													
CISs	UC-3	0.52	0.64	0.70	0.40	0.37	1.28	1.38	0.73	0.85	0.25	0.00	0.24
CIPs	UC-3	0.22	0.26	0.29	0.16	0.15	0.53	0.56	0.30	0.35	0.10	0.00	0.10
CISs	UC-4	0.40	0.49	0.53	0.30	0.14	0.44	0.48	0.25	0.29	0.09	0.00	0.18
CISs	UC-5	0.15	0.19	0.20	0.12	0.11	0.37	0.40	0.21	0.25	0.07	0.00	0.07
Addalam RIP	outlet-5	3.85	5.31	6.35	0.82	4.72	3.26	4.26	2.68	1.22	0.76	0.35	3.44
CISs	UC-6B	0.47	0.54	0.72	0.38	0.38	1.27	1.90	1.36	1.12	0.26	0.00	0.19
Dabubu IP	6	-	-	-	-	-	-	-	-	-	-	-	-
CIPs	UC-6	-	-	-	-	-	-	-	-	-	-	-	-
CISs	UC-7	0.85	0.99	1.31	0.70	0.70	2.30	3.44	2.47	2.04	0.48	0.00	0.35
CIPs	UC-7	-	-	-	-	-	-	-	-	-	-	-	-
Gappal IS/IP	8	0.65	0.83	0.96	0.10	0.79	0.57	0.72	0.46	0.18	0.12	0.04	0.56
CIPs	UC-8B	-	-	-	-	-	-	-	-	-	-	-	-
CIPs	UC-9	-	-	-	-	-	-	-	-	-	-	-	-
Lulutan IP	15	-	-	-	-	-	-	-	-	-	-	-	-
Sub total		7.11	9.25	11.06	2.98	7.36	10.02	13.14	8.46	6.30	2.13	0.39	5.13
II. Magat Basin													
CISs	M-1	8.52	10.50	11.80	6.87	2.96	9.47	10.52	8.03	7.63	2.61	0.00	3.91
CIPs	M-1	0.13	0.16	0.18	0.11	0.09	0.32	0.36	0.27	0.26	0.09	0.00	0.06
Matuno (Manam.)	10	-	-	-	-	-	-	-	-	-	-	-	-
Matuno (Bayom.)	11	-	-	-	-	-	-	-	-	-	-	-	-
CISs	M-2	0.12	0.15	0.17	0.10	0.05	0.19	0.25	0.19	0.19	0.05	0.00	0.06
CISs	M-3	11.54	20.21	16.66	9.19	4.86	16.73	22.00	20.17	14.59	4.94	0.00	5.47
CIPs	M-3	0.06	0.11	0.09	0.05	0.05	0.19	0.24	0.22	0.16	0.05	0.00	0.03
Magat RIIS	13	115.96	116.85	82.95	54.86	109.23	96.74	140.02	72.93	40.51	29.47	48.09	89.46
CISs	M-4	1.12	1.36	1.66	1.03	0.55	1.83	2.42	2.08	1.70	0.56	0.00	0.51
CISs	M-5	0.06	0.08	0.10	0.06	0.03	0.10	0.13	0.11	0.09	0.03	0.00	0.03
Sub total		137.51	149.42	113.61	72.27	117.82	125.57	175.94	104.00	65.13	37.80	48.09	99.53
III. Ilagan Basin													
Ilagan IP	18	-	-	-	-	-	-	-	-	-	-	-	-
Tumauini (Ila.)	18	-	-	-	-	-	-	-	-	-	-	-	-
CISs	I-3	0.06	0.07	0.09	0.05	0.05	0.17	0.25	0.18	0.15	0.03	0.00	0.03
CISs	I-4	0.18	0.21	0.28	0.15	0.15	0.49	0.73	0.52	0.43	0.10	0.00	0.07
CIPs	I-4	0.17	0.20	0.27	0.14	0.14	0.47	0.70	0.50	0.42	0.10	0.00	0.07
Sub total		0.41	0.48	0.64	0.34	0.34	1.13	1.68	1.20	1.00	0.23	0.00	0.17
IV. Siffu, Mallig Basin													
CISs	S-1	0.91	1.10	1.34	0.83	0.30	0.89	1.17	1.01	0.83	0.27	0.00	0.41
Siffu RIS	29	13.68	15.97	16.70	5.50	5.22	14.90	16.90	8.22	7.42	4.79	3.43	11.79
CISs	S-3	0.12	0.15	0.18	0.11	0.07	0.22	0.28	0.25	0.21	0.07	0.00	0.05
Mallig RIS	31	1.36	1.78	0.84	0.00	1.11	3.25	3.10	2.66	0.92	0.00	0.35	1.03
CISs	S-5	0.27	0.34	0.42	0.24	0.21	0.73	1.13	0.87	0.64	0.19	0.00	0.11
CIPs	S-5	0.19	0.23	0.29	0.17	0.15	0.51	0.79	0.61	0.45	0.13	0.00	0.07
Sub total		16.53	19.57	19.77	6.85	7.06	20.50	23.37	13.62	10.47	5.45	3.78	13.46
V. Chico Basin													
CISs	C-1	2.30	2.55	2.32	1.01	0.42	1.23	0.76	0.68	0.76	0.35	0.00	0.99
CISs	C-2	1.00	1.17	1.10	0.56	0.44	1.24	0.87	0.74	0.86	0.25	0.00	0.42
CISs	C-3	0.50	0.58	0.54	0.28	0.21	0.58	0.41	0.35	0.40	0.12	0.00	0.21
Chico RIS	23	22.41	26.99	12.33	0.00	8.22	25.71	21.13	17.93	6.83	0.00	5.24	19.06
Chico Malig IP	30	-	-	-	-	-	-	-	-	-	-	-	-
CISs	C-4	0.44	0.52	0.63	0.37	0.25	0.87	1.17	0.88	0.72	0.21	0.00	0.18
CISs	C-5	0.50	0.59	0.71	0.42	0.28	0.99	1.34	1.01	0.83	0.24	0.00	0.20
Chico RIS(West)	25	2.27	2.82	1.30	0.00	0.83	2.50	2.07	1.82	0.72	0.00	0.56	1.93
CISs	C-6	1.56	1.89	2.29	1.29	0.62	1.98	2.67	2.07	1.77	0.52	0.00	0.64
CIPs	C-6	0.20	0.25	0.30	0.17	0.15	0.52	0.70	0.54	0.46	0.14	0.00	0.08
Sub total		31.18	37.36	21.52	4.10	11.42	35.62	31.12	26.02	13.35	1.83	5.80	23.71
VI. Lower Cagayan Basin													
CISs	LC-1	0.13	0.16	0.20	0.12	0.10	0.35	0.54	0.42	0.31	0.09	0.00	0.05
CIPs	LC-1	0.07	0.08	0.10	0.06	0.05	0.18	0.28	0.21	0.16	0.05	0.00	0.03
Tumauini IS	33	1.32	1.72	1.99	0.30	1.70	1.51	1.73	1.46	1.24	0.15	0.85	0.72
S/Pab.Caba. IS	34	0.81	0.98	0.45	0.00	0.59	1.86	1.53	1.30	0.49	0.00	0.19	0.69
Pinacanauan RIS	35	1.15	1.31	1.31	0.11	1.17	1.14	1.10	0.71	0.23	0.19	0.08	0.89
CISs	LC-5	1.12	1.33	1.60	0.94	0.81	2.99	4.03	3.03	2.49	0.72	0.00	0.46
CIPs	LC-5	0.11	0.13	0.15	0.09	0.08	0.28	0.38	0.29	0.24	0.07	0.00	0.04
Tuguegarao PIS	36	0.13	0.19	0.21	0.05	0.10	0.08	0.10	0.06	0.04	0.03	0.02	0.09
Solana PIS	37	1.10	1.33	1.49	0.23	0.00	0.00	0.00	0.00	0.00	0.00	0.65	0.75
A/Amul. West PIP	37	6.44	8.13	8.47	1.22	6.05	5.49	5.71	3.65	1.48	1.16	0.68	4.89
CISs	LC-6	0.30	0.36	0.44	0.26	0.13	0.42	0.57	0.43	0.35	0.10	0.00	0.13
CIPs	LC-6	-	-	-	-	-	-	-	-	-	-	-	-
IAAPIS(Iguig)	38	0.78	0.89	0.89	0.08	0.80	0.78	0.75	0.49	0.04	0.00	0.00	0.57
CISs	LC-7	0.34	0.40	0.49	0.29	0.14	0.47	0.64	0.48	0.39	0.11	0.00	0.14
CIPs	LC-7	-	-	-	-	-	-	-	-	-	-	-	-
IAAPIS(A/Amulu)	39	2.31	2.61	2.62	0.22	2.35	2.28	2.19	1.42	0.12	0.00	0.00	1.68
Baggao IS(Pared)	40	0.58	0.70	0.79	0.12	0.61	0.60	0.57	0.48	0.45	0.05	0.35	0.40
Baggao IS(Paranan)	42	0.79	0.95	1.07	0.17	1.13	1.10	1.06	0.88	0.83	0.10	0.47	0.54
CISs	LC-10	1.38	1.63	1.97	1.16	0.58	1.93	2.61	1.96	1.61	0.47	0.00	0.56
CIPs	LC-10	-	-	-	-	-	-	-	-	-	-	-	-
CISs	LC-11	0.05	0.06	0.07	0.04	0.02	0.07	0.09	0.07	0.06	0.02	0.00	0.02
Zinundungan RIS	44	2.57	3.00	3.03	0.24	2.56	2.38	2.36	1.58	0.14	0.00	0.00	1.89
Zinun. Exten.	44	-	-	-	-	-	-	-	-	-	-	-	-
Dumuman RIS	46	1.04	1.64	2.01	0.33	1.75	1.65	1.71	1.41	1.04	0.12	0.82	0.64
CIPs	LC-12	-	-	-	-	-	-	-	-	-	-	-	-
CISs	LC-13	0.70	0.97	1.29	0.81	0.41	1.32	1.91	1.45	0.93	0.26	0.00	0.31
CIPs	LC-13	-	-	-	-	-	-	-	-	-	-	-	-
Magapit PIS(L/Caga.)	47	9.66	14.13	15.58	1.42	15.25	14.36	14.84	9.60	0.62	0.00	0.00	8.55
CISs	LC-14	0.41	0.57	0.75	0.47	0.24	0.77	1.11	0.85	0.54	0.15	0.00	0.18
CIPs	LC-14	-	-	-	-	-	-	-	-	-	-	-	-
Sub total		33.29	43.27	46.97	8.73	36.62	42.01	45.81	32.23	13.80	3.84	4.11	24.22
TOTAL		226.03	259.35	213.57	95.27	180.62	234.85	291.06	185.53	110.05	51.28	62.17	166.22

Note: Updated based on the same titled table in the 1987 Master Plan

Table 5.2.2 Future Irrigation Water Demand (3/5, Year 2010)

