Therefore, the following procedure was adopted to make formulae for the said seven sites.

i) For bed load, the values K_1 and P_1 were estimated by use of the Sato-Kikkawa-Ashida formula.

ii) For suspended load including wash load, the value P_2 estimated by use of the Engelund - Hansen formula, and the value K_2 was estimated from the observed data.

The obtained coefficients of the above equations are as follows:

Site	Coefficient			
	K_1	P_1	K_2	P_2
Talavera	6.745×10^{-7}	1.736	8.166×10^{-6}	1.579
Zaragoza	4.920×10^{-8}	1.678	2.825×10^{-6}	1.601
Bamban	1.567×10^{-4}	0.868	7.638×10^{-7}	2.677
San Isidro	1.186×10^{-11}	2.602	1.186×10^{-5}	1.463
Arayat	1.479×10^{-6}	0.990	1.986×10^{-6}	1.610
Candaba	1.667×10^{-7}	1.465	3.631×10^{-8}	2.134
Sulipan	2.239×10^{-8}	1.652	2.296×10^{-10}	2.903

2.6.3 Formula of Sediment Discharge

Sato-Kikkawa-Ashida formula:

$$\frac{q_B}{U_* d_m} = \phi F(T_0/T_c) \cdot \frac{U_*^2}{(\frac{r_s}{r_w} - 1) g\, d_m} \quad \text{.........................} \quad (2.4)$$

where,
q_B: bed load per unit river width per unit time ($m^3/s/m$)
U_*: friction velocity (m/sec)
d_m: mean diameter (m)
g: acceleration of gravity (9.8 m/sec^2)
T_0: tractive force of flow (t/m^2)
T_c: critical tractive force (t/m^2)
F: function of T_0/T_c
r_s: unit weight of bed material (t/m^3)
r_w: unit weight of water (t/m^3)

Engelund-Hansen formula:

$$q_s = 0.05\ r_s V^2 \sqrt{\frac{d_{50}}{g(\frac{r_s}{r_w} - 1)}} \left[\frac{T_o}{(r_s - 1)d_{50}}\right]^{3/2} \quad \text{.......... (2.5)}$$

where, q_s: suspended load per unit river width per unit time (t/sec/m)

V: mean velocity (m/sec)

d_{50}: grain size of 50% of bed materials

2.6.4 *Sedimentation*

Applying the daily discharge during the period from 1966 to 1975, annual sediment yield at the said seven sites are calculated as shown in Table 2.18, using the eq. 2.3. The annual sediment yields in 10-year average are as follows:

River	Site	Catchment Area (km^2)	Ave. Annual Sediment ($t/km^2/yr$)
Talavera	Talavera Br.	401	262
Rio Chico	Zaragoza Br.	1,675	134
Bamban	Bamban Br.	206	1,213
Pampanga	San Isidro Br.	3,472	685
Pampanga	Arayat Br.	6,532	387
Pampanga	Candaba Br.	7,270	163
Pampanga	Sulipan Br.	7,715	59

CHAPTER 3 FLOOD DISCHARGE

3.1 Methodology for Analysis

3.1.1 Review of Previous Study

Report on PD/CS Area Development Project

In the study, the synthetic series of daily rainfall were adopted on the basis of the principle of random events of rainfall in everyday. Using these rainfall, 30 years daily discharges were calculated with the runoff simulation program named MM08. This is called "natural discharge" during the period of 30 years from 1946 to 1975. The probable peak discharges were estimated on the basis of the natural daily discharge as shown in Table 3.1.

However, such a synthetic rainfall series differs from the actual precipitation characteristics explained as follows:

a) Tropical cyclones, tropical storms and depressions which are the main causes of large floods in the Pampanga River Basin bring the successive heavy precipitation over as much as several days or more. The time-wise distributions of the synthetic rainfall are not similar to the observed rainfall data, even if the total volume of monthly rainfall is the same as the observed one.

b) In case of actual rainfall, the high correlation exists usually among the adjacent rainfall stations on the distributions of daily rainfall. However, the intensity and distribution of calculated synthetic series of daily rainfall are so random and no relation exists among the adjacent stations in the basin. The outflow at the confluent points have therefore a tendency to smaller amount than the real flow when it is calculated from the synthetic rainfall data.

For example, the synthetic series of daily rainfall is compared with the observed data as shown in Fig. 3.1. The definite difference on the rainfall pattern can be recognized between two rainfall series. Furthermore, probabilistic evaluation is made on the peak discharge at some tributaries and main channel stations for both calculated values and observed discharge data. The results are shown in Table 3.2. The values derived from the observed data are bigger than the ones from the synthetic rainfall at three stations out of four. Those differences are presumed mainly due to the different patterns of rainfall.

Report on Hydraulic Design Studies of Pampanga River Control Project, MPW, 1961

In the study, 100-year daily rainfall was adopted as design rainfall on the basis of rainfall records in the Pampanga basin. Using the rainfall, flood discharges were calculated by the unit hydrograph method. The adopted 100-year design rainfall and the estimated flood peak discharges are shown in Table 3.3. The assumption and used data for the method are as follows;

a) The daily rainfall records in the period from 1911 to 1937 were used to estimate the maximum 1-day through 7-day rainfall magnitude. The annual maximum basin rainfall was calculated by the Isohyetal map methods based on the records mentioned above.

b) The unit hydrographs were prepared at the following 3 stations based on the observed discharge hydrograph in the period from 1920 to 1955.

	Watershed	Station	Catchment Area (km^2)
1.	Upper Pampanga and Rio-Chico	Arayat	6,126
2.	Candaba	Calumpit	1,485
3.	Angat	Calumpit	939
	Total at Calumpit, Bulacan		8,550

c) The rainfall loss was considered in the form of infiltration on the basis of the data on the past typical floods.

In the estimation of 100 year design rainfall, it was not considered large rainfall such as May 1976 rainfall which was the biggest rainfall in the past with 7-day continuous rainfall of 877 mm at Cabanatuan City. This fact implies an underestimate in runoff volume of flood hydrograph, although the estimated peak discharge may be accepted as reasonable.

3.1.2 Methodology for Analysis

After reviewing the previous study reports and scrutinizing all the existing data, it was concluded to analyze by adopting the design rainfall based on the historical flood rainfall pattern with probabilistic analysis and runoff simulation model. There are many methods to estimate discharge from the rainfall. Among them, the storage function method was adopted, because discharge hydrograph is necessary to study the storage effects due to discharge control by dam, channel, and swamp.

The storage function method needs the time-wise and aerial distribution of rainfall. The typical flood from the past records was selected in consideration of aerial distribution of rainfall, magnitude of discharge and other elements. The selected flood is May 1976 which was a biggest in rainfall volume at Cabanatuan City and also a biggest in water level at Arayat and Sulipan since 1960. The storm characteristics of the flood are as follows:

Storm Characteristics of Flood of May 1976:

The flood was caused by the typhoon "DIDANG" which crossed the Luzon Island from May 21 to May 23, 1976. The typhoon made a loop over Central Luzon while crossing the Luzon Island. The amount of point rainfall at Cabanatuan City from May 21 to May 27 was 877 mm. The maximum daily rainfall was 226.1 mm on May 23. The daily discharge at Arayat exceeded 1,700 m^3/s from May 24 to May 30. The maximum peak discharges at Arayat and Sulipan were 2,780 m^3/s on May 25 and 2,710 m^3/s on May 27 respectively.

Probable Discharges:

In runoff calculation, probability of exceedance of average rainfall over the Pampanga River Basin was estimated based on the correlation between the basin average rainfall and rainfall at Cabanatuan City.

The probable discharges were calculated by storage function method by use of an electronic computer.

3.2 Runoff Analysis

3.2.1 Rainfall Probability of Exceedance

Using 1-day through 7-day annual maximum rainfall records in the period from 1951 to 1979 at Cabanatuan City as shown in Table 3.4, the probable rainfalls are estimated by Gumbel method as shown in Table 3.5 and Fig. 3.2. To estimate the probable rainfall of the basin average of the Pampanga River, the rainfall correlations between Cabanatuan City and basin average for 1-day through 7-day are established as shown in Fig. 3.3, using the daily rainfall records on high range in the period from 1970 to 1979. Then the probable rainfalls of the basin average are estimated from the rainfall at Cabanatuan City through the correlation curves. The estimated rainfalls of the basin average are shown in Table 3.6.

3.2.2 Flood Runoff Calculation

The equation of the storage function method is as follows:

Equation for the drainage area:

$$S_1 = Kq_1^p \quad \text{(storage equation)} \quad \dots\dots\dots\dots \quad (3.1)$$

$$r - q_1 = \frac{dS_1}{dt} \quad \text{(continuity equation)} \quad \dots\dots\dots\dots \quad (3.2)$$

where, S_1: storage in a drainage area

q_1: effective rainfall

r: rainfall in the drainage area

K,p: storage-coefficient

The factors such as primary runoff percentage, f1, and saturation rainfall, Rsa are used for estimates of effective rainfall. The following assumptions were used in the calculation.

i) The runoff consists of flood and base flows.

ii) The drainage area is divided into the infiltration and primary areas.

iii) In the infiltration area, the rainfall is infiltrated up to saturation point after that all rainfall becomes runoff. The rainfall volume from the beginning to saturation point is called the saturation rainfall (Rsa).

iv) In the primary area, all rainfall changes to runoff, and a ratio of primary and drainage areas is called the primary runoff percentage (f_1).

The effective rainfall in the primary area, q_1 is calculated by the following equation which is a transformation of Eqs. 3.1 and 3.2.

$$q_1(t) = 2 \left[r(t) - \frac{K}{\Delta t} \left\{ q_1^p(t) - q_1^p(t-\Delta t) \right\} \right] - q_1(t-\Delta t) \quad \ldots\ldots (3.3)$$

Where Δt is time interval in calculation. In the calculation, the trial and error procedure is used. The effective rainfall in the saturation area, q_{sa1} is calculated by the following equation.

$$q_{sa1} = 0, \quad (\sum r < Rsa) \quad \ldots\ldots (3.4)$$

$$q_{sa1} = q_1, \quad (\sum r > Rsa) \quad \ldots\ldots (3.5)$$

Where $\sum r$ is cumulative rainfall from the beginning.

The discharge from a drainage area was calculated by use of the following equation.

$$\overline{Q} = \frac{1}{3.6} f_1 A q_1 + \frac{1}{3.6} (1 - f_1) A q_{sa1} + Q_1 \quad \ldots\ldots (3.6)$$

$$Q(t) = \overline{Q}(t - T_1) \quad \ldots\ldots (3.7)$$

where,

- Q: runoff from a drainage area (m^3/s)
- $\overline{Q}$: hypothetical runoff (m^3/s)
- q_1: effective rainfall in the primary area
- q_{sa1}: effective rainfall in the saturation area
- f_1: primary runoff percentage
- A: drainage area (km^2)
- Q_1: base flow (m^3/s)
- T_1: lag-time

Equation for the channel:

$S_1 = K\, O_1^p - T_1\, O_1$ (storage eq.) .... (3.8)

$I - O_1 = \frac{ds_1}{dt}$ (continuity eq.) .... (3.9)

$O(t) = O_1(t + T_1)$ (eq. of retarded runoff) .... (3.10)

where, S_1: storage in the channel (m^3/s)

O_1: discharge at the middle point in the channel (m^3/s)

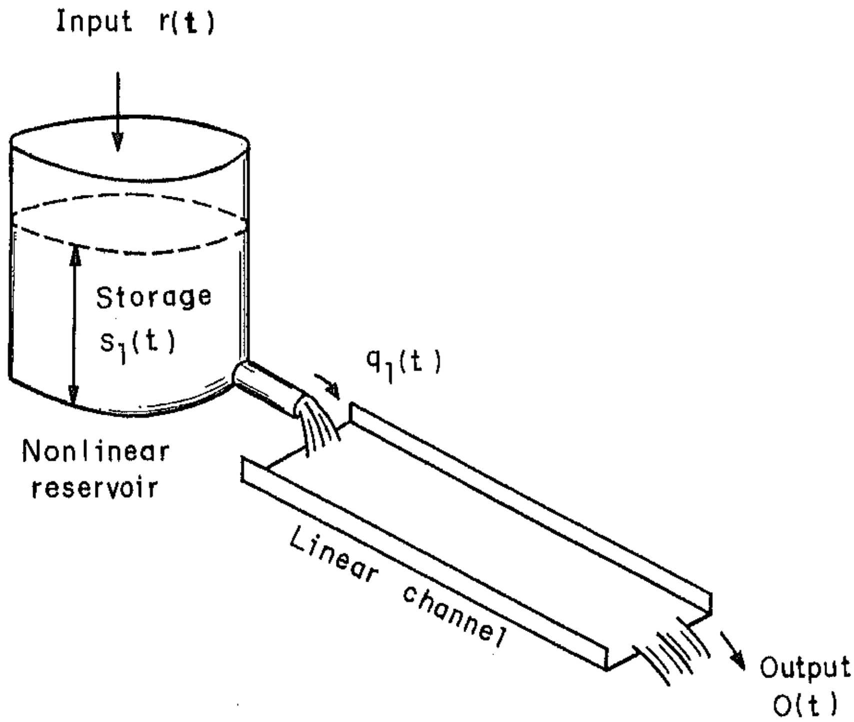
I: inflow at the channel entrance (m^3/s)

K, p: storage coefficient

T_1: time-lag

O: outflow at the channel exit (m^3/s)

Basic model element of storage function method



The Pampanga River and the Guagua River Basins were divided into 45 sub-basins for the analysis as shown in Fig. 3.4. The calculation model for the analysis is shown in Fig. 3.5.

3.2.3 Estimate of Storage Coefficients

To determine the storage coefficients in the Pampanga Basin, the runoff calculations were carried out about selected floods of Oct. 1973, Aug. 1974 and May 1976 which were selected in consideration of the data on hourly rainfall and water level records. The following check points were selected for the calculated runoff hydrographs.

River	Check Point
Pampanga	San Isidro
Rio Chico	Zaragoza
Angat	Longos

Thiessen's method was used for the calculation of average rainfall. For the estimation of storage coefficients, trial and error procedure was used. After several tentative calculations, the storage coefficients in the Pampanga River Basin were obtained as shown in Table 3.7. The storage coefficients on channel were assumed as shown in Table 3.8, based on the channel conditions as shown in Table 3.9. The calculated discharge hydrographs at the checking points are shown in Fig. 3.6 together with the observed discharge. The calculated discharges at the stations are compiled in DATA BOOK IV.

3.3 Probable Flood Discharge

Using the estimated storage coefficients, the flood runoff hydrographs were calculated for the return periods of 5-year, 10-year, 20-year, 50-year and 100-year. The hourly rainfall distribution in the flood of May 1976 was applied as the basic rainfall for the calculation. The probable rainfall on each sub-basin was assumed in proportion to the actual basin rainfalls.

For the calculation in the case of the present conditions, the storage coefficient of the channel for the flood of May 1976 was applied assuming that the river channel condition has not been changed since 1976. For the case of the probable flood, the storage coefficient of the channel was obtained from channel capacity in the conditions after completion of the projects of the Proposed San Antonio-Cabanatuan Levee and the Rio Chico River Control. These storage coefficients are shown in the foregoing Table 3.8.

The storage effects by reservoirs were also considered: the Pantabangan and Angat dams for the present conditions. The results of calculation are shown in Table 3.10. The outputs of computer on flood discharge are compiled in DATA BOOK IV.

3.4 Comparison of Flood Discharge

For comparison purpose, the peak flood discharges at main stations are summarized in Table 3.11, which shows differences in values as estimated by MPW, TAHAL and the Team.

As described in the foregoing Section 3.1.1, the adopted rainfall for runoff analysis by TAHAL is the synthetic rainfall. When it is calculated from the synthetic rainfall, the outflow at the confluent points have a tendency to be smaller than the real flow. On the other hand, the method for runoff analysis as adopted by MPW is the unit hydrograph. In the estimation of the design rainfall, it was not considered large rainfall such as May 1976 rainfall which was the biggest rainfall in the past. This fact implies an underestimate in runoff volume of flood hydrograph, although the estimated peak discharge may be accepted.

The method for runoff analysis as adopted by the Team is the storage function method. The adopted coefficients of the method are obtained from the data on the past flood records. The calculated flood hydrographs agree with the observed values of the past floods of Oct. 1973, Aug. 1974 and May 1976 as shown in Fig. 3.6. Thus the probable flood discharges as estimated by the Team may be accepted as reasonable.

CHAPTER 4 HYDRAULIC ANALYSIS BY SIMULATION MODEL

4.1 Simulation Model

4.1.1 General

The hydraulic simulation model was developed by the Team in order to calculate the flood water level on the San Antonio Swamp, the Candaba Swamp and the Pampanga River for the purposes of flood control planning. The model includes:

a. San Antonio Swamp

b. Candaba Swamp

c. the Pampanga River on the stretch (Cabiao-Manila Bay),

d. the rivers flowing into the Candaba Swamp such as San Miguel, Bulu, Garlang and Maasim originating in the Sierra Madre,

e. the Cabiao-Candaba Floodway,

f. the Angat River as far east as the expressway bridge,

g. the Labangan Floodway on the stretch (Calumpit-Manila Bay),

h. the various natural and artificial openings between the Candaba Swamp, the Pampanga and Angat Rivers.

The network of hydraulic simulation model is shown schematically in Fig. 4.1. The model is considered to calculate the flood retarding effects of the swamps of the lower Pampanga River, simulating the existing natural system giving hourly flood levels and the flooded areas in the San Antonio and Candaba Swamps. It also simulates flood water levels and discharges at intermediate points along the Pampanga River.

The simulation model program was drawn up to simulate hydraulic conditions in and around the Candaba Swamp. In principle, this program follows the natural sequence of flows, i.e., rivers coming from the east discharge into the swamp.

The discharges from the Upper Pampanga Basin at Cabiao and the Rio Chico-Talavera Basin are considered as inputs. As long as water levels at Cabiao are below +9 m (the assumed crest of the floodway), no water enters the Candaba Swamp at that point. However, when water levels at Cabiao exceed +9 m, the Cabiao - Candaba Floodway passes the excess flows to the Candaba Swamp according to gradient of water level between Cabiao and the Candaba Swamp. The direction of flow i.e., from the river to the Candaba Swamp or vice versa, as well as the rate of calculated flow at 5 points along the Pampanga River and 1 point along the Angat River are determined by comparison of calculated water levels in the river and in the swamp.

Model outputs are: discharges and water levels at 18 locations along the Pampanga River, the Angat River, the Hagonoy River and the Labangan Floodway, water levels and volumes retained in the swamps, and inflows and outflows of the swamps.

4.1.2 Equation for Water Level on Swamp

When water passes through a swamp, the difference between inflow and outflow is equal to the rate of storage of water in a swamp; that is,

$$\frac{ds}{dt} = I - Q \quad \text{......} \quad (4.1)$$

where, ds/dt: change in storage during a period dt
I: average inflow during dt
Q: average outflow during dt

Eliminating ds from the above equation using the following eqs. 4.2, 4.3 and 4.4,

$$ds = F\Delta H = \frac{F_{t-\Delta t} + F_t}{2} (H_t - H_{t-\Delta t}) \quad \text{......} \quad (4.2)$$

$$I = 1/2\ (I_{t-\Delta t} + I_t) \quad \text{......} \quad (4.3)$$

$$Q = 1/2\ (Q_{t-\Delta t} + Q_t) \quad \text{......} \quad (4.4)$$

and solving for H_t, the equation 4.5 is obtained.

$$H_t = H_{t-\Delta t} + \frac{\Delta t}{F_{t-\Delta t} + F_t} \left\{ (I_{t-\Delta t} + I_t) - (Q_{t-\Delta t} + Q_t) \right\} \quad \text{.....} \quad (4.5)$$

where, H: water level of swamp
F: water surface area of swamp

4.1.3 Equation for Water Level on Channel

In general equation for unsteady, nonuniform flow in open channel is expressed as follows:

$$-\frac{aH}{ax} = \frac{av}{2g} \cdot \frac{av}{ax} + \frac{1}{g} \cdot \frac{av}{at} + S_f \quad \text{......} \quad (4.6)$$

The dimensionless form of the forms in the eq. 4.6 is

$$\frac{aH}{ax} = \text{Total slope}$$

$$\frac{av}{2g} \cdot \frac{av}{ax} = \text{Acceleration slope with distance}$$

$$\frac{I}{g} \cdot \frac{av}{at} = \text{Acceleration slope with time}$$

$$S_f = \text{Friction slope}$$

All 4 terms are dimensionless slopes. It is significant to examine the magnitude of each in any real problem to evaluate the relative significance of each. The magnitude of each term shows that the terms of the acceleration slope with distance and with time are to be rather small compared with the friction slope. As a result, neglect it so that,

$$-\frac{dH}{dx} = S_f \quad \text{...} \quad (4.7)$$

where, dH/dx: rate of change of depth H with distance x

Eliminating S_f from the above equation using the following equation,

$$S_f = \left(\frac{Q\ n}{AR^2/3}\right)^2 \quad \text{..} \quad (4.8)$$

and solving for H_t, the following equation is obtained.

$$H_t = H_{t-\Delta t} + \left(\frac{Q\ n}{AR^2/3}\right)^2 \cdot \Delta x \quad \text{...........................} \quad (4.9)$$

where H: water level of channel

Q: average discharge during dt

A: average cross-section of channel during dt

R: average hydraulic depth during dt

4.1.4 Equation for Overflow-discharge

The flow over a wide-crested weir with free flow may be expressed by

$Q = KBh_1\sqrt{2gh_1}$ .... (4.10)

where, Q: overflow discharge

B: length of weir crest

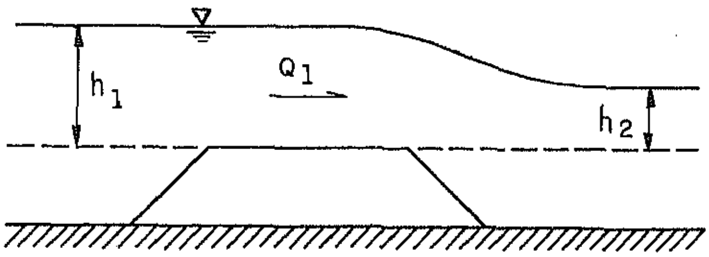
h_1: difference between elevation of water surface upstream from weir and elevation of weir

g: acceleration of gravity

k: coefficient

The coefficient K is determined experimentally. In this study, K = 0.35 was used.

