Figures

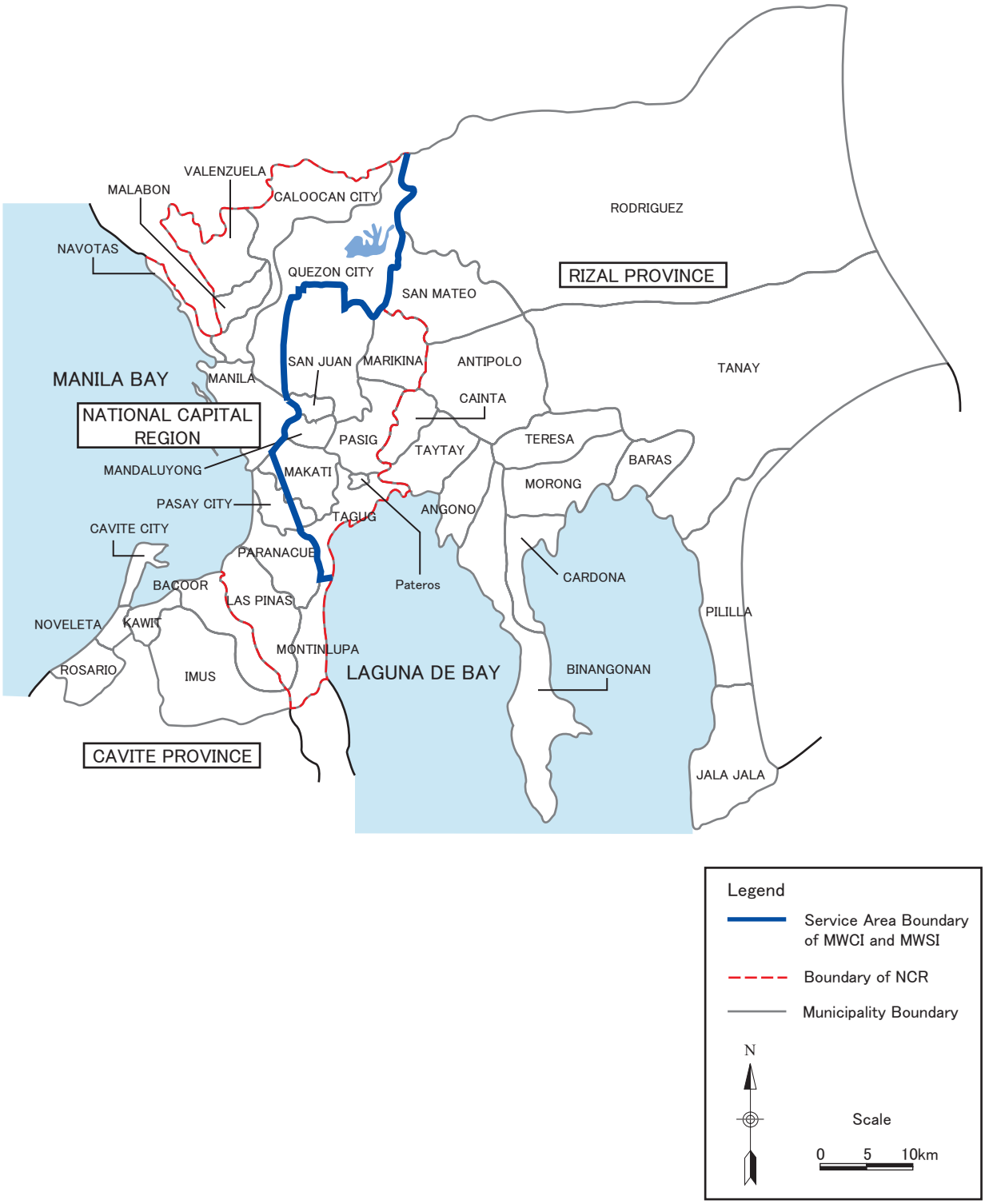

Figure B3.1 Service Area of MWCI and MWSI

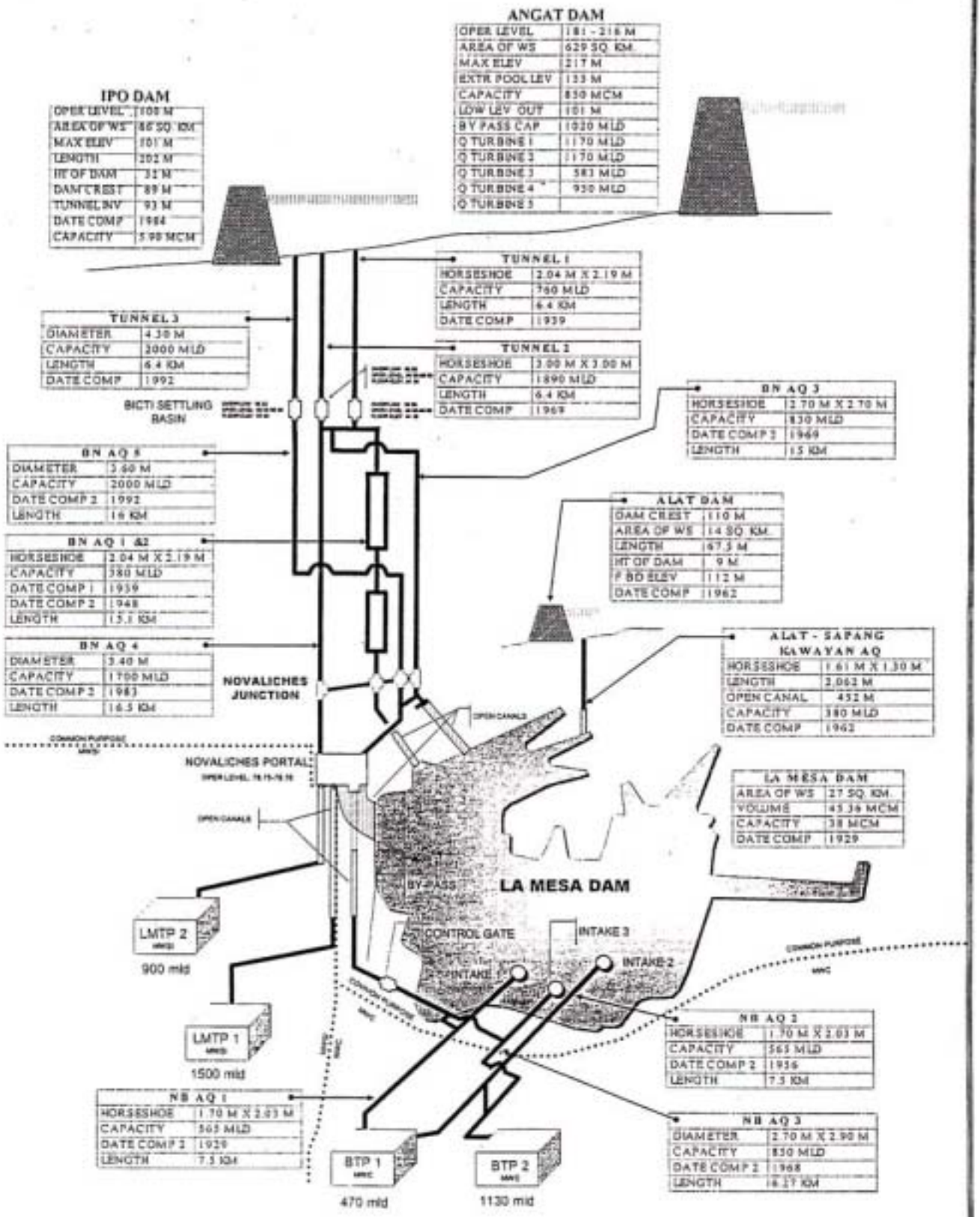

Figure B3.2 Schematic Diagram of MWSS Headworks

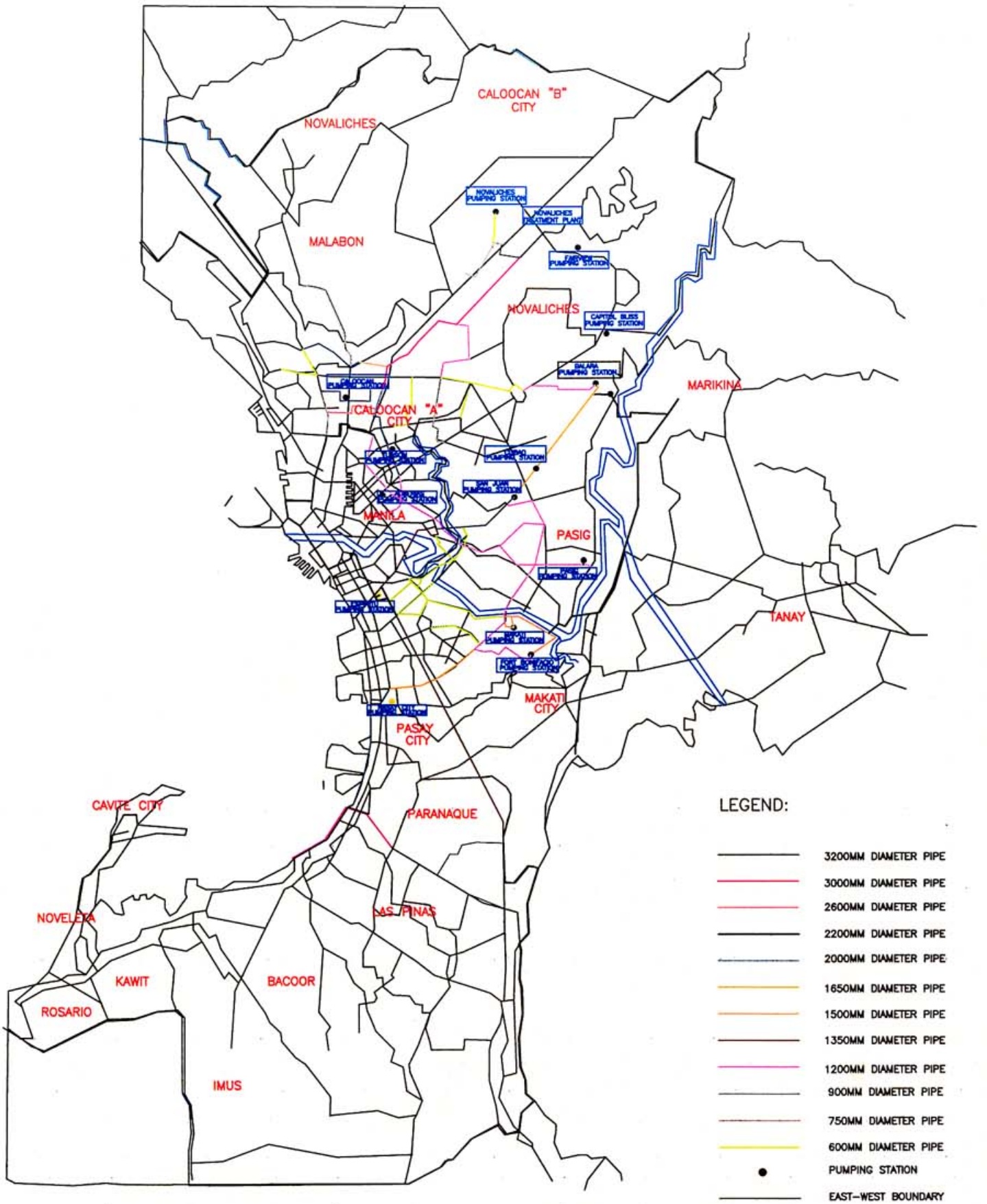

Figure B3.3 Existing Primary Main

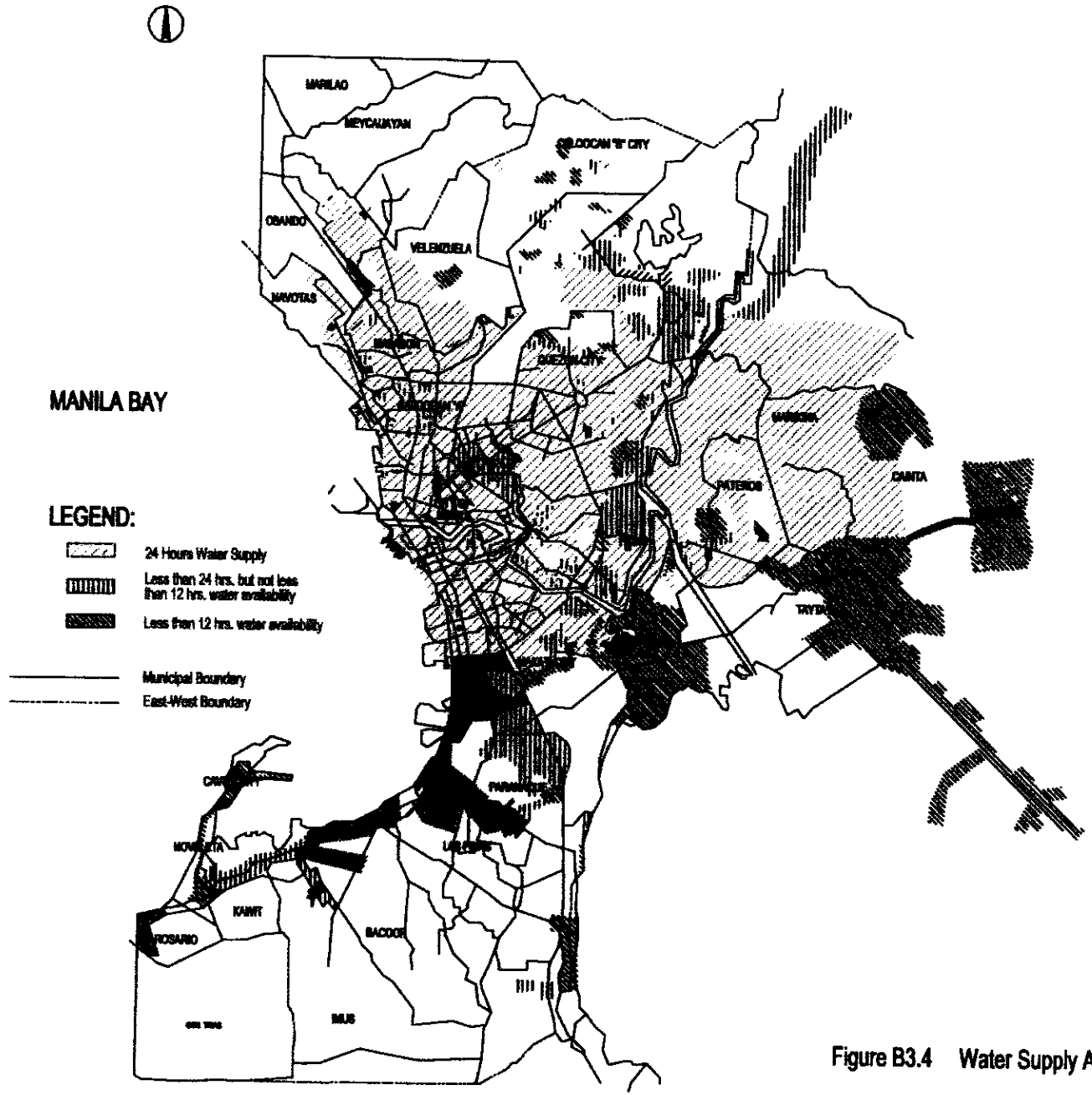

Figure B3.4 Water Supply Availability Map

Part-C

Meteorology and Hydrology

Part-C: METEOROLOGY AND HYDROLOGY

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Part-C : METOROLOGY AND HYDROLOGY

C1 General

In the Master Plan stage spanning between March and August 2001, the Hydrologist of the JICA Study Team carried out the following hydrological investigations in cooperation with the counterpart personnel of NWRB:

- Hydrological investigation works comprise the installation of 3 new streamflow gauging station (S.G.S.), each on the Agos mainstream, Kanan and Kaliwa, discharge measurements, water sampling/laboratory tests for suspended load analysis and water quality analysis. The works have been carried out on a local contract basis under the supervision of the JICA Study Team as well as the counterpart personnel of NWRB,
- Hydrological analysis including runoff analysis, flood analysis, and sediment study, and
- Water balance study on proposed water resources development plans in the Agos River basin, including reservoir operation study for reservoir type development schemes.

At the initial stage of the Master Plan stage starting in April 2001, it was found that the Banugao streamflow gauging station on the Agos mainstream, which was a sole one to observe the river flow over a long-term period since 1949, was abolished in 1986. Therefore, the hydrological investigation was carried out placing a focus on installation of a new streamflow gauging station on each of the Agos mainstream, Kanan and Kaliwa Rivers in order to resume the water level observation as early as possible.

After the 1st Field Investigation Work, the 1st Home Office Work was performed for three (3) months from September to November 2001 to carry out the following hydrological analysis:

- Arrangement and analysis of runoff data observed at the three (3) new streamflow gauging stations,