Name of System	Area Code/ Base Point N	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
I. Upper Cagayan Basin													
CISs	UC-3	0.52	0.64	0.70	0.40	0.37	1.28	1.38	0.73	0.85	0.25	0.00	0.24
CIPs	UC-3	0.22	0.26	0.29	0.16	0.15	0.53	0.56	0.30	0.35	0.10	0.00	0.10
CISs	UC-4	0.40	0.49	0.53	0.30	0.14	0.44	0.48	0.25	0.29	0.09	0.00	0.18
CISs	UC-5	0.15	0.19	0.20	0.12	0.11	0.37	0.40	0.21	0.25	0.07	0.00	0.07
Addalam RIP	outlet-5	3.85	5.31	6.35	0.82	4.72	3.26	4.26	2.68	1.22	0.76	0.35	3.44
CISs	UC-6B	0.47	0.54	0.72	0.38	0.38	1.27	1.90	1.36	1.12	0.26	0.00	0.19
Dabubu IP	6	0.66	0.91	1.09	0.14	0.81	0.56	0.73	0.46	0.21	0.13	0.06	0.59
CIPs	UC-6	0.43	0.51	0.67	0.35	0.36	1.17	1.75	1.26	1.04	0.24	0.00	0.18
CISs	UC-7	0.85	0.99	1.31	0.70	0.70	2.30	3.44	2.47	2.04	0.48	0.00	0.35
CIPs	UC-7	0.19	0.22	0.29	0.15	0.15	0.51	0.76	0.54	0.45	0.10	0.00	0.08
Gappal IS/IP	8	0.65	0.83	0.96	0.10	0.79	0.57	0.72	0.46	0.18	0.12	0.04	0.56
CIPs	UC-8B	-	-	-	-	-	-	-	-	-	-	-	-
CIPs	UC-9	-	-	-	-	-	-	-	-	-	-	-	-
Lulutan IP	15	-	-	-	-	-	-	-	-	-	-	-	-
Sub total		8.39	10.89	13.11	3.62	8.68	12.26	16.38	10.72	8.00	2.60	0.45	5.98
II. Magat Basin													
CISs	M-1	8.52	10.50	11.80	6.87	2.96	9.47	10.52	8.03	7.63	2.61	0.00	3.91
CIPs	M-1	0.13	0.16	0.18	0.11	0.09	0.32	0.36	0.27	0.26	0.09	0.00	0.06
Matuno (Manam.)	10	-	-	-	-	-	-	-	-	-	-	-	-
Matuno (Bayom.)	11	-	-	-	-	-	-	-	-	-	-	-	-
CISs	M-2	0.12	0.15	0.17	0.10	0.05	0.19	0.25	0.19	0.19	0.05	0.00	0.06
CISs	M-3	11.54	20.21	16.66	9.19	4.86	16.73	22.00	20.17	14.59	4.94	0.00	5.47
CIPs	M-3	0.30	0.53	0.44	0.24	0.24	0.93	1.22	1.12	0.81	0.27	0.00	0.15
Magat RIIS	13	115.96	116.85	82.95	54.86	109.23	96.74	140.02	72.93	40.51	29.47	48.09	89.46
CISs	M-4	1.12	1.36	1.66	1.03	0.55	1.83	2.42	2.08	1.70	0.56	0.00	0.51
CISs	M-5	0.06	0.08	0.10	0.06	0.03	0.10	0.13	0.11	0.09	0.03	0.00	0.03
Sub total		137.75	149.84	113.96	72.46	118.01	126.31	176.92	104.90	65.78	38.02	48.09	99.65
III. Ilagan Basin													
Ilagan IP	18	-	-	-	-	-	-	-	-	-	-	-	-
Tumauini (Ila.)	18	-	-	-	-	-	-	-	-	-	-	-	-
CISs	I-3	0.06	0.07	0.09	0.05	0.05	0.17	0.25	0.18	0.15	0.03	0.00	0.03
CISs	I-4	0.16	0.19	0.25	0.13	0.13	0.44	0.65	0.47	0.39	0.09	0.00	0.07
CIPs	I-4	0.24	0.28	0.38	0.20	0.20	0.66	0.98	0.71	0.58	0.14	0.00	0.10
Sub total		0.46	0.54	0.72	0.38	0.38	1.27	1.88	1.36	1.12	0.26	0.00	0.20
IV. Siffu, Malling Basin													
CISs	S-1	0.91	1.10	1.34	0.83	0.30	0.89	1.17	1.01	0.83	0.27	0.00	0.41
Siffu RIS	29	13.68	15.97	16.70	5.50	5.22	14.90	16.90	8.22	7.42	4.79	3.43	11.79
CISs	S-3	0.12	0.15	0.18	0.11	0.07	0.22	0.28	0.25	0.21	0.07	0.00	0.05
Malling RIS	31	1.36	1.78	0.84	0.00	1.11	3.25	3.10	2.66	0.92	0.00	0.35	1.03
CISs	S-5	0.27	0.34	0.42	0.24	0.21	0.73	1.13	0.87	0.64	0.19	0.00	0.11
CIPs	S-5	0.53	0.66	0.82	0.47	0.42	1.44	2.22	1.71	1.26	0.37	0.00	0.21
Sub total		16.87	20.00	20.30	7.15	7.33	21.43	24.80	14.72	11.28	5.69	3.78	13.60
V. Chico Basin													
CISs	C-1	2.30	2.55	2.32	1.01	0.42	1.23	0.76	0.68	0.76	0.35	0.00	0.99
CISs	C-2	1.00	1.17	1.10	0.56	0.44	1.24	0.87	0.74	0.86	0.25	0.00	0.42
CISs	C-3	0.50	0.58	0.54	0.28	0.21	0.58	0.41	0.35	0.40	0.12	0.00	0.21
Chico RIS	23	22.41	26.99	12.33	0.00	8.22	25.71	21.13	17.93	6.83	0.00	5.24	19.06
Chico Malig IP	30	19.62	22.66	22.95	2.24	19.70	18.94	18.44	11.92	4.04	3.28	1.50	15.10
CISs	C-4	0.44	0.52	0.63	0.37	0.25	0.87	1.17	0.88	0.72	0.21	0.00	0.18
CISs	C-5	0.50	0.59	0.71	0.42	0.28	0.99	1.34	1.01	0.83	0.24	0.00	0.20
Chico RIS(West)	25	2.27	2.82	1.30	0.00	0.83	2.50	2.07	1.82	0.72	0.00	0.56	1.93
CISs	C-6	1.56	1.89	2.29	1.29	0.62	1.98	2.67	2.07	1.77	0.52	0.00	0.64
CIPs	C-6	0.71	0.86	1.04	0.58	0.51	1.81	2.45	1.89	1.63	0.48	0.00	0.29
Sub total		51.31	60.63	45.21	6.75	31.48	55.85	51.31	39.29	18.56	5.45	7.30	39.02
VI. Lower Cagayan Basin													
CISs	LC-1	0.13	0.16	0.20	0.12	0.10	0.35	0.54	0.42	0.31	0.09	0.00	0.05
CIPs	LC-1	0.07	0.08	0.10	0.06	0.05	0.18	0.28	0.21	0.16	0.05	0.00	0.03
Tumauini IS	33	1.32	1.72	1.99	0.30	1.70	1.51	1.73	1.46	1.24	0.15	0.85	0.72
S/Pab.Caba. IS	34	0.81	0.98	0.45	0.00	0.59	1.86	1.53	1.30	0.49	0.00	0.19	0.69
Pinacanauan RIS	35	1.15	1.31	1.31	0.11	1.17	1.14	1.10	0.71	0.23	0.19	0.08	0.89
CISs	LC-5	1.12	1.33	1.60	0.94	0.81	2.99	4.03	3.03	2.49	0.72	0.00	0.46
CIPs	LC-5	0.63	0.75	0.90	0.53	0.46	1.67	2.26	1.70	1.39	0.40	0.00	0.26
Tuguegarao PIS	36	0.13	0.19	0.21	0.05	0.10	0.08	0.10	0.06	0.04	0.03	0.02	0.09
Solana PIS	37	3.64	4.11	4.14	0.35	3.71	3.60	3.47	2.25	0.73	0.60	0.26	2.81
A/Amul. West PIP	37	6.44	8.13	8.47	1.22	6.05	5.49	5.71	3.65	1.48	1.16	0.68	4.89
CISs	LC-6	0.30	0.36	0.44	0.26	0.13	0.42	0.57	0.43	0.35	0.10	0.00	0.13
CIPs	LC-6	0.43	0.51	0.62	0.36	0.31	1.15	1.55	1.16	0.95	0.28	0.00	0.18
IAAPIS(Iguig)	38	0.78	0.89	0.89	0.08	0.80	0.78	0.75	0.49	0.04	0.00	0.00	0.57
CISs	LC-7	0.34	0.40	0.49	0.29	0.14	0.47	0.64	0.48	0.39	0.11	0.00	0.14
CIPs	LC-7	0.14	0.16	0.20	0.12	0.10	0.36	0.49	0.37	0.31	0.09	0.00	0.06
IAAPIS(A/Amulu)	39	2.31	2.61	2.62	0.22	2.35	2.28	2.19	1.42	0.12	0.00	0.00	1.68
Baggao IS(Pared)	40	0.58	0.70	0.79	0.12	0.61	0.60	0.57	0.48	0.45	0.05	0.35	0.40
Baggao IS(Paranan)	42	0.79	0.95	1.07	0.17	1.13	1.10	1.06	0.88	0.83	0.10	0.47	0.54
CISs	LC-10	1.38	1.63	1.97	1.16	0.58	1.93	2.61	1.96	1.61	0.47	0.00	0.56
CIPs	LC-10	-	-	-	-	-	-	-	-	-	-	-	-
CISs	LC-11	0.05	0.06	0.07	0.04	0.02	0.07	0.09	0.07	0.06	0.02	0.00	0.02
Zinundungan RIS	44	2.57	3.00	3.03	0.24	2.56	2.38	2.36	1.58	0.14	0.00	0.00	1.89
Zinun. Exten.	44	-	-	-	-	-	-	-	-	-	-	-	-
Dumuman RIS	46	1.04	1.64	2.01	0.33	1.75	1.65	1.71	1.41	1.04	0.12	0.82	0.64
CIPs	LC-12	-	-	-	-	-	-	-	-	-	-	-	-
CISs	LC-13	0.62	0.86	1.14	0.72	0.37	1.17	1.70	1.29	0.83	0.23	0.00	0.28
CIPs	LC-13	-	-	-	-	-	-	-	-	-	-	-	-
Magapit PIS(L/Caga.)	47	9.66	14.13	15.58	1.42	15.25	14.36	14.84	9.60	0.62	0.00	0.00	8.55
CISs	LC-14	0.41	0.57	0.75	0.47	0.24	0.77	1.11	0.85	0.54	0.15	0.00	0.18
CIPs	LC-14	-	-	-	-	-	-	-	-	-	-	-	-
Sub total		36.84	47.23	51.04	9.68	41.08	48.36	52.99	37.26	16.84	5.11	3.72	26.71
TOTAL		251.62	289.13	244.34	100.04	206.96	265.48	324.28	208.25	121.58	57.13	63.34	185.16