The submerging of a wide-crested weir is illustrated in the following figure.



The flow over a wide-creasted weir with submerged flow may be expressed by

$Q_1 = K_1 \; B \; h_2\sqrt{2g(h_1 - h_2)}$ .... (4.11)

where, h_1, h_2: defined in the above figure

K_1: coefficient

The coefficient K_1 is determined experimentally. In this study, $K_1 = 0.91$ was used.

The following value is used to discriminate the flow conditions.

$h_2/h_1 \leqq 2/3$: free flow

$h_2/h_1 > 2/3$: submerged flow

4.1.5 Flow Charts of Model

The flow charts of the program of the simulation model used in this study are presented in Fig. 4.2.

4.2 Calculations and Results under the Existing Conditions

To determine hydraulic parameters and to establish interrelationships between phenomena, hydraulic calculations by use of the simulation model were carried out with regard to the selected floods of July 1972, Oct. 1973, Aug. 1974 and May 1976. The water gage stations at Arayat, Candaba and Sulipan were selected as check points for the calculated water level hydrographs. After several tentative calculations, the parameters were determined. The calculated results are summarized in Table 4.1 in terms of maximum. The calculated water level hydrographs at the check points for the above-mentioned floods are shown in Fig. 4.3 together with the observed water levels. As the calculated water level hydrographs agree with the observed values, the simulation model developed by the Team may be accepted as reasonable.

Using this hydraulic simulation Model, flood water levels under the existing conditions were calculated with regard to the probable floods of 5-yr, 10-yr, 20-yr, 50-yr and 100-yr. The calculated results are summarized in Table 4.2 in terms of maximum. The flood discharge distribution and the maximum water level at the major stations for the 100-yr flood are illustrated in Fig. 4.4. The output of computer on calculations for the probable floods are compiled in DATA BOOK V.

Table 2.1 (1) LOCATION OF RAINFALL STATION

No.	Station Name	Lat. N	Long. E	Province
1.	Tris Dam Tayabo San Jose City	15°51'08"	121°01'04"	Nueva Ecija
2.	Pantabangan Dam	15°50'45"	121°08'45"	"
3.	Palayupay Pantabangan	15°49'34"	121°06'25"	"
4.	Camanacsacan San Jose City	15°46'25"	120°59'17"	"
5.	Pris Dam Rizal	15°43'42"	121°05'35"	"
6.	Tondod San Jose City	15°43'16"	120°58'06"	"
7.	Ltris Dam Llanera	15°42'10"	121°00'10"	"
8.	Baloc Santo Domingo	15°38'24"	120°53'16"	"
9.	Sibul Talavera	15°38'12"	120°57'34"	"
10.	Pinahan General Natividad	15°37'43"	121°03'36"	"
11.	Pbris Dam Natividad	15°36'30"	121°06'00"	"
12.	Sapan Buho General Tinio	15°35'32"	121°05'24"	"
13.	Murcon Dam Talavera	15°34'31"	120°59'18"	"
14.	Ilog Baliwag	15°33'	120°48'	"
15.	Quezon	15°32'47"	120°48'45"	"
16.	San Juan Aliaga	15°32'	120°46'	"
17.	Bantug Talavera	15°30'33"	120°54'47"	"
18.	Bangad Cabanatuan	15°30'12"	121°02'20"	"
19.	Pamaldan Cinco-Cinco Cabanatuan	15°29'32"	120°55'30"	"
20.	Cabanatuan City	15°29'	120°58'	"
21.	San Jose Peñaranda	15°28'50"	121°00'30"	"
22.	Gabaldon	15°28'	121°20'	"
23.	Zaragoza	15°26'55"	120°46'54"	"
24.	Concepcion Zaragoza	15°26'48"	120°45'02"	"
25.	Soledad Sant Rosa	15°26'12"	121°00'18"	"
26.	Zaragoza	15°26'08"	120°45'00"	"
27.	Mallorca San Leonardo	15°22'37"	120°58'48"	"
28.	Lambakin Jaen	15°22'12"	120°51'59"	"
29.	Papaya	15°20'08"	121°02'24"	"
30.	Gapan	15°19'	120°57'	"
31.	Mangino Gapan	15°18'45"	120°58'10"	"
32.	San Isidro	15°17'55"	120°54'10"	"
33.	Manggs San Isidro	15°14'50"	120°54'50"	"
34.	Concepcion Cabiao	15°14'30"	120°49'15"	"
35.	Bulak Gapan	15°14'10"	120°58'45"	"
36.	Cabiao	15°14'05"	120°54'30"	"
37.	Sibul Spring	15°09'54"	121°06'22"	Bulacan
38.	Batasan San Miguel	15°09'30"	120°55'15"	"
39.	Salacot San Miguel	15°09'	120°59'	"
40.	Santa Rita San Miguel	15°08'30"	120°57'30"	"
41.	Calawitan San Ildefonso	15°05'	120°55'	"
42.	Talacsan San Rafael	14°58'	120°59'	"
43.	Sabang Baliwag	14°58'	120°55'	"
44.	Marungo Angat	14°56'	121°02'	"
45.	Makinabang Baliwag	14°55'	120°53'	"
46.	Angat	14°54'	121°10'	"

(to be continued)

Table 2.1 (2) LOCATION OF RAINFALL STATION

No.	Station Name	Lat. N	Long. E	Province
47.	San Lorenzo Norzagaray	14°54'	121°02'	Bulacan
48.	Ipo Norzagaray	14°52'	121°09'	"
49.	Catmon Malolos	14°51'	120°49'	"
50.	Borol II Balagtas	14°49'	120°54'	"
51.	Minuyan San Jose del Monte	14°49'	121°03'	"
52.	Santa Maria	14°49'	120°57'	"
53.	Obando	14°42'	120°56'	"
54.	Surgui Camiling	15°51'	120°25'	Tarlac
55.	San Clemente	15°43'	120°21'	"
56.	Anoling Camiling	15°40'	120°15'30"	"
57.	Santa Ignacia	15°36'	120°25'	"
58.	Gerona	15°36'	120°37'	"
59.	Mambaran Mayantoc	15°34'	120°20'	"
60.	San Jacinto Victoria	15°33'	120°35'	"
61.	Amucao Tarlac	15°28'	120°41'	"
62.	Carangian Tarlac	15°27'30"	120°33'	"
63.	Hacienda Luisita San Miguel	15°27'	120°38'	"
64.	Armenia Dam Tarlac	15°27'	120°30'	"
65.	La Paz	15°23'	120°43'	"
66.	Dolores Capas	15°21'30"	120°35'30"	"
67.	Arayat	15°09'50"	120°46'30"	Pampanga
68.	San Agustin Arayat	15°09'	120°46'	"
69.	Candaba	15°07'06"	120°51'43"	"
70.	Santa Cruz Porac	15°04'	120°33'	"
71.	Bahay Pare Candaba	15°02'24"	120°52'48"	"
72.	San Fernando	15°02'	120°42'	"
73.	Cabambagan Bacolor	15°00'	120°39'	"
74.	San Matias Santo Tomas	15°00'	120°42'	"
75.	Becuran Santa Rita	15°00'	120°34'	"
76.	Balucoc Apalit	14°58'	120°51'	"
77.	Cansinala Apalit	14°58'	120°46'36"	"
78.	Sulipan Apalit	14°56'08"	120°45'30"	"
79.	Masantol	14°52'	120°42'	"
80.	Lubao	14°50'	120°36'	"
81.	Talisai Balanga	14°41'	120°33'	Bataan
82.	Mariveles	14°26'	120°29'	"

Table 2.2 (1) RAINFALL AT CABANATUAN CITY

Month	Monthly Rainfall (mm)		
	Average	Maximum	Minimum
Jan.	7.4	67.3	0
Feb.	5.3	49.5	0
Mar.	10.9	69.8	0
Apr.	31.2	261.4	0
May	172.3	931.1	7.7
June	262.8	590.8	64.2
July	302.2	1,064.7	141.9
Aug.	406.6	622.7	213.0
Sep.	309.7	628.7	144.6
Oct.	173.4	514.1	12.2
Nov.	125.7	344.4	14.0
Dec.	52.0	197.1	0
Annual	1,868.6	2,369.5	1,338.9
Wet Season (May - Oct.)	1,627.0		
Percent (%)	87.1		

Source: PAGASA

Table 2.2 (2) MONTHLY RAINFALL AT CABANATUAN CITY (1951-1979)

(Unit: mm)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
1951	1.8	0	0	14.5	193.0	224.3	278.5	446.3	188.3	45.5	214.2	88.6	1,695.0
1952	3.1	3.5	11.5	10.9	231.1	355.7	142.6	308.4	308.4	210.1	42.5	65.9	1,693.7
1953	1.0	3.0	27.4	25.4	255.7	208.0	215.1	485.7	213.3	120.1	148.8	71.7	1,775.2
1954	1.5	17.0	5.3	89.4	39.7	94.1	225.9	289.3	262.0	152.3	162.1	0.3	1,338.9
1955	22.3	0.8	0	16.5	79.0	130.9	218.5	417.2	278.8	134.1	95.6	30.7	1,424.4
1956	5.1	0	2.5	261.4	66.3	64.2	162.3	355.7	505.1	113.8	289.7	90.0	1,916.1
1957	23.2	1.0	7.3	13.7	88.6	333.7	271.8	365.1	217.8	82.3	176.2	0	1,600.7
1958	0	19.0	0	0	55.6	310.2	286.6	264.2	367.9	-	-	-	-
1959	-	-	32.8	0	42.1	94.6	179.0	558.0	214.7	80.0	138.7	9.9	-
1960	2.6	49.5	10.2	55.6	160.5	245.0	231.7	622.7	452.7	403.2	39.9	3.3	2,276.9
1961	0	1.3	56.0	2.0	156.1	590.9	460.0	492.3	267.5	158.5	82.4	1.0	2,268.0
1962	4.6	0	2.8	37.2	133.5	308.4	468.4	280.0	453.8	35.6	57.6	0.3	1,782.2
1963	0	27.4	1.3	0	145.0	528.3	217.3	389.3	385.1	12.2	14.0	63.4	1,783.3
1964	9.3	1.4	69.8	7.2	124.2	400.6	223.7	429.9	288.8	330.0	287.5	197.1	2,369.5
1965	0	0	0	135.6	162.9	354.4	608.1	262.9	245.0	119.4	116.1	19.4	2,023.8
1966	1.8	0	7.9	24.4	586.8	116.1	223.5	462.0	226.8	114.1	344.4	54.6	2,162.4
1967	2.6	0	0.8	14.1	202.3	384.8	262.1	400.2	628.7	255.8	86.7	0	2,238.1
1968	5.8	0	0	22.1	144.1	90.4	242.0	567.0	338.5	125.5	51.3	0	1,586.7
1969	6.5	0	0	6.8	87.2	283.0	360.7	242.4	314.8	128.2	57.5	13.0	1,500.1
1970	1.5	1.3	4.9	22.8	16.6	234.6	169.0	361.9	179.3	222.6	76.5	34.5	1,325.5
1971	1.3	2.3	11.5	0.8	279.7	237.2	354.5	213.0	239.4	360.1	161.9	186.7	2,048.5
1972	67.3	0	31.5	12.9	190.2	144.4	1,064.7	434.9	305.4	17.5	38.7	18.4	2,325.9
1973	5.6	3.3	0.3	1.9	126.4	249.5	246.4	610.3	146.9	-	191.9	9.0	-
1974	-	0	1.0	73.2	14.5	323.6	258.3	628.3	144.6	400.0	226.6	72.3	2,142.4
1975	16.1	0.3	0.3	16.8	7.7	121.4	205.9	253.6	296.7	255.5	35.0	139.4	1,348.7
1976	2.4	-	11.2	0.8	931.1	468.6	141.9	338.6	350.3	28.5	32.6	44.8	2,350.8
1977	6.4	0	8.9	6.9	109.6	170.7	389.0	-	285.9	-	190.9	-	-
1978	0	5.4	0	-	-	291.1	433.4	604.9	563.8	514.1	33.9	15.7	-
1979	-	-	-	0.2	194.4	-	224.8	302.4	140.9	87.4	127.0	12.5	-
Average	7.4	5.3	10.9	31.2	172.3	262.8	302.2	406.6	309.7	173.4	125.7	52.0	1,868.6
Max.	67.3	49.5	69.8	261.4	931.1	590.0	1,064.7	622.7	628.7	514.1	344.4	197.1	2,369.5
Min.	0	0	0	0	7.7	64.2	141.9	213.0	144.6	12.2	14.0	0	1,338.9

Table 2.3 STAGE-DISCHARGE RELATION OBSERVED BY TEAM (AUG. - NOV., 1980)

Station	Observed Date	Gage Height (El. m)	Discharge Area (m^3/s)	Discharge (m^3/s)
Sulipan, Apalit, Pampanga	Sep. 12, 1980	1.83	710.4	817.7
	Sep. 19, 1980	2.58	811.5	930.2
	Sep. 26, 1980	1.66	641.7	618.9
	Nov. 7, 1980	4.28	845.0	1,571.0
Pasig, Candaba, Pampanga	Sep. 12, 1980	3.23	562.3	518.9
	Sep. 19, 1980	5.36	827.8	1,078.7
	Sep. 26, 1980	2.58	489.2	440.4
San Agustin, Arayat, Pampanga	Sep. 10, 1980	5.07	431.0	433.2
	Sep. 17, 1980	6.58	597.0	706.5
	Sep. 24, 1980	4.88	412.0	387.3
	Nov. 10, 1980	8.60	1,832.0	2,035.4
San Isidro, Nueva Ecija	Aug. 13, 1980	9.74	69.8	24.0
	Sep. 11, 1980	10.40	204.7	165.9
	Sep. 18, 1980	11.52	427.6	557.2
	Sep. 25, 1980	10.20	190.0	129.0
	Nov. 6, 1980	16.38	1,460.7	3,140.8
	Nov. 7, 1980	15.14	1,191.2	1,848.3
	Nov. 10, 1980	11.30	400.2	440.5
Sto. Rosario, Zaragoza, Nueva Ecija	Aug. 14, 1980	11.50	106.2	79.0
	Sep. 11, 1980	13.39	214.2	217.4
	Sep. 18, 1980	14.23	328.7	315.4
	Sep. 25, 1980	12.61	201.4	155.6

Table 2.4(1) DISCHARGE RATING CURVE

Station	Period	a	b	n
1. Pampanga R. Pialuan, Pantabangan, N.E.	up to Aug. 69	80.0	1.00	2.19
	Aug. 69	80.0	0.68	2.19
	Jun. 71	80.0	1.00	2.19
	Jul. 71	80.0	1.60	2.19
	Jun. 72	80.0	1.00	2.19
	Feb. 72	80.0	0	2.19
2. Coronel R. Bangkerohan, Bongabon, N.E.	up to Aug. 78	84.0	0.70	1.23
3. Pompanga R. Valdefuente, Cabanatuan City, N.E.	up to Dec. 64	15.0	-0.50	3.62
	May 66	15.0	0.75	3.62
	Nov. 66	15.0	0.69	3.62
	Oct. 68	15.0	0.89	3.60
	Dec. 68	15.0	0.79	3.62
	Jul. 69	15.0	0.70	3.62
	Jul. 69	15.0	0.32	3.62
	Feb. 70	15.0	0.65	3.62
	Apr. 70	15.0	0.55	3.62
	Dec. 70	15.03	0.75	3.62
	Dec. 70	15.0	0.50	3.62
	Dec. 71	15.0	0.75	3.62
4. Chico R. Gen. Tinio, N.E.	up to Jun. 71	28.25	1.15	3.82
	Jul. 72	28.25	1.00	3.85
	Dec. 75	28.25	0.70	3.85
5. Sumacbao R. Pias, Gen. Tinio N.E.	up to Jul. 71	49.5	0.40	1.29
	Dec. 75	49.5	0.22	1.79
6. Peñaranda R. (R.R. Bridge) San Jose, Peñaranda	up to Dec. 75	15.1	25.90	3.87
7. Peñaranda R. San Vicente, Gappan, N.E.	up to Aug. 74	3.0	1.90	5.00
	Dec. 75	3.0	0.20	5.00
8. Pampanga R. San Vicente, Cabiao, N.E.	up to Dec. 65	44.0	3.10	1.53
	Mar. 66	44.0	3.00	1.53
	Nov. 67	44.0	3.10	1.53
	Dec. 68	44.0	1.62	1.53

Remarks: Form of rating curve: $Q = a(H - b)^n$

Table 2.4(2) DISCHARGE RATING CURVE

Station	Period	a	b	n
9. Talavera R, Kaboboloonan, Taravera, N.E.	up to Sep. 63	4.85	0.80	2.40
	Nov. 66	4.85	0.30	2.40
	Dec. 66	4.85	0.15	2.40
	Nov. 67	4.85	0.70	2.40
	Nov. 69	4.85	-0.10	2.40
	Mar. 70	4.85	-0.30	2.40
	Dec. 75	4.85	-0.75	2.40
10. Rio Chico R, Sto. Rosario Zaragoza, N.E.	up to Oct. 60	0.65	2.00	3.10
	Jun. 61	0.65	0.50	3.10
	Apr. 66	0.65	0.90	3.10
	Nov. 73	0.65	1.00	3.10
	Feb. 74	0.65	6.50	3.10
	Apr. 74	0.65	1.00	3.10
	Dec. 75	0.65	6.80	3.10
11. Pampanga R, San Agustin, Arayat, Pampanga	up to Nov. 73	16.82	3.48	2.13
	Dec. 75	16.82	0	2.13
12. Bulu R. Malibay, San Miguel Bulacan	up to Dec. 75	1.86	1.00	2.22
13. San Miguel R, San Vicente, Sn. Miguel, Bulacan	up to Jun. 67	10.7	18.10	1.72
	Nov. 67	10.7	18.00	1.72
	Mar. 68	10.7	18.65	1.72
	Jul. 68	10.7	18.24	1.72
	Dec. 75	10.7	17.00	1.72
14. Garlang R, Garlang, San Ildefonso, Bulacan	up to Dec. 67	3.55	1.55	1.85
	Dec. 67	3.55	1.25	1.85
	Jun. 72	3.55	1.55	1.85
	Jul. 72	3.55	1.00	1.85
	Dec. 75	3.55	1.55	1.85
15. Maasim R, Diliman, San Rafael, Bulacan	up to Dec. 75	13.25	0.44	2.07
16. Maasim R, Bahay-Pare, Candaba, Pampanga	up to Sep. 66	3.02	0.55	2.33
	Sep. 68	3.02	0.83	2.33
	Nov. 72	3.02	1.30	2.33
	Dec. 75	3.02	0.30	2.33
17. Angat (below Ipo Dam) Norzagaray, Bulacan	up to Dec. 75	25.2	0.90	3.31
18. Labangan R, Bagbag Calumpit, Bulacan	up to Nov. 66	9.5	9.4	2.59
	Jan. 67	9.5	9.7	2.59
	Dec. 75	9.5	9.4	2.54