- Rainfall analysis and runoff analysis by means of the Tank Model method using the rainfall data derived through the rainfall analysis,
- Reservoir sediment study including estimate of sediment trap efficiencies and sediment deposition volumes

This Part-C describes the results of the hydrological investigations performed in the Master Plan stage (Phase 1).

C2 Available Data

C2.1 Meteorological Data

The meteo-hydrological data of the Study area, including rainfall, discharge, temperature, evaporation, relative humidity and wind speed/direction, were collected from PAGASA, DPWH, NPC and previous reports. Figure C2.1 shows the locations of those meteorological stations in and around the Kanan, Kaliwa and Agos mainstream basins.

Figure C2.2 shows the available data at each station concerned in and around the Kanan, Kaliwa and Agos mainstream basins. The monthly records of temperature, evaporation, relative humidity and wind speed/direction are shown in Tables C2.1 to C2.6.

The temperature, relative humidity and wind speed/direction have been recorded at Infanta meteorological station for 40 years from 1961 to 2000. The average temperature thereat is 26.9^{O}C, average maximum temperature is 34.6^{O}C, and average minimum temperature is 19.9^{O}C. The average relative humidity is 83% and average wind speed is 2 m. The evaporation records are available at Cuyambay meteorological station for 10 years from 1969 to 1978. The average evaporation is estimated to be 1,423 mm/year.

C2.2 Rainfall Data

During the Master Plan Stage, the JICA Study Team gathered the rainfall data at 19 rainfall gauging stations in and around the Kanan, Kaliwa and Agos mainstream basins from the concerned agencies including PAGASA.

The JICA Study Team at first collected the rainfall data at 15 rainfall stations. On the other hand, the data at other 4 rainfall stations in the western area of the Agos River basin were additionally collected at the end of Master Plan stage. These data were for the purpose of filling in the missing data at rainfall stations in the Agos River basin through the rainfall analysis described in Chapter C5 hereafter.