Note: Updated based on the same titled table in the 1987 Master Plan

Table 5.2.2 Future Irrigation Water Demand (4/5, Year 2015)

Name of System	Area Code/ Base Point N	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	(unit: m3/s)
I. Upper Cagayan Basin														
CISs	UC-3	0.52	0.64	0.70	0.40	0.37	1.28	1.38	0.73	0.85	0.25	0.00	0.24	
CIPs	UC-3	0.22	0.26	0.29	0.16	0.15	0.53	0.56	0.30	0.35	0.10	0.00	0.10	
CISs	UC-4	0.40	0.49	0.53	0.30	0.14	0.44	0.48	0.25	0.29	0.09	0.00	0.18	
CISs	UC-5	0.15	0.19	0.20	0.12	0.11	0.37	0.40	0.21	0.25	0.07	0.00	0.07	
Addalam RIP	outlet-5	3.85	5.31	6.35	0.82	4.72	3.26	4.26	2.68	1.22	0.76	0.35	3.44	
CISs	UC-6B	0.47	0.54	0.72	0.38	0.38	1.27	1.90	1.36	1.12	0.26	0.00	0.19	
Dabubu IP	6	0.66	0.91	1.09	0.14	0.81	0.56	0.73	0.46	0.21	0.13	0.06	0.59	
CIPs	UC-6	0.87	1.01	1.33	0.71	0.71	2.34	3.51	2.52	2.08	0.49	0.00	0.36	
CISs	UC-7	0.85	0.99	1.31	0.70	0.70	2.30	3.44	2.47	2.04	0.48	0.00	0.35	
CIPs	UC-7	0.47	0.55	0.72	0.39	0.39	1.27	1.91	1.37	1.13	0.26	0.00	0.19	
Gappal IS/IP	8	0.65	0.83	0.96	0.10	0.79	0.57	0.72	0.46	0.18	0.12	0.04	0.56	
CIPs	UC-8B	0.15	0.17	0.22	0.12	0.12	0.39	0.59	0.42	0.35	0.08	0.00	0.06	
CIPs	UC-9	-	-	-	-	-	-	-	-	-	-	-	-	
Lulutan IP	15	3.46	4.30	4.92	0.46	4.23	3.09	3.81	2.44	0.95	0.62	0.20	2.93	
Sub total		12.72	16.19	19.34	4.80	13.62	17.67	23.69	15.67	11.02	3.71	0.65	9.26	
II. Magat Basin														
CISs	M-1	8.52	10.50	11.80	6.87	2.96	9.47	10.52	8.03	7.63	2.61	0.00	3.91	
CIPs	M-1	0.13	0.16	0.18	0.11	0.09	0.32	0.36	0.27	0.26	0.09	0.00	0.06	
Matuno (Manam.)	10	-	-	-	-	-	-	-	-	-	-	-	-	
Matuno (Bayom.)	11	-	-	-	-	-	-	-	-	-	-	-	-	
CISs	M-2	0.12	0.15	0.17	0.10	0.05	0.19	0.25	0.19	0.19	0.05	0.00	0.06	
CISs	M-3	11.54	20.21	16.66	9.19	4.86	16.73	22.00	20.17	14.59	4.94	0.00	5.47	
CIPs	M-3	0.30	0.53	0.44	0.24	0.24	0.93	1.22	1.12	0.81	0.27	0.00	0.15	
Magat RIIIS	13	115.96	116.85	82.95	54.86	109.23	96.74	140.02	72.93	40.51	29.47	48.09	89.46	
CISs	M-4	1.12	1.36	1.66	1.03	0.55	1.83	2.42	2.08	1.70	0.56	0.00	0.51	
CISs	M-5	0.06	0.08	0.10	0.06	0.03	0.10	0.13	0.11	0.09	0.03	0.00	0.03	
Sub total		137.75	149.84	113.96	72.46	118.01	126.31	176.92	104.90	65.78	38.02	48.09	99.65	
III. Ilagan Basin														
Ilagan IP	18	0.28	0.60	0.83	0.18	0.35	0.17	0.31	0.17	0.15	0.09	0.08	0.32	
Tumauini (Ila.)	18	-	-	-	-	-	-	-	-	-	-	-	-	
CISs	I-3	0.06	0.07	0.09	0.05	0.05	0.17	0.25	0.18	0.15	0.03	0.00	0.03	
CISs	I-4	0.16	0.19	0.25	0.13	0.13	0.44	0.65	0.47	0.39	0.09	0.00	0.07	
CIPs	I-4	0.24	0.28	0.38	0.20	0.20	0.66	0.98	0.71	0.58	0.14	0.00	0.10	
Sub total		0.74	1.14	1.55	0.56	0.73	1.44	2.19	1.53	1.27	0.35	0.08	0.52	
IV. Siftu, Mallig Basin														
CISs	S-1	0.91	1.10	1.34	0.83	0.30	0.89	1.17	1.01	0.83	0.27	0.00	0.41	
Siftu RIS	29	13.68	15.97	16.70	5.50	5.22	14.90	16.90	8.22	7.42	4.79	3.43	11.79	
CISs	S-3	0.12	0.15	0.18	0.11	0.07	0.22	0.28	0.25	0.21	0.07	0.00	0.05	
Mallig RIS	31	1.36	1.78	0.84	0.00	1.11	3.25	3.10	2.66	0.92	0.00	0.35	1.03	
CISs	S-5	0.27	0.34	0.42	0.24	0.21	0.73	1.13	0.87	0.64	0.19	0.00	0.11	
CIPs	S-5	0.53	0.66	0.82	0.47	0.42	1.44	2.22	1.71	1.26	0.37	0.00	0.21	
Sub total		16.87	20.00	20.30	7.15	7.33	21.43	24.80	14.72	11.28	5.69	3.78	13.60	
V. Chico Basin														
CISs	C-1	2.30	2.55	2.32	1.01	0.42	1.23	0.76	0.68	0.76	0.35	0.00	0.99	
CISs	C-2	1.00	1.17	1.10	0.56	0.44	1.24	0.87	0.74	0.86	0.25	0.00	0.42	
CISs	C-3	0.50	0.58	0.54	0.28	0.21	0.58	0.41	0.35	0.40	0.12	0.00	0.21	
Chico RIS	23	22.41	26.99	12.33	0.00	8.22	25.71	21.13	17.93	6.83	0.00	5.24	19.06	
Chico Mallig IP	30	39.23	45.32	45.91	4.47	39.39	37.88	36.87	23.85	8.08	6.55	3.01	30.19	
CISs	C-4	0.44	0.52	0.63	0.37	0.25	0.87	1.17	0.88	0.72	0.21	0.00	0.18	
CISs	C-5	0.50	0.59	0.71	0.42	0.28	0.99	1.34	1.01	0.83	0.24	0.00	0.20	
Chico RIS(West)	25	2.27	2.82	1.30	0.00	0.83	2.50	2.07	1.82	0.72	0.00	0.56	1.93	
CISs	C-6	1.30	1.58	1.91	1.07	0.52	1.65	2.23	1.72	1.48	0.44	0.00	0.53	
CIPs	C-6	0.83	1.01	1.22	0.69	0.60	2.13	2.88	2.23	1.92	0.56	0.00	0.34	
Sub total		70.78	83.13	67.97	8.87	51.16	74.78	69.73	51.21	22.60	8.72	8.81	54.05	
VI. Lower Cagayan Basin														
CISs	LC-1	0.13	0.16	0.20	0.12	0.10	0.35	0.54	0.42	0.31	0.09	0.00	0.05	
CIPs	LC-1	0.07	0.08	0.10	0.06	0.05	0.18	0.28	0.21	0.16	0.05	0.00	0.03	
Tumauini IS	33	1.32	1.72	1.99	0.30	1.70	1.51	1.73	1.46	1.24	0.15	0.85	0.72	
S/Pab.Caba. IS	34	0.81	0.98	0.45	0.00	0.59	1.86	1.53	1.30	0.49	0.00	0.19	0.69	
Pinacanuan RIS	35	1.15	1.31	1.31	0.11	1.17	1.14	1.10	0.71	0.23	0.19	0.08	0.89	
CISs	LC-5	0.64	0.75	0.91	0.53	0.46	1.70	2.29	1.73	1.42	0.41	0.00	0.26	
CIPs	LC-5	1.14	1.34	1.62	0.95	0.83	3.02	4.08	3.07	2.52	0.73	0.00	0.46	
Tuguegarao PIS	36	0.13	0.19	0.21	0.05	0.10	0.08	0.10	0.06	0.04	0.03	0.02	0.09	
Solana PIS	37	3.64	4.11	4.14	0.35	3.71	3.60	3.47	2.25	0.73	0.60	0.26	2.81	
A/Amul.West PIP	37	6.44	8.13	8.47	1.22	6.05	5.49	5.71	3.65	1.48	1.16	0.68	4.89	
CISs	LC-6	0.30	0.36	0.44	0.26	0.13	0.42	0.57	0.43	0.35	0.10	0.00	0.13	
CIPs	LC-6	0.45	0.53	0.64	0.37	0.32	1.19	1.61	1.21	0.99	0.29	0.00	0.18	
IAAPIS(Iguig)	38	0.78	0.89	0.89	0.08	0.80	0.78	0.75	0.49	0.04	0.00	0.00	0.57	
CISs	LC-7	0.04	0.05	0.06	0.04	0.01	0.06	0.08	0.06	0.05	0.01	0.00	0.02	
CIPs	LC-7	0.66	0.78	0.94	0.55	0.48	1.76	2.37	1.78	1.46	0.42	0.00	0.27	
IAAPIS(A/Amulu)	39	2.31	2.61	2.62	0.22	2.35	2.28	2.19	1.42	0.12	0.00	0.00	1.68	
Baggao IS(Pared)	40	0.58	0.70	0.79	0.12	0.61	0.60	0.57	0.48	0.45	0.05	0.35	0.40	
Baggao IS(Paraman)	42	0.79	0.95	1.07	0.17	1.13	1.10	1.06	0.88	0.83	0.10	0.47	0.54	
CISs	LC-10	1.38	1.63	1.97	1.16	0.58	1.93	2.61	1.96	1.61	0.47	0.00	0.56	
CIPs	LC-10	0.50	0.59	0.72	0.42	0.37	1.34	1.80	1.36	1.11	0.32	0.00	0.02	
CISs	LC-11	0.05	0.06	0.07	0.04	0.02	0.07	0.09	0.07	0.06	0.02	0.00	0.02	
Zinundungan RIS	44	2.57	3.00	3.03	0.24	2.56	2.38	2.36	1.58	0.14	0.00	0.00	1.89	
Zinun. Exten.	44	-	-	-	-	-	-	-	-	-	-	-	-	
Dummun RIS	46	1.04	1.64	2.01	0.33	1.75	1.65	1.71	1.41	1.04	0.12	0.82	0.64	
CIPs	LC-12	0.05	0.08	0.10	0.06	0.06	0.20	0.29	0.22	0.14	0.04	0.00	0.02	
CISs	LC-13	0.62	0.86	1.14	0.72	0.37	1.17	1.70	1.29	0.83	0.23	0.00	0.28	
CIPs	LC-13	0.23	0.32	0.42	0.27	0.23	0.83	1.20	0.92	0.59	0.16	0.00	0.10	
Magapit PIS(L/Caga.)	47	9.66	14.13	15.58	1.42	15.25	14.36	14.84	9.60	0.62	0.00	0.00	8.55	
CISs	LC-14	0.41	0.57	0.75	0.47	0.24	0.77	1.11	0.85	0.54	0.15	0.00	0.18	
CIPs	LC-14	-	-	-	-	-	-	-	-	-	-	-	-	
Sub total		37.89	48.52	52.64	10.63	42.02	51.82	57.74	40.87	19.59	5.89	3.72	26.94	
TOTAL		276.75	318.82	275.76	104.47	232.87	293.45	355.07	228.90	131.54	62.38	65.13	204.02	