Table 2.4(3) DISCHARGE RATING CURVE

Station	Period	a	b	n
19. Pasig-Potrero R, Cabetican, Bacolor, Pampanga	up to Dec. 75	16.0	0	2.10
20. Parac R, Del Carmen, Floridablanca, Pampanga	up to Sep. 66	19.55	2.91	1.83
	Dec. 66	19.55	3.08	1.83
	May 67	19.55	3.22	1.83
	Dec. 67	19.55	3.00	1.83
	Apr. 68	19.55	3.22	1.83
	Dec. 75	19.55	3.17	1.83
21. Gumain R, Pabanlag, Floridablanca,	up to Jul. 63	69.0	0	2.50
	Jun. 64	69.0	0.09	2.51
	Dec. 64	59.6	0.03	1.08
	Apr. 66	59.6	0.14	1.08
	May 66	59.6	0	1.08
	Aug. 69	59.6	0.3	1.08
	Jul. 72	59.6	0	1.08
	Dec. 75	59.6	0.53	1.08
22. Caulaman R, Pabanlag, Floridablanca, Pampanga	up to Aug. 63	13.5	0.40	3.37
	Dec. 63	13.5	0.50	3.37
	Jan. 66	13.5	0.18	3.37
	May 66	13.5	0.55	3.37
	Jul. 67	13.5	0.74	3.37
	Dec. 67	13.5	0.69	3.37
	Aug. 68	13.5	0.56	3.37
	Feb. 69	13.5	0.69	3.37
	Jul. 69	13.5	0.62	3.37
	Aug. 69	13.5	0.80	3.37
	Sep. 70	13.5	0.66	3.37
	Mar. 71	13.5	0.61	3.37
	Nov. 71	13.5	0.57	3.37
	Mar. 72	13.5	0.66	3.37
	Jul. 72	13.5	0.54	3.37
	Dec. 75	13.5	0.60	3.37
23. Baliwag R, Catalanacan, Muñoz, N.E.	up to Dec. 75	17.1	0	2.31
24. Bayabas R, Pulong, Sampaloc, Angat, Bulacan	up to Jun. 69	27.75	0.60	2.94
	Aug. 69	27.75	0.97	2.94
	Dec. 71	27.75	0.66	2.94
	Dec. 75	27.75	0.54	2.94
25. Pantabangan R, Pantabangan, N.E.	up to Dec. 75	42.0	1.05	2.06

Table 2.4(4) DISCHARGE RATING CURVE

Station	Period	a	b	n
26. Sulipan Cut-off Channel, Sulipan, Apalit, Pampanga	up to May 70	36.0	9.80	2.24
	Dec. 75	36.0	10.80	2.24
	Nov. 77	72.966/1	-1.229/1	2/1
	Nov. 77	47.087/2	-1.934/2	2/2
	Nov. 77	28.794/3	-3.170/3	2/3
27. Angat R, Longos, Pulilan, Bulacan	up to Jun. 68	36.2	10.60	1.75
	Nov. 72	36.2	10.25	1.75
	Dec. 75	36.2	0.65	1.75
28. Pampanga R, Pasig-Cardaba, Pampanga	up to May 66	38.0	10.25	1.70
	Jun. 67	56.0	10.40	1.55
	Oct. 68	56.0	10.85	1.55
	Dec. 68	56.0	10.28	1.55
	Sep. 69	56.0	10.39	1.55
	Oct. 69	56.0	11.00	1.55
	Apr. 74	56.0	10.10	1.55
	Jun. 74	56.0	9.90	1.55
	Dec. 75	56.0	10.25	1.55
	Nov. 77	91.470/4	0/4	2/4
	Nov. 77	56.671/5	-0.270/5	2/5
	Nov. 77	20.017/6	-1.991/6	2/6
29. Pampanga R, Sulipan, Apalit, Pampanga	up to Dec. 76	26.0	-8.50	2.00

Remarks:
/1: $H \leq 1.65m$
/2: $1.65m < H \leq 2.50m$
/3: $2.50m < H \leq 5.0$ m
/4: $H \leq 1.00m$
/5: $1.00m \leq H \leq 2.25m$
/6: $2.25m < H \leq 7.0$ m

Table 2.5 DISCHARGE CORRELATION COEFFICIENTS BETWEEN STATIONS

Gage Station	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
1. Pampanga R. Pialuan, Pantabangan, Nueva Ecija		0.497	0.843	0.504	0.288	0.151	0.212	0.821	0.606	0.585	0.770	-0.676	0.033	0.338	0.058	0.683	0.075	0.373	-0.001	0.544	0.737	0.742	0.535	0.034	0.653	0.620	0.488	0.756	—
2. Coronel R. Bangkerohan, Bongabon, Nueva Ecija	0.497		0.808	0.785	0.712	0.468	0.456	0.916	0.423	0.663	0.830	0.916	0.563	0.606	0.271	0.661	0.395	0.618	0.137	0.413	0.391	0.575	0.666	0.349	0.701	0.606	0.646	0.737	0.457
3. Pampanga R. Valdefuente, Cabanatuan City, N.E.	0.843	0.808		0.729	0.703	0.402	0.245	0.949	0.565	0.549	0.953	0.716	0.546	0.130	0.565	0.782	0.575	0.720	-0.001	0.683	0.831	0.810	0.745	0.027	0.593	0.893	0.738	0.925	—
4. Chico R. Gen. Tinio, Nueva Ecija	0.504	0.785	0.729		0.683	0.511	0.331	0.803	0.558	0.708	0.823	0.881	0.581	0.695	0.341	0.682	0.412	0.731	0.241	0.361	0.566	0.696	0.713	0.404	0.702	0.667	0.573	0.762	0.282
5. Sumacbao R. Pias, Gen. Tinio, Nueva Ecija	0.288	0.712	0.703	0.683		0.596	0.454	0.740	0.458	0.502	0.655	0.716	0.554	0.541	0.282	0.677	0.401	0.546	0.109	0.293	0.513	0.403	0.498	0.272	0.435	0.482	0.452	0.575	0.007
6. Penaranda R. (R.R. Bridge) San Jose, Penaranda	0.151	0.468	0.402	0.511	0.596		0.295	0.533	0.306	0.320	0.431	0.270	0.178	0.483	0.185	0.409	0.496	0.323	0.052	0.017	0.390	0.249	0.384	0.289	0.240	0.277	0.318	0.361	—
7. Penaranda R. San Vicente, Gapan, Nueva Ecija	0.212	0.456	0.245	0.331	0.454	0.295		-0.107	0.295	0.399	0.434	-0.499	0.442	0.396	0.610	0.423	0.293	0.353	0.106	0.329	0.269	0.492	0.326	0.260	0.317	0.380	0.552	0.466	0.691
8. Pampanga R. San Vicente, Cabiao, Nueva Ecija	0.821	0.916	0.949	0.803	0.740	0.533	-0.107		0.816	0.904	0.953	0.783	0.715	-0.475	0.624	0.814	0.429	0.879	-0.031	0.848	0.883	0.711	0.799	0.524	0.391	0.871	0.852	0.965	—
9. Talavera R. Kabobolonan, Talavera, Nueva Ecija	0.606	0.423	0.565	0.558	0.458	0.306	0.295	0.816		0.623	0.621	0.662	0.245	0.473	0.276	0.576	0.228	0.486	0.064	0.307	0.581	0.472	0.502	0.205	0.486	0.385	0.465	0.732	0.112
10. Rio Chico R. Sto. Rosario, Zaragoza, N. Ecija	0.585	0.663	0.549	0.708	0.502	0.320	0.399	0.904	0.623		0.834	0.729	0.365	0.549	0.325	0.794	0.357	0.700	0.162	0.529	0.576	0.524	0.671	0.528	0.673	0.623	0.526	0.769	0.142
11. Pampanga R. San Agustin, Arayat, Pampanga	0.770	0.830	0.953	0.823	0.655	0.431	0.434	0.953	0.621	0.834		0.810	0.510	0.679	0.365	0.770	0.426	0.774	0.198	0.510	0.626	0.683	0.730	0.363	0.748	0.736	0.660	0.936	0.062
12. Bulu R. Malibay, San Miguel, Bulacan	-0.676	0.916	0.716	0.881	0.716	0.270	-0.499	0.783	0.662	0.729	0.810		0.442	-0.360	0.506	0.760	0.323	0.811	0.154	0.698	0.542	0.768	0.928	0.131	0.607	0.884	0.801	0.801	0.620
13. San Miguel R. San Vicente, Sn. Miguel, Bul.	0.033	0.563	0.546	0.581	0.554	0.178	0.442	0.715	0.245	0.365	0.510	0.442		0.543	0.568	0.385	0.312	0.549	0.274	0.384	0.342	0.519	0.493	0.571	0.506	0.232	0.422	0.337	0.079
14. Garlang R. Garlang, San Ildefonso, Bulacan	0.338	0.606	0.130	0.695	0.541	0.483	0.396	-0.475	0.473	0.549	0.679	-0.360	0.543		0.630	0.622	0.408	0.403	0.489	0.097	0.554	0.609	0.620	0.108	0.656	0.434	0.246	0.423	—
15. Maasim R. Diliman, San Rafael, Bulacan	0.058	0.271	0.565	0.341	0.282	0.185	0.610	0.624	0.276	0.325	0.365	0.506	0.568	0.630		0.400	0.227	0.321	0.144	0.152	0.320	0.334	0.335	0.424	0.266	0.338	0.257	0.191	0.006
16. Maasim R. Bahay-Pare, Candaba, Pampanga	0.683	0.661	0.782	0.682	0.677	0.409	-0.423	0.814	0.576	0.794	0.770	0.760	0.385	0.622	0.400		0.479	0.648	0.174	0.533	0.550	0.670	0.623	0.339	0.662	0.745	0.597	0.729	0.117
17. Angat (below Ipo Dam) Norzagaray, Bulacan	0.075	0.395	0.575	0.412	0.401	0.496	0.293	0.429	0.228	0.357	0.426	0.323	0.312	0.408	0.227	0.479	-	0.196	0.097	0.105	0.342	0.441	0.291	0.325	0.282	0.394	0.184	0.255	—
18. Labangen R. Bagbag, Calumpit, Bulacan	0.373	0.618	0.720	0.731	0.546	0.323	0.353	0.879	0.486	0.700	0.774	0.811	0.549	0.403	0.321	0.648	0.196		0.187	0.551	0.582	0.594	0.631	0.445	0.583	0.551	0.646	0.754	0.248
19. Pasig-Potrero R. Cabetican, Bacalor, Pampanga	-0.001	0.137	-0.001	0.241	0.109	0.052	0.106	-0.031	0.064	0.162	0.198	0.154	0.274	0.489	0.144	0.174	0.097	0.187		0.003	0.128	0.298	0.140	0.092	0.180	0.288	0.045	0.033	0.492
20. Porac R. Del Carman, Floridablanca, Pampanga	0.544	0.413	0.683	0.361	0.293	0.017	0.329	0.848	0.307	0.529	0.510	0.698	0.384	0.097	0.152	0.533	0.105	0.551	0.003		0.529	0.517	0.345	0.102	0.440	0.563	0.458	0.450	—
21. Gumain R. Pabanlag, Floridablanca, Pampanga	0.737	0.391	0.831	0.566	0.513	0.390	0.269	0.883	0.581	0.576	0.626	0.542	0.342	0.554	0.320	0.550	0.342	0.582	0.128	0.529		0.433	0.591	0.174	0.601	0.491	0.496	0.691	0.140
22. Caulaman R. Pabanlag, Floridablanca, Pampanga	0.742	0.575	0.810	0.696	0.403	0.249	0.492	0.711	0.472	0.524	0.683	0.768	0.519	0.609	0.334	0.670	0.441	0.594	0.298	0.511	0.433		0.505	0.425	0.616	0.665	0.236	0.732	0.717
23. Baliwag R. Catalancan, Munoz, Nueve Ecija	0.535	0.666	0.745	0.713	0.498	0.384	0.326	0.799	0.502	0.671	0.730	0.928	0.493	0.620	0.335	0.623	0.291	0.631	0.140	0.345	0.591	0.505		0.297	0.716	0.611	0.634	0.717	0.148
24. Bayabas R. Pulong, Sampaloc, Angat, Bulacon	0.034	0.349	0.027	0.404	0.272	0.289	0.260	0.524	0.205	0.528	0.363	0.131	0.571	0.108	0.424	0.339	0.325	0.445	0.092	0.102	0.174	0.425	0.297		0.259	0.314	-0.003	0.053	-0.062
25. Pantabangan R. Pantabangan, Nueva Ecija	0.653	0.701	0.593	0.702	0.435	0.240	0.317	0.391	0.486	0.673	0.748	0.607	0.506	0.656	0.266	0.662	0.282	0.583	0.180	0.440	0.601	0.616	0.716	0.259		0.673	0.369	0.554	—
26. Sulipan Cut-off Channel, Sulipan, Apalit, Pamp.	0.620	0.606	0.893	0.667	0.482	0.288	0.380	0.871	0.385	0.623	0.736	0.884	0.232	0.484	0.338	0.745	0.394	0.551	0.288	0.563	0.491	0.665	0.611	0.314	0.673		0.425	0.712	0.401
27. Angat R. Longos, Pulilan, Bulacan	0.488	0.646	0.738	0.573	0.452	0.318	0.552	0.852	0.465	0.526	0.660	0.801	0.422	0.246	0.257	0.597	0.184	0.646	0.045	0.458	0.496	0.236	0.634	-0.003	0.369	0.425		0.701	0.250
28. Pampanga R. Pasig-Candaba, Pampanga	0.756	0.737	0.925	0.762	0.575	0.361	0.466	0.965	0.732	0.769	0.936	0.801	0.337	0.423	0.191	0.729	0.255	0.754	0.033	0.450	0.691	0.732	0.717	0.053	0.554	0.712	0.701		0.033
29. Pampanga R. Sulipan, Apalit, Pampanga	—	0.457	—	0.282	0.007	—	0.691	—	0.112	0.142	0.062	0.620	0.079	—	0.006	0.117	—	0.248	0.492	—	0.140	0.717	0.148	-0.062	—	0.401	0.250	0.033	

Table 2.6 (1) DISCHARGE CORRELATION FORMULA BETWEEN STATIONS

(Correlation coefficient ≥0.7)

Station		a	b
1. Pantabangan, N.E.	3. Cabanatuan City, N.E.	0.4643	-0.87
	8. Cabiao, N.E.	0.1481	5.04
	11. Arayat, Pampanga	0.1634	6.05
	12. Floridablanca, Pampanga (Gumain R.)	4.7496	-0.74
	22. Floridablanca, Pampanga (Caulaman R.)	11.9462	13.53
	28. Pasig-Candaba, Pampanga	0.1823	0.92
2. Bongabon, N.E.	3. Cabanatuan City, N.E.	0.3281	22.55
	4. Gen Tinio, N.E. (Chico R.)	1.8304	26.90
	5. Gen Tinio, N.E. (Sumacbao R.)	1.6122	9.63
	8. Cabiao, N.E.	0.2170	34.10
	11. Arayat, Pampanga	0.0984	23.15
	12. San Miguel, Bulacan (Bulu R.)	36.1991	39.21
	25. Pantabangan, N.E.	1.3564	19.13
	28. Pasig-Candaba, Pampanga	0.1005	28.22
3. Cabanatuan City, N.E.	1. Pantabangan, N.E.	1.5626	14.87
	2. Bongabon, N.E.	2.0234	-24.12
	4. Gen Tinio, N.E. (Chico R.)	4.9417	25.57
	5. Gen Tinio, N.E. (Sumacbao R.)	5.8471	-33.31
	8. Cabiao, N.E.	0.6595	11.60
	11. Arayat, Pampanga	0.2922	19.92
	16. Candaba, Pampanga	6.7135	19.17
	18. Calumpit, Bulacan	0.7779	16.71
	21. Floridablanca, Pampanga (Gumain R.)	8.8928	10.39
	22. Floridablanca, Pampanga (Caulaman R.)	20.7257	32.32
	23. Muñoz, N.E.	6.0048	26.06
	26. Aparit, Pampanga	0.4673	25.74
	27. Pulian, Bulacan	0.9646	11.45
	28. Pasig-Candaba, Pampanga	0.3907	8.64

Remarks: $Y = ax + b$

Table 2.6 (2) DISCHARGE CORRELATION FORMULA BETWEEN STATIONS

(Correlation coefficient ≥0.7)

Station		a	b
4. Gen. Tinio, N.E. (Chico R.)	2. Bongabon, N.E.	0.3386	-4.55
	3. Cabanatuan City N.E.	0.1100	0.67
	8. Cabiao, N.E.	0.0750	0.90
	10. Zaragoza, N.E.	0.2130	3.10
	11. Arayat, Pampanga	0.0448	0.94
	12. San Miguel, Bulacan (Bulu R.)	10.4767	5.56
	18. Calumpit, Bulacan	0.1243	1.42
	23. Muñoz, N.E.	0.9033	3.25
	25. Pantabangan, N.E.	0.7131	-5.61
	28. Pasig-Candaba, Pampanga	0.0439	0.83
5. Gen. Tinio, N.E. (Sumacbao R.)	2. Bongabon, N.E.	0.3176	8.60
	3. Cabanatuan City, N.E.	0.0870	11.19
	8. Cabiao, N.E.	0.0665	11.37
	12. San Miguel, Bulacan, (Bulu R.)	19.4489	13.57
8. Cabiao, N.E.	1. Pantabangan, N.E.	5.3782	-19.88
	2. Bongabon, N.E.	3.9388	-117.08
	3. Cabanatuan City, N.E.	1.3809	-5.42
	4. Gen. Tinio, N.E. (Chico R.)	8.9922	30.46
	5. Gen. Tinio, N.E. (Sumacbao R.)	8.7671	-50.22
	9. Talavera, N.E.	15.6389	-80.19
	10. Zaragoza, N.E.	2.3439	36.37
	11. Arayat, Pampanga	0.4371	27.49
	12. San Miguel, Bulacan (Bulu R.)	237.9469	52.06
	13. San Miguel, Bulacan (San Miguel R.)	3.9002	-10.94
	20. Floridablanca, Pampanga (Porac R.)	62.6906	-51.34
	21. Floridablanca, Pampanga (Gumain R.)	15.5798	11.09
	22. Floridablanca, Pampanga (Caulaman R.)	26.9083	65.05
	23. Muñoz, N.E.	8.1707	34.46
	26. Apalit, Pampanga	-0.3879	49.37
	27. Pulilan, Bulacan	1.7817	21.22
9. Talavera, N.E.	8. Cabiao, N.E.	0.0444	7.44
	28. Pasig-Candaba, Pampanga	0.0341	11.65

Table 2.6 (3) DISCHARGE CORRELATION FORMULA BETWEEN STATIONS

(Correlation coefficient ≥0.7)

Station		a	b
10. Zaragoza, N.E.	4. Gen. Tinio, N.E. (Chico R.)	2.3742	15.68
	8. Cabiao, N.E.	0.3562	-7.17
	11. Arayat, Pampanga	0.1713	4.13
	12. San Miguel, Bulacan (Bulu R.)	29.8953	26.21
	16. Candaba, Pampanga	3.2656	4.09
	18. Calumpit, Bulacan	0.4574	11.86
	28. Pasig-Candaba, Pampanga	0.1884	0.23
11. Arayat, Pampanga	1. Pantabangan, N.E.	3.6813	54.39
	2. Bongabon, N.E.	7.0262	-86.03
	3. Cabanatuan City, N.E.	3.1198	-49.03
	4. Gen. Tinio, N.E. (Chico R.)	15.1621	60.46
	8. Cabiao, N.E.	2.0978	-40.41
	10. Zaragoza, N.E.	4.0759	70.02
	12. San Miguel, Bulacan (Bulu R.)	535.1787	32.87
	16. Candaba, Pampanga	16.5825	43.84
	18. Calumpit, Bulacan	2.3874	55.44
	23. Muñoz, N.E.	17.9582	68.47
	25. Pentabangan, N.E.	14.2920	-95.84
	26. Apalit, Pampanga	1.2963	121.48
	28. Pasig-Candaba, Pampanga	1.1809	-25.80
12. San Miguel, Bulacan (Bulu R.)	2. Bongabon, N.E.	0.0235	-0.82
	3. Cabanatuan City, N.E.	0.0037	0.01
	4. Gen. Tinio, N.E. (Chico R.)	0.0759	-0.21
	5. Gen. Tinio, N.E. (Smacbao R.)	0.0291	-0.21
	8. Cabiao, N.E.	0.0028	0
	10. Zaragoza, N.E.	0.0189	-0.19
	11. Arayat, Pampanga	0.0013	0.10
	16. Candaba, Pampanga	0.0918	-0.31
	18. Calumpit, Bulacan	0.0144	-0.34
	22. Floridablanca, Pampanga (Caulman R.)	0.0946	0.18
	23. Muñoz, N.E.	0.0807	-0.27
	26. Apalit, Pampanga	0.0060	-0.42
	27. Pulilan	0.0163	-0.36
	28. Pasig-Candaba, Pampanga	0.0017	0.07