The location of rainfall stations are shown in Figure C2.1 and their observation periods of rainfall are enumerated in Figure C2.2 and summarized below:

Rainfall Data Observation Period

No.	Station Name	River Basin	Data Observation Period	Observation Period in years
1	Infanta	Agos Mainstream	1926-1940, 1950-2000	66
2	Bayokan	Agos Mainstream	1939-1940, 1947-1950	6
3	Mahabang Lalim	Agos Mainstream	1978-1979	2
4	Matatio	Kanan	1939-1940, 1947-1950	6
5	Upper Matatio	Kanan	1947-1950,1979-1981	7
6	Tuno	Kanan	1978-1984	7
7	Masanga	Kanan	1979-1983	5
8	Lagmac	Kanan	1979	1
9	Longoy	Kanan	1979-1982	4
10	Sta. Ines	Kaliwa	1939-1940, 1978-1982	7
11	Daraitan	Kaliwa	1939-1940, 1947-1949, 1978-1985	13
12	Lumutan	Kaliwa	1978-1985	8
13	Mamuyao	Kaliwa	1979-1989	11
14	Laiban damsite	Kaliwa	1983-1989	7
15	Cuyambay	Kaliwa	1977-1978	2
16	Quezon	Pasig-Laguna	1961-2000	40
17	Bosoboso	Pasig-Laguna	1972, 1976-1996	22
18	Baguio	Agno	1961-2000	40
19	NAIA	Pasig-Laguna	1961-1999	39

The monthly rainfall records at each rainfall station are shown in Table C2.7. The observation periods of rainfall at those stations are very short-term with many interrupted periods of observation except for Infanta station in the Agos River basin.

C2.3 Discharge Data

In the Agos River basin, the runoff data are available at 6 streamflow-gauging stations in and around the Agos mainstream, Kanan, Kaliwa River basins as shown in Figure C2.1. In addition thereto, those at two stations in the Marikina River basin were also collected. The water level observation periods of those stations are enumerated in Figure C2.2 and summarized below:

Discharge Data Observation Period

No.	Station Name	River Basin	Data Observation Period	Observation Period in years
1	Banugao	Agos Mainstream	1949-1974, 1976-1979	30
2	Bayokan	Agos Mainstream	1944, 1945-1950	7
3	Daraitan	Kaliwa	1946-1950	5
4	Lenatin	Kaliwa	1981-1989	9
5	Limutan	Kaliwa	1983-1989	7
6	Matatio	Kanan	1946-1950	5
7	Sto. Nino	Marikina	1962-1969, 1985-1992	16
8	San Rafael	Marikina	1956-1957, 1962-1969	10

The monthly discharge record at each station is shown in Table C2.8.

C3 Hydrological Investigation Works

In the 1st site reconnaissance conducted by the JICA Study Team and counterpart personnel of NWRB between 5th and 7th April 2001 in the Master Plan stage, the following three new streamflow gauging sites were selected taking into consideration the streamflow and topographic conditions:

1) New streamflow gauging station on the Agos mainstream: near Barangay Magsaysay, about 10 km downstream of the Kanan-Kaliwa confluence.
2) New streamflow gauging station on the Kanan River: near Barangay Pagasangahan on the Kanan River, about 2-km upstream of the Kanan-Kaliwa confluence.
3) New streamflow gauging station on the Kaliwa River: near Barangay Daraitan, about 20 km upstream of the Kanan-Kaliwa confluence.

The locations of the above 3 new streamflow gauging stations are shown in Figure C2.1. Out of the 3 new streamflow gauging stations, those on the Agos mainstream and Kanan River are equipped with an AWLR (Automatic Water Level Recorder) and cable system, while that installed on the Kaliwa River is a manual type. The cable system is installed for use for discharge measurement at the event of floods. The outline of each new streamflow gauging station is presented in the following table:

Outline of New Streamflow Gauging Stations

Station Name	Agos S.G.S.	Kanan S.G.S.	Daraitan S.G.S.
River	Agos Mainstream	Kanan	Kaliwa
Location	N 14°41'92" E 121°34'56"	N 14°42'07" E 121°31'76"	N 14°36'02" E 121°26'03"
Height of Staff Gauges	7 m (Right Bank)	6 m (Left Bank)	8 m (Left Bank)
Automatic Water Level Recorder	Installed (Right Bank)	Installed (Left Bank)	None
Cable System	Installed	Installed	None

Note: Automatic water level recorder and cable system at Kanan S.G.S. were stolen in April 2002 and therefore are not in function at present.

The photographs of installed AWLR, staff-gauge and cable system are shown in Figure C3.1.

In addition to the above 3 gauges, Pagsangahan streamflow gauging station located just confluence of Kaliwa River was established in February 2002 during the Feasibility Study stage,

C3.1 Discharge Measurement

The discharge measurements at each of the 3 new streamflow gauging stations have been carried out for 4 months from May to August 2001 under the supervision of the JICA Study Team. The results of discharge measurements are shown in Table C3.1 and graphically plotted in Figure C3.2. As seen in Figure C3.2, the discharge measurement data are still insufficient for higher river stages so as to

construct the stage-discharge rating curve (H-Q curve), since the comparatively dry period lasted during the Master Plan stage. The photograph of discharge measurement during the Master Plan stage is shown in Figure C3.1.

C3.2 Sediment Sampling and Suspended Load Analysis

A total of 50 river water samples have been taken at each of the aforesaid 3 new streamflow gauging stations to be used for the suspended load analysis. The sediment sampling has been carried out for 4 months from May to August 2001. The suspended loads contained in the river water were analyzed in a laboratory under the local contract. The results of the suspended load analysis are shown in Table C3.2 and graphically plotted in Figure C3.3.

Since the comparatively dry period continued during the Master Plan stage, the water samples taken in the Master Plan stage do not cover the high flow portion.

C3.3 River Water Quality

One river water sample was taken at each of the aforesaid 3 new streamflow gauging stations in July 2001 in order to carry out the water quality analysis. The water samples were analyzed in the laboratory in accordance with the specifications prepared by the JICA Study Team. The results of the water quality analysis are shown in Table C3.3.

C4 Meteorology

C4.1 The Agos River Basin

The Agos River basin with a drainage area of 940 km^2 is located in the eastern coast area of Central Luzon, extending between 14°32'N and 15°00'N in latitude and between 121°18'E and 121°40'E in longitude. It is largely divided into three sub-basins, namely the Agos mainstream, Kanan and Kaliwa rivers. The name of Agos mainstream is given to the river reach of about 23 km from the confluence of two major tributaries, the Kanan and Kaliwa, to its estuary to the Pacific Ocean, where the municipalities of Infanta and General Nakar in Quezon Province are situated.

Out of 940 km^2 of the total drainage area to the estuary, 393 km^2 belongs to the Kanan River, 465 km^2 to the Kaliwa River and the rest of 82 km^2 to the sub-basin along the mainstream of the Agos River.

The Kanan River, the eastern tributary, originates from latitudes 15°00'N and flows down from the north to south between the two mountain ranges; one named Sierra Madre separating it from the Pacific coast on the east, and another separating it from the adjoining two river basins of the Kaliwa and Umiray on the west for about 35 km by linear distance. The heights of surrounding mountains range from 800 to 1,500 meters in elevation AMSL.

The Kaliwa River, another tributary of the Agos River, has a "V" shape basin located in the west of the Kanan River basin, separated by a north-south mountain range on the west between the altitudes of 400 and 1,300 meters, beyond which the Marikina River drains further west area to the Manila Plain. On the southern divide, a series of hill ranges from 400 to 700 meters separates the Kaliwa river basin from the Laguna de Bay (Laguna Lake) basin.

The Kanan River basin is so sparsely populated and is still well covered with thick virgin forest blessed with tropical climate. On the contrary, the Kaliwa River basin has already been comparatively developed by past logging operations and by many settlers due to the shortest distance from Metro Manila and Laguna Lake.

C4.2 General Climatic Condition of the Agos River Basin

Luzon Island is located between 12°N and 19°N in latitude and, therefore, has a tropical climate, predominantly affected by the north-east monsoon prevailing from November to February and the south-west monsoon prevailing from July to September. The trade winds come from the east during the rest of the year and whenever the monsoon is weak. The mountain ranges in Luzon, generally running from north to south, receive showers on the slope facing the wind inflow direction, and on the other hand they also function as the mountain barriers against the humid air mass inflow into inland area. Therefore, the seasonal rainfall patterns are quite different by the locality and topographic conditions.

As the Kanan River basin is located near the east coast of Central Luzon, the rainy season of this area is mainly affected by the north-east monsoon, while the Kaliwa River basin is affected by both north-east and south-west monsoons due to its location in the midland.

Typhoons have so often hit the municipalities of Infanta and General Nakar as well as the Agos upper basins.

C5 Rainfall Analysis

C5.1 General

For the time being, as discussed in Chapter C2, the hydrological data related to the Agos River basin are not sufficiently available especially on the Kanan River basin. Tank Model method is applied to the runoff analysis to estimate the long-term discharges at the proposed water sources sites in the Agos River basin so as to confirm the consistency of the runoff analysis carried out in the Master Plan stage. The Tank Model developed originally in Japan is widely used not only in Japan, but also in other countries, in order to generate long-term runoff data from long-term rainfall data.