Note: Updated based on the same titled table in the 1987 Master Plan

Table 5.2.2 Future Irrigation Water Demand (5/5, Year 2020)

Name of System	Area Code/ Base Point N	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
I. Upper Cagayan Basin													
CISs	UC-3	0.52	0.64	0.70	0.40	0.37	1.28	1.38	0.73	0.85	0.25	0.00	0.24
CIPs	UC-3	0.22	0.26	0.29	0.16	0.15	0.53	0.56	0.30	0.35	0.10	0.00	0.10
CISs	UC-4	0.40	0.49	0.53	0.30	0.14	0.44	0.48	0.25	0.29	0.09	0.00	0.18
CISs	UC-5	0.15	0.19	0.20	0.12	0.11	0.37	0.40	0.21	0.25	0.07	0.00	0.07
Addalam RIP	outlet-5	3.85	5.31	6.35	0.82	4.72	3.26	4.26	2.68	1.22	0.76	0.35	3.44
CISs	UC-6B	0.47	0.54	0.72	0.38	0.38	1.27	1.90	1.36	1.12	0.26	0.00	0.19
Dabubu IP	6	0.66	0.91	1.09	0.14	0.81	0.56	0.73	0.46	0.21	0.13	0.06	0.59
CIPs	UC-6	1.12	1.30	1.72	0.91	0.92	3.03	4.53	3.25	2.68	0.63	0.00	0.46
CISs	UC-7	0.85	0.99	1.31	0.70	0.70	2.30	3.44	2.47	2.04	0.48	0.00	0.35
CIPs	UC-7	0.47	0.55	0.72	0.39	0.39	1.27	1.91	1.37	1.13	0.26	0.00	0.19
Gappal IS/IP	8	0.65	0.83	0.96	0.10	0.79	0.57	0.72	0.46	0.18	0.12	0.04	0.56
CIPs	UC-8B	0.32	0.37	0.49	0.26	0.26	0.86	1.29	0.93	0.77	0.18	0.00	0.13
CIPs	UC-9	0.10	0.12	0.16	0.08	0.08	0.25	0.37	0.27	0.22	0.05	0.00	0.04
Lulutan IP	15	3.46	4.30	4.92	0.46	4.23	3.09	3.81	2.44	0.95	0.62	0.20	2.93
Sub total		13.24	16.80	20.16	5.22	14.05	19.08	25.78	17.18	12.26	4.00	0.65	9.47
II. Magat Basin													
CISs	M-1	8.06	9.93	11.16	6.50	2.80	8.95	9.95	7.60	7.22	2.47	0.00	3.69
CIPs	M-1	0.13	0.16	0.18	0.11	0.09	0.32	0.36	0.27	0.26	0.09	0.00	0.06
Matuno (Manam.)	10	0.96	1.14	1.21	0.12	1.04	1.08	1.02	0.81	0.24	0.20	0.12	0.91
Matuno (Bayom.)	11	12.47	14.75	15.59	1.47	13.47	13.94	13.15	10.49	3.12	2.52	1.57	11.72
CISs	M-2	0.12	0.15	0.17	0.10	0.05	0.19	0.25	0.19	0.19	0.05	0.00	0.06
CISs	M-3	6.01	10.52	8.67	4.79	2.53	8.71	11.45	10.50	7.59	2.57	0.00	2.85
CIPs	M-3	0.30	0.53	0.44	0.24	0.24	0.93	1.22	1.12	0.81	0.27	0.00	0.15
Magat RIIS	13	115.96	116.85	82.95	54.86	109.23	96.74	140.02	72.93	40.51	29.47	48.09	89.46
CISs	M-4	1.12	1.36	1.66	1.03	0.55	1.83	2.42	2.08	1.70	0.56	0.00	0.51
CISs	M-5	0.06	0.08	0.10	0.06	0.03	0.10	0.13	0.11	0.09	0.03	0.00	0.03
Sub total		145.19	155.47	122.13	69.28	130.03	132.79	179.97	106.10	61.73	38.23	49.78	109.44
III. Ilagan Basin													
Ilagan IP	18	0.28	0.60	0.83	0.18	0.35	0.17	0.31	0.17	0.15	0.09	0.08	0.32
Tumauini (Ila.)	18	2.65	3.24	3.35	0.28	2.97	2.65	3.04	2.00	0.15	0.00	0.00	1.89
CISs	I-3	0.06	0.07	0.09	0.05	0.05	0.17	0.25	0.18	0.15	0.03	0.00	0.03
CISs	I-4	0.16	0.19	0.25	0.13	0.13	0.44	0.65	0.47	0.39	0.09	0.00	0.07
CIPs	I-4	0.24	0.28	0.38	0.20	0.20	0.66	0.98	0.71	0.58	0.14	0.00	0.10
Sub total		3.39	4.38	4.90	0.84	3.70	4.09	5.23	3.53	1.42	0.35	0.08	2.41
IV. Siffu, Mallig Basin													
CISs	S-1	0.91	1.10	1.34	0.83	0.30	0.89	1.17	1.01	0.83	0.27	0.00	0.41
Siffu RIS	29	13.68	15.97	16.70	5.50	5.22	14.90	16.90	8.22	7.42	4.79	3.43	11.79
CISs	S-3	0.12	0.15	0.18	0.11	0.07	0.22	0.28	0.25	0.21	0.07	0.00	0.05
Mallig RIS	31	1.36	1.78	0.84	0.00	1.11	3.25	3.10	2.66	0.92	0.00	0.35	1.03
CISs	S-5	0.27	0.34	0.42	0.24	0.21	0.73	1.13	0.87	0.64	0.19	0.00	0.11
CIPs	S-5	0.53	0.66	0.82	0.47	0.42	1.44	2.22	1.71	1.26	0.37	0.00	0.21
Sub total		16.87	20.00	20.30	7.15	7.33	21.43	24.80	14.72	11.28	5.69	3.78	13.60
V. Chico Basin													
CISs	C-1	2.30	2.55	2.32	1.01	0.42	1.23	0.76	0.68	0.76	0.35	0.00	0.99
CISs	C-2	1.00	1.17	1.10	0.56	0.44	1.24	0.87	0.74	0.86	0.25	0.00	0.42
CISs	C-3	0.50	0.58	0.54	0.28	0.21	0.58	0.41	0.35	0.40	0.12	0.00	0.21
Chico RIS	23	22.41	26.99	12.33	0.00	8.22	25.71	21.13	17.93	6.83	0.00	5.24	19.06
Chico Malig IP	30	39.23	45.32	45.91	4.47	39.39	37.88	36.87	23.85	8.08	6.55	3.01	30.19
CISs	C-4	0.44	0.52	0.63	0.37	0.25	0.87	1.17	0.88	0.72	0.21	0.00	0.18
CISs	C-5	0.50	0.59	0.71	0.42	0.28	0.99	1.34	1.01	0.83	0.24	0.00	0.20
Chico RIS(West)	25	2.27	2.82	1.30	0.00	0.83	2.50	2.07	1.82	0.72	0.00	0.56	1.93
CISs	C-6	1.30	1.58	1.91	1.07	0.52	1.65	2.23	1.72	1.48	0.44	0.00	0.53
CIPs	C-6	0.83	1.01	1.22	0.69	0.60	2.13	2.88	2.23	1.92	0.56	0.00	0.34
Sub total		70.78	83.13	67.97	8.87	51.16	74.78	69.73	51.21	22.60	8.72	8.81	54.05
VI. Lower Cagayan Basin													
CISs	LC-1	0.13	0.16	0.20	0.12	0.10	0.35	0.54	0.42	0.31	0.09	0.00	0.05
CIPs	LC-1	0.07	0.08	0.10	0.06	0.05	0.18	0.28	0.21	0.16	0.05	0.00	0.03
Tumauini IS	33	2.12	2.59	2.68	0.24	3.94	3.54	4.05	2.66	1.86	1.50	0.47	1.76
S/Pab.Caba. IS	34	0.81	0.98	0.45	0.00	0.59	1.86	1.53	1.30	0.49	0.00	0.19	0.69
Pinacanauan RIS	35	1.15	1.31	1.31	0.11	1.17	1.14	1.10	0.71	0.23	0.19	0.08	0.89
CISs	LC-5	0.64	0.75	0.91	0.53	0.46	1.70	2.29	1.73	1.42	0.41	0.00	0.26
CIPs	LC-5	1.14	1.34	1.62	0.95	0.83	3.02	4.08	3.07	2.52	0.73	0.00	0.46
Tuguegarao PIS	36	0.13	0.19	0.21	0.05	0.10	0.08	0.10	0.06	0.04	0.03	0.02	0.09
Solana PIS	37	3.28	3.70	3.73	0.32	3.34	3.24	3.12	2.02	0.65	0.54	0.23	2.53
A/Amul. West PIP	37	6.44	8.13	8.47	1.22	6.05	5.49	5.71	3.65	1.48	1.16	0.68	4.89
CISs	LC-6	0.30	0.36	0.44	0.26	0.13	0.42	0.57	0.43	0.35	0.10	0.00	0.13
CIPs	LC-6	0.45	0.53	0.64	0.37	0.32	1.19	1.61	1.21	0.99	0.29	0.00	0.18
IAAPIS(Iguig)	38	0.78	0.89	0.89	0.08	0.80	0.78	0.75	0.49	0.04	0.00	0.00	0.57
CISs	LC-7	0.04	0.05	0.06	0.04	0.01	0.06	0.08	0.06	0.05	0.01	0.00	0.02
CIPs	LC-7	1.34	1.58	1.91	1.12	0.97	3.56	4.80	3.62	2.97	0.86	0.00	0.55
IAAPIS(A/Amulu)	39	2.31	2.61	2.62	0.22	2.35	2.28	2.19	1.42	0.12	0.00	0.00	1.68
Baggao IS(Pared)	40	0.69	0.78	0.79	0.07	0.80	0.78	0.74	0.48	0.15	0.13	0.05	0.54
Baggao IS(Paranan)	42	1.92	2.17	2.18	0.19	1.96	1.90	1.84	1.18	0.38	0.31	0.14	1.49
CISs	LC-10	1.38	1.63	1.97	1.16	0.58	1.93	2.61	1.96	1.61	0.47	0.00	0.56
CIPs	LC-10	1.43	1.69	2.04	1.20	1.04	3.81	5.13	3.87	3.17	0.92	0.00	0.58
CISs	LC-11	0.05	0.06	0.07	0.04	0.02	0.07	0.09	0.07	0.06	0.02	0.00	0.02
Zinundungan RIS	44	2.57	3.00	3.03	0.24	2.56	2.38	2.36	1.58	0.14	0.00	0.00	1.89
Zinun. Exten.	44	1.95	2.37	2.43	0.24	1.90	1.72	1.73	1.17	0.43	0.36	0.17	1.50
Dumuman RIS	46	1.59	2.33	2.57	0.24	2.52	2.37	2.45	1.58	0.45	0.27	0.11	1.45
CIPs	LC-12	0.05	0.08	0.10	0.06	0.06	0.20	0.29	0.22	0.14	0.04	0.00	0.02
CISs	LC-13	0.62	0.86	1.14	0.72	0.37	1.17	1.70	1.29	0.83	0.23	0.00	0.28
CIPs	LC-13	0.64	0.89	1.18	0.74	0.65	2.31	3.35	2.55	1.63	0.45	0.00	0.28
Magapit PIS(L/Caga.)	47	9.66	14.13	15.58	1.42	15.25	14.36	14.84	9.60	0.62	0.00	0.00	8.55
CISs	LC-14	0.41	0.57	0.75	0.47	0.24	0.77	1.11	0.85	0.54	0.15	0.00	0.18
CIPs	LC-14	0.18	0.25	0.33	0.20	0.18	0.64	0.93	0.70	0.45	0.12	0.00	0.08
Sub total		44.27	56.06	60.40	12.68	49.34	63.30	71.97	50.16	24.28	9.43	2.14	32.20
TOTAL		293.74	335.84	295.86	104.04	255.61	315.47	377.48	242.90	133.57	66.42	65.24	221.17