Table 2.6 (4) DISCHARGE CORRELATION FORMULA BETWEEN STATIONS

(Correlation coefficient ≥0.7)

Station		a	b
13. San Miguel Bulacan (San Miguel R.)	8. Cabiao, N.E.	0.1403	16.56
16. Candaba, Pampanga	3. Cabanatuan City, N.E.	0.0928	0.70
	8. Cabiao, N.E.	0.0656	0.21
	10. Zaragoza, N.E.	0.1943	3.53
	11. Arayat, Pampanga	0.0360	2.87
	12. San Miguel, Bulacan (Bulu R.)	6.5736	6.25
	26. Apalit, Pampanga	0.0577	5.71
	28. Pasig-Candaba, Pampanga	0.0407	1.48
18. Calumpit, Bulacan	3 Cabanatuan City, N.E.	0.6834	15.96
	4. Gen. Tinio, N.E. (Chico R.)	4.3316	27.88
	8. Cabiao N.E.	0.4807	6.94
	10. Zaragoza, N.E.	1.0788	28.17
	11. Arayat, Pampanga	0.2523	15.45
	12. San Miguel, Bulacan (Bulu R.)	47.2982	37.93
	28. Pasig-Candaba, Pampanga	0.3232	12.74
20. Floridablance, Pampanga (Porac R.)	8. Cabiao, N.E.	0.0119	1.30
21. Floridablanca, Pampanga (Gumain R.)	1. Pantabangan, N.E.	0.1162	3.77
	3. Cabanatuan City, N.E.	0.0788	1.03
	8. Cabiao, N.E.	0.0514	0.88
22. Floridablanca, Pampanga (Caulaman R.)	1. Pantabangan, N.E.	0.0469	0.25
	3. Cabanatuan City, N.E.	0.0322	-0.54
	8. Cabiao, N.E.	0.0201	-0.40
	12. San Miguel, Bulacan (Bulu R.)	6.7328	-0.25
	28. Pasig-Candaba, Pampanga	0.0109	-0.20
	29. Aparit, Pampanga	0.0848	-27.18
23. Muñoz, N.E.	3. Cabanatuan City, N.E.	0.0945	0.22
	4. Gen. Tinio, N.E. (Chico R.)	0.5668	2.76
	8. Cabiao, N.E.	0.0446	1.37
	11. Arayat, Pampanga	0.0299	2.25
	12. San Miguel, Bulacan (Bulu R.)	10.8393	4.46
	25. Pantabangan, N.E.	0.4940	-3.52
	28. Pasig-Candaba, Pampanga	0.0312	0.84

Table 2.6 (5) DISCHARGE CORRELATION FORMULAE BETWEEN STATIONS

(Correlation coefficient ≥0.7)

Station		a	b
25. Pantabangan, N.E.	2. Bongabon, N.E.	0.3683	5.89
	4. Gen. Tinio, N.E. (Chico R.)	0.7021	16.71
	11. Arayat, Pampanga	0.0397	14.88
	23. Muñoz, N.E.	1.0537	15.97
26. Apalit, Pampanga	3. Cabanatuan City, N.E.	1.7206	-28.52
	8. Cabiao, N.E.	1.1165	-5.87
	11. Arayat, Pampanga	0.4213	-0.10
	12. San Miguel, Bulacan (Bulu R.)	135.0229	97.01
	16. Candaba, Pampanga	9.6924	-8.53
	28. Pasig-Candaba, Pampanga	0.3934	-6.34
27. Pulilan, Bulacan	3. Cabanatuan City, N.E.	0.5793	18.37
	8. Cabiao, N.E.	0.4221	5.37
	12. San Miguel, Bulacan (Bulu R.)	40.7777	35.57
	28. Pasig-Candaba, Pampanga	0.1836	25.77
28. Pasig-Candaba, Pampanga	1. Pantabangan, N.E.	3.1886	92.03
	2. Bongabon, N.E.	5.4702	-52.78
	3. Cabanatuan City, N.E.	2.1693	-0.05
	4. Gen. Tinio, N.E. (Chico R.)	13.3512	82.36
	8. Cabiao, N.E.	1.5899	-30.30
	9. Talavera, N.E.	15.9399	-82.40
	10. Zaragoza, N.E.	3.1765	90.51
	11. Arayat, Pampanga	0.7438	45.91
	12. San Miguel, Bulacan (Bulu R.)	404.7615	39.31
	16. Candaba, Pampanga	13.2323	76.83
	18. Calumpit, Bulacan	1.7797	66.99
	22. Floridablanca, Pampanga (Caulaman R.)	49.6901	111.01
	23. Muñoz, N.E.	16.6894	91.19
	26. Apalit, Pampanga	1.3058	116.47
	27. Pulilan, Bulacan	2.7160	40.80
29. Apalit, Pampanga	22. Floridablanca, Pampanga (Caulaman R.)	8.8194	393.35

Table 2.7(1) TEN-DAY AVERAGE DISCHARGE AT ARAYAT OF PAMPANGA RIVER

Year	Period	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1968	1 - 10	46.8	35.8	28.1	22.3	22.6	28.1	46.4	399.0	1,365.5	829.7	53.9	171.8
	11 - 20	41.6	29.8	32.7	20.1	21.2	25.3	36.9	463.0	855.9	261.6	42.7	48.8
	21 - 31	38.8	26.2	23.0	19.9	24.6	26.3	318.7	916.3	647.9	103.0	51.0	34.5
1969	1 - 10	36.7	28.4	13.8	14.6	9.4	22.4	29.7	1,318.0	284.8	339.5	43.2	50.5
	11 - 20	36.1	19.1	14.6	16.1	15.8	60.9	43.6	778.9	585.7	207.5	33.0	76.2
	21 - 31	30.1	16.5	12.9	10.8	16.9	25.4	375.0	144.4	301.0	104.4	130.4	41.0
1970	1 - 10	32.7	20.7	12.9	20.2	11.3	24.8	75.1	177.8	1,429.5	405.4	500.0	243.7
	11 - 20	26.3	16.2	11.4	20.1	11.0	133.9	188.5	290.0	1,032.5	933.9	215.6	136.5
	21 - 31	23.1	13.7	12.4	14.9	12.8	101.3	92.1	456.9	342.9	620.5	391.8	94.9
1971	1 - 10	56.1	31.6	22.9	21.7	64.3	278.9	304.4	583.4	195.6	845.8	125.5	455.1
	11 - 20	42.0	32.4	53.7	19.0	54.2	507.3	711.8	590.7	263.0	1,730.2	119.3	219.3
	21 - 31	35.9	28.8	24.9	15.3	48.0	359.9	1,076.8	139.0	326.5	596.9	448.7	282.0
1972	1 - 10	739.3	78.9	25.4	34.8	21.0	73.1	704.0	1,897.2	566.1	189.9	160.7	97.9
	11 - 20	114.2	66.0	26.7	25.6	23.1	79.5	2,070.8	1,438.9	728.0	57.4	94.8	63.1
	21 - 31	68.8	34.1	35.4	22.4	68.6	70.2	2,022.7	1,301.5	489.3	42.1	66.6	32.0
1973	1 - 10	23.3	23.8	6.7	2.6	2.1	4.4	19.8	45.5	372.0	354.8	64.6	94.8
	11 - 20	19.4	22.4	5.0	3.5	4.1	19.2	92.4	144.3	219.0	1,496.2	63.8	63.7
	21 - 31	16.5	15.0	2.9	2.4	3.4	28.1	46.3	602.8	138.3	710.8	595.1	34.4
1974	1 - 10	27.7	12.3	19.8	8.7	18.2	42.8	40.3	145.1	336.2	95.4	1,323.6	345.3
	11 - 20	21.3	11.2	13.5	7.5	7.7	538.7	119.3	1,102.4	253.5	974.6	990.1	391.1
	21 - 31	16.1	10.2	10.9	15.2	10.3	64.3	666.3	1,216.0	106.0	1,021.7	404.6	243.8
1975	1 - 10	151.8	101.1	42.8	43.8	44.5	117.5	84.8	62.3	150.6	159.0	173.7	41.9
	11 - 20	109.1	59.3	40.7	43.2	41.6	81.5	41.2	240.1	202.5	84.0	41.9	98.7
	21 - 31	160.8	56.4	47.7	61.4	64.4	102.1	45.5	212.5	359.4	358.7	26.3	376.3
1976	1 - 10	223.1	56.6	27.4	13.4	15.8	277.0	969.2	336.6	394.8	559.5	367.3	98.2
	11 - 20	159.9	37.6	23.3	23.3	28.6	244.5	280.0	642.0	524.9	376.2	347.2	94.4
	21 - 31	96.0	24.5	15.2	12.8	1,720.7	255.4	226.7	568.6	651.9	363.1	195.4	70.4
1977	1 - 10	77.9	32.3	17.8	13.5	10.1	46.1	87.1	364.9	640.2	500.8	111.6	221.7
	11 - 20	64.7	23.1	15.8	12.2	9.2	39.0	92.9	336.4	726.8	242.0	887.6	131.6
	21 - 31	47.2	19.8	14.8	11.1	36.9	70.8	231.4	430.5	616.5	138.1	887.6	132.4
1978	1 - 10	81.7	87.6	33.2	47.3	59.5	113.2	169.1	281.3	1,087.0	1,030.0	1,727.3	429.6
	11 - 20	91.1	72.4	37.9	52.0	44.8	153.2	307.7	662.3	896.0	1,074.9	475.4	375.1
	21 - 31	91.7	57.8	42.3	55.9	42.5	220.0	495.5	1,117.0	1,075.9	626.9	407.1	305.9

Table 2.7(2) TEN-DAY AVERAGE DISCHARGE AT ZARAGOZA OF RIO-CHICO RIVER

Year	Period	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1968	1 - 10	4.5	3.7	2.7	1.4	3.0	4.8	9.8	144.3	203.1	146.0	2.0	13.4
	11 - 20	4.0	3.2	2.6	1.1	2.8	5.3	8.7	118.2	71.0	46.7	1.1	5.4
	21 - 31	3.9	2.7	1.8	0.9	3.8	4.5	92.8	199.0	69.9	7.6	0.6	2.4
1969	1 - 10	1.8	2.0	1.8	1.4	0.6	2.8	272.4	39.0	48.8	52.1	2.8	4.3
	11 - 20	2.1	2.0	1.6	1.1	3.9	5.3	183.5	105.9	100.3	48.3	2.5	4.8
	21 - 31	2.1	1.9	1.2	0.8	2.7	49.2	33.6	36.7	51.6	15.0	5.5	3.4
1970	1 - 10	3.2	2.8	2.2	0.1	0.1	8.2	14.2	48.9	262.3	47.6	37.4	11.2
	11 - 20	3.5	2.6	2.0	0.0	1.7	31.1	35.4	61.8	244.8	113.9	11.9	7.3
	21 - 31	2.9	2.4	2.1	0.0	2.5	10.5	29.3	131.3	45.6	51.7	13.9	8.5
1971	1 - 10	6.7	5.9	3.6	0.0	1.0	18.6	47.2	88.4	41.1	155.4	10.5	32.1
	11 - 20	5.6	5.5	1.7	0.0	11.7	100.2	121.9	142.1	69.4	279.1	15.6	11.3
	21 - 31	5.6	5.0	0.5	0.0	13.5	95.9	213.2	15.6	58.1	56.6	37.2	7.6
1972	1 - 10	46.1	8.4	6.3	2.1	5.4	10.1	113.0	337.4	136.3	43.3	5.3	3.9
	11 - 20	7.3	7.7	4.6	1.3	6.6	23.6	272.3	226.7	164.7	9.7	4.9	4.3
	21 - 31	6.4	6.4	2.9	1.4	8.7	20.4	308.8	272.7	143.6	5.8	3.2	4.2
1973	1 - 10	3.2	0.4	1.1	0.4	0.4	1.7	4.3	18.9	109.0	52.3	9.7	9.5
	11 - 20	2.4	0.0	0.9	0.6	3.4	4.1	10.7	42.9	56.0	314.2	6.3	6.3
	21 - 31	1.5	0.0	0.5	0.4	2.3	5.5	10.8	157.1	28.0	81.5	31.7	4.3
1974	1 - 10	4.3	3.0	1.5	0.2	2.3	21.1	7.1	51.2	57.7	19.5	20.9	242.9
	11 - 20	4.6	6.6	1.1	1.3	1.2	68.8	18.8	226.2	71.6	207.3	13.3	112.6
	21 - 31	4.4	2.1	0.6	3.0	1.0	8.3	104.1	223.4	17.1	251.1	10.1	29.5
1975	1 - 10	26.0	0.0	0.0	0.0	2.4	14.3	15.1	10.7	25.8	27.2	29.8	7.2
	11 - 20	18.7	0.0	0.0	0.1	2.3	5.4	8.7	41.1	34.7	14.4	7.2	16.9
	21 - 31	0.1	0.0	0.0	0.0	6.9	4.8	16.8	36.4	61.6	61.4	4.5	64.5
1976	1 - 10	40.5	6.1	4.7	2.3	2.7	177.1	195.2	68.3	9.0	251.4	8.7	6.9
	11 - 20	32.5	6.1	4.0	4.0	4.9	0.5	70.7	132.8	122.6	47.8	8.0	6.1
	21 - 31	20.2	4.2	2.6	2.2	346.3	38.8	93.0	171.9	229.1	11.4	7.3	0.1
1977	1 - 10	0.3	5.5	3.0	4.1	4.0	4.5	4.2	23.3	139.9	105.7	9.8	37.2
	11 - 20	11.1	4.0	2.7	5.1	3.2	4.2	5.6	12.6	175.2	42.2	10.2	15.1
	21 - 31	8.1	3.4	2.5	4.6	2.9	0.2	39.6	26.9	174.3	16.7	200.6	15.3
1978	1 - 10	14.0	15.0	11.2	10.2	10.2	10.6	24.3	193.4	262.6	262.0	406.6	83.5
	11 - 20	15.6	12.4	11.5	8.9	7.7	20.4	58.3	252.1	261.0	306.4	92.3	73.1
	21 - 31	15.7	9.9	12.2	9.6	9.8	36.8	104.4	355.7	205.4	205.3	79.2	59.8

Table 2.7(3) TEN-DAY AVERAGE DISCHARGE AT FLORIDABLANCA OF GUMAIN RIVER

Year	Period	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1968	1 - 10	6.9	2.8	0.9	0.1	0.6	2.4	2.5	12.4	35.4	17.6	3.9	3.4
	11 - 20	6.7	1.1	0.9	0.0	0.6	1.6	3.7	11.8	25.1	8.0	3.9	3.4
	21 - 31	6.7	0.9	0.8	0.0	1.3	1.4	21.1	25.1	16.9	5.1	1.8	2.9
1969	1 - 10	2.7	1.7	0.8	5.5	0.4	0.9	0.9	29.9	13.7	17.8	3.0	5.0
	11 - 20	2.3	1.2	0.6	7.1	0.4	1.9	4.4	12.3	17.0	8.8	2.9	3.4
	21 - 31	1.8	0.9	4.7	1.0	1.0	0.4	15.8	3.5	18.5	4.0	4.2	1.7
1970	1 - 10	1.2	2.3	0.9	0.4	1.0	6.7	18.8	15.7	46.5	14.7	11.6	5.9
	11 - 20	1.0	2.6	0.6	1.1	0.9	14.0	15.9	17.3	30.4	28.7	12.9	5.0
	21 - 31	1.5	0.9	0.5	1.4	1.1	3.6	4.9	22.4	15.0	17.2	10.1	4.3
1971	1 - 10	3.9	2.3	2.1	1.8	2.7	9.8	9.4	20.1	12.3	39.3	10.2	10.4
	11 - 20	3.2	2.3	1.8	1.8	3.4	29.3	18.9	17.0	11.9	35.8	6.8	7.1
	21 - 31	2.5	2.3	1.8	1.8	4.5	12.1	56.3	11.5	13.4	12.9	12.9	5.0
1972	1 - 10	5.0	3.1	3.8	3.2	4.0	15.2	29.9	35.7	17.3	11.8	6.9	15.2
	11 - 20	3.4	3.1	3.8	3.6	4.4	13.1	34.2	4.1	28.1	7.6	6.6	14.4
	21 - 31	3.4	2.7	3.6	3.5	10.7	19.2	72.0	9.1	14.4	7.3	11.0	13.5
1973	1 - 10	14.0	12.2	8.2	4.3	8.4	22.7	13.9	16.8	34.8	13.3	5.8	3.6
	11 - 20	14.6	10.8	6.1	4.0	7.8	34.7	26.2	19.5	42.9	12.9	5.2	2.5
	21 - 31	14.6	9.2	4.5	6.1	7.5	14.8	54.7	18.9	17.4	9.4	4.6	1.6
1974	1 - 10	3.6	1.0	2.2	0.6	0.9	52.5	3.9	35.3	9.0	4.2	18.6	5.6
	11 - 20	2.5	0.7	1.2	0.5	8.4	26.4	13.5	92.8	5.8	17.6	14.8	4.7
	21 - 31	1.6	0.7	0.6	0.4	20.6	4.6	9.6	36.7	5.1	40.6	18.4	4.1
1975	1 - 10	3.9	1.5	9.9	9.4	9.7	11.3	10.5	15.2	14.5	6.9	11.3	22.2
	11 - 20	3.0	0.8	9.5	9.4	9.8	12.5	12.9	13.2	13.6	8.9	12.5	16.6
	21 - 31	2.1	0.7	9.5	10.3	9.5	13.7	14.5	23.5	8.4	5.9	14.1	17.4
1976	1 - 10	10.5	10.5	10.5	10.5	10.5	9.5	19.3	5.1	26.4	27.1	18.6	19.1
	11 - 20	10.5	10.5	10.5	10.5	10.5	10.5	12.9	14.2	6.0	25.1	18.6	11.6
	21 - 31	10.5	10.5	10.5	10.5	32.1	3.7	6.5	15.0	21.1	18.5	18.6	9.7
1977	1 - 10	4.1	3.0	2.7	2.6	2.5	3.3	4.3	10.5	19.6	15.5	3.9	7.2
	11 - 20	3.8	2.8	2.7	2.6	2.5	3.2	2.4	9.9	18.6	7.8	4.0	4.6
	21 - 31	3.4	2.7	2.6	2.5	3.1	3.9	5.6	12.0	16.2	4.8	26.9	4.6
1978	1 - 10	4.1	4.3	3.0	3.4	3.6	4.8	6.1	8.6	26.7	25.4	51.8	14.8
	11 - 20	4.3	3.9	3.2	3.5	3.3	5.7	9.2	17.2	22.4	26.5	16.5	12.9
	21 - 31	4.4	3.6	3.3	3.6	3.3	7.2	13.4	27.4	26.5	16.4	14.0	10.5