The Tank Model is set up for the Kaliwa River basin in which the recent hydrological and rainfall data are available over longer period as compared with the Kanan River basin. The simulation models similar to the Tank Model were used in the previous runoff studies on the Kaliwa River basin. These are the 1979 MWSP III study and 2001 EDCOP study.

As described in Chapter C2, there are many interrupted periods of rainfall observation at rainfall stations in the Agos River basin except for the Infanta rainfall station. Hence, the rainfall analysis is performed to generate the rainfall data for the interrupted periods and further extend the rainfall data in the Kaliwa River basin that are to be input into the Tank Model.

As the first step of the rainfall correlation analysis, the correlation coefficient between monthly rainfall data at two (2) different rainfall stations in the Agos River basin is estimated to assess the extent of their correlation. For each rainfall station, the other rainfall station with the high correlation of monthly rainfall is selected to fill in monthly rainfall of the interrupted period and further extend the monthly rainfall through the regression analysis using the data at both stations.

C5.2 Relationship between Correlation of Rainfall Stations

The correlation coefficient is expressed by the following formula:

$$R = \frac{(xyt - (xt \times yt)/Nos)}{\sqrt{(xxt - xt^2/Nos) \times (yyt - yt^2/Nos)}}$$

$$A_1 = xt/Nos \quad , \quad A_2 = yt/Nos$$

$$xyt = \sum_{m=1}^{Nos} (R_1 m \times R_2 m)$$

$$xxt = \sum_{m=1}^{Nos} (R_1 m^2) \quad , \quad yyt = \sum_{m=1}^{Nos} (R_2 m^2)$$

$$xt = \sum_{m=1}^{Nos} (R_1 m) \quad , \quad yt = \sum_{m=1}^{Nos} (R_2 m)$$

where, R : correlation coefficient
R_1 : monthly rainfall at A station (mm)
R_2 : monthly rainfall at B station (mm)
Nos : data numbers
A_1 : correlation parameter at A station
A_2 : correlation parameter at B station

The correlation coefficients for monthly rainfalls at each rainfall station with those other stations together with the regression formula are derived as shown in Table C5.1. The results of the rainfall correlation analysis show that monthly rainfall has a comparatively high correlation with those of the Marikina and Laguna Lake basins located in the western part of the Kaliwa River basin. The complete long-term monthly rainfall data in and around the Agos River basin are derived applying the regression formulae shown in Table C5.1.

C5.3 Basin Mean Rainfall

The mean annual rainfalls of the Kanan, Kaliwa and Agos mainstream basins are estimated by means of the Thiessen's Polygon method shown in Figure C5.1. The basic procedures for working out the Thiessen's Polygons are as follows:

i) To draw lines connecting the points to their nearest neighbors.

ii) To find the bisectors of each line.

iii) To connect the bisectors of the lines and assign the resulting polygon the values of the center point.

The long-term basin average rainfall data are calculated for each of the following four (4) catchments by means of the Thiessen Polygons method, to which the Tank Model method is applied to derive the long-term monthly discharges as explained in the succeeding Chapter C6:

Ratio of Thiessen's Polygons in the Kaliwa River Basin

Rainfall Station	Limutan River Basin	Lenatin River Basin	Kaliwa Low Damsite	Kaliwa Confluence
Lumutan	56.7 %	-	20.5 %	16.7 %
Sta.Ines	4.9 %	31.9 %	12.8 %	10.5 %
Mamuyao	17.8 %	53.8 %	25.0 %	20.5 %
Laiban	9.7 %	3.7 %	13.7 %	12.7 %
Upper Matatio	11.0 %	-	5.5 %	4.4 %
Cuyambay	-	4.4 %	6.3 %	5.2 %
Daraitan	-	6.2 %	16.2 %	19.4 %
Bayokan	-	-	-	10.7 %
Total	100.0 %	100.0 %	100.0 %	100.0 %

The basin average monthly rainfall of four (4) catchment areas estimated by means of the Thiessen Polygons method are shown in Tables C5.2 to C5.5. The basin average monthly rainfall is summarized in following table:

Basin Average Monthly Rainfall

(Unit: mm)

Month	Limutan River Basin	Lenatin River Basin	Kaliwa Low Damsite	Kaliwa Confluence
Jan	194.4	143.1	168.7	199.3
Feb	119.8	89.9	105.8	127.2
Mar	100.3	76.5	88.6	103.7
Apr	105.9	84.8	93.1	106.4
May	223.0	190.1	188.5	191.7
Jun	405.3	359.2	337.6	320.2
Jul	509.2	460.8	423.1	396.7
Aug	510.6	456.8	423.6	390.3
Sep	461.0	410.5	387.8	373.2
Oct	496.6	397.6	425.2	458.5
Nov	369.9	278.0	317.2	363.1
Dec	270.8	204.7	244.3	296.8
Total	3,767	3,152	3,204	3,327

C6 Runoff Analysis

C6.1 General

The runoff analysis was carried out applying the monthly discharge patterns of the Agos and Kaliwa River basins. In the Master Plan stage, the Tank Model method is used to generate long-term runoff data at the proposed water source sites in the Agos River basin from rainfall data derived through the rainfall analysis described above.

This Chapter C6 presents the results of runoff analysis derived by both methods.

C6.2 Method-1: Based on Monthly Discharge Patterns

C6.2.1 General

In the Agos River basin, the long-term streamflow records were observed only at the Banugao streamflow gauging station on the Agos mainstream as discussed in the foregoing Chapter C2. Though the discharge data at Banugao streamflow gauging station are available for 31 years from 1949 to 1979, there are many missing data since the start of the water level observation in 1949 and no water level observation was made in June 1974 to March 1976. In this lowflow analysis, the discharge data at Banugao streamflow gauging station for 26 years from 1950 to 1973, 1977 and 1978 were used to work out the long-term inflow series at the propose dam/intake weir sites. Besides, the study also used the streamflow data observed on the Kaliwa River under the MWS III Project (MWSP III).

This Study examined 10 damsites and weir sites in total, for which the long-term discharge is estimated in the preliminary runoff analysis. As the first step, drainage area at each of the proposed sites was measured with a planimeter on 1 to 50,000 scale maps. The following table shows the catchment areas measured this time as well as those used in the previous studies:

Comparison of Catchment Areas Measured in this Study and the Previous Studies

(Unit: km^2)

No.	Location	Catchment Area (C.A.)				
		C.A. measured in this Study	MWSP III, 1979 & 1997		JICA F/S, 1981	
			C.A.	Difference	C.A.	Difference
Kanan River Basin						
1	Kanan No.2 Damsite	289	290	- 1		
2	Kanan Low Damsite	356				
3	Kanan Confluence	393	384	+ 9	393	0
Kaliwa River Basin						
4	Laiban Damsite	276	276	0	279	- 3
5	Kaliwa Low Damsite	366				
6	Kaliwa Confluence	465			473	- 8
Agos River Basin						
7	Agos Confluence	858			866	- 8
8	Agos Damsite	860			867	- 7
9	Agos Afterbay Weir	889			894	- 5
10	Banugao G.S.	908	879	+ 29	911	- 3

In the lowflow analysis, in succession, the long-term discharges are estimated dividing the whole Agos River basin into the 3 sub-basins, namely the Agos mainstream, Kanan, and Kaliwa basins, in accordance with the following procedures:

(i) Agos mainstream basin

In the Agos mainstream basin, the long-term discharges are estimated for the 3 sites, namely the Kanan-Kaliwa confluence point on the Agos River, Agos afterbay weir site and Agos damsite. To estimate the long-term discharges at these 3 sites, the discharge data observed at the Banugao streamflow gauging station are transposed thereto in proportion to their catchment areas, since these sites are situated close to one another on the Agos mainstream.

(ii) Kaliwa River basin

For the Kaliwa River basin, many studies have been carried out so far and more meteo-hydrological data were available than the Kanan River basin. Therefore, the lowflow condition of the Kaliwa River basin was examined to work out the long-term discharges at Laiban damsite, Kaliwa Low damsite, and the Kanan-Kaliwa confluence on the Kaliwa River.

(iii) Kanan River basin

The meteo-hydrological data on the Kanan River basin are very limited as seen in Figure C2.2. In particular, no meteo-hydrological data are observed after 1950s. Therefore, the long-term discharges at the Kanan-Kaliwa confluence is estimated by deducting the Kaliwa discharges from the Agos discharges. Concerning the Kanan River basin, the long-term discharges at Kanan No.2 and Kanan low damsite are estimated based on those at the Kanan-Kaliwa confluence in proportion to their catchment areas.

C6.2.2 Kaliwa River Basin

(1) Laiban Damsite

According to the report on Manila Water Supply III Project (MWSP III) in February 1997, water level observation was conducted for 6-7 years under the Project at streamflow gauging stations on the Lenatin and Limutan Rivers as well as at Laiban damsite on the Kaliwa River. Besides, the periodical discharge measurements were carried out to construct the stage-discharge rating curves. As the first step, the runoff condition for catchment of Laiban damsite is assessed based on the hydrological data worked out through the MWSP III.