Note: Updated based on the same titled table in the 1987 Master Plan

Table 5.4.1 Simulated 10-day Mean Runoff at Point 137

Station : Point 137 (C.A. = 27,281km²)

(Unit : m³/sec)

		Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	10-day avg	Monthly avg
1963	(F)	728.7	499.0	395.0	289.9	229.7	636.3	4,001.4	2,912.9	1,844.7	1,331.0	601.0	2,250.6	1,310.0	1,414.8
	(M)	617.8	836.5	339.9	268.8	423.0	3,700.9	2,964.6	2,103.8	1,969.2	1,489.6	547.0	2,974.0	1,519.6	
	(L)	495.6	616.2	308.7	236.7	885.7	3,914.5	1,793.5	2,877.3	2,479.1	1,038.8	1,147.4	1,184.9	1,414.9	
1964	(F)	642.5	418.7	625.7	286.6	353.7	1,829.9	1,664.1	3,811.0	2,162.5	3,602.1	3,649.3	3,566.2	1,884.4	2,039.8
	(M)	547.5	403.5	367.2	272.1	314.9	1,933.1	1,605.0	2,223.2	2,707.6	1,924.0	9,323.4	4,672.3	2,191.1	
	(L)	448.0	1,053.7	297.8	245.9	1,899.3	2,262.8	2,325.8	1,547.8	3,085.2	1,914.4	7,277.3	2,167.9	2,043.8	
1965	(F)	1,190.1	831.9	529.7	363.5	1,067.7	1,425.4	1,850.5	1,471.9	2,696.7	628.1	1,700.0	517.1	1,189.4	1,165.7
	(M)	1,556.1	694.9	448.4	361.8	840.8	1,304.2	3,998.3	1,682.5	953.5	1,660.2	556.2	699.3	1,229.7	
	(L)	1,226.0	762.1	365.7	758.7	960.3	1,513.9	2,735.1	1,017.6	1,687.0	578.3	659.2	671.9	1,078.0	
1966	(F)	419.9	302.9	268.0	254.8	2,115.5	1,981.7	1,253.1	1,622.4	919.4	665.4	1,805.0	4,044.4	1,304.4	1,441.2
	(M)	362.0	274.5	244.9	485.3	1,425.7	1,705.9	1,134.2	1,713.2	725.8	949.0	3,252.2	2,314.3	1,215.6	
	(L)	310.2	344.9	228.2	727.3	2,749.0	1,322.0	1,134.6	1,779.9	479.7	1,263.7	7,772.3	3,532.0	1,803.6	
1967	(F)	1,770.0	665.2	437.0	1,208.4	290.6	1,503.6	1,791.6	2,199.9	2,898.9	4,212.7	3,352.7	1,104.7	1,786.4	1,432.3
	(M)	1,243.3	598.4	372.5	505.2	446.4	513.1	707.8	2,171.4	1,949.1	4,060.1	1,509.0	670.5	1,228.9	
	(L)	719.8	637.2	298.8	375.0	437.8	3,146.3	2,495.0	2,584.2	1,804.6	1,378.4	809.5	693.8	1,281.7	
1968	(F)	522.1	341.7	284.9	221.7	1,175.5	2,707.9	1,441.5	3,712.6	2,404.1	1,763.1	651.1	473.8	1,308.3	1,332.0
	(M)	448.1	301.7	255.5	229.7	633.4	2,044.3	1,450.3	5,689.3	1,624.2	1,327.2	567.2	878.0	1,287.4	
	(L)	346.7	304.4	281.1	2,237.8	656.9	2,570.6	2,073.3	2,701.4	3,722.9	725.5	780.4	403.2	1,400.4	
1969	(F)	393.1	280.4	205.4	290.8	303.6	1,566.4	1,115.4	2,221.0	1,943.8	3,142.1	459.6	1,673.0	1,132.9	1,059.7
	(M)	353.2	246.0	227.9	315.2	1,081.7	1,000.9	827.3	1,500.0	1,017.2	1,184.0	1,979.2	1,774.6	958.9	
	(L)	298.3	273.8	182.4	195.0	853.7	368.0	3,562.1	1,289.0	1,248.6	505.5	2,469.2	1,801.6	1,087.3	
1970	(F)	2,567.0	433.9	662.9	260.4	780.7	1,743.3	329.2	1,586.1	1,230.9	2,690.9	3,749.9	3,959.1	1,666.2	1,587.0
	(M)	955.3	351.4	271.2	217.0	1,076.5	1,625.9	936.7	1,572.4	2,856.7	3,980.8	3,156.9	3,694.3	1,724.6	
	(L)	466.6	403.7	586.8	599.4	857.5	812.7	1,061.8	1,535.1	1,418.4	4,252.8	3,072.1	1,380.2	1,370.3	
1971	(F)	1,795.0	609.4	452.5	359.2	958.7	1,546.5	1,835.9	1,524.0	2,576.4	6,940.7	3,616.8	5,593.0	2,317.4	2,320.1
	(M)	815.2	681.7	1,836.3	314.1	2,468.5	2,445.4	4,137.3	1,744.6	3,598.7	4,846.9	4,152.9	3,687.9	2,560.8	
	(L)	689.1	1,013.4	417.0	265.8	831.4	957.4	2,494.7	2,012.4	2,393.0	3,272.6	7,791.8	2,848.8	2,082.3	
1972	(F)	2,857.3	959.1	600.5	498.1	864.5	1,550.2	2,302.3	1,925.2	1,454.1	626.6	1,127.3	985.9	1,312.8	1,223.1
	(M)	1,223.8	836.0	551.8	1,166.1	2,411.7	752.2	2,351.7	2,556.8	718.3	519.5	480.4	463.9	1,169.3	
	(L)	1,299.4	795.9	449.1	930.8	2,429.5	1,439.8	1,816.8	1,430.5	1,090.6	489.5	1,643.5	428.5	1,187.0	
1973	(F)	365.7	301.1	253.6	244.3	628.4	2,119.5	1,165.0	1,846.5	2,401.7	3,284.5	2,506.1	4,102.1	1,601.5	1,725.5
	(M)	328.7	272.6	250.2	241.3	1,063.0	2,629.3	821.8	2,826.4	1,894.8	5,802.7	3,827.0	1,829.4	1,815.6	
	(L)	286.2	328.6	416.0	311.0	661.5	2,041.6	1,085.9	3,103.3	1,216.9	2,634.5	8,106.9	1,009.4	1,759.3	
1974	(F)	936.2	407.7	363.5	725.0	2,566.4	688.8	735.8	953.0	4,021.7	6,758.8	1,897.0	1,724.1	1,687.6	
	(M)	802.1	539.7	355.5	305.8	807.7	1,327.5	1,113.7	2,011.9	1,148.6	5,229.2	4,384.5	4,024.3	1,837.6	
	(L)	689.3	590.2	286.4	688.5	613.3	711.5	518.5	875.2	2,271.2	6,079.2	2,607.7	2,082.1	1,501.1	
1975	(F)	1,054.4	723.5	460.6	412.6	894.6	1,183.3	831.9	1,107.9	1,625.3	1,086.3	1,973.3	1,540.0	1,074.5	1,059.6
	(M)	1,428.6	626.8	409.1	281.3	549.3	1,225.3	1,011.8	770.4	1,298.8	2,217.4	1,031.1	1,948.6	1,066.5	
	(L)	1,051.2	671.8	337.6	260.4	1,178.3	1,044.9	789.4	1,376.1	469.3	2,877.7	574.5	1,821.1	1,037.7	
1976	(F)	1,286.7	389.6	815.1	815.8	755.1	2,194.0	1,418.1	2,898.9	1,234.2	2,340.4	2,475.7	1,619.4	1,520.2	1,466.0
	(M)	544.5	324.2	476.6	252.8	583.3	1,401.0	612.3	1,475.3	3,176.2	1,214.0	3,532.5	2,344.0	1,327.8	
	(L)	424.9	325.8	237.8	218.6	3,671.8	3,011.4	1,641.5	1,481.1	1,573.8	1,660.1	3,346.5	1,007.0	1,550.0	
1977	(F)	707.0	546.5	346.0	287.0	214.6	902.7	961.2	2,999.2	1,556.9	1,067.6	533.8	560.8	890.3	1,037.0
	(M)	688.4	472.1	312.6	336.7	223.2	1,097.3	1,113.3	1,244.1	3,690.9	741.3	3,413.8	465.2	1,149.9	
	(L)	588.2	508.5	250.0	218.5	2,259.3	970.2	2,192.2	1,034.9	2,802.1	537.4	1,105.9	384.0	1,070.9	
1978	(F)	342.0	233.9	197.2	177.2	187.9	1,019.6	582.4	1,591.8	2,931.1	2,778.4	2,119.7	891.6	1,087.7	1,217.3
	(M)	297.5	217.0	188.7	267.0	208.7	1,026.4	1,274.2	964.8	2,976.5	1,769.9	2,972.9	1,140.4	1,108.7	
	(L)	239.6	268.2	164.5	612.8	1,615.8	376.9	1,288.8	3,640.1	3,159.1	3,560.0	1,283.8	1,255.5	1,455.4	
1979	(F)	592.5	356.7	245.1	178.5	325.8	2,723.4	2,338.8	1,738.8	2,696.0	3,004.5	2,018.3	616.4	1,410.4	1,228.0
	(M)	481.0	307.8	211.1	173.4	1,512.9	851.1	2,596.8	1,746.4	1,788.6	2,096.0	1,546.9	819.2	1,177.6	
	(L)	374.3	340.0	178.9	1,021.3	2,195.8	1,397.1	2,765.7	558.8	1,396.5	700.4	1,391.1	831.5	1,096.1	
1980	(F)	509.9	319.2	251.9	220.5	380.3	1,080.1	1,372.2	1,243.5	1,003.4	6,214.5	1,199.6	1,171.3	1,185.8	
	(M)	431.5	305.3	213.6	571.2	251.5	2,348.9	919.2	1,462.1	894.8	2,871.3	1,777.9	1,169.9		
	(L)	343.4	299.7	843.4	209.3	1,574.0	374.6	2,081.5	1,141.2	876.2	4,881.6	1,312.0	658.4	1,017.4	
1981	(F)	606.4	376.1	244.4	174.8	400.1	3,485.9	1,925.5	2,343.5	1,440.7	1,201.2	3,741.4	769.2	1,392.5	1,377.8
	(M)	531.2	316.1	207.4	186.1	1,472.0	2,879.8	3,135.6	2,481.2	2,698.3	1,018.3	1,935.9	663.2	1,460.4	
	(L)	412.0	358.3	168.7	1,084.3	2,424.6	1,556.2	1,104.9	1,857.4	2,012.7	2,602.0	537.9	1,280.4	1,024.1	
1982	(F)	490.2	306.2	220.1	642.7	310.9	1,323.7	970.5	1,049.3	2,882.3	557.1	953.9	1,654.8	946.8	661.9
	(M)	411.4	275.7	210.8	1,046.6	1,023.6	1,333.7	1,103.1	918.5	2,051.1	2,125.0	1,807.9	989.9	1,108.1	
	(L)	325.4	306.4	746.4	909.2	1,956.6	967.4	815.7	2,028.7	1,398.1	696.5	1,447.9	610.3	1,017.4	
1983	(F)	812.9	336.5	217.3	184.8	164.5	189.9	170.3	1,222.6	922.3	2,363.3	1,296.5	649.9	710.9	661.9
	(M)	1,036.8	295.5	188.9	168.0	415.6	380.8	369.2	852.3	628.3	1,304.1	757.4	507.8	575.4	
	(L)	397.2	317.3	167.5	165.6	597.3	190.4	807.3	494.1	1,694.0	2,412.2	615.8	535.9	695.9	
1984	(F)	276.4	159.1	137.2	155.3	2,473.4	1,023.8	2,645.9	2,238.3	1,400.1	523.5	1,663.3	1,966.8	1,221.9	1,234.0
	(M)	241.4	147.2	710.2	1,233.4	998.0	1,310.1	1,353.1	1,						