Table 2.8 TEN-DAY AVERAGE DISCHARGE AS INFLOW TO SAN ANTONIO SWAMP

Year	Period	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1968	1 - 10	11.0	8.7	6.6	4.5	6.1	8.7	17.7	261.1	367.6	264.2	9.5	37.2
	11 - 20	9.8	7.3	7.1	3.9	5.7	9.6	15.7	213.9	128.5	84.5	7.0	12.2
	21 - 31	9.3	6.3	5.0	3.7	7.2	8.1	167.9	360.1	126.5	13.8	7.7	7.2
1969	1 - 10	6.9	5.9	3.7	3.4	1.9	5.1	493.0	70.6	88.3	94.3	8.8	11.3
	11 - 20	7.1	4.6	3.6	3.3	6.1	9.6	332.1	191.6	181.5	87.4	7.1	15.4
	21 - 31	6.3	4.2	3.0	2.3	5.0	89.0	60.8	66.4	93.4	27.1	23.6	9.1
1970	1 - 10	7.7	5.7	4.0	2.9	1.7	14.8	25.7	88.5	474.7	86.1	106.7	45.0
	11 - 20	7.1	4.8	3.6	2.8	3.2	56.3	64.1	111.8	443.0	206.1	41.8	26.2
	21 - 31	6.1	4.3	3.8	2.1	4.3	19.0	53.0	237.6	82.5	93.6	68.2	21.7
1971	1 - 10	14.5	10.3	6.8	3.0	9.9	33.7	85.4	160.0	74.4	281.2	27.9	93.8
	11 - 20	11.4	10.0	9.1	2.6	19.2	181.3	220.6	257.2	125.6	505.1	32.1	41.7
	21 - 31	10.6	9.0	4.0	2.1	20.2	173.6	385.8	28.2	105.1	102.4	99.4	46.7
1972	1 - 10	148.6	19.3	9.8	6.9	8.3	18.3	204.5	610.6	246.7	78.4	27.6	17.5
	11 - 20	23.1	16.9	8.3	4.9	9.8	42.7	492.8	410.3	298.1	17.6	18.0	13.1
	21 - 31	15.9	11.1	7.8	4.5	18.2	36.9	558.8	493.5	259.9	10.5	12.4	8.6
1973	1 - 10	6.4	3.7	2.0	0.8	0.7	3.1	7.8	34.2	197.3	94.6	18.7	22.6
	11 - 20	5.1	3.1	1.6	1.1	4.0	7.4	19.4	77.6	101.3	568.6	15.1	15.1
	21 - 31	3.8	2.1	0.9	0.7	2.8	10.0	19.5	284.3	50.7	147.5	114.2	9.1
1974	1 - 10	8.1	4.7	4.2	1.4	4.8	38.2	12.8	92.7	104.4	35.3	204.5	290.8
	11 - 20	7.6	8.2	3.0	2.3	2.3	124.5	34.0	409.4	129.6	375.2	150.6	166.8
	21 - 31	6.6	3.5	2.1	5.1	2.4	15.0	188.4	404.3	30.9	454.4	66.2	63.3
1975	1 - 10	47.1	14.0	5.9	6.1	8.6	25.9	27.3	19.4	46.7	49.2	53.9	13.0
	11 - 20	33.8	8.2	5.6	6.1	8.1	9.8	15.7	74.4	62.8	26.1	13.0	30.6
	21 - 31	22.4	7.8	6.6	8.5	15.8	8.7	30.4	65.9	111.5	111.1	8.1	116.7
1976	1 - 10	73.3	11.0	8.5	4.2	4.9	320.5	353.3	123.6	16.3	455.0	59.6	12.5
	11 - 20	58.8	11.0	7.2	7.2	8.9	0.9	127.9	240.3	221.9	86.5	56.2	11.0
	21 - 31	36.6	7.6	4.7	4.0	626.7	70.2	168.3	311.1	414.6	20.6	13.2	0.2
1977	1 - 10	11.1	10.0	5.5	7.4	7.2	8.1	7.6	42.2	253.2	191.3	17.7	67.3
	11 - 20	20.1	7.2	4.9	9.2	5.8	7.6	10.1	22.8	317.1	76.4	18.5	27.3
	21 - 31	14.6	6.1	4.6	8.3	5.2	0.4	71.7	48.7	315.4	30.2	363.0	27.7
1978	1 - 10	25.3	27.1	15.8	16.8	18.5	19.2	44.0	350.0	475.2	474.1	735.8	151.1
	11 - 20	28.2	22.4	16.8	16.1	13.9	36.9	105.0	456.2	472.3	554.5	167.0	132.3
	21 - 31	28.4	17.9	18.1	17.4	15.7	66.6	188.9	643.7	371.7	371.5	143.3	108.2

Table 2.9 MONTHLY MEAN TIDE LEVEL AT MANILA HARBOR (1951 - 1979)

(Unit: meter above MSL)

Item	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Average
Mean Higher High Level (MHHL)													
Ave.	0.45	0.41	0.39	0.44	0.51	0.61	0.65	0.66	0.61	0.56	0.55	0.53	0.53
Max.	0.72	0.62	0.58	0.64	0.76	0.87	0.93	0.92	0.84	0.84	0.78	0.78	0.77
Min.	0.21	0.23	0.20	0.23	0.30	0.40	0.45	0.42	0.45	0.34	0.30	0.30	0.32
Mean High Level (MHL)													
Ave.	0.27	0.22	0.25	0.32	0.39	0.49	0.51	0.50	0.47	0.43	0.40	0.38	0.39
Max.	0.57	0.42	0.45	0.52	0.61	0.75	0.79	0.81	0.72	0.73	0.63	0.61	0.63
Min.	0.01	0.04	0.06	0.11	0.17	0.22	0.29	0.31	0.30	0.21	0.12	0.10	0.16
Mean Sea Level (MSL)													
Ave.	-0.13	-0.13	-0.10	-0.05	0	0.04	0.09	0.14	0.12	0.07	0.01	-0.06	0
Max.	0.13	0.14	0.18	0.23	0.41	0.34	0.37	0.43	0.43	0.45	0.28	0.18	0.30
Min.	-0.32	-0.29	-0.27	-0.23	-0.18	-0.12	-0.08	-0.08	-0.06	-0.14	-0.21	-0.25	-0.19
Mean Low Level (MLL)													
Ave.	-0.51	-0.47	-0.44	-0.40	-0.39	-0.37	-0.30	-0.23	-0.23	-0.28	-0.37	-0.47	-0.37
Max.	-0.21	-0.13	-0.09	-0.04	0	0	0.04	0.08	0.14	0.17	-0.05	-0.20	-0.02
Min.	-0.69	-0.64	-0.62	-0.59	-0.56	-0.55	-0.54	-0.42	-0.42	-0.49	-0.56	-0.68	-0.56
Mean Lower Low Level (MLLL)													
Ave.	-0.61	-0.56	-0.53	-0.52	-0.52	-0.47	-0.40	-0.31	-0.31	-0.39	-0.48	-0.56	-0.47
Max.	-0.31	-0.18	-0.14	-0.13	-0.09	-0.09	-0.05	0.01	0.07	0.08	-0.16	-0.28	-0.11
Min.	-0.80	-0.74	-0.73	-0.72	-0.69	-0.64	-0.61	-0.49	-0.52	-0.60	-0.70	-0.75	-0.67

Table 2.10(1) WATER QUALITY ANALYSIS RESULT
(HIGH WATER FLOW, SEPT. 1980)

Parameter		Unit	Sample Number 1	2	3	4	5	6	7	8	9	10
Chemist & Physics												
Conductivity		micromhos/cm	145	153	150	128	111	120	129	115	77	140
P.H.			6.6	6.6	7.1	7.2	7.2	6.9	7.1	7.2	7.2	7.1
S.A.R.			0.169	0.173	0.181	0.235	0.204	0.177	0.319	0.371	0.322	0.168
Dissolved Solid		mg/l	94	99	98	83	72	78	84	75	50	91
Suspended Solid		"	202	1,028	214	*	1,366	239	*	*	*	273
Hardness		"	77	79	76	61	59	74	41	23	43	82
K^+												
Potassium	(K)	meq/l	0.032	0.021	0.023	0.072	0.070	0.032	0.158	0.100	0.168	0.023
Sodium	(Na)	"	0.148	0.154	0.158	0.184	0.156	0.152	0.204	0.178	0.212	0.152
Calcium	(Ca)	"	0.901	1.166	0.848	0.901	0.742	0.901	0.530	0.318	0.636	0.954
Magnesium	(Mg)	"	0.629	0.415	0.682	0.323	0.431	0.578	0.286	0.143	0.231	0.678
Iron	(Fe)	"	0.004	0.005	0.004	0.005	0.005	0.004	0.004	0.006	0.005	0.004
Manganese	(Mn)	mg/l	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.050	<0.025	<0.025
Nitrogen Total		"										
A^-												
Chloride	(Cl)	meq/l	0.121	0.061	0.121	0	0.061	0	0.182	0	0.121	0.030
Sulphate	(SO4)	"	0.200	0.446	0.171	0.190	0.196	0.208	0.117	0.117	0.200	0.190
Phosphate	(PO4)	"										
Bicarbonate	(HCO3)	"	1.375	1.500	1.406	1.406	0.813	1.438	1.094	0.594	1.094	1.406
Carbonate	(CO3)	"	0	0	0	0	0	0	0	0	0	0
Copper	(Cu)	mg/l	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Cadmium	(Cd)	"										
Chromium	(Cr)	"	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Lead	(Pb)	"	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Zinc	(Zn)	"	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Phosphor	(P)	"	0.112	0.164	0.112	0.172	0.181	0.152	0.352	0.184	0.410	0.087
Silicon	(Si)	"	5.6	36.0	5.6	12.5	7.8	6.1	53.0	56.0	20.0	5.6

* : No analysis

Table 2.10(2) WATER QUALITY ANALYSIS RESULT (LOW WATER FLOW, JAN. 1981)

Parameter		Unit	Sample Number 1	2	3	4	5	6	7	8	9	10
Chemist & Physics												
Conductivity		micromhos/cm	250	215	265	353	168	246	265		155	265
P.H.			7.3	7.3	7.5	7.0	7.3	7.3	7.1		7.5	7.5
S.A.R.			0.648	0.504	0.671	1.030	1.001	0.572	0.870		0.801	0.691
Dissolved Solid		mg/l	163	140	172	229	109	160	172		101	172
Suspended Solid		"	71	57	100	37	1,024	73	320		354	58
Hardness		"	120	107	125	118	56	125	87		56	128
K^{+}												
Potassium	(K)	meq/l	0.050	0.045	0.050	0.335	0.115	0.050	0.315		0.195	0.068
Sodium	(Na)	"	0.710	0.540	0.750	1.140	0.750	0.640	0.810		0.600	0.780
Calcium	(Ca)	"	1.219	1.219	1.060	1.107	0.689	1.113	0.901	no water	0.636	1.060
Magnesium	(Mg)	"	1.178	0.923	1.439	1.344	0.433	1.386	0.833		0.486	0.490
Iron	(Fe)	"	0.029	0.120	0.075	0.228	0.013	0.029	0.021		0.013	0.013
Manganese	(Mn)	mg/l	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025		<0.025	<0.025
Nitrogen Total		"										
A^{-}												
Chloride	(Cl)	meq/l	0.242	0.121	0.182	0.424	0.424	0.182	0.303		0.182	0.303
Sulphate	(SO4)	"	0.488	0.600	0.571	0.404	0.433	0.556	0.473		0.515	0.488
Phosphate	(PO4)	"	*	*	*	*	*	*	*		*	*
Bicarbonate	(HCO3)	"	2.281	1.969	2.406	3.156	1.031	2.250	2.063		1.063	2.250
Carbonate	(CO3)	"	0	0	0	0	0	0	0		0	0
Copper	(Cu)	mg/l	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05		<0.05	<0.05
Cadmium	(Cd)	"	*	*	*	*	*	*	*		*	*
Chromium	(Cr)	"	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10		<0.10	<0.10
Lead	(Pb)	"	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20		<0.20	<0.20
Zinc	(Zn)	"	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01		<0.01	<0.01
Phosphor	(P)	"	0.100	0.068	0.070	0.152	0.194	0.010	0		0.120	0.088
Silicon	(Si)	"	14.5	14.5	15.4	34.2	28.2	12.5	27.6		27.6	11.8

* : No analysis

Table 2.11(1) CHLORIDE CONCENTRATION IN RIVERS MEASURED BY TEAM AND MPW

Sampling Station	Distance from Rivermouth (km)	Sampling Date	Tide Level (MSL)	Chloride Concentration Water Surface (ppm)	Chloride Concentration Channel Bottom (ppm)
San Fernando River					
No. 1	22.5	Jan. 27, 1981	-0.14	4,850	5,500
			-0.01	3,650	5,450
			0.11	3,500	4,350
			0.22	4,900	5,500
		Mar. 3, 1981	0.23	5,400	5,600
			0.49	5,700	5,700
		Mar. 24, 1981	0.37	6,100	5,600
			0.21	6,150	6,200
			0.05	6,200	6,150
No. 2	31.0	Jan. 27, 1981	-0.14	2,320	2,450
			-0.01	2,350	2,350
			0.11	2,280	2,320
			0.22	2,350	2,350
		Mar. 3,1981	0.40	4,900	5,050
			0.58	5,100	5,050
		Mar. 24, 1981	0.32	5,700	5,800
			0.28	5,900	5,950
			0.12	5,900	6,100
No. 3	35.0	Jan. 27, 1981	-0.14	600	600
			-0.01	535	535
			0.11	465	465
			0.22	470	470
		Mar. 3, 1981	0.15	1,020	1,020
			0.36	1,000	1,000
			0.55	990	990
		Mar. 24, 1981	0.34	1,550	1,300
			0.25	1,800	1,530
			0.09	2,050	2,050
Hagonoy River					
No. 4	9.0	Jan. 28, 1981	-0.09	2,080	3,950
			0.03	2,050	6,500
			0.16	6,800	8,000
			0.31	8,450	9,600

Remarks: 1. Data in January were measured by the Team
2. Data during the period of March - April were measured by MPW
*: less than 10 p.p.m.

Table 2.11(2) CHLORIDE CONCENTRATION IN RIVERS MEASURED BY TEAM AND MPW

Sampling Station	Distance from Rivermouth (km)	Sampling Date	Tide Level (MSL)	Chloride Concentration Water Surface (ppm)	Chloride Concentration Channel Bottom (ppm)
		Mar. 3, 1981	0.16	6,000	7,100
			0.37	6,400	7,900
			0.54	8,000	9,600
		Mar. 24, 1981	0.36	8,600	9,800
			0.28	8,400	9,900
			0.16	6,300	8,700
		Apr. 29, 1981	0.39	5,500	7,600
			0.51	6,300	10,200
			0.62	8,400	11,500
No. 5	13.0	Jan. 28, 1981	-0.09	225	238
			0.03	305	305
			0.16	425	450
			0.31	2,050	2,050
		Mar. 3, 1981	0.16	1,950	2,700
			0.37	2,350	2,950
			0.54	4,050	4,250
		Mar. 24, 1981	0.32	2,300	2,450
			0.33	4,200	4,300
			0.12	2,250	2,250
No. 6	18.5	Jan. 28, 1981	-0.09	74	74
			0.03	32	32
			0.16	28	28
			0.31	30	30
		Mar. 3, 1981	0.37	100	100
			0.54	46	46
		Mar. 24, 1981	0.29	22	21
			0.37	30	24
			0.08	26	24
		Apr. 29, 1981	0.33	11	13
			0.55	90	96
			0.67	32	12
Pampanga River					
No. 7	10.0	Jan. 29, 1981	-0.07	940	3,100
			0.06	820	2,850
			0.28	3,950	12,700
			0.37	12,600	18,600

Table 2.11(3) CHLORIDE CONCENTRATION IN RIVERS MEASURED BY TEAM AND MPW

Sampling Station	Distance from Rivermouth (km)	Sampling Date	Tide Level (MSL)	Chloride Concentration	
				Water Surface (ppm)	Channel Bottom (ppm)
No. 8	14.0	Jan. 29, 1981	-0.07	26	1,630
			0.06	18	1,350
			0.28	375	2,950
			0.37	410	5,100
		Mar. 25, 1981	0.32	21	4,650
			0.42	820	7,700
			0.25	1,050	7,400
		Apr. 30, 1981	0.55	1,500	8,100
No. 9	17.0	Jan. 29, 1981	-0.07	13	13
			0.06	13	13
			0.28	30	30
			0.37	265	570
		Mar. 5, 1981	-0.06	18	18
			0.07	18	18
			0.04	18	18
			0.35	18	18
		Mar. 25, 1981	0.40	16	15
			0.33	89	34
			0.17	19	20
		Apr. 30, 1981	0.29	*	*
			0.45	*	*
			0.58	16	14
No. 10	22.5	Jan. 29, 1981	-0.07	14	14
			0.06	13	13
			0.28	14	14
			0.37	13	13
		Mar. 4, 1981	0.09	20	17
			0.31	17	17
			0.54	18	18
		Mar. 26, 1981	0.33	15	16
			0.44	16	16
			0.37	16	16
		Apr. 30, 1981	0.22	*	*
			0.36	*	*
			0.51	*	*

Table 2.11(4) CHLORIDE CONCENTRATION IN RIVERS MEASURED BY TEAM AND MPW

Sampling Station	Distance from Rivermouth (km)	Sampling Date	Tide Level (MSL)	Chloride Concentration Water Surface (ppm)	Chloride Concentration Channel Bottom (ppm)
No. 11	22.6	Jan. 29, 1981	-0.07	14	14
			0.06	15	17
			0.28	14	14
			0.37	14	14
		Mar. 4, 1981	0.03	21	22
			0.25	20	19
			0.44	20	19
		Mar. 26, 1981	0.35	17	16
			0.47	16	16
			0.34	16	15
		Apr. 30, 1981	0.24	*	*
			0.37	*	*
			0.52	*	*
No. 12	26.0	Jan. 29, 1981	-0.07	14	14
			0.06	14	14
			0.28	14	14
			0.37	13	13
		Mar. 4, 1981	0.14	18	17
			0.37	17	17
			0.59	17	18
		Mar. 26, 1981	0.37	14	14
			0.51	15	15
			0.29	15	14
		Apr. 30, 1981	0.19	*	*
			0.35	*	*
			0.49	*	*
Labangan River					
No. 13	9.5	Jan. 30, 1981	0.02	787	16,220
			0.16	1,080	17,183
			0.36	15,059	22,160
			0.46	17,907	23,467
No. 14	16.5	Jan. 30, 1981	0.02	16	16
			0.16	13	13
			0.46	14	14

Table 2.11(5) CHLORIDE CONCENTRATION IN RIVERS MEASURED BY TEAM AND MPW

Sampling Station	Distance from Rivermouth (km)	Sampling Date	Tide Level (MSL)	Chloride Concentration Water Surface (ppm)	Chloride Concentration Channel Bottom (ppm)
		Mar. 5, 1981	-0.05	12	11
			0.05	11	11
			0.19	11	11
		Mar. 25, 1981	0.27	24	23
			0.42	22	24
			0.30	23	23
			0.16	24	24
		Apr. 30, 1981	0.26	*	*
			0.38	*	*
			0.53	*	*
No. 15	17.0	Jan. 30, 1981	0.02	13	13
			0.16	13	13
			0.46	24	24
		Mar. 5, 1981	-0.02	11	11
			0.05	11	11
			0.33	11	11
		Mar. 25, 1981	0.30	24	25
			0.44	23	28
			0.27	24	28
No. 16	22.0	Jan. 30, 1981	0.16	12	12
			0.46	12	12
		Mar. 25, 1981	0.33	15	15
			0.47	14	15
			0.23	15	15

Table 2.12(1) MAXIMUM POINT OF SEAWATER INTRUSION ON THE PAMPANGA RIVER UNDER EXISTING CONDITION

(Unit: Km)

Discharge (m^3/s)	Maximum Point of Seawater Intrusion from Rivermouth			
	h = 1^m	h = 2^m	h = 3^m	Bottom
1. At Time of High Tide /1				
2	42.0	-	-	46.8
5	18.8	45.4	-	46.6
10	8.2	32.7	-	46.2
20	2.8	18.3	36.2	45.2
30	1.0	8.8	22.0	38.8
40	0.8	4.4	11.2	21.1
50	0.5	2.2	6.6	12.7
2. At Time of Low Tide /2				
2	40.4	-	-	46.5
5	18.0	45.2	-	46.2
10	7.7	32.6	-	45.4
20	2.4	14.3	29.2	36.7
30	0.9	5.8	12.3	15.4
40	0.6	3.1	7.4	8.1
50	0.5	1.5	-	2.9
3. Average of above /3				
2	41.2	-	-	46.7
5	18.4	45.3	-	46.4
10	8.0	32.7	-	45.8
20	2.6	16.3	32.7	41.0
30	1.0	7.3	17.2	27.1
40	0.7	3.8	9.3	16.0
50	0.5	1.9	-	7.8

Remarks: /1: El. = 0.53 m (MSL)

/2: El. - -0.47 m (MSL)

/3: Average distance of high and low tides

Table 2.12(2) MAXIMUM POINT OF SEAWATER INTRUSION ON THE LABANGAN FLOODWAY UNDER EXISTING CONDITION

(Unit: Km)

Discharge (m^3/s)	Maximum Point of Seawater Intrusion from Rivermouth			
	h = 1^m	h = 2^m	h = 3^m	Bottom
1. <u>At Time of High Tide</u> /1				
2	-	-	-	-
5	13.0	-	-	24.7
10	0.8	5.8	11.4	12.7
20	0.6	1.6	4.6	7.9
30	0.4	0.9	2.4	5.9
2. <u>At Time of Low Tide</u> /2				
2	18.0	-	-	18.0
5	7.5	-	-	15.6
10	0.9	4.6	8.8	9.3
20	0.5	1.4	3.8	6.0
30	0.3	0.7	1.8	4.0
3. <u>Average of Above</u> /3				
2	-	-	-	-
5	10.3	-	-	20.2
10	0.9	5.2	10.1	11.0
20	0.6	1.5	4.2	7.0
30	0.4	0.8	2.1	5.0