(a) Discharge Measurement and Water Level Observation

The discharge measurement and water level observation on the Lenatin and Limutan Rivers, both being a tributary of the Kaliwa River, as well as

Laiban damsite were carried out under MWSP III between 1981 and 1989. The hydrological measurement and observation conducted under the MWSP III are summarized in the following table:

Period of Discharge Measurement and Measurement of Water Level Gauge

Tributary/Site	Period of Discharge Measurement	Period of Water Level Observation
Lenatin River	1981.11.17 - 1985.5.29 (Total: 56 Nos.)	1981.12 - 1989.8 (80 month)
Limutan River	1983.6.28 - 1985.5.29 (Total: 28 Nos.)	1983.7 - 1989.8 (74 month)
Laiban Damsite	1981.3.25 - 1989.4.20 (Total: 48 Nos.)	1981.12 - 1982.12 (13 month)

The stage-discharge rating curves (H-Q Curve) at the above sites are shown in Figure C6.1 together with the discharge measurement results. Though it seems that the accuracy of those H-Q curves is not necessarily very high, it is judged that the runoff data observed on the two tributaries would be applicable. On the other hand, there is no correlation between stage heights and discharge measurement data at Laiban damsite. Therefore, it is determined that the runoff data at Laiban damsite are not used for the lowflow analysis.

Thus, the discharges observed on the two tributaries of the Kaliwa River are summed up to calculate the discharges at Laiban damsite. The mean monthly discharge for 6 years from July 1983 to August 1989 thus derived are shown in the following table:

Mean Monthly Discharge at Laiban Damsite

(Unit: m^3/sec)

Month	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Mean
Mean Discharge	16.3	11.8	9.0	11.8	15.9	26.0	32.3	41.1	40.2	50.9	34.0	20.6	25.8

(b) Estimate of Long-Term Mean Monthly Discharge at Laiban Damsite

The monthly discharge at Laiban damsite was derived from correlation with the discharge records at Banugao streamflow gauging station, using parameters such as mean discharges at both sites, monthly discharge pattern at Laiban damsite, and monthly discharge at Banugao streamflow gauging station.

As mentioned above, the mean discharge at Laiban damsite is estimated at 25.8 m^3/sec. The mean discharge is judged to be consistent as compared with those estimated in the previous studies as shown below:

Results of Previous Studies
(Runoff Analysis on Laiban Dam in the Kaliwa River Basin)

Report	Mean Discharge	Difference
MWSP III, 1979	25.2 m^3/sec	+0.6 m^3/sec
JICA F/S, 1981	26.0 m^3/sec	-0.2 m^3/sec
MWSP III Review, 1997	25.5 m^3/sec	+0.3 m^3/sec

The monthly discharge pattern at Laiban damsite was calculated by using the data for 6 years from July 1983 to August 1989 and results of discharge measurement in the Master Plan stage as shown in the following table:

Monthly Discharge Pattern at Laiban Damsite

(Unit: %)

Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
7.6	2.8	1.6	1.0	0.9	1.3	12.8	15.6	15.3	18.8	13.3	9.0	100.0

In the Feasibility Study on Agos River Hydropower Project (March 1981), the long-term discharges at the respective sites were estimated applying the following hydrological data:

i) Mean monthly discharges at Banugao S.G.S. on the Agos mainstream between 1950-1978

ii) Mean monthly discharges at Daraitan S.G.S. on the Kaliwa River between 1936-1942 and between 1946 and 1950

iii) Mean monthly discharges at Matatio S.G.S. on the Kanan River between 1946-1950

In the previous lowflow analysis, the monthly discharge pattern and mean discharges of each basin were determined based on the above runoff data on each basin. In this study, the monthly discharge pattern at Laiban damsite, which was derived above, was applied to estimate the long-term discharges at Laiban damsite instead of the old discrete runoff data at Daraitan on the Kaliwa River. Consequently, the following formula was set up to estimate the long-term runoff at Laiban damsite:

$$Q_{LD} = Q_B / Q_{Bmean} \times Q_{LP}$$

where, Q_{LD} : Monthly discharge at Laiban damsite (m^3/sec)
Q_B : Monthly discharge at Banugao S.G.S. (m^3/sec)
Q_{Bmean} : Mean monthly discharge at Banugao S.G.S. (m^3/sec)
Q_{LP} : Monthly discharge pattern at Laiban damsite (m^3/sec)

The estimated monthly discharges at Laiban damsite, which are calculated by means of the above formula, are shown in the following table.

Estimated Monthly Discharge at Laiban Damsite

(Unit : m^3/sec)

Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Mean
23.6	8.8	4.8	3.1	2.8	4.1	39.6	48.4	47.5	58.2	41.3	27.9	25.8

(2) Kaliwa Low Damsite and Kaliwa Confluence

The long-term discharges at Kaliwa low damsite and the Kanan-Kaliwa confluence are estimated by means of transposing the runoff data at Laiban damsite to those two sites taking into account the catchment area and monthly rainfall ratios.

(a) Basin Average Rainfall

Out of the 5 rainfall stations in the Kaliwa River basin, rainfall data are available at 4 rainfall stations for the period from latter half of 1970's to early 1980's. The monthly average rainfall for the catchment of the Kaliwa low damsite and Kaliwa confluence are estimated by means of the Thiessen's Polygons method. The ratio of the Thiessen's Polygons for each rainfall station is derived as shown in the following table:

Ratio of Thiessen's Polygons

Rainfall Station	Laiban Damsite	Kaliwa Low Damsite	Kaliwa Confluence
Lumutan	33.5 %	24.2 %	19.7 %
Sta.Ines	19.3 %	13.9 %	11.3 %
Mamuyao	41.1 %	30.0 %	24.5 %
Daraitan	6.1 %	31.9 %	44.5 %
Total	100.0 %	100.0 %	100.0 %

The monthly average basin rainfall for these three catchments are calculated applying the above Thiessen's polygons as shown in the following table:

Monthly Rainfall in the Kaliwa Basin

(Unit: mm)

Catchment at:	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	yearly
Laiban Damsite	47	24	94	78	174	376	498	622	395	576	335	169	3,387
Kaliwa Low Damsite	57	24	85	64	158	352	439	548	378	575	312	187	3,180
Kaliwa-Kanan Confluence	62	25	80	57	151	340	410	513	370	574	301	195	3,079

The monthly rainfall patterns of the Kaliwa River basin are summarized below:

Monthly Rainfall Pattern

(Unit : %)

Station Name	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
Laiban Dam	1.4	0.7	2.8	2.3	5.1	11.1	14.7	18.4	11.7	17.0	9.9	5.0	100
Kaliwa Low Dam	1.8	0.8	2.7	2.0	5.0	11.1	13.8	17.2	11.9	18.1	9.8	5.9	100
Kaliwa-Kanan Confluence	2.0	0.8	2.6	1.8	4.9	11.1	13.3	16.6	12.0	18.7	9.8	6.3	100
Average	1.7	0.8	2.7	2.0	5.0	11.1	13.9	17.4	11.9	17.9	9.8	5.7	100

The rainfall ratio of each site to Laiban damsite is derived as follows:

- Kaliwa Low Damsite : 3,180 mm / 3,387 mm = 0.939
- Kaliwa-Kanan Confluence : 3,079 mm / 3,387 mm = 0.909

Consequently, the mean discharge at each site is estimated by multiplying mean discharge of 25.8 m^3/sec by the rainfall ratio and basin area ratio as shown below:

- Kaliwa Low Damsite : 25.8m^3/secx0.939x(366/276)km^2=32.1 m^3/sec
- Kaliwa-Kanan Confluence : 25.8m^3/secx0.909x(465/276)km^2=39.5 m^3/sec

(b) Monthly Discharge Pattern

Figure C6.2 and Figure C6.3 show the monthly discharge patterns for Laiban damsite and Daraitan streamflow gauging station, respectively. These figures reveal that the monthly discharge pattern for Laiban damsite is more reliable than that for Daraitan streamflow gauging station.

(c) Long-Term Discharge

The long-term monthly discharges at Kaliwa low damsite and Kaliwa confluence are estimated based on monthly discharge pattern at Laiban damsite applying the following formula:

$$Q_{MD} = Q_L / Q_{Lmean} \times Q_{MP}$$

where, Q_{MD} : Monthly discharge at each site (m^3/sec)
Q_L : Monthly discharge at Laiban damsite (m^3/sec)
Q_{Lmean} : Monthly mean discharge at Laiban damsite (m^3/sec)
Q_{MP} : Monthly discharge pattern at each site (m^3/sec)

Mean monthly discharges so estimated are shown below.