Table 5.4.2 5-year Probable Annual Water Deficit at Balance Points

(Annual Deficit)		(President Condition)			Unit:	Million m ³ /Year
Balance Point	2000 Demand	2005 Demand	2010 Demand	2015 Demand	2020 Demand	
1	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00
6	0.00	0.00	-1.79	-5.85	-8.77	
7	0.00	0.00	0.00	0.00	0.00	0.00
8	-1.43	-6.51	-6.51	-6.51	-6.51	
9	0.00	0.00	0.00	0.00	0.00	0.00
10	0.00	0.00	0.00	0.00	0.00	0.00
11	-4.80	-4.80	-4.87	-4.95	-112.99	
12	-0.29	-0.29	-0.34	-0.40	-0.48	
13	-85.27	-85.27	-89.95	-91.83	-93.37	
14	0.00	0.00	0.00	0.00	0.00	0.00
15	0.00	0.00	0.00	0.00	0.00	0.00
16	0.00	0.00	0.00	0.00	0.00	0.00
17	0.00	0.00	0.00	0.00	0.00	0.00
18	0.00	0.00	0.00	0.00	0.00	0.00
19	0.00	0.00	0.00	0.00	0.00	0.00
20	0.00	0.00	0.00	0.00	0.00	0.00
21	-0.04	-0.04	-0.07	-0.10	-0.14	
22	-0.38	-0.38	-0.38	-0.40	-0.42	
23	-6.52	-61.30	-61.44	-61.58	-61.75	
24	0.00	0.00	0.00	0.00	0.00	0.00
25	0.00	0.00	0.00	0.00	0.00	0.00
26	0.00	0.00	0.00	0.00	0.00	0.00
27	0.00	0.00	0.00	0.00	0.00	0.00
28	0.00	0.00	0.00	0.00	0.00	0.00
29	-68.96	-68.96	-68.96	-68.96	-68.96	
30	-162.10	-162.10	-162.10	-162.10	-162.10	
31	-18.45	-18.45	-18.45	-18.45	-18.45	
32	-15.18	-16.56	-20.61	-22.43	-24.75	
33	-4.15	-4.15	-4.15	-4.15	-13.36	
34	0.00	-1.45	-1.45	-1.45	-1.45	
35	0.00	0.00	0.00	0.00	0.00	0.00
36	0.00	0.00	0.00	0.00	0.00	0.00
37	0.00	0.00	0.00	0.00	0.00	0.00
38	0.00	0.00	0.00	0.00	0.00	0.00
39	0.00	0.00	0.00	0.00	0.00	0.00
40	-3.38	-11.24	-11.24	-11.24	-11.24	
41	0.00	0.00	0.00	0.00	0.00	0.00
42	-9.90	-9.90	-9.90	-9.90	-31.54	
43	0.00	0.00	0.00	0.00	0.00	0.00
44	-24.93	-24.00	-24.00	-24.00	-24.00	
45	-7.27	-7.27	-7.27	-7.27	-11.85	
46	-20.32	-20.32	-20.32	-20.32	-32.98	
47	0.00	0.00	0.00	0.00	0.00	0.00
48	0.00	0.00	0.00	0.00	0.00	0.00
Total	-433.37	-502.99	-513.80	-521.89	-685.09	

Table 8.2.1 Result of Salinity Intrusion Survey (1/6)

STATION 5+000 - Aparri

Table 8.2.1 Result of Salinity Intrusion Survey (2/6)

STATION 10+000 - Camalaniugan

1000 HRS							2400 HRS						
Depth	pH	Ec	% Salinity	DO	°T	Remarks	Depth	pH	Ec	% Salinity	DO	°T	Remarks
0	6.81	0.157	0.00	0.22		26.2 T measured after 2 PM	0	7.24	0.164	0.00	0.23		T not measured
1	6.94	0.156	0.00	0.19		26	1	7.37	0.163	0.00	0.35		
2	6.95	0.155	0.00	0.2		26.2	2	7.40	0.163	0.00	0.33		
3	6.98	0.156	0.00	0.49		26	3	7.40	0.163	0.00	0.24		
4	6.94	0.152	0.00	0.24		26.5	4	7.39	0.163	0.00	0.83		
5	6.96	0.154	0.00	0.28		25.9	5	7.31	0.162	0.00	0.51		
6	6.70	0.130	0.00	0.49		26.1	bottom	7.30	0.161	0.00	0.74		
bottom	6.55	0.155	0.00	0.34		25.8							
1200 HRS							2000 HRS						
Depth	pH	Ec	% Salinity	DO	°T	Remarks	Depth	pH	Ec	% Salinity	DO	°T	Remarks
0	6.92	0.156	0.00	0.38		26.1 T measured after 2 PM	0	7.31	0.163	0.00	0.64		T not measured
1	6.90	0.156	0.00	1.05		26.1	1	7.38	0.165	0.00	0.6		
2	6.91	0.155	0.00	0.92		26	2	7.30	0.163	0.00	0.51		
3	0.96	0.164	0.00	1.25		26	3	7.28	0.165	0.00	0.36		
4	7.09	0.154	0.00	1.48		26.1	4	7.38	0.166	0.00	0.44		
5	6.96	0.150	0.00	0.84		26	5	7.35	0.165	0.00	0.7		
bottom	6.98	0.157	0.00	0.97		25.9	bottom	7.35	0.165	0.00	0.44		
1400 HRS							4000 HRS						
Depth	pH	Ec	% Salinity	DO	°T	Remarks	Depth	pH	Ec	% Salinity	DO	°T	Remarks
0	7.03	0.154	0.00	1.35		26.1 T measured after 2 PM	0	7.36	0.165	0.00	0.4		T not measured
1	6.70	0.156	0.00	0.74		25.8	1	7.43	0.165	0.00	0.41		
2	6.66	0.155	0.00	0.47		25.8	2	7.42	0.165	0.00	0.38		
3	6.81	0.156	0.00	1.25		25.6	3	7.45	0.166	0.00	0.59		
4	6.89	0.154	0.00	0.73		25.8	4	7.43	0.164	0.00	0.38		
5	6.87	0.155	0.00	1.68		25.8	5	7.43	0.165	0.00	0.47		
bottom	6.85	0.154	0.00	1.24		25.6	bottom	7.47	0.166	0.00	0.45		
1600 HRS							6000 HRS						
Depth	pH	Ec	% Salinity	DO	°T	Remarks	Depth	pH	Ec	% Salinity	DO	°T	Remarks
0	6.84	0.155	0.00	3.81		T not measured	0	7.44	0.171	0.00	0.39		T not measured
1	6.05	0.155	0.00	2.41			1	7.42	0.167	0.00	0.64		
2	6.07	0.156	0.00	3.93			2	7.54	0.167	0.00	0.52		
3	6.22	0.157	0.00	3.22			3	7.44	0.166	0.00	0.39		
4	6.22	0.156	0.00	2.53			4	7.51	0.166	0.00	0.92		
5	6.23	0.157	0.00	4.79			5	7.51	0.166	0.00	0.48		
bottom	6.26	0.156	0.00	2			6	7.47	0.165	0.00	0.49		
bottom	7.51						bottom	7.51	0.166	0.00	0.89		
1800 HRS							8000 HRS						
Depth	pH	Ec	% Salinity	DO	°T	Remarks	Depth	pH	Ec	% Salinity	DO	°T	Remarks
0	6.28	0.162	0.00	1.91		T not measured	0	7.31	0.169	0.00	0.39		T not measured
1	6.28	0.158	0.00	2.74			1	7.35	0.168	0.00	0.64		
2	6.29	0.156	0.00	3.05			2	7.45	0.167	0.00	0.52		
3	6.32	0.157	0.00	2.16			3	7.36	0.167	0.00	0.39		
4	6.39	0.157	0.00	2.03			4	7.45	0.165	0.00	0.92		
5	6.29	0.156	0.00	2.55			5	7.22	0.167	0.00	0.48		
6	6.34	0.155	0.00	3.63			6	7.43	0.168	0.00	0.49		
bottom	6.36	0.157	0.00	1.94			7	7.23	0.168	0.00	0.89		
bottom	7.23						bottom	7.23	0.168	0.00	0.89		
2000 HRS							1000 HRS						
Depth	pH	Ec	% Salinity	DO	°T	Remarks	Depth	pH	Ec	% Salinity	DO	°T	Remarks
0	7.30	0.164	0.00	0.11		T not measured	0	7.56	0.173	0.00			
1	7.42	0.159	0.00	0.23			1	7.57	0.170	0.00			
2	7.43	0.158	0.00	0.19			2	7.55	0.168	0.00			
3	7.43	0.158	0.00	0.21			3	7.57	0.170	0.00			
4	7.43	0.160	0.00	0.24			4	7.48	0.169	0.00			
5	7.45	0.159	0.00	0.23			5	7.49	0.169	0.00			
6	7.48	0.159	0.00	0.12			bottom	7.45	0.170	0.00			
bottom	7.45	0.160	0.00	0.17			bottom	7.45	0.170	0.00			
2200 HRS							Remarks						
Depth	pH	Ec	% Salinity	DO	°T	Remarks	Depth	pH	Ec	% Salinity	DO	°T	Remarks
0	7.40	0.168	0.00	0.56		T not measured	0						
1	7.40	0.130	0.00	1.04			1						
2	7.44	0.161	0.00	0.53			2						
3	7.43	0.161	0.00	0.37			3						
4	7.41	0.161	0.00	0.37			4						
5	7.45	0.162	0.00	0.37			5						
6	7.39	0.161	0.00	0.37			6						
bottom	7.39	0.162	0.00	0.32			bottom						