Remarks: /1: El. = 0.53 m (MSL)

/2: El. = -0.47 m (MSL)

/3: Average distance of high and low tides

Table 2.13(1) ESTIMATED TEN-DAY AVERAGE DISCHARGE (PAMPANGA RIVER)

Year	Period	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1968	1 - 10	50.5	37.4	29.2	23.4	25.3	30.2	65.0	586.8	1,520.3	971.7	69.3	183.5
	11 - 20	45.3	31.4	33.8	21.2	23.3	28.5	66.2	596.0	921.3	423.9	68.8	56.8
	21 - 31	40.4	29.3	24.1	21.0	29.4	36.9	488.4	1,098.8	684.1	155.7	62.2	41.9
1969	1 - 10	45.7	38.5	22.1	23.6	19.0	33.6	65.9	1,566.4	337.0	399.6	61.8	58.5
	11 - 20	46.7	28.7	22.0	25.1	24.3	77.4	62.8	839.7	620.3	257.5	42.0	83.6
	21 - 31	40.2	26.1	23.5	18.8	25.4	43.0	425.0	208.2	349.4	132.6	138.4	49.0
1970	1 - 10	40.7	28.1	20.3	28.2	19.3	33.8	85.7	254.9	1,804.0	456.5	721.8	325.1
	11 - 20	35.7	23.6	19.4	28.6	19.6	145.6	225.2	375.1	1,217.6	1,117.4	334.8	199.3
	21 - 31	32.1	22.2	20.4	23.4	21.8	124.7	151.2	588.3	439.7	721.6	518.4	138.5
1971	1 - 10	92.3	53.9	39.4	35.0	88.8	375.2	413.5	655.8	287.1	412.8	178.2	525.4
	11 - 20	77.6	52.9	66.5	33.9	118.0	638.2	828.3	629.0	297.6	1,947.8	165.6	302.8
	21 - 31	64.2	48.5	39.3	28.6	98.0	453.0	1,219.9	160.3	367.5	723.5	609.9	328.8
1972	1 - 10	807.4	114.5	41.9	43.8	22.6	81.1	790.2	2,247.8	678.4	256.4	204.9	134.1
	11 - 20	189.7	100.0	35.2	34.1	24.7	91.2	2,341.6	1,760.2	868.4	107.4	136.3	89.2
	21 - 31	132.6	48.5	45.0	28.8	72.9	130.8	2,363.2	1,512.7	587.7	87.3	110.2	49.6
1973	1 - 10	36.6	33.4	15.7	12.7	10.1	12.9	32.6	82.7	431.6	428.2	86.9	119.8
	11 - 20	33.2	33.6	14.0	14.1	13.7	28.8	158.4	174.6	253.6	1,784.0	79.2	75.4
	21 - 31	30.9	25.6	12.5	9.3	12.4	38.2	96.8	663.4	160.6	809.8	715.3	41.3
1974	1 - 10	34.1	18.2	25.7	15.6	27.8	260.9	133.4	639.3	408.0	124.7	1,568.9	418.7
	11 - 20	26.6	16.5	19.9	16.5	19.9	579.7	380.5	1,527.5	311.0	1,158.1	1,176.8	472.5
	21 - 31	21.4	15.0	17.3	24.8	47.0	92.5	712.6	1,641.1	137.4	1,213.8	488.1	299.1
1975	1 - 10	191.2	131.4	48.1	49.1	49.8	126.5	130.6	112.3	195.3	199.4	216.8	60.0
	11 - 20	141.0	82.2	45.5	48.0	46.9	92.1	63.5	500.2	223.2	111.1	60.0	128.5
	21 - 31	201.8	79.3	53.0	66.2	70.8	133.5	57.2	346.6	365.8	434.2	38.5	455.0
1976	1 - 10	275.2	78.9	40.2	20.8	24.3	338.1	1,327.8	408.4	476.8	670.2	444.4	128.7
	11 - 20	200.9	54.1	34.5	34.5	41.9	299.8	341.7	767.6	629.9	454.9	420.6	123.7
	21 - 31	125.8	36.2	23.2	20.2	2,035.6	312.9	279.4	680.9	779.0	439.7	242.2	95.4
1977	1 - 10	104.5	46.7	26.8	20.9	16.5	65.2	115.3	441.5	765.2	600.8	142.5	273.3
	11 - 20	88.6	34.3	24.3	19.1	15.1	56.0	122.2	408.2	867.2	297.3	280.2	167.2
	21 - 31	66.8	29.9	22.8	18.0	52.9	95.8	285.7	518.8	737.3	174.8	1,056.2	168.6
1978	1 - 10	108.8	115.8	48.1	67.0	82.3	145.7	211.7	343.0	1,290.8	1,223.6	2,043.3	517.9
	11 - 20	119.8	97.9	54.4	73.8	64.0	192.5	374.0	791.0	1,065.7	1,276.5	571.7	453.8
	21 - 31	120.4	80.7	60.3	78.2	60.5	271.0	595.0	1,326.1	1,277.5	749.8	491.2	371.9

Table 2.13(2) ESTIMATED TEN-DAY AVERAGE DISCHARGE (LABANGAN FLOODWAY)

Year	Period	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1968	1 - 10	3.9	8.0	0.4	14.6	16.3	9.9	16.0	42.9	149.4	71.0	4.2	5.9
	11 - 20	4.4	6.2	8.6	13.2	15.4	11.1	12.1	31.1	51.5	44.2	0.9	3.4
	21 - 31	4.7	7.4	5.8	24.3	10.3	16.5	4.7	86.3	84.2	21.9	2.2	5.2
1969	1 - 10	2.6	2.7	1.2	2.4	6.7	3.7	2.5	117.2	39.7	35.9	0.7	0.6
	11 - 20	3.0	1.8	0.9	1.0	1.6	8.8	1.2	95.2	38.9	21.8	0.9	5.1
	21 - 31	2.7	1.2	1.2	2.6	5.9	9.5	42.0	59.5	28.1	8.0	0.9	4.4
1970	1 - 10	0.9	0.6	14.9	36.9	36.8	9.2	34.3	29.9	142.2	28.2	43.6	46.8
	11 - 20	1.1	0.6	28.3	31.3	74.0	17.9	44.8	42.5	63.5	57.4	20.4	44.1
	21 - 31	1.2	2.0	37.4	30.2	33.0	15.4	35.3	57.8	25.5	31.8	20.6	43.8
1971	1 - 10	27.9	26.1	26.5	47.1	12.4	43.2	35.8	51.8	29.9	44.6	24.6	87.8
	11 - 20	15.5	27.6	39.9	29.8	11.6	61.1	58.4	43.3	39.0	130.6	24.3	49.6
	21 - 31	22.9	32.2	45.1	35.6	11.1	32.8	63.7	40.6	29.3	39.3	48.1	89.5
1972	1 - 10	63.5	18.8	46.9	33.7	33.8	13.1	63.2	157.8	31.0	28.1	13.5	16.7
	11 - 20	43.1	27.5	33.8	42.3	19.8	13.6	21.1	121.3	65.1	119.5	7.9	12.9
	21 - 31	40.2	23.8	35.0	42.9	26.1	12.9	167.8	31.0	46.1	49.1	34.7	5.4
1973	1 - 10	9.2	9.2	7.8	7.5	7.5	7.7	8.9	10.9	36.8	35.4	12.4	14.8
	11 - 20	8.8	9.1	7.7	7.6	7.6	8.8	14.6	18.7	24.7	126.0	12.3	12.3
	21 - 31	8.6	8.5	7.5	7.5	7.6	9.5	11.0	55.1	18.3	63.7	54.5	10.0
1974	1 - 10	1.1	4.6	5.2	4.8	1.4	2.0	1.0	1.6	19.3	4.2	85.7	28.3
	11 - 20	2.6	2.5	2.5	4.5	0.2	35.3	2.2	133.2	14.0	35.6	87.7	57.1
	21 - 31	3.2	4.3	5.2	4.3	0.6	51.9	25.8	59.5	9.0	29.5	43.2	58.1
1975	1 - 10	21.3	7.0	14.0	14.7	16.6	12.5	16.6	19.0	16.1	17.0	14.1	10.6
	11 - 20	7.6	8.9	10.4	15.4	6.6	13.4	2.7	25.0	14.5	14.9	9.7	15.1
	21 - 31	6.7	9.2	12.8	14.8	15.2	12.1	1.0	24.0	20.6	14.0	2.1	37.2
1976	1 - 10	4.6	3.7	4.4	14.0	9.1	44.6	91.9	28.6	22.0	30.3	12.5	8.4
	11 - 20	4.3	3.4	4.7	8.0	13.1	37.2	24.6	42.1	56.1	3.5	8.3	4.6
	21 - 31	1.0	6.7	4.9	13.8	197.7	54.1	34.3	41.2	37.1	15.9	5.7	8.9
1977	1 - 10	5.8	7.7	3.4	2.5	3.4	2.8	5.3	12.0	5.2	2.2	2.0	0.1
	11 - 20	7.4	21.6	2.5	2.5	3.2	3.3	15.4	7.7	13.8	1.2	47.1	15.4
	21 - 31	9.6	15.7	2.5	2.1	3.7	2.5	10.3	16.3	8.9	0.1	4.0	15.4
1978	1 - 10	14.9	15.3	9.9	3.7	2.6	10.6	3.2	4.7	45.2	48.5	110.4	7.6
	11 - 20	15.6	14.2	0.7	5.5	2.1	4.9	5.3	38.6	28.6	76.7	32.4	5.5
	21 - 31	15.6	1.8	2.8	6.1	6.0	2.1	4.9	72.9	30.5	119.3	16.9	1.2

Table 2.14(1) FREQUENCY ON SEAWATER INTRUSION UNDER EXISTING CONDITION

At Channel Bottom, Pampanga River

(Unit: Km)

Period	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
1 - 10	40.2	42.2	41.1	31.1	39.4	45.2	43.3	18.3	40.4	43.3	9.4
11 - 20	40.2	42.0	41.1	25.1	36.0	45.1	43.2	12.0	40.3	43.0	5.4
21 - 30	37.8	38.3	41.0	22.0	29.4	45.0	43.0	11.0	39.0	42.3	2.4
31 - 40	37.7	38.1	40.4	17.1	23.0	45.0	43.0	10.0	36.2	41.3	2.4
41 - 50	37.0	36.1	40.4	17.1	21.2	44.3	42.3	10.0	23.0	40.4	1.4
51 - 60	34.0	36.0	40.0	9.2	16.0	44.3	42.0	9.0	23.0	39.0	-
61 - 70	30.2	35.3	39.3	7.0	13.4	44.2	41.0	8.4	20.4	37.0	
71 - 80	28.2	34.3	38.0	6.1	12.1	44.0	41.0	6.4	16.3	33.0	
81 - 90	28.1	34.2	37.4	1.3	9.4	44.0	40.3	4.2	15.2	28.0	
91 - 100	28.0	33.4	30.0	1.0	8.3	43.2	36.0	3.0	6.0	24.4	
101 - 110	27.0	29.1	29.4	-	-	34.2	34.3	3.0	-	11.0	
111 - 120	26.2	24.4	29.0			30.1	33.1	2.0		7.0	
121 - 130	25.0	18.1	26.1			27.0	31.4	1.1		5.0	
131 - 140	20.0	16.3	24.3			25.2	23.1	-		1.1	
141 - 150	19.0	15.2	21.1			24.4	10.6			1.0	
151 - 160	16.3	14.2	-			24.2	-			-	
161 - 170	15.1	11.3				24.0					
171 - 180	12.0	11.1				20.3					
181 - 190	8.1	9.1				19.0					
191 - 200	5.0	3.4				15.3					
201 - 210	2.3	2.3				-					
211 - 220	1.4	2.2									
221 - 230	1.0	1.0									
231 - 240	-	-									
Ave.	22.6	23.0	34.6	13.7	20.8	34.4	36.5	7.6	25.9	26.4	4.2

Table 2.14(2) FREQUENCY OF SEAWATER INTRUSION UNDER EXISTING CONDITION

At 1 m below Water Surface, Pampanga River

(Unit: Km)

Period	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
1 - 10	2.2	3.0	2.4	1.2	2.1	8.4	4.2	0.8	2.3	4.1	0.5
11 - 20	2.1	2.4	2.3	1.0	1.4	8.0	4.0	0.6	2.2	3.1	0.4
21 - 30	2.0	2.1	2.3	0.9	1.1	6.2	3.3	0.6	2.0	2.4	0.2
31 - 40	2.0	2.1	2.2	0.7	0.9	6.2	3.3	0.5	1.4	2.4	0.2
41 - 50	1.4	2.0	2.2	0.7	0.9	6.0	3.2	0.5	0.9	2.2	0.1
51 - 60	1.2	2.0	2.1	0.5	0.7	5.4	3.0	0.5	0.9	2.0	-
61 - 70	1.1	1.4	2.0	0.4	0.6	5.2	2.3	0.5	0.8	1.4	
71 - 80	1.1	1.3	1.4	0.4	0.6	5.0	2.3	0.4	0.7	1.2	
81 - 90	1.1	1.3	1.4	-	0.5	5.0	1.3	0.3	0.7	1.1	
91 - 100	1.1	1.2	1.2		0.5	4.1	1.3	0.2	0.4	0.9	
101 - 110	1.0	1.1	1.2		-	1.3	1.2	0.2	-	0.6	
111 - 120	1.0	1.0	1.1			1.2	1.2	0.1		0.4	
121 - 130	0.9	0.8	1.0			1.0	1.1	-		0.3	
131 - 140	0.8	0.7	1.0			1.0	0.9			-	
141 - 150	0.8	0.7	0.9			1.0	0.5				
151 - 160	0.7	0.7	0.7			0.9	-				
161 - 170	0.7	0.6	-			0.9					
171 - 180	0.6	0.6				0.8					
181 - 190	0.5	0.5				0.8					
191 - 200	0.3	0.3				0.7					
201 - 210	0.1	0.2				-					
211 - 220	-	0.1									
221 - 230		-									
Ave.	1.1	1.2	1.6	0.7	0.9	3.5	2.2	0.4	1.2	1.7	0.3

Table 2.14(3) FREQUENCY OF SEAWATER INTRUSION UNDER EXISTING CONDITION

At Channel Bottom, Labangan Floodway

(Unit: Km)

Period	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
1 - 10	22.5	22.4	22.4	10.5	18.0	13.1	22.5	22.3	22.3	22.6	22.4
11 - 20	22.3	22.4	22.4	10.1	12.7	13.1	22.4	22.0	21.4	22.6	22.2
21 - 30	21.9	22.3	22.3	9.7	9.5	13.1	22.3	21.7	21.3	22.2	22.0
31 - 40	21.4	22.3	22.3	8.4	9.5	13.1	22.3	13.9	21.2	22.0	21.9
41 - 50	21.1	22.3	22.3	6.3	9.4	13.0	22.2	13.8	20.8	22.0	21.9
51 - 60	20.9	22.3	22.0	6.0	9.2	13.0	22.1	13.5	20.7	21.9	21.7
61 - 70	20.7	22.3	11.6	6.0	9.2	13.0	22.0	13.0	20.5	21.8	21.6
71 - 80	20.4	22.3	8.6	5.7	8.0	13.0	21.9	11.9	20.5	21.8	21.4
81 - 90	20.4	22.3	8.5	5.6	7.4	12.9	21.8	11.7	20.4	21.8	21.2
91 - 100	19.6	22.2	7.6	5.4	7.1	12.8	21.8	11.4	20.2	21.8	20.4
101 - 110	14.9	22.1	6.9	5.4	6.7	12.2	21.7	10.9	15.6	21.7	20.2
111 - 120	14.9	22.1	6.9	5.1	6.1	12.1	21.4	10.8	13.8	21.6	20.2
121 - 130	14.4	21.8	5.8	5.1	5.7	11.9	20.9	9.9	12.7	21.4	18.3
131 - 140	13.2	21.7	5.3	5.0	5.4	11.9	20.8	9.7	12.4	21.4	17.1
141 - 150	12.6	21.7	5.3	4.7	5.3	11.9	20.8	9.6	12.3	21.4	16.8
151 - 160	12.1	21.7	5.0	4.6	4.9	11.8	20.6	9.3	11.8	21.3	14.7
161 - 170	11.2	21.7	5.0	4.1	4.8	11.7	20.5	9.0	11.8	21.2	14.5
171 - 180	11.0	21.7	4.8	4.1	4.4	11.7	20.3	9.0	9.7	21.0	13.0
181 - 190	10.5	21.5	4.7	3.6	4.4	11.5	19.6	8.9	9.4	19.6	11.2
191 - 200	9.9	21.2	4.5	3.6	4.4	11.1	19.0	8.8	9.1	18.3	10.8
201 - 210	9.4	20.7	4.3	3.5	4.3	10.6	11.8	8.7	9.0	15.3	8.9
211 - 220	8.8	19.9	4.2	3.4	4.2	10.5	9.0	8.7	8.3	13.1	8.7
221 - 230	8.5	14.8	4.0	3.0	3.5	9.8	7.2	8.7	6.5	13.0	8.5
231 - 240	8.2	13.8	3.9	3.0	3.2	9.8	5.7	8.6	6.0	12.9	8.4
241 - 250	8.1	12.6	3.9	2.8	3.1	9.7	5.3	8.5	5.3	11.9	8.4
251 - 260	8.1	11.9	3.1	2.8	3.1	8.8	5.1	8.5	5.0	11.4	7.9
261 - 270	6.5	11.5	3.0	2.5	2.6	8.7	4.2	8.2	4.3	11.0	5.3
271 - 280	6.0	6.6	3.0	2.4	2.5	7.5	4.1	8.0	3.9	9.9	4.9
281 - 290	4.8	5.3	2.9	2.2	2.2	7.4	3.0	8.0	3.9	9.1	4.6
291 - 300	3.1	4.1	2.8	1.9	0.8	6.0	1.9	7.9	3.3	8.5	3.7
301 - 310	2.9	3.6	2.5	1.2	0.7	4.2	1.3	7.3	3.2	8.5	2.8
311 - 320	2.0	3.5	1.3	0.9	0.6	4.0	1.2	6.8	2.8	8.4	2.3
321 - 330	0.2	3.2	1.3	0.7	-	1.6	1.1	6.7	1.7	8.3	-
331 - 340	-	1.1	0.7	-		1.5	-	6.1	1.4	8.1	
341 - 350		-	-			0.7		5.9	-	6.6	
351 - 360						-		3.9		2.5	
Ave.	12.5	16.9	7.8	4.5	5.7	10.0	14.8	10.3	11.5	16.3	13.6

Table 2.14(4) FREQUENCY OF SEAWATER INTRUSION UNDER EXISTING CONDITION

At 1 m below Water Surface, Labangan Floodway

(Unit: Km)