Mean Monthly Discharge in Kaliwa River Basin

(Unit : m^3/sec)

Location	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Mean
Kaliwa Low Damsite	29.4	10.9	6.0	3.9	3.5	5.1	49.3	60.2	59.1	72.4	51.4	34.7	32.1
Kaliwa-Kanan Confluence	36.1	13.5	7.3	4.7	4.3	6.3	60.6	74.1	72.7	89.1	63.2	42.7	39.5

C6.2.3 Agos River Basin

To estimate the long-term discharges at Agos damsite (860 km^2), Agos afterbay weir site (889 km^2), Agos confluence (858 km^2), those at Banugao streamflow gauging station (908 km^2) are transposed thereto in proportion to their catchment areas. The estimated mean monthly discharge at Agos River basin is summarized in the following table:

Mean Monthly Discharge at Agos River Basin

(Unit: m^3/sec)

Location	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Mean
Banugao S.G.S.	169.3	116.2	85.2	56.3	49.9	54.4	78.6	92.8	96.9	166.3	225.7	254.3	120.5
Agos Damsite	162.1	111.2	81.5	53.8	47.8	52.1	75.2	88.8	92.7	159.1	216.0	243.3	115.3
Agos Afterbay Weir	165.8	113.8	83.4	55.1	48.9	53.3	77.0	90.8	94.8	162.8	221.0	248.9	118.0
Agos Confluence	160.0	109.8	80.5	53.2	47.2	51.4	74.3	87.6	91.5	157.1	213.3	240.3	113.9

C6.2.4 Kanan River Basin

The runoff of the Kanan River basin at the Kanan-Kaliwa confluence was estimated by deducting the Kaliwa discharges from the Agos discharges. As a result, the long-term mean monthly discharges in the whole Kanan River basin are estimated as summarized in the following table:

Mean Monthly Discharge of the Whole Kanan River Basin

(Unit: m^3/sec)

Location	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Mean
Kanan-Kaliwa Confluence	123.9	96.3	73.2	48.5	42.9	45.1	13.7	13.5	18.8	68.0	150.1	197.6	74.3

The long-term discharges at the Kanan No. 2 and Kanan Low damsites were estimated based on those of the whole Kanan River basin in proportion to their catchment area ratios. The estimated mean monthly discharges at each damsite are summarized in the following table:

Mean Monthly Discharge at Kanan No. 2 and Kanan Low Damsites

(Unit : m^3/sec)

Location	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Mean
Kanan No.2 Damsite	91.1	70.8	53.8	35.7	31.5	33.2	10.1	9.9	13.8	50.0	110.4	145.3	54.6
Kanan Low Damsite	112.2	87.2	66.3	43.9	38.9	40.9	12.4	12.2	17.0	61.6	136.0	179.0	67.3

C6.3 Method-2: Runoff Analysis by Tank Model Method

C6.3.1 General

In the present runoff analysis, the Tank Model method is applied to estimate the long-term monthly discharges for the Kaliwa River basin. The runoff analysis by

this method is performed in accordance with the following procedures:

i) The tank model parameters for the Kaliwa River basin are determined for the catchments covered by the Limutan and Lenatin streamflow gauging stations where discharge measurement records on the Kaliwa River basin are available,

ii) The long-term discharges at Laiban damsite are estimated by aggregating long-term discharges at the Limutan and Lenatin streamflow gauging stations that are derived through the simulation by the Tank Model,

iii) The long-term monthly discharges at the proposed Kaliwa Low damsite and the downstream end of the Kaliwa River (a point just upstream of the Kanan-Kaliwa confluence) are simulated by the Tank Model using the parameters set up for the Limutan streamflow gauging station,

iv) The long-term monthly discharges at the proposed Agos damsite and the point just downstream of Kaliwa-Kanan confluence are calculated based on discharge records at Banugao streamflow gauging station in proportion to the catchment area ratios,

v) The long-term monthly discharges for the Kanan River basin are estimated to be the difference between those estimated for the Agos River (at the point just downstream of the Kaliwa-Kanan confluence) and the Kaliwa River (at the point just upstream of the Kaliwa-Kanan confluence).

C6.3.2 Concept of the Tank Model

The basic component of the tank model is a simple tank with holes to pass the water content. The outflow from each hole is proportionate to the height between the hole and water surface. Provided that a tank is accommodated with one bottom hole and two side holes, as shown in Figure C6.4, the rule for outflow computation is as follows;

$$
\begin{aligned}
yn &= 0 && (Xn \le h1) \\
yn &= \alpha 1(Xn - h1) && (h1 < Xn \ge h2) \\
yn &= \alpha 2(Xn - h2) + \alpha 1(Xn - h1) && (h2 < Xn), \\
zn &= \beta Xn, \\
Xn' &= Xn - yn - zn, \\
Zn+1 &= Xn' + xn + 1 \text{ ----- } (1)
\end{aligned}
$$

where, Xn : water depth of stage n,
yn : outflow from side holes of stage n,
zn : outflow from bottom hole of stage n,
xn : inflow of stage n,
$\alpha 1$, $\alpha 2$: coefficient of side holes, and
β : coefficient of bottom hole.

Normally, a tank model combining several tanks in a series makes a better simulation results. In Japan, the tank model consisting of four tanks in a series successfully analyzes a number of river basins. In such models, each tank interacts in the manner described in the above equation (1). The top tank receives the rainfall as inflow to the tank, while the tanks below get the supply from the bottom holes of the tank directory above. The last or the bottom tank only has a side hole. The aggregated outflow from all the side holes of the tanks constitutes the inflow into the river course. The basic model above is illustrated in Figure C6.4.

C6.3.3 Input Data and Result of the Tank Model

The Tank Model requires input of the basin average rainfall, observed discharge and evaporation, and also tank parameters. The basin average rainfall data derived through rainfall analysis in Chapter C5 are applied to the Tank Model, while observed discharge records at Limutan and Lenatin streamflow gauging stations (Table C2.8) are used as the input data for observed discharge. Based on the evaporation records observed at Cuyambay meteorological station shown in Table C2.4, the input data on evaporation are determined.

The long-term mean monthly discharges at each of the water source sites in the Kaliwa River basin which are estimated through the application of the Tank Model are summarized in the following table:

Estimated Discharge by Tank Model : Kaliwa River Basin

(Unit: m^3/sec)

Location	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Mean
Laiban Damsite	18.7	13.5	9.3	7.0	8.8	19.0	31.3	35.3	39.0	39.5	33.3	25.9	23.4
Kaliwa Low Damsite	25.2	18.9	13.5	10.0	10.6	20.3	33.1	38.0	43.2	46.0	41.7	34.3	27.9

As a result, the long-term discharges at the proposed water source sites in the Agos mainstream and Kanan River basins are derived as follows:

Estimated Discharge in the Agos Mainstream and Kanan River Basins

(Unit: m3/sec)

Location	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Mean
Kanan No.2 Damsite	85.7	55.9	40.2	23.7	19.3	17.8	24.0	30.4	28.4	73.1	118.4	140.7	54.8
Kanan Low Damsite	105.6	68.9	49.5	29.2	23.8	21.9	29.6	37.5	34.9	90.0	145.9	173.4	67.5
Agos Damsite	155.4	104.9	75.5	47.6	42.1	51.3	74.5	88.5	92.2	161.6	221.8	244.4	113.3

C6.4 Comparison of the Estimated Mean Discharge

The mean discharges at each water source site in the Agos River basin that are estimated by means of the Method-1 and Method-2 mentioned above are compared in the following table:

Estimated Long-Term Mean Discharge

(Unit : m^3/sec)

Method	Laiban Damsite	Kaliwa Low Damsite	Agos Damsite	Kanan No. 2 Damsite	Kanan Low Damsite
Method-1: Monthly Discharge Pattern	25.8	32.1	115.3	54.6	67.3
Method-2: Tank Model	23.4	27.9	113.3	54.8	67.5

As shown in table above, mean discharges estimated for the Kaliwa River basin show a notable difference between the Method-1 and Method-2 due to different approaches adopted as explained in the foregoing Sections C6.1 and C6.3. On one hand, there is no large difference in the mean discharges estimated for the Agos and Kanan River basins. The main reason is that the estimates by both methods are based on common data, i.e. discharge records at Banugao streamflow gauging station.

It is noted that the Method-1 is primarily based on the mean discharge value and monthly discharge pattern at Laiban damsite, which were derived from runoff records only for 6 years, while the Method-2 is based on rainfall patterns for 29 years (Table C5.4), though they are generated ones. Therefore, it is determined to adopt the results of runoff analysis estimated by the Method-2 (Tank Model). It is noted that the Method-2 estimates the Kaliwa discharges more conservatively than the Method-1 not only in the long-term mean discharge as shown in the above table, but also in the low flow discharges in the dry seasons.

The long-term monthly discharges at each water source site estimated by the Method-2 are shown in Tables C6.1 to C6.8.

C6.5 Flow Duration Curve

The required river maintenance flow is defined to be 10% of 80% discharge on the flow duration curve at the site, while a dependable discharge for water supply in the case of run-of-river type is adopted to be 90% discharge on the flow duration curve. To estimate the river maintenance flow and dependable discharge at each water source site in the Agos River basin, the flow duration curve thereat is established based on the long-term monthly discharges as shown in the Table C6.9 and Figure C6.5 and summarized in the following table:

Flow Duration Curve

(Unit : m^3/sec)

Duration	Laiban Damsite	Kaliwa Low Damsite	Kanan No.2 Damsite	Kanan Low Damsite	Agos Damsite
10%	49.76	56.63	126.07	155.29	236.87
20%	38.23	44.67	96.91	119.37	183.56
30%	30.21	36.62	71.39	87.94	140.30
40%	22.77	27.39	47.86	58.96	107.86
50%	17.97	22.52	36.25	44.65	85.27
60%	14.29	17.60	26.73	32.93	70.73
70%	10.12	14.23	20.04	24.69	57.14
80%	6.70	10.18	13.24	16.31	43.45
90%	3.88	6.40	7.23	8.91	30.24
95%	3.08	5.22	5.01	6.17	23.64
100%	1.73	3.27	0.57	0.71	7.58

The river maintenance flow at each water source site is estimated as follows:

Kaliwa River

Laiban damsite : 6.70 m^3/sec x 10% = 0.67 m^3/sec

Kaliwa low damsite : 10.18 m^3/sec x 10% = 1.02 m^3/sec

Kanan River

Kanan No.2 damsite : 13.24 m^3/sec x 10% = 1.32 m^3/sec

Kanan low damsite : 16.31 m^3/sec x 10% = 1.63 m^3/sec

Agos River

Agos damsite : 43.45 m^3/sec x 10% = 4.35 m^3/sec

C6.6 Recommendation on Hydrological Observation and Measurement on the Kaliwa River

During the Master Plan stage, the water levels at new streamflow gauging station on the Kaliwa River (Daraitan S.G.S.) were at a low stage height of the staff gauge during the period from May to August 2001, while those on the Kanan River showed large variations for the same period. It appears that, on one hand, this phenomenon is attributed to the prevailing dry climate over the Kaliwa River basin during the filed investigation as compared with the climate condition in the Kanan River basin where the rainy season starts earlier. On the other hand, there is a possibility that the Kaliwa River water goes into limestone areas lying upstream of the Daraitan streamflow gauging station and come out into the river channel downstream from the Daraitan limestone area. This was inferred by a fact that the Kaliwa streamflow was rather abundant at the Kaliwa Low Dam No.2 site.