Table 8.2.1 Result of Salinity Intrusion Survey (3/6)

STATION 15+000 - Dugo

Table 8.2.1 Result of Salinity Intrusion Survey (4/6)

STATION 20+000 - Lal lo proper

1200 HRS							2400 HRS						
Depth	pH	Ec	% Salinity	DO	°T	Remarks	Depth	pH	Ec	% Salinity	DO	°T	Remarks
0	6.84	0.156	0.00	2.5		T not measured	0	7.62	0.166	0.00			
1	6.85	0.156	0.00	1.93			1	7.63	0.164	0.00			
2	6.85	0.156	0.00	2.39			2	7.71	0.165	0.00			
3	7.31	0.157	0.00	3.74			3	7.71	0.165	0.00			
4	7.13	0.156	0.00	2.95			4	7.75	0.165	0.00			
5	7.06	0.155	0.00	2.57			5	7.75	0.165	0.00			
bottom	7.08	0.157	0.00	2.04			6	7.71	0.165	0.00			
							bottom	7.76	0.165	0.00			
1400 HRS							2000 HRS						
Depth	pH	Ec	% Salinity	DO	°T	Remarks	Depth	pH	Ec	% Salinity	DO	°T	Remarks
0	6.75	0.158	0.00	1.85		T not measured	0						
1	6.73	0.158	0.00	1.95			1						
2	6.63	0.158	0.00	1.71			2						
3	6.55	0.159	0.00	2.59			3						
4	6.49	0.157	0.00	1.63			4						
5	6.50	0.157	0.00	2.89			5						
6	6.36	0.157	0.00	1.9			6						
7	6.27	0.157	0.00	2.14			7						
bottom	6.11	0.157	0.00	4.46			8						
							9						
1600 HRS							bottom						
Depth	pH	Ec	% Salinity	DO	°T	Remarks	0400 HRS						
0	7.52	0.159	0.00	2.01		T not measured	Depth	pH	Ec	% Salinity	DO	°T	Remarks
1	7.54	0.160	0.00	2.73			0	7.56	0.169	0.00			
2	7.58	0.160	0.00	1.51			1	7.51	0.169	0.00			
3	7.54	0.159	0.00	2.69			2	7.49	0.469	0.00			
4	7.51	0.160	0.00	1.76			3	7.46	0.169	0.00			
5	7.52	0.160	0.00	0.86			4	7.57	0.169	0.00			
6	7.38	0.157	0.00	3.76			5	7.52	0.169	0.00			
7	7.33	0.157	0.00	1.91			6	7.61	0.169	0.00			
8	7.32	0.158	0.00	1.41			7	7.61	0.169	0.00			
9	7.33	0.159	0.00	1.09			bottom	7.6	0.169	0.00			
bottom	7.29	0.159	0.00	0.72									
1800 HRS							0600 HRS						
Depth	pH	Ec	% Salinity	DO	°T	Remarks	Depth	pH	Ec	% Salinity	DO	°T	Remarks
0	7.38	0.159	0.00	2.36		T not measured	0	7.58	0.169	0.00			
1	7.37	0.159	0.00	2.92			1	7.58	0.168	0.00			
2	7.34	0.159	0.00	0.91			2	7.64	0.169	0.00			
3	7.23	0.159	0.00	1.79			3	7.65	0.169	0.00			
4	7.41	0.159	0.00	1.44			4	7.79	0.168	0.00			
5	7.40	0.160	0.00	1.17			5	7.68	0.168	0.00			
6	7.39	0.159	0.00	0.68			6	7.68	0.169	0.00			
7	7.31	0.160	0.00	1			7	7.69	0.169	0.00			
8	7.37	0.159	0.00	2.12			bottom	7.68	0.169	0.00			
9	7.39	0.160	0.00	3.22									
bottom	7.43	0.160	0.00	0.72									
2000 HRS							0800 HRS						
Depth	pH	Ec	% Salinity	DO	°T	Remarks	Depth	pH	Ec	% Salinity	DO	°T	Remarks
0	7.41	0.162	0.00			T not measured	0	7.43	0.168	0.00			
1	7.51	0.163	0.00				1	7.32	0.166	0.00			
2	7.57	0.162	0.00				2	7.36	0.167	0.00			
3	7.57	0.162	0.00				3	7.44	0.167	0.00			
4	7.61	0.163	0.00				4	7.48	0.166	0.00			
5	7.59	0.162	0.00				5	7.34	0.167	0.00			
6	7.59	0.163	0.00				6	7.42	0.167	0.00			
7	7.65	0.163	0.00				7	7.42	0.168	0.00			
bottom	7.64	0.163	0.00				bottom	7.4	0.167	0.00			
2200 HRS							1000 HRS						
Depth	pH	Ec	% Salinity	DO	°T	Remarks	Depth	pH	Ec	% Salinity	DO	°T	Remarks
0	7.67	0.165	0.00			T not measured	0	7.48	0.168	0.00			
1	7.64	0.164	0.00				1	7.48	0.168	0.00			
2	7.63	0.164	0.00				2	7.48	0.167	0.00			
3	7.65	0.166	0.00				3	7.45	0.166	0.00			
4	7.64	0.162	0.00				4	7.47	0.168	0.00			
5	7.63	0.165	0.00				5	7.47	0.168	0.00			
6	7.61	0.166	0.00				6	7.48	0.168	0.00			
7	7.58	0.166	0.00				7	7.48	0.468	0.00			
bottom	7.66	0.165	0.00				bottom	7.47	0.168	0.00			

Table 8.2.1 Result of Salinity Intrusion Survey (5/6)

STATION 25+000 - Catayuan, Lal lo

2000 HRS																
Depth	pH	Ec	% Salinity	DO	°T	Remarks	Depth	pH	Ec	% Salinity	DO	°T	Remarks			
0	6.09	0.158	0.00	1.05		T not measured	0	6.72	0.163	0.00	1.33		T not measured			
1	6.00	0.157	0.00		2.4		1	6.96	0.163	0.00		0.89				
2	6.00	0.157	0.00		2.66		2	6.99	0.163	0.00		1.25				
3	5.91	0.157	0.00		2.22		3	7.09	0.163	0.00		1.04				
4	5.87	0.159	0.00		1.35		4	7.13	0.163	0.00		0.58				
bottom	5.94	0.157	0.00		1.87		5	7.11	0.164	0.00		0.56				
							bottom	7.21	0.163	0.00		0.41				
1200 HRS																
Depth	pH	Ec	% Salinity	DO	°T	Remarks	2200 HRS									
0	5.88	0.157	0.00		2.3		Depth	pH	Ec	% Salinity	DO	°T	Remarks			
1	5.97	0.158	0.00		2.95		0	7.27	0.164	0.00			T not measured			
2	5.87	0.158	0.00		2.67		1	7.27	0.166	0.00						
3	5.93	0.158	0.00		2.78		2	7.34	0.166	0.00						
4	6.04	0.157	0.00		3.56		3	7.36	0.166	0.00						
5	6.01	0.158	0.00		3.73		4	7.35	0.166	0.00						
bottom	6.00	0.158	0.00		3.59		5	7.32	0.166	0.00						
							bottom	7.36	0.166	0.00						
1400 HRS																
Depth	pH	Ec	% Salinity	DO	°T	Remarks	0200 HRS									
0	6.14	0.159	0.00		1.39		Depth	pH	Ec	% Salinity	DO	°T	Remarks			
1	6.08	0.159	0.00		1.41		0	7.65	0.169	0.00			T not measured			
2	6.22	0.159	0.00		1.65		1	7.57	0.169	0.00						
3	6.29	0.160	0.00		2.41		2	7.55	0.169	0.00						
4	6.10	0.159	0.00		1.86		3	7.54	0.169	0.00						
5	6.13	0.159	0.00		1.25		4	7.57	0.168	0.00						
bottom	6.10	0.159	0.00		2.38		5	7.54	0.169	0.00						
							bottom	7.55	0.168	0.00						
1600 HRS																
Depth	pH	Ec	% Salinity	DO	°T	Remarks	0400 HRS									
0	6.10	0.129	0.00		0.8		Depth	pH	Ec	% Salinity	DO	°T	Remarks			
1	6.56	0.160	0.00		0.9		0	7.56	0.165	0.00			T not measured			
2	6.75	0.161	0.00		1.9		1	7.58	0.169	0.00						
3	6.97	0.162	0.00		1.87		2	7.65	0.168	0.00						
4	7.02	0.162	0.00		0.67		3	7.66	0.169	0.00						
5	7.00	0.162	0.00		1.95		4	7.65	0.169	0.00						
bottom	7.03	0.161	0.00		0.91		5	7.60	0.169	0.00						
							bottom	7.63	0.169	0.00						
1800 HRS																
Depth	pH	Ec	% Salinity	DO	°T	Remarks	0600 HRS									
0	6.22	0.164	0.00		0.2		Depth	pH	Ec	% Salinity	DO	°T	Remarks			
1	6.14	0.162	0.00		0.15		0	7.65	0.167	0.00			T not measured			
2	6.12	0.161	0.00		0.37		1	7.60	0.169	0.00						
3	6.12	0.161	0.00		1.13		2	7.61	0.169	0.00						
4	6.22	0.161	0.00		0.39		3	7.63	0.169	0.00						
5	6.26	0.162	0.00		0.53		4	7.63	0.168	0.00						
bottom	6.19	0.160	0.00		0.37		5	7.63	0.169	0.00						
							bottom	7.60	0.169	0.00						
1800 HRS																
Depth	pH	Ec	% Salinity	DO	°T	Remarks	0800 HRS									
0	6.82	0.164	0.00		0.53		Depth	pH	Ec	% Salinity	DO	°T	Remarks			
1	6.90	0.163	0.00		0.71		0	7.63	0.168	0.00			T not measured			
2	7.09	0.162	0.00		0.48		1	7.63	0.169	0.00						
3	7.18	0.161	0.00		0.37		2	7.64	0.169	0.00						
4	7.14	0.161	0.00		0.61		3	7.72	0.167	0.00						
5	7.15	0.161	0.00		0.59		4	7.69	0.169	0.00						
bottom	7.14	0.161	0.00				5	7.69	0.167	0.00						
							bottom	7.68	0.167	0.00						
2000 HRS																
Depth	pH	Ec	% Salinity	DO	°T	Remarks	1000 HRS									
0	7.14	0.162	0.00		0.32		Depth	pH	Ec	% Salinity	DO	°T	Remarks			
1	7.06	0.161	0.00		0.9		0	7.65	0.169	0.00			T not measured			
2	7.16	0.162	0.00		0.88		1	7.65	0.169	0.00						
3	7.16	0.163	0.00		0.93		2	7.64	0.169	0.00						
4	7.14	0.162	0.00		0.48		3	7.68	0.167	0.00						
5	7.18	0.163	0.00		0.9		4	7.70	0.168	0.00						
bottom	7.18	0.162	0.00		0.95		5	7.68	0.168	0.00						
							bottom	7.68	0.168	0.00						