Period	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
1 - 10	14.8	14.8	14.8	0.9	5.8	1.9	14.9	14.6	14.6	15.0	14.7
11 - 20	14.6	14.7	14.8	0.9	1.6	1.9	14.8	14.1	13.1	15.0	14.5
21 - 30	14.0	14.7	14.7	0.8	0.8	1.9	14.6	13.6	13.0	14.5	14.2
31 - 40	13.1	14.7	14.6	0.7	0.8	1.9	14.6	2.7	12.8	14.1	14.0
41 - 50	12.6	14.6	14.6	0.5	0.8	1.8	14.5	2.6	12.2	14.1	14.0
51 - 60	12.3	14.6	14.1	0.5	0.8	1.8	14.3	2.3	11.9	14.0	13.7
61 - 70	11.9	14.6	1.1	0.5	0.8	1.8	14.1	1.8	11.4	13.8	13.5
71 - 80	11.2	14.6	0.7	0.5	0.7	1.8	14.0	1.2	11.4	13.8	13.2
81 - 90	11.2	14.6	0.7	0.5	0.6	1.8	13.8	1.1	11.3	13.8	12.7
91 - 100	7.3	14.5	0.6	0.4	0.6	1.7	13.8	1.0	10.8	13.8	11.3
101 - 110	4.1	14.3	0.6	0.4	0.6	1.4	13.7	0.9	4.4	13.8	10.8
111 - 120	3.9	14.2	0.6	0.4	0.5	1.3	13.2	0.9	2.6	13.6	10.6
121 - 130	3.2	13.9	0.5	0.4	0.5	1.2	12.3	0.8	1.6	13.2	6.0
131 - 140	2.0	13.8	0.4	0.4	0.4	1.2	12.2	0.8	1.5	13.2	5.3
141 - 150	1.6	13.7	0.4	0.3	0.4	1.2	12.2	0.8	1.4	13.1	5.1
151 - 160	1.3	13.7	0.4	0.3	0.4	1.2	11.7	0.8	1.2	13.0	3.6
161 - 170	1.0	13.6	0.4	0.2	0.4	1.2	11.5	0.8	1.2	12.7	3.4
171 - 180	0.9	13.6	0.4	0.2	0.3	1.1	10.9	0.8	0.8	12.4	1.8
181 - 190	0.9	13.4	0.3	0.1	0.3	1.1	7.3	0.8	0.8	7.3	1.0
191 - 200	0.8	12.8	0.3	0.1	0.3	1.0	6.3	0.7	0.8	6.0	0.9
201 - 210	0.8	11.9	0.3	0.1	0.3	0.9	1.2	0.7	0.8	4.3	0.8
211 - 220	0.7	8.1	0.2	0.1	0.3	0.9	0.8	0.7	0.7	1.9	0.7
221 - 230	0.7	3.8	0.2	-	0.1	0.8	0.6	0.7	0.5	1.8	0.7
231 - 240	0.7	2.6	0.2		-	0.8	0.5	0.7	0.5	1.8	0.7
241 - 250	0.7	1.6	0.2			0.8	0.4	0.7	0.4	1.2	0.7
251 - 260	0.7	1.2	-			0.7	0.4	0.7	0.4	1.1	0.7
261 - 270	0.5	1.1				0.7	0.2	0.7	0.3	1.0	0.4
271 - 280	0.5	0.5				0.6	0.2	0.7	0.2	0.8	0.4
281 - 290	0.4	0.4				0.6	-	0.7	0.2	0.8	0.3
291 - 300	-	0.2				0.5		0.7	0.1	0.7	0.1
301 - 310		0.1				0.2		0.6	-	0.7	-
311 - 320		0.1				0.2		0.6		0.7	
321 - 330		-				-		0.6		0.7	
331 - 340								0.5		0.7	
341 - 350								0.5		0.6	
351 - 360								0.2		-	
Ave.	4.9	9.5	3.6	0.4	0.7	1.2	8.9	2.0	4.6	8.0	6.3

Table 2.15 ESTIMATED ANNUAL SEDIMENT YIELD (PAMPANGA RIVER BASIN)

	Location	Period of Analyses	Drainage Area (km^2)	Average Annual Yield ($t/km^2/yr$)
1.	Talavera R. Lomboy, San Jose	1957 - 67	261	295
2.	Peñaranda R. Gapan	1946 - 68	573	535
3.	Sumacbao R. Pias, Gen. Tinio	1960 - 68	287	1,395
4.	Maasim R. Diliman, San Rafael	1946 - 64	150	1,595
5.	Cabu R., Cabanatuan City	1966 - 68	143	401
6.	Coronel R. Bangkerohan, Bongabon	1960 - 68	709	1,390
7.	Pampanga R. Pialuan, Pantabangan	1960 - 68	838	982
8.	Digmala R. Labi, Bongabon	1959 - 68	52	115
9.	Rio Chico R. Sto. Rosario, Zaragosa	1960 - 69	1,177	213
10.	Pampanga R. San Antonio, San Leonardo	1959 - 68	2,851	1,078
11.	Pampanga R. San Agustin, Arayat	1946 - 69	6,487	537
12.	Carranglan R. Baluarte, Carranglan	1960 - 65	258	224
13.	Peñaranda R. San Jose Peñaranda	1946 - 68	512	157
14.	Pampanga R. San Vicente, Cabiao	1959 - 68	3,467	588
15.	Madlum R. Sibul Springs, Bulacan	1957 - 64	102	388

Source: Report on Irrigation Development Plan for Central Luzon, Appendix E Jan. 1978, by NIA

Note: The yields are based on average monthly sediment discharge records.

Table 2.16 SEDIMENT DISCHARGE OBSERVED BY TEAM (AUG. - NOV. 1980)

Site	Observed Date	Discharge (m^3/s)	Sediment Discharge (g/s)
Sulipan Highway Br.	Sept. 5, 1980	596.4 /1	0.99×10^5
	Sept. 12, 1980	817.7	1.94×10^5
	Sept. 19, 1980	930.2	2.54×10^5
	Sept. 26, 1980	618.9	0.46×10^5
	Nov. 7, 1980	1,571.0	17.17×10^5
Candaba Br.	Sept. 12, 1980	518.3	0.64×10^5
	Sept. 19, 1980	1,078.7	2.58×10^5
	Sept. 26, 1980	440.4	0.48×10^5
Arayat Br.	Aug. 14, 1980	529.5 /1	1.07×10^5
	Aug. 27, 1980	520.6 /1	1.57×10^5
	Sept. 10, 1980	433.2	1.46×10^5
	Sept. 17, 1980	706.5	1.43×10^5
	Sept. 24, 1980	387.3	0.27×10^5
	Nov. 7, 1980	1,645.5 /1	6.77×10^5
	Nov. 10, 1980	2,035.4	5.61×10^5
San Isidro Br.	Sept. 11, 1980	165.9	0.22×10^5
	Sept. 18, 1980	557.2	5.73×10^5
	Sept. 25, 1980	129.0	0.07×10^5
	Nov. 7, 1980	1,848.3	18.67×10^5
	Nov. 10, 1980	440.5	2.46×10^5
Rio Chico Br.	Aug. 14, 1980	79.0	0.08×10^5
	Aug. 28, 1980	109.1 /1	0.13×10^5
	Sept. 11, 1980	217.4	0.34×10^5
	Sept. 18, 1980	315.4	0.67×10^5
	Sept. 25, 1980	155.6	0.27×10^5
	Nov. 7, 1980	556.4 /1	2.71×10^5
	Nov. 11, 1980	356.7 /1	0.63×10^5
Talavera Br.	Aug. 28, 1980	21.6	0.02×10^5
	Sept. 10, 1980	38.1	0.07×10^5
	Sept. 17, 1980	70.8	0.22×10^5
	Sept. 24, 1980	41.3	0.11×10^5
Bamban Br.	Aug. 29, 1980	25.9	0.10×10^5
	Sept. 11, 1980	17.0	0.02×10^5
	Sept. 18, 1980	51.0	0.70×10^5
	Sept. 25, 1980	8.7	0.01×10^5

Remarks: /1 Estimated discharge by use of rating curve.

Table 2.17(1) SAMPLING TEST DATA OF RIVER BED MATERIAL

(Unit: mm)

River	Sampling No.	Distance from River Mouth (Km)	Percentage of Weight Passing through the Sieve												
			37.5	19.0	9.5	4.76	2.00	0.600	0.420	0.250	0.106	0.053	65%	50%	dm
Pampanga	1	0						100	99	99	97	17	0.08	0.07	0.105
	2	6.5						100	99	99	93	16	0.082	0.072	0.111
	3	14.5		100	79	77	77	77	75	75	73	17	0.0965	0.08	4.265
	4	20.5						100	99	99	87	12	0.086	0.0745	0.122
	5	26.5						100	99	98	97	28	0.076	0.066	0.101
	6	29.5								100	99	33	0.074	0.063	0.090
	7	32.5							100	99	97	37	0.073	0.0615	0.092
	8	38.5						100	99	95	61	4	0.116	0.092	0.170
	9	45.5						100	99	98	92	12	0.082	0.0725	0.116
	10	49.5							100	99	97	44	0.069	0.057	0.089
	11	57.5							100	99	98	26	0.074	0.066	0.097
	12	62.5							100	99	69	8	0.101	0.085	0.148
	13	67.5							100	99	77	3	0.094	0.082	0.139
	14	71.5						100	99	98	37	1	0.153	0.125	0.201
	15	74.5			100	97	89	76	47	27	1	1	0.51	0.425	1.249
	16	82.0	100	90	72	58	42	31	21	12	4	2	6.8	3.08	9.603
	17	85.5		100	90	71	46	24	11	6	1	1	3.55	2.15	5.447
	18	102.0		100	93	67	43	28	19	12	3	1	4.25	2.48	5.351
Rio Chico	19	1.0						100	99	96	67	12	0.102	0.084	0.156
	20	6.0						100	99	97	63	9	0.11	0.088	0.161
	21	42.0							100	99	92	32	0.078	0.066	0.102
	22	44.0							100	99	76	15	0.093	0.078	0.134
	23	46.0						100	99	98	91	34	0.077	0.064	0.106
Angat	24							100	99	97	73	11	0.0955	0.081	0.146
	25							100	96	74	29	3	0.21	0.158	0.258
Labangan	26							100	99	98	82	13	0.0885	0.0765	0.130
	27							100	99	98	84	13	0.088	0.076	0.127
Bamban	28	14.5			100	99	98	96	77	59	28	1	0.288	0.189	0.479
	29	27.5		100	91	90	86	79	46	26	8	1	0.51	0.435	2.470

Table 2.17(2) SAMPLING TEST DATA OF RIVER BED MATERIAL

(Unit: mm)

River	Sampling No.	Distance from River Mouth (Km)	Percentage of Weight Passing through the Sieve												
			37.5	19.0	9.5	4.76	2.00	0.600	0.420	0.250	0.106	0.053	65%	50%	dm
Bamban	30	27.9		100	97	91	90	86	64	49	26	1	0.42	0.25	1.547
	31	28.3	100	84	79	76	72	65	40	26	11	1	0.59	0.48	7.823
Penaranda	32			100	88	81	67	42	12	9	5	1	1.75	0.84	4.319
Talavera	33			100	69	48	31	18	9	8	6	1	7.8	4.76	9.023
	34			100	92	73	54	30	8	5	3	1	3.15	1.55	4.862
	35		100	92	75	56	40	24	8	5	2	1	6.2	3.1	9.234
Hagoney	36							100	89	57	16	1	0.28	0.21	0.319
	37							100	99	98	97	24	0.077	0.067	0.103
Cabiao	38				100	97	96	93	85	80	55	6	0.15	0.098	0.579
Candaba-Floodway						100	97	77	47	37	27	7	0.52	0.435	0.815
Bagbag	40							100	99	98	93	16	0.081	0.071	0.113
Bebe San Esteban Channel	41							100	99	99	96	11	0.082	0.0725	0.109

Table 2.18 ANNUAL SEDIMENT YIELD ESTIMATED BY TEAM

Location	Drainage Area (Km^2)	Annual Yield ($t/km^2/yr$)										
		1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	Ave.
Arayat	6,532	471	540	290	192	318	442	797	228	512	80	387
Sulipan	7,715	166	89	55	40	10	22	171	9	26	1	59
Candaba	7,270	199	230	94	60	182	201	391	94	150	24	163
Bamban	206	1,444	1,495	835	557	906	1,284	3,039	728	1,610	233	1,213
Talavera	401	55	97	130	90	304	347	383	355	426	434	262
Zaragoza	1,675	191	184	94	105	97	132	231	81	197	30	134
San Isidro	3,472	947	1,254	460	347	785	838	1,083	345	596	191	685

Table 3.1 (1) PROBABLE NATURAL DAILY AVERAGE PEAK DISCHARGE AS ESTIMATED BY PD/CS TAHAL

(Unit: m^3/s)

Sub-Basin	Station Name	Return Periods in Years 10	50	100
A1	Pampanga River, Pialuan, Pantabangan, Nueva Ecija	836	1,122	1,240
A2	Coronel River, Bangkerohan, Bongabon Nueva Ecija	961	1,344	1,504
A3	Pampanga River, Valdefuente, Cabanatuan City, Nueva Ecija	1,122	1,464	1,606
A4	Chico River, General Tinio, Nueva Ecija	267	377	422
A5	Sumacbao River, Pias, General Tinio, Nueva Ecija	537	756	847
A6	Peñaranda River, (RR Bridge), San Jose, Peñaranda, Nueva Ecija	882	1,243	1,393
A7	Peñaranda River, San Vicente, Gapan, Nueva Ecija	884	1,244	1,394
A8	Pampanga River, San Vicente, Cabiao, Nueva Ecija	1,959	2,673	2,970
B1	Talavera River, Kaboboloonan, Talavera, Nueva Ecija	354	492	546
B2	Rio Chico River, Sto. Rosario, Zaragoza, Nueva Ecija, Pampanga	938	1,227	1,343
B3	Rio Chico River, Banga Arayat, Pampanga	1,135	1,466	1,604
B4	Pampanga River, San Agustin, Arayat, Pampanga	2,200	2,850	3,150
C1	Bulu River, Malibay, San Miguel, Bulacan	93	132	149
C2	Candaba Swamp, Ducma, Candaba, Pampanga	964	1,347	1,506
C3	San Miguel, San Vicente, Gapan, Nueva Ecija	318	456	513

(to be cont'd)

Table 3.1 (2) PROBABLE NATURAL DAILY AVERAGE PEAK DISCHARGE AS ESTIMATED BY PD/CS TAHAL

(Unit: m^3/s)

Sub-Basin	Station Name	Return Periods in Years 10	50	100
C4	Garlang River, Garlang San Ildefonso, Bulcan	109	148	164
C5	Maasim River, Diliman, San Rafael, Bulacan	255	338	373
C6	Maasim River, Bahay Pare, Candaba, Pampanga	273	364	402
C7	Angat (below IPO Dam) Norzaragay, Bulacan	710	944	1,041
C8	Labangan River, Bagbag, Calumpit, Bulacan	850	1,127	1,242
D1	San Fernando River, Pampanga	306	448	508
D2	San Fernando River, Pampanga	678	992	1,123
D3	San Fernando River, Pampanga	960	1,403	1,391
D4	Pasig-Potrero River, Cabetican, Bacolor, Pampanga	212	300	349
D5	Porac River, Valdez, Floridablanca, Pampanga	339	491	555
D6	Gumain River, Pabanlag, Floridablanca, Pampanga	254	369	417
D7	Caulaman River, Pabanlag, Floridablanca, Pampanga	315	454	511
D8	Lower Gumain River	663	957	1,080

Table 3.2 COMPARISON OF PROBABLE PEAK DISCHARGE

(Unit: m^3/s)

Station	No.	Return Periods in Years					
		10		50		100	
		Real	Synt	Real	Synt	Real	Synt
Chico River	A4	456	267	669	377	759	422
Arayat	B4	2,698	2,200	3,328	2,850	3,595	3,150
Gumain River	D6	365	254	564	369	649	417
Coronel River	A2	806	961	1,159	1,344	1,308	1,504

Remarks: Real: Probable peak discharge calculated from observed discharge data

Synt: Probable peak discharge calculated from synthetic rainfall series

Table 3.3 100 YEAR DESIGN RAINFALL AND FLOOD PEAK DISCHARGE AS ESTIMATED BY MPW IN 1958

100-Year Design Rainfall

Daily Rainfall	Depth	Maximum Rainfall	Depth
1 st day	54 mm	1 - day	207 mm
2 nd day	111 mm	2 - day	318 mm
3 rd day	207 mm	3 - day	382 mm
4 th day	64 mm	4 - day	436 mm
5 th day	53 mm	5 - day	489 mm
6 th day	29 mm	6 - day	518 mm
7 th day	28 mm	7 - day	546 mm

100-Year Flood Peak Discharge

Location	Peak Discharge (m^3/sec)
Pampanga at Arayat /1	9,100
Candaba outlet at Calumpit	1,900
Angat at Calumpit	1,090

Remarks, /1: Including Rio Chico River Watershed

Table 3.4 ANNUAL MAXIMUM RAINFALL AT CABANATUAN CITY

(Unit: mm)

Year	Day						
	1	2	3	4	5	6	7
1951	77.7	124.2	169.9	192.5	206.0	231.7	241.6
1952	61.7	94.7	95.2	139.4	170.9	172.4	172.9
1953	79.5	110.0	115.1	177.3	188.2	196.3	228.0
1954	102.4	118.1	121.1	153.7	153.7	161.6	161.6
1955	65.3	75.5	86.9	99.6	116.6	129.3	145.0
1956	110.7	110.7	119.4	133.6	154.2	170.0	206.6
1957	122.4	168.1	168.6	172.5	224.3	227.6	229.6
1958	90.9	98.0	135.9	137.7	144.8	183.4	185.2
1959	127.8	173.8	182.7	204.0	204.8	280.3	301.6
1960	137.4	223.0	260.8	262.1	265.2	270.3	312.2
1961	115.6	200.9	262.9	289.6	311.2	349.8	371.4
1962	182.4	237.0	290.6	300.3	335.9	342.3	345.1
1963	100.8	148.8	167.9	182.6	184.9	223.2	242.3
1964	140.3	175.9	179.2	182.0	192.0	197.8	201.1
1965	111.9	179.7	204.1	213.5	227.5	251.6	316.9
1966	197.4	303.3	334.3	337.9	340.7	363.8	367.4
1967	109.2	160.0	168.6	168.6	241.9	302.9	302.9
1968	90.4	104.4	159.5	173.5	199.3	213.3	228.3
1969	81.3	125.0	125.0	182.1	218.2	219.5	249.4
1970	90.7	115.8	134.1	136.6	154.0	156.5	163.5
1971	103.2	160.6	169.6	242.2	242.2	242.2	260.0
1972	224.2	337.0	350.2	390.9	459.4	468.1	474.7
1973	88.8	145.6	161.1	167.4	196.8	218.3	223.6
1974	228.4	347.3	404.2	426.8	445.8	447.3	462.3
1975	61.0	70.1	96.0	111.0	116.1	119.1	131.8
1976	226.1	442.0	582.9	688.8	832.0	850.8	877.0
1977	92.7	138.2	182.6	185.6	185.6	185.6	185.6
1978	230.6	300.9	306.4	319.7	319.7	325.5	335.1
1979	69.0	97.0	109.4	135.2	147.6	154.6	164.4

Table 3.5 PROBABLE RAINFALL AT CABANATUAN CITY

Return Period (year)	Probable Rainfall (mm)						
	1-day	2-day	3-day	4-day	5-day	6-day	7-day
2	109.1	152.7	172.3	189.2	204.5	229.8	238.1
5	167.1	253.7	295.9	327.4	367.6	385.4	402.7
10	205.5	320.5	377.8	418.9	475.7	493.1	511.6
20	242.4	384.6	456.3	506.7	579.3	596.4	616.2
50	290.1	467.6	558.0	620.3	713.4	730.1	751.5
80	314.3	509.8	609.7	678.1	781.6	798.1	820.3
100	325.8	529.8	634.2	705.5	813.8	830.3	852.9
150	346.7	566.1	678.6	755.1	872.5	888.7	912.0
200	361.4	591.8	710.1	790.3	914.0	930.1	953.9
500	408.4	673.6	810.2	902.2	1,046.1	1,061.8	1,087.1
1,000	443.9	735.4	885.9	986.8	1,145.9	1,161.3	1,187.9

Remarks: 29 samples during the period 1951 through 1979 are used for calculation of probability of exceedence by Gumbel method.

Table 3.6 PROBABLE RAINFALL IN THE BASIN AVERAGE

Return Period (year)	Probable Rainfall (mm)						
	1 - day	2 - day	3 - day	4 - day	5 - day	6 - day	7 - day
2	77.1	119.6	141.3	159.4	173.1	193.1	211.7
5	116.5	198.8	246.2	280.3	316.9	340.3	365.1
10	142.6	251.2	315.8	360.3	412.3	437.8	466.6
20	167.7	301.4	382.4	437.2	503.6	531.2	564.1
50	200.2	366.5	468.7	536.6	621.9	652.2	690.2
80	216.6	399.6	512.6	587.1	682.1	713.8	754.3
100	224.4	415.3	533.4	611.1	710.5	742.9	784.7
150	238.7	443.7	571.1	654.5	762.2	795.8	839.7
200	248.7	463.9	597.9	685.3	798.8	833.2	878.8
500	280.6	528.0	682.9	783.2	915.4	952.4	1,002.9
1,000	304.8	576.5	747.1	857.3	1,003.4	1,042.5	1,096.9

Remarks: Probable rainfalls in the basin average are estimated from the probable rainfalls at Cabanatuan City through the correlation curves.