To clarify whether the Kaliwa streamflow is affected by presence of the limestone areas, it is recommended to monitor the Kaliwa discharges at the nearby location of the Kanan-Kaliwa confluence during the Feasibility Study stage. It is expected that the hydrological phenomenon will be clarified through comparing the discharges at the Daraitan streamflow gauging station and the downstream location close to the Kanan-Kaliwa confluence.

C7 Flood Study

C7.1 Statistical Analysis of Flood Records at Banugao Gauging Station

The maximum discharge records for the Agos River basin are availability for 26 years at Banugao streamflow gauging station as shown in Table C7.1. For estimating the probable floods, two theoretical probability distributions, Log Pearson Type III and Gumbel methods, were applied to the maximum discharges. The results of the frequency analysis are shown in the following table:

Probable Flood at Banugao Streamflow Gauging Station

Return Period	Probable Discharge (m^3/sec)	
	Log Pearson Type III	Gumbel
2-year	1,535	1,690
5-year	2,651	2,979
10-year	3,530	3,832
20-year	4,474	4,650
50-year	5,845	5,709
100-year	6,988	6,503
200-year	8,230	7,294
1,000-year	11,542	9,126
10,000-year	17,472	11,744

As seen in a table above, the Log Pearson Type III method gives higher values than the values estimated by the Gumbel method for a recurrence period of 100 years and larger. Therefore, the Log Pearson Type III method was applied to estimate the probable floods.

C7.2 Probable Flood at Proposed Damsites

The probable floods at proposed damsite were estimated from the corresponding floods at Banugao streamflow gauging station and adjusted by the drainage area ratio using the following Creager's equation:

$$q = 0.503 \times C \times A \times 0.386^{b}$$

$$b = -0.93578 \times A^{-0.048}$$

where, q : Specific flood discharge (m^3/sec/km^2)
A : Drainage area (km^2)
C : Coefficient obtained from the Banugao flood

The estimated probable floods at the proposed damsites are shown in Table C7.2.

C8 Sediment Study

C8.1 General

In this stage, the sediment study was performed through reviewing the previous studies related to the Agos River basin.

During the investigation period in Master Plan stage, there was no opportunity of taking water samples at high flow condition, since the period virtually corresponds to the dry period. The data collected during this stage were only sediment discharge data for low flows.

C8.2 Review of Previous Sediment Study

A sediment analysis for the Agos River basin is available in the feasibility study on Agos River Hydropower Project (JICA 1981), which was carried out between November 1978 and May 1980. Most of the subsequent studies assessed the sediment yield of the Agos River basin with reference to the analysis results of the previous JICA study.

In the previous JICA study, 36, 11 and 19 sediment samples were collected at Mahabang Lalim streamflow gauging station on the Agos River, Binugawan streamflow gauging station on the Kanan River and Nio streamflow gauging station on the Kaliwa River, respectively. The results of suspended load analysis for those water samples are shown in Table C8.1. Since the runoff data such as stage-discharge rating curve at the latter two stream gauges were not available, the sediment yield was estimated only based on the results of suspended load on the Agos mainstream. As a result, the following formula representing discharge and suspended sediment load was constructed:

$$Qs = 0.005802 \times Q^{2.4515}$$

where, Qs : Suspended sediment load (ton/day)
Q : Mean daily discharge (m^3/sec)

Applying the above formula to the long-term mean daily discharges at the Agos damsite, the annual sediment yield consisting of suspended load and bed load was estimated at 557 m^3/km^2/year.

In the site reconnaissance conducted by helicopter in July 2000, on the other hand, it was confirmed that the Kaliwa flow contained much sediment, although the Kanan river water seems to be comparatively transparent probably because of the smaller rainfall in that month. Further, the sediment yield of 557 m^3/km^2/year might be slightly small as compared with annual sediment yield rates estimated for existing and proposed reservoir dam projects in Luzon Island (See Table C8.2). The 1991 ELC's feasibility study on the Agos River Hydropower Project recommended adopting a sediment yield of 1,000 m^3/km^2/year.

In the present study, a sediment yield of 1,000 m^3/km^2/year is tentatively adopted as the sediment yield rate for the Agos River basin. This was proposed taking account of the planning of the proposed reservoir projects on a conservative side and also the change of the basin conditions that might have occurred after the completion of the JICA feasibility study in 1981. The further study will be carried out in the successive stage based on the results of the suspended load analysis.

C8.3 Sediment Deposited in Proposed Reservoirs

After creation of reservoir, the sediment transported by the Agos River will deposit in the reservoir, shortening the life of the reservoir. In this Study, the reservoir life is taken at 100 years in accordance with the design code in dam in Japan. The sediment deposit volume in the proposed reservoirs is estimated based on the sediment yield (1,000 m^3/km^2/year) and trap efficiency of the proposed reservoir.

The trap efficiency of the proposed reservoirs is determined using the Brune's empirical curve. The Brune's empirical curve shows a relationship between the trap efficiency and a ratio of the average annual inflow to the storage capacity of the reservoir. The relationship between reservoir sediment trap efficiency and reservoir volume/inflow is shown in Figure C8.1.

The sediment trap volume for the reservoir life of 100 years is estimated for each of the proposed reservoir schemes as follows:

Trap Efficiency and Trapped Sediment Volume by Reservoir for Each Reservoir Type Scheme

Item	Unit	Laiban Dam	Kanan No.2 Dam	Agos Dam
Reservoir Volume/Inflow		0.88	0.56	0.26
Catchment Area	km^2	276	289	860
Trap Efficiency	%	96.5	96.0	93.0
Sediment Yield	$mil.m^3$	27.6	28.9	86.0
Trapped Sediment Volume by Reservoir	$mil.m^3$	26.6	27.7	80.0

C9 Water Balance Study

C9.1 General

The 8 alternative development scenarios in the Agos River basin are worked out for the purpose of supplying water to Metro Manila area as well as hydropower generation to effectively utilize the water resources of the basin as described in Part-E of this Supporting Report for Master Plan. These development scenarios are summarized in Table C9.1 and explained in more detail in Part-E. The reservoir operation is carried out to estimate the exploitable discharges for each of the proposed reservoir and run-of-river projects included in the development scenarios.

In principle, each scenario is contemplated to meet the water demand of Metro Manila towards the year 2025 after securing the required river maintenance flow to be released downstream. The hydropower generation in each scenario is contemplated as long as water head is available along the conveyance waterway for water supply and/or excess discharge becomes available for the hydropower purpose.

The methodologies/procedures as well as the results of the water balance study are described in the following subsections.

C9.2 Reservoir Operation Rule

The water balance calculation was done applying the following rule for each of the proposed reservoir development projects:

(1) Dependable discharge for Metro Manila Water Supply

In case of the storage type development, dependable discharge that can be conveyed to Metro Manila is estimated by means of reservoir operation for the hydrological target year equivalent to a 10-year probable draughty. Since the hydrological data of 31 years are generated for each of the proposed dam sites through the lowflow analysis, the 3rd draught year is selected as the hydrological target year to estimate the dependable discharge under the planned reservoir scale.

In case of a run-of-river type development, a discharge of 90% firmness is taken as the dependable discharge, which represents a reduced dependability criterion adopted in view of a relatively short service period of the run-of-river schemes until a permanent water source (reservoir scheme) is commissioned.

(2) River Maintenance Flow

As for the dam in the Philippines, a criterion on the river maintenance flow is suggested by the NWRB. The river maintenance flow is taken to be 10% of 80% discharge at each of the proposed weir/dam sites according to the NWRB's criteria thereon. At the downstream reach of the Agos dam, the required maintenance flow is estimated to be 4.35 m^3/sec (see Section C6.5 for the maintenance flow

rates applied for the other sites). The reservoir operation for each of the proposed dams/reservoirs is performed to constantly release the required maintenance flow to the downstream reach.

(3) Spillout discharge in dam/reservoir

In the case hydropower plant is planned for peak generation (herein assumed as 6-hours operation a day), the inflow discharge in excess of the designated 6-hour peak generation is used for the secondary energy generation for the remaining 18 hours when the reservoir water level is at FSL. The spillout discharge takes place when the whole of such excess discharges cannot be released through turbines for the secondary energy generation.

(4) Power Generation

In the hydropower development, the minimum turbine output of hydropower plant is set at 40 % of installed capacity. It does not generate power in case that the reservoir water level drops below the level corresponding to such a power output.