Table 8.2.1 Result of Salinity Intrusion Survey (6/6)

STATION 30-000 - Magapit

1000 HRS						2400 HRS					
Depth	pH	Ec	% Salinity	DO	°T	Depth	pH	Ec	% Salinity	DO	°T
0	7.14	0.156	0.00	0.4		0	7.69	0.167	0.00		
2	7.19	0.156	0.00	2.13		2	7.66	0.168	0.00		
4	7.29	0.156	0.00	0.61		4	7.50	0.169	0.00		
6	7.25	0.159	0.00	1.29		6	7.51	0.168	0.00		
8	7.24	0.157	0.00	1.56		8	7.50	0.168	0.00		
10	7.23	0.157	0.00	1.52		10	7.52	0.168	0.00		
11	7.28	0.156	0.00	0.72		11	7.56	0.168	0.00		
12	7.29	0.158	0.00	1.75		12	7.68	0.168	0.00		
13	7.32	0.158	0.00	1.74		13	7.67	0.168	0.00		
14	7.35	0.159	0.00	0.87		14	7.60	0.168	0.00		
15	7.38	0.158	0.00	3.48		15	7.60	0.167	0.00		
16	7.39	0.158	0.00	3.55		16	7.61	0.168	0.00		
bottom	7.40	0.157	0.00	0.79		17	7.65	0.167	0.00		
						18	7.63	0.168	0.00		
						19	7.65	0.170	0.00		
1200 HRS						2000 HRS					
Depth	pH	Ec	% Salinity	DO	°T	Depth	pH	Ec	% Salinity	DO	°T
0	7.42	0.160	0.00	3.63		0	7.13	0.168	0.00		
2	7.38	0.159	0.00	1.77		2	7.28	0.170	0.00		
4						4	7.35	0.168	0.00		
6	7.34	0.159	0.00	0.73		6	7.39	0.168	0.00		
8	7.33	0.159	0.00	1.24		8	7.45	0.168	0.00		
10	7.35	0.158	0.00	1.46		10	7.25	0.167	0.00		
11	7.36	0.158	0.00	3.76		11	7.40	0.169	0.00		
12	7.33	0.159	0.00	0.48		12	7.39	0.168	0.00		
13	7.36	0.160	0.00			13	7.35	0.170	0.00		
14	7.26	0.161	0.00	2.33		14	7.41	0.168	0.00		
15	7.35	0.159	0.00	1.59		15	7.46	0.170	0.00		
16	7.33	0.158	0.00	2.05		16	7.45	0.168	0.00		
17	7.35	0.160	0.00	2.05		17	7.42	0.169	0.00		
18						18	7.44	0.169	0.00		
19						19	7.48	0.167	0.00		
20	7.32	0.160	0.00	2.19		20	7.45	0.169	0.00		
1400 HRS						2400 HRS					
Depth	pH	Ec	% Salinity	DO	°T	Depth	pH	Ec	% Salinity	DO	°T
0	7.00	0.160	0.00	0.14		0	7.45	0.169	0.00		
2	7.08	0.162	0.00	0.29		2	7.71	0.169	0.00		
4	7.18	0.161	0.00	0.42		4	7.72	0.170	0.00		
6	7.25	0.160	0.00	0.21		6	7.73	0.168	0.00		
8	7.18	0.161	0.00	0.1		8	7.75	0.168	0.00		
10	7.14	0.162	0.00	0.2		10	7.76	0.168	0.00		
11	7.28	0.163	0.00	0.27		11	7.75	0.168	0.00		
12	7.24	0.162	0.00	0.44		12	7.84	0.168	0.00		
13	7.23	0.161	0.00	0.32		13	7.81	0.168	0.00		
14	7.23	0.161	0.00	0.3		14	7.79	0.169	0.00		
15	7.22	0.162	0.00	0.3		15	7.77	0.168	0.00		
16	7.30	0.162	0.00	0.36		16	7.80	0.168	0.00		
17	7.41	0.163	0.00	0.23		17	7.75	0.169	0.00		
18	7.40	0.162	0.00	0.29		18	7.87	0.168	0.00		
19	7.35	0.162	0.00	0.33		19	7.87	0.168	0.00		
20	7.34	0.162	0.00	0.23		20	7.81	0.168	0.00		
1600 HRS						2400 HRS					
Depth	pH	Ec	% Salinity	DO	°T	Depth	pH	Ec	% Salinity	DO	°T
0	7.60	0.164	0.00			0	7.72	0.168	0.00		
2	7.63	0.162	0.00			2	7.70	0.170	0.00		
4	7.59	0.164	0.00			4	7.68	0.171	0.00		
6	7.67	0.162	0.00			6	7.69	0.168	0.00		
8	7.59	0.164	0.00			8	7.69	0.169	0.00		
10	7.53	0.162	0.00			10	7.81	0.169	0.00		
11	7.54	0.163	0.00			11	7.85	0.169	0.00		
12	7.63	0.162	0.00			12	7.75	0.169	0.00		
13	7.61	0.165	0.00			13	7.73	0.168	0.00		
14	7.59	0.162	0.00			14	7.85	0.169	0.00		
15	7.52	0.163	0.00			15	7.79	0.168	0.00		
16	7.51	0.163	0.00			16	7.73	0.168	0.00		
17	7.50	0.166	0.00			17	7.85	0.168	0.00		
18	7.56	0.163	0.00			18	7.72	0.168	0.00		
19	7.56	0.163	0.00			19	7.85	0.168	0.00		
20	7.56	0.163	0.00			20	7.85	0.170	0.00		
1800 HRS						2400 HRS					
Depth	pH	Ec	% Salinity	DO	°T	Depth	pH	Ec	% Salinity	DO	°T
0	7.60	0.165	0.00			0	7.85	0.170	0.00		
2	7.70	0.164	0.00			2	7.85	0.170	0.00		
4	7.67	0.164	0.00			4	7.45	0.168	0.00		
6	7.69	0.164	0.00			6	7.81	0.168	0.00		
8	7.79	0.163	0.00			8	7.50	0.169	0.00		
10	7.69	0.164	0.00			10	7.48	0.167	0.00		
11	7.73	0.164	0.00			11	7.49	0.167	0.00		
12	7.69	0.169	0.00			12	7.54	0.167	0.00		
13	7.71	0.165	0.00			13	7.66	0.169	0.00		
14	7.74	0.165	0.00			14	7.59	0.166	0.00		
15	7.72	0.165	0.00			15	7.58	0.168	0.00		
16	7.72	0.165	0.00			16	7.64	0.167	0.00		
17	7.64	0.166	0.00			17	7.66	0.169	0.00		
18	7.61	0.164	0.00			18	7.65	0.167	0.00		
19	7.57	0.164	0.00			19	7.78	0.167	0.00		
20	7.71	0.166	0.00			20	7.80	0.167	0.00		
2000 HRS						2400 HRS					
Depth	pH	Ec	% Salinity	DO	°T	Depth	pH	Ec	% Salinity	DO	°T
0	7.57	0.164	0.00			0	7.45	0.168	0.00		
2	7.58	0.165	0.00			2	7.35	0.169	0.00		
4	7.65	0.164	0.00			4	7.47	0.170	0.00		
6	7.59	0.165	0.00			6	7.37	0.169	0.00		
8	7.59	0.164	0.00			8	7.47	0.168	0.00		
10	7.62	0.165	0.00			10	7.50	0.170	0.00		
11	7.63	0.165	0.00			11	7.54	0.168	0.00		
12	7.63	0.165	0.00			12	7.59	0.168	0.00		
13	7.60	0.166	0.00			13	7.49	0.168	0.00		
14	7.56	0.164	0.00			14	7.50	0.172	0.00		
15	7.50	0.169	0.00			15	7.57	0.170	0.00		
16	7.73	0.167	0.00			16	7.57	0.172	0.00		
17	7.70	0.166	0.00			17	7.49	0.170	0.00		
18	7.58	0.168	0.00			18	7.49	0.170	0.00		
19	7.62	0.170	0.00			19	7.62	0.168	0.00		
20	7.53	0.168	0.00			20	7.58	0.169	0.00		
2200 HRS						2400 HRS					
Depth	pH	Ec	% Salinity	DO	°T	Depth	pH	Ec	% Salinity	DO	°T
0	7.57	0.165	0.00			0	7.69	0.168	0.00		
2	7.54	0.173	0.00			2	7.66	0.168	0.00		
4	7.51	0.167	0.00			4	7.50	0.169	0.00		
6	7.60	0.169	0.00			6	7.60	0.168	0.00		
8	7.48	0.166	0.00			8	7.63	0.168	0.00		
10	7.54	0.166	0.00			10	7.58	0.168	0.00		
11	7.53	0.167	0.00			11	7.54	0.168	0.00		
12	7.54	0.166	0.00			12	7.59	0.168	0.00		
13	7.50	0.167	0.00			13	7.49	0.168	0.00		
14	7.50	0.166	0.00			14	7.50	0.172	0.00		
15	7.50	0.169	0.00			15	7.57	0.170	0.00		
16	7.73	0.167	0.00			16	7.57	0.172	0.00		
17	7.70	0.166	0.00			17	7.49	0.170	0.00		
18	7.58	0.168	0.00								

Table 8.4.1 Results of Discharge Measurement at Magapit

Date	Time	Average Velocity m/s	Area m ²	Discharge m ³ /s	Gauge Height m, elevation
10-Jan-01	11:00	0.548	3,426	1,877	2.39
10-Jan-01	15:00	0.477	3,365	1,605	2.19
10-Jan-01	18:00	0.422	3,417	1,442	2.49
11-Jan-01	3:00	0.434	3,343	1,451	2.06
11-Jan-01	10:00	0.487	3,396	1,654	2.31

Mean Discharge : 1,606 m³/sec