Table 3.7 STORAGE COEFFICIENTS ON SUB-BASINS

Sub-basin No.	Catchment Area (Km^2)	Storage Coefficient			Lag-time
		K	P	f_1	(hr)
A. Upper Pampanga Basin					
101	890	59.34	0.519	0.5	1.33
102	383	67.02	0.472	0.5	0.79
103	135	40.56	0.406	0.5	0.41
104	84	35.91	0.447	0.5	0.68
105	166	88.26	0.522	0.5	0.62
106	47	37.20	0.435	0.5	0.52
107	259	57.40	0.533	0.5	0.62
108	143	23.04	0.693	0.5	1.97
109	375	38.46	0.729	0.5	1.66
110	389	33.84	0.806	0.5	1.25
111	125	27.04	0.558	0.5	1.27
112	226	24.86	0.596	0.5	2.30
113	250	45.36	0.641	0.5	0.32
114	40	11.40	1.000	0.5	0.55
Sub-total	3,512				
B. Rio Chico-Talavera Basin					
201	484	75.33	0.591	0.5	3.90
202	177	51.24	0.800	0.5	0.67
203	769	79.20	0.712	0.5	3.13
204	245	45.80	0.873	0.5	0.64
205	197	40.43	0.963	0.5	1.41
206	464	54.63	0.761	0.5	1.11
207	430	68.04	0.641	0.5	1.84
208	185	37.26	1.000	0.5	0.82
209	69	11.40	1.000	0.5	0
Sub-total	3,020				
C. Sierra Madre Mountain Basin					
301	62	37.26	1.000	0.5	0.15
302	220	54.52	0.762	0.5	1.09
303	46	74.40	0.435	0.5	0.30
304	164	41.40	0.945	0.5	1.68
305	78	65.08	0.483	0.5	0.82
306	330	83.40	0.546	0.5	2.07
307	241	86.10	0.533	0.5	2.09
308	140	11.00	1.000	0.5	0
309	129	42.34	0.926	0.5	0.40
310	69	11.00	1.000	0.5	0
311	565	55.58	0.546	0.5	3.35
312	212	32.81	0.480	0.5	1.54
313	119	29.59	0.520	0.5	0.08
Sub-total	2,375				
D. Zambales Mountains Basin					
401	304	11.40	1.000	0.5	1.40
402	141	11.40	1.000	0.5	1.11
403	103	59.00	0.521	0.5	1.01
404	108	71.55	0.616	0.5	0.65
405	183	22.80	1.000	0.5	1.26
406	106	34.20	1.000	0.5	0.45
407	130	53.70	0.561	0.5	2.93
408	156	78.60	0.416	0.5	1.69
409	365	67.00	0.472	0.5	1.54
Sub-total	1,596				
Total Area	10,503				

Table 3.8(1) DISCHARGE-STORAGE RELATION ON CHANNEL

(Unit: m^3/s)

Channel No. 11		Channel No. 12		Channel No. 13		Channel No. 14		Channel No. 15		Channel No. 21	
Discharge	Storage	Discharge	Storage	Discharge	Storage	Discharge	Storage	Discharge	Storage	Discharge	Storage
Existing Channel Condition											
50	710	50	370	50	980	50	1,090	50	660	50	660
100	1,090	100	570	100	1,480	100	1,650	100	990	100	990
200	1,630	300	1,100	300	2,890	200	2,500	200	1,500	150	3,350
300	2,090	500	1,500	500	3,900	300	3,200	300	1,900	200	7,700
500	2,830	690	1,810	700	4,750	500	4,400	445	2,410	300	26,000
580	3,100	800	2,600	900	5,600	700	5,350	500	2,600	400	60,000
800	7,000	1,000	4,400	1,200	11,000	840	6,000	700	3,200		
1,000	12,100	1,200	7,000	1,500	18,600	1,000	6,700	800	3,500		
1,150	17,200	1,400	10,000	1,800	28,000	1,500	8,600	1,200	8,800		
2,000	24,000	2,000	12,300	2,000	36,000	2,000	21,000	1,600	17,000		
4,000	36,500	3,000	15,700	2,500	61,000	2,250	30,000	2,000	19,400		
6,000	47,000	5,000	21,000	3,000	92,000	2,300	100,000	3,000	25,000		
After Channel Improvement											
						50	1,090			50	660
						100	1,650			100	990
						300	3,200			150	3,350
						500	4,400			200	7,700
						700	5,350			270	18,000
						1,000	6,700			500	26,000
						1,500	8,600			1,000	40,000
						2,000	21,000			2,000	60,000
						2,300	32,000				
						3,000	38,000				
						4,000	45,000				
						5,000	52,000				
						7,000	64,000				

(to be cont'd)

Table 3.8(2) DISCHARGE-STORAGE RELATION ON CHANNEL (cont'd)

Channel No. 22		Channel No. 23		Channel No. 31		Channel No. 41		Channel No. 42	
Discharge	Storage	Discharge	Storage	Discharge	Storage	Discharge	Storage	Discharge	Storage
Existing Channel Condition									
50	390	50	480	0	0	0	0	0	0
90	560	100	700	50	1,150	50	390	50	320
130	1,860	140	840	100	1,750	100	580	100	500
185	5,800	200	3,500	300	3,350	200	5,000	250	850
200	7,800	240	7,600	500	4,600	500	8,800	500	5,600
250	16,000	300	18,500	800	9,300	800	11,800	800	7,400
300	29,000	400	65,000	1,000	15,000	1,000	13,500	1,000	8,500
2,400	70,000			1,200	21,000	1,500	17,200	1,500	11,000
				1,500	24,500	2,000	20,500	2,000	13,100
				2,000	29,000	3,000	26,000	3,000	17,000
				3,000	37,000			5,000	23,000
				5,000	50,000				
After Channel Improvement									
50	390	50	480						
90	560	100	700						
130	1,800	140	840						
185	6,000	240	7,700						
300	7,900	300	8,700						
500	10,800	500	12,000						
1,000	16,300	1,000	18,000						
2,000	24,600	2,000	27,500						
		3,000	35,000						

Table 3.9 ASSUMED CHANNEL CONDITIONS

River	Channel No.	Length (km)	Slope	Manning's n	Low-water Channel		Channel Width	
					Depth (m)	Width (m)	Existing (m)	After Improve. (m)
Pampanga	11	33.5	1/600	0.045	3.0	100	2,500	
"	12	19.8	1/400	0.045	3.0	100	2,500	
"	13	30.0	1/1,200	0.040	3.0	200	4,000	
"	14	27.5	1/3,000	0.035	3.5	200	5,000	3,000
Peñaranda	15	25.9	1/1,000	0.045	3.0	100	2,000	
Taravera	21	32.5	1/10,000	0.030	2.0	50	6,000	3,000
Rio Chico	22	12.0	1/20,000	0.025	3.0	50	6,000	3,000
"	23	12.5	1/20,000	0.025	3.0	80	7,000	1,000
Angat	31	36.0	1/1,600	0.040	3.0	150	2,000	
Guagua	41	14.5	1/10,000	0.025	2.5	50	4,000	
"	42	7.5	1/20,000	0.025	3.0	100	4,000	

Remarks: The above values were assumed on the basis of s = 1/50,000 topographical maps.

Table 3.10 (1) PEAK DISCHARGE OF PROBABLE FLOOD

(Unit: m^3/sec)

Calculation Point No.	Location	Return Period (year) 5	10	20	50	100
A. Upper Pampanga Basin						
1		1,534	2,448	3,394	4,686	5,711
2	Pantabangan Dam	986	1,218	1,450	1,450	1,450
3		874	975	1,088	1,292	1,430
4		368	558	819	1,198	1,505
5		1,215	1,446	1,704	2,041	2,380
6		172	229	316	424	507
7		172	229	316	424	507
8		106	142	194	259	309
9		106	142	194	259	309
10		132	182	235	305	358
11		227	318	406	522	611
12		59	80	109	145	173
13		59	80	109	145	173
14		458	626	789	1,043	1,259
15		207	289	364	462	538
16		659	911	1,151	1,464	1,741
17		647	811	978	1,168	1,319
18		1,817	2,244	2,661	3,180	3,582
19		147	195	240	310	364
20		1,960	2,431	2,889	3,462	3,907
21		340	451	555	725	860
22		2,297	2,881	3,442	4,149	4,697
23	Cabanatuan	1,977	2,365	2,725	3,205	3,572
24		325	439	545	679	782
25		2,240	2,704	3,133	3,692	4,122
26		2,091	2,629	3,101	3,657	4,081
27		146	191	234	291	334
28		146	191	234	291	334
29		286	405	511	643	744
30		286	405	511	643	744
31		392	535	667	834	961
32		166	235	301	398	470
33		541	753	947	1,196	1,388
34		529	732	864	1,046	1,192
35	San Isidro Br.	2,408	3,051	3,641	4,315	4,857
36		33	47	59	74	85
37	Cabiao	2,424	3,071	3,668	4,349	4,895

Table 3.10 (2) PEAK DISCHARGE OF PROBABLE FLOOD (continued)

(Unit: m^3/sec)

Calculation Point No.	Location	Return Period (year) 5	10	20	50	100
B. Rio Chico-Talavera Basin						
38		597	926	1,272	1,753	2,140
39		98	146	192	253	300
40		675	1,048	1,436	1,971	2,401
41		502	735	932	1,203	1,410
42		500	722	959	1,279	1,531
43		96	136	173	222	259
44		583	834	1,110	1,482	1,774
45		568	778	985	1,269	1,488
46	Zaragoza	1,061	1,497	1,883	2,422	2,840
47		1,022	1,469	1,863	2,398	2,812
48		86	116	147	186	217
49		241	332	418	528	612
50		1,247	1,816	2,341	3,069	3,605
51		193	285	386	521	627
52		96	133	167	211	243
53		1,485	2,180	2,812	3,667	4,307
54		56	76	97	122	140
55		1,508	2,212	2,853	3,721	4,368
C. Sierra Madre Mountain Basin						
57		26	36	44	55	65
58		88	138	184	239	280
59		24	35	50	74	95
60		24	35	50	74	95
61		87	121	159	211	250
62		106	152	209	282	336
63		41	60	88	127	163
64		41	60	88	127	163
65		154	216	294	423	530
66		190	264	380	546	681
67		59	94	130	172	201
68		466	655	869	1,233	1,520
69		89	117	142	187	228
70		551	764	970	1,393	1,728

Table 3.10 (3) PEAK DISCHARGE OF PROBABLE FLOOD (continued)

(Unit: m^3/sec)

Calculation Point No.	Location	Return Period (year) 5	10	20	50	100
72		49	70	86	106	121
73		38	55	66	82	97
74		86	120	147	182	218
76		608	941	1,339	1,954	2,440
77	Angat Dam	608	941	1,339	1,732	1,917
78		254	397	616	894	1,087
79		819	1,271	1,868	2,478	2,774
80		48	65	86	110	128
81		855	1,316	1,929	2,558	2,872
82	Longos	737	1,015	1,367	2,050	2,429
D. Zambales Mountain Basin						
83		185	241	289	396	482
84		88	112	134	201	265
85		272	353	423	566	682
86	San Fernando	156	242	315	462	583
87		44	66	85	121	151
88		198	297	389	574	727
89		196	268	350	492	648
90		34	52	68	93	114
91		229	310	409	579	763
92		80	115	139	169	202
93		292	418	509	705	921
94		36	54	66	82	99
95		326	470	573	774	1,004
96		58	84	119	167	206
97		60	93	122	178	223
98		130	184	245	351	436

Table 3.11 COMPARISON OF FLOOD PEAK DISCHARGE

(Unit: m^3/s)

Location	Discharge estimated by MPW /1	Discharge estimated by PD/CS-TAHAL /2			Discharge estimated by the Team /3			
	100-yr	10-yr	50-yr	100-yr	10-yr	50-yr	100-yr	100-yr /4
- Pampanga R. at Cabanatuan	-	1,122	1,465	1,606	2,365	3,205	3,572	4,273
- Pampanga R. at Cabiao	9,100 /5	1,959	2,673	2,970	3,071	4,349	4,895	5,581
- Rio Chico R. at Zaragoza	-	938	1,227	1,343	1,497	2,422	2,840	-
- Rio Chico R. before retarding by San Antonio Swamp	-	1,135	1,466	1,604	2,212	3,721	4,368	-
- Angat R. Longos	1,090 /6	850	1,127	1,242	1,013	2,050	2,429	2,850
- San Fernando R. at San Fernando	-	306	448	508	242	462	583	-
- Guagua R. at Guagua	1,200	960	1,403	1,391	470	774	1,004	-

Remarks /1: Discharge estimated by MPW in 1958 with BPW Scheme III in full operation.

/2: Daily average peak discharge excluding Pantabangan and Angat Dams.

/3: Including Pantabangan and Angat Dams.

/4: Excluding Pantabangan and Angat Dams.

/5: Including Rio Chico River Watershed.

/6: Including Angat Dam.

Table 4.1(1) CALCULATED MAXIMUM WATER LEVELS AND DISCHARGES (PAST FLOOD)

Swamp/Channel		Code	Unit	Flood 1972	1973	1974	1976
1. San Antonio Swamp							
Inflow	(Pampanga River)	QI1	m^3/sec	2,687	3,199	3,177	3,509
-do-	(Rio Chico River)	QI2	m^3/sec	1,579	1,934	2,261	2,085
at Swamp		HSA	El.m	10.91	11.18	11.35	11.96
at Arayat		HAY	El.m	10.06	10.30	10.45	11.01
-do-		QAY	m^3/sec	2,298	2,421	2,500	2,784
Cabiao Candaba Floodway		Qcc	m^3/sec	1,101	1,313	1,365	1,839
2. North Candaba Swamp							
Inflow	(Maasim River)	QI3	m^3/sec	1,993	1,832	3,469	1,728
-do-	(from Pampanga River)	QCN1	m^3/sec	0	2	116	419
at Swamp		HCN	El.m	7.40	7.47	7.85	8.18
Outflow	(to Pampanga River)	QCN2	m^3/sec	733	761	1,340	1,844
-do-	(to South Candaba Swamp)	QMD	m^3/sec	813	855	1,116	1,361
3. South Candaba Swamp							
Inflow		QI4	m^3/sec	179	306	454	218
-do-	(from Pampanga River)	QCS1	m^3/sec	685	767	1,491	2,417
-do-	(-do-)	QCS2	m^3/sec	751	779	1,117	1,184
at Swamp		HCS	El.m	5.22	5.27	5.82	6.32
Outflow	(to Pampanga River)	QCS3	m^3/sec	2,130	2,199	2,860	3,497
-do-	(to Angat River)	QCS4	m^3/sec	0	0	0	25
4. Pampanga River (Arayat-Sulipan)							
		HAC	El.m	7.98	8.07	8.35	8.59
at Candaba		QAC	m^3/sec	2,232	2,326	2,326	2,514
-do-		HCD	El.m	7.53	7.61	7.96	8.27
		QCD	m^3/sec	2,280	2,280	2,372	2,448
		HMR	El.m	7.39	7.46	7.84	8.16
		QMR	m^3/sec	2,856	2,963	3,488	3,959
		HSP	El.m	6.34	6.36	6.55	6.72
		QSS	m^3/sec	2,225	2,267	2,317	2,322
		HSS	El.m	5.82	5.85	6.20	6.52
		QSP	m^3/sec	2,176	2,217	2,266	2,275
		HAP	El.m	5.23	5.28	5.81	6.32
		QPAU	m^3/sec	2,037	1,982	1,871	1,902

Table 4.1(2) CALCULATED MAXIMUM WATER LEVELS AND DISCHARGES (PAST FLOOD)

Swamp/Channel	Code	Unit	Flood 1972	1973	1974	1976
5. Angat River						
	QI5	m^3/sec	322	624	891	778
	HAG	EL.m	4.88	4.92	5.47	5.97
	QAG	m^3/sec	309	612	853	767
6. Rivers (Downstream Sulipan)						
at Sulipan	HSC	EL.m	4.88	4.93	5.47	5.96
Pampanga River	QPAD	m^3/sec	2,752	2,798	3,356	4,178
-do-	HBH	EL.m	3.46	3.50	3.89	4.42
-do-	QPA2	m^3/sec	2,678	2,723	3,264	4,050
at Masantol	HBM	EL.m	3.21	3.24	3.62	4.12
Pampanga River	QPA1	m^3/sec	1,528	1,557	1,918	2,467
Bebe-San Esteban Channel	QBS	m^3/sec	1,151	1,166	1,346	1,584
Hagonoy River	HSJ	EL.m	2.53	2.56	2.86	3.30
-do-	QHA	m^3/sec	74	75	93	128
-do-	HHA	EL.m	1.93	1.96	2.24	2.71
Labangan Floodway	HLR	EL.m	4.55	4.93	5.15	5.42
-do-	QLF	m^3/sec	869	883	1,130	1,365
-do-	HLF	EL.m	3.70	4.60	4.31	4.67

Table 4.2(1) CALCULATED MAXIMUM WATER LEVELS AND DISCHARGES (PROBABLE FLOOD UNDER THE PRESENT CONDITION)

Swamp/Channel		Code	Unit	Return Period (Year) 5	10	20	50	100
1. San Antonio Swamp								
Inflow	(Pampanga River)	QI1	m^3/sec	2,424	3,070	3,664	4,345	4,895
-do-	(Rio Chico River)	QI2	m^3/sec	1,507	2,203	2,849	3,714	4,365
at Swamp		HSA	El.m	11.02	11.85	12.52	13.24	13.75
at Arayat		HAY	El.m	10.16	10.90	11.51	12.17	12.62
-do-		QAY	m^3/sec	2,349	2,731	3,068	3,451	3,734
Cabiao Candaba Floodway		Qcc	m^3/sec	1,217	1,796	2,489	3,432	4,160
2. North Candaba Swamp								
Inflow	(Maasim River)	QI3	m^3/sec	551	764	970	1,392	1,728
-do-	(from Pampanga River)	QCN1	m^3/sec	0	180	694	1,675	2,239
at Swamp		HCN	El.m	7.29	7.85	8.34	8.95	9.39
Outflow	(to Pampanga River)	QCN2	m^3/sec	611	1,252	2,092	3,659	4,469
-do-	(to South Candaba Swamp)	QMD	m^3/sec	746	1,120	1,482	1,986	2,374
3. South Candaba Swamp								
Inflow		QI4	m^3/sec	86	120	147	181	218
-do-	(from Pampanga River)	QCS1	m^3/sec	520	1,610	2,883	4,081	4,705
at Swamp		HCS	El.m	5.06	5.91	6.54	7.13	7.53
Outflow	(to Pampanga River)	QCS2	m^3/sec	-776	-1,077	1,855	2,520	2,961
-do-	(-do-)	QCS3	m^3/sec	1,922	2,920	3,711	4,227	4,818
-do-	(to Angat River)	QCS4	m^3/sec	0	0	310	1,091	1,412
4. Pampanga River (Arayat-Sulipan)								
		HAC	El.m	7.90	8.42	8.72	9.10	9.46
at Candaba		QAC	m^3/sec	2,260	2,545	2,661	2,759	2,791
-do-		HCD	El.m	7.43	7.98	8.42	8.96	9.38
		QCD	m^3/sec	2,237	2,494	2,604	2,677	2,715
		HMR	El.m	7.28	7.84	8.32	8.92	9.35
		QMR	m^3/sec	2,719	3,459	4,213	5,092	5,717
		HSP	El.m	6.28	6.57	6.80	7.25	7.63
		QSS	m^3/sec	2,194	2,233	2,227	2,179	2,109
		HSS	El.m	5.72	6.25	6.67	7.19	7.58
		QSP	m^3/sec	2,143	2,181	2,176	2,131	2,060
		HAP	El.m	5.08	5.92	6.53	7.13	7.53
		QPAU	m^3/sec	1,858	1,824	1,822	1,906	2,115

Table 4.2(2) CALCULATED MAXIMUM WATER LEVELS AND DISCHARGES (PROBABLE FLOOD UNDER THE PRESENT CONDITION)

Swamp/Channel	Code	Unit	Return Period (Year)				
			5	10	20	50	100
5. Angat River							
	QI5	m^3/sec	737	1,014	1,367	2,048	2,429
	HAG	El.m	4.73	5.59	6.31	7.06	7.48
	QAG	m^3/sec	725	999	1,342	1,727	2,390
6. Rivers (Downstream Sulipan)							
at Sulipan	HSC	El.m	4.72	5.58	6.21	6.82	7.20
Pampanga River	QPAD	m^3/sec	2,654	3,517	4,779	6,111	7,039
-do-	HBH	El.m	3.38	4.01	4.77	5.50	5.97
-do-	QPA2	m^3/sec	2,584	3,419	4,626	5,902	6,793
at Masantol	HBM	El.m	3.14	3.72	4.46	5.15	5.62
Pampanga River	QPA1	m^3/sec	1,466	2,026	2,880	3,791	4,372
Bebe-San Esteban Channel	QBS	m^3/sec	1,118	1,394	1,747	2,112	2,422
Hagonoy River	HSJ	El.m	2.47	2.95	3.60	4.24	4.72
-do-	QHA	m^3/sec	71	98	154	209	246
-do-	HHA	El.m	1.87	2.32	3.06	3.80	4.35
Labangan Floodway	HLR	El.m	4.40	5.21	5.56	5.89	6.10
-do-	QLF	m^3/sec	824	1,186	1,488	1,781	1,964
-do-	HLF	El.m	3.56	4.40	4.85	5.30	5.57