(a) Reservoir Operation

$$d(S2 - S1) / dt = Qin - Qp - Qws - Evap - Qspill$$

where,
- S : Reservoir storage volume (m^3) (suffix 1 and 2 denote the start and end of the period dt)
- Qin : Reservoir inflow (m^3/sec)
- Qp : Water utilized for power generation (m^3/sec)
- Qws : Water supply for Metro Manila (m^3/sec)
- Evap : Reservoir evaporation (m^3/sec)
- Qspill: Spillout from reservoir (m^3/sec)

(b) Power Generation

$$P = 9.8 \times HL \times Qp \times CE$$

where,
- P : Power output (kW)
- HL : Effective head (m)
- Qp : Water utilized for power generation (m^3/sec)
- CE : Combined efficiency of turbine and generator (=0.86)

C9.3 Basic Data on Water Balance Study

The basic data used for the water balance study are 1) evaporation from reservoir surface, 2) reservoir storage curve, 3) long-term inflow discharge, as explained below:

(1) Evaporation from Reservoir Surface

The evaporation records in the Agos River basin is measured only at Cuyambay meteorological station. The yearly evaporation from reservoir surface is adopted at 996 mm, which is equivalent to 70% of annual mean pan evaporation depth observed at Cuyambay meteorological station (1,423 mm x 0.7).

(2) Reservoir Storage Curve

The reservoir storage curve for each of the proposed dam/weir sites is compiled in Appendix E-1 of Part-E. Those reservoir storage curves are used for the reservoir operation.

(3) Inflow Discharge

The long-term discharges at each of the proposed dam/weir sites for 31 years that are estimated in the foregoing Section C6 are applied to reservoir operation for the water balance study.

C9.4 Results of Water Balance Study

The results of the water balance study for each of the 8 development scenarios are summarized in Table C9.1 together with their features. The results are utilized to compare the viability of the alternative development scenarios as discussed in Part-E of this Volume.

Tables

Table C2.1 Monthly Mean Temperature Record at Infanta Station

Unit : ^{o}C

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
1961	23.9	25.0	26.4	27.2	28.2	27.8	28.2	28.2	28.1	26.7	26.1	25.8	26.8
1962	23.9	24.0	26.1	26.8	28.0	28.5	27.5	27.6	26.8	27.2	26.2	24.6	26.4
1963	22.0	23.1	24.5	25.9	27.3	28.4	27.9	27.5	27.6	26.6	26.8	25.5	26.1
1964	25.0	25.0	25.7	26.9	28.0	28.6	27.8	28.4	27.5	26.7	25.8	24.9	26.7
1965	23.5	24.8	25.0	27.0	27.9	28.7	27.4	27.3	27.6	26.4	26.3	25.7	26.5
1966	25.1	25.4	26.3	27.9	27.7	28.7	27.6	29.4	27.7	26.8	26.7	25.8	27.1
1967	24.6	24.5	25.3	26.9	28.7	28.4	28.9	28.1	27.8	27.0	26.2	24.0	26.7
1968	23.9	23.9	25.5	26.4	28.3	28.8	28.7	28.8	28.3	25.6	25.4	24.8	26.5
1969	24.9	24.5	25.9	27.0	29.3	29.7	27.9	27.4	27.8	26.8	25.9	25.2	26.9
1970	24.5	25.1	26.5	27.3	28.7	28.3	28.6	29.1	27.4	26.7	26.3	26.2	27.1
1971	23.7	24.3	25.1	27.1	27.3	27.3	27.7	28.2	28.7	26.4	25.7	25.3	26.4
1972	24.5	25.7	24.8	26.7	28.3	28.8	27.7	27.9	27.4	27.2	27.0	26.0	26.8
1973	25.0	25.2	26.2	27.7	29.1	29.6	28.7	28.5	27.0	27.2	26.7	24.4	27.1
1974	23.8	24.7	25.6	27.5	27.7	28.8	28.5	28.4	28.6	27.2	26.5	26.0	26.9
1975	24.9	24.7	26.0	27.3	28.7	28.2	28.2	28.8	27.1	27.4	26.2	24.7	26.9
1976	23.8	24.4	25.5	27.1	27.4	27.7	28.3	26.9	27.8	26.8	25.7	24.9	26.4
1977	25.1	24.1	25.1	27.1	28.4	28.7	28.2	29.3	28.0	27.0	25.8	25.4	26.8
1978	24.6	24.4	26.6	27.6	28.5	28.2	28.7	28.5	27.5	26.4	25.8	25.2	26.8
1979	24.9	25.5	26.1	27.6	28.5	27.8	28.9	28.3	27.2	26.2	26.0	24.8	26.8
1980	24.6	25.0	26.4	27.0	28.3	27.7	28.1	28.3	27.6	26.9	26.6	25.1	26.8
1981	23.2	24.9	26.0	27.3	28.6	28.5	27.9	29.4	28.2	27.0	26.3	24.3	26.8
1982	23.6	24.4	26.1	26.5	27.9	29.1	28.4	28.6	28.1	26.9	26.0	25.3	26.7
1983	25.0	25.2	26.6	27.4	28.3	29.2	28.0	28.2	27.9	27.0	26.2	24.5	27.0
1984	24.6	25.2	26.5	27.7	28.0	28.0	28.4	28.0	27.1	26.1	26.5	25.0	26.8
1985	24.0	25.9	26.5	27.3	28.0	29.2	27.4	29.7	27.2	27.1	26.2	24.8	26.9
1986	23.6	23.7	25.3	27.2	29.0	28.7	28.0	28.2	27.2	26.8	26.6	25.5	26.6
1987	24.5	24.5	26.1	27.7	29.4	30.1	29.6	28.8	28.3	27.7	27.1	25.6	27.5
1988	26.0	26.1	26.9	27.7	29.2	28.6	28.7	28.8	28.3	27.0	26.0	24.7	27.3
1989	25.3	24.4	25.5	27.6	28.3	28.5	28.4	28.4	28.1	27.7	26.5	24.0	26.9
1990	24.5	25.8	25.8	28.8	29.0	28.7	28.6	28.8	28.3	26.4	26.6	25.3	27.2
1991	25.0	24.9	26.4	27.3	28.8	28.7	28.3	27.8	28.8	27.2	26.0	24.9	27.0
1992	24.7	25.3	26.7	28.2	29.0	29.4	27.7	27.9	28.0	26.9	25.6	25.6	27.1
1993	24.6	24.3	25.6	27.3	28.5	28.9	28.6	28.4	27.9	26.7	26.7	25.0	26.9
1994	24.8	25.5	26.3	27.9	29.0	28.6	28.6	29.1	27.9	26.9	26.5	25.7	27.2
1995	24.3	24.3	25.7	27.5	28.4	29.5	28.4	27.9	27.6	27.1	26.6	24.1	26.8
1996	24.5	24.5	26.4	26.7	29.3	28.6	28.6	29.5	29.2	28.4	26.8	25.2	27.3
1997	24.4	25.6	26.0	27.8	29.1	29.8	28.5	29.8	28.0	28.4	27.1	26.2	27.6
1998	26.4	27.1	-	29.1	29.4	29.6	29.8	29.4	29.2	27.5	27.2	26.1	28.3
1999	25.7	24.9	26.9	27.4	28.8	28.5	29.1	28.3	28.4	27.7	26.5	25.4	27.3
2000	25.6	25.7	26.8	28.3	28.6	29.0	28.2	29.0	28.3	27.2	27.0	26.3	27.5
Mean	24.5	24.9	26.0	27.4	28.5	28.7	28.3	28.5	27.9	27.0	26.3	25.2	26.9

Source : PAGASA

Note : - ; missing data

Table C2.2 Monthly Maximum Temperature Record at Infanta Station

Unit : ^{o}C

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Max.
1961	26.5	28.1	29.7	30.8	32.0	31.5	32.1	31.9	32.4	30.2	28.6	28.4	32.4
1962	26.2	26.6	29.6	29.9	31.9	33.2	30.7	31.5	30.0	30.8	29.2	26.9	33.2
1963	24.1	25.7	27.8	29.3	31.3	32.3	32.0	31.3	30.7	29.9	29.5	28.1	32.3
1964	27.8	27.5	28.8	30.1	32.0	33.0	31.9	32.1	31.1	29.9	28.5	27.1	33.0
1965	26.2	27.6	28.0	30.6	31.8	33.1	31.2	31.1	31.7	29.5	29.1	28.2	33.1
1966	28.2	28.9	30.2	32.0	31.4	33.1	31.6	33.6	31.0	29.7	29.8	28.0	33.6
1967	26.7	26.8	28.3	30.3	32.8	32.1	33.0	31.5	31.9	30.6	28.9	26.2	33.0
1968	26.3	26.7	28.4	29.9	32.7	33.5	32.7	32.7	32.2	28.8	27.9	27.2	33.5
1969	28.2	28.4	29.8	30.5	33.6	34.0	31.5	30.8	31.2	30.3	28.8	27.2	34.0
1970	27.1	27.9	30.0	30.8	32.7	31.9	32.7	33.3	31.1	29.8	29.1	28.9	33.3
1971	26.6	26.8	27.8	30.6	30.7	30.8	30.9	31.9	33.0	29.4	28.2	27.7	33.0
1972	26.8	29.2	28.0	29.9	32.5	32.9	30.6	31.6	31.0	30.4	29.9	29.0	32.9
1973	28.4	28.6	30.0	31.6	33.5	34.1	32.6	32.3	30.3	30.2	29.4	26.4	34.1
1974	26.2	27.4	28.7	31.3	31.5	33.2	32.6	31.6	33.1	30.6	29.5	28.4	33.2
1975	27.5	27.6	29.5	30.5	32.8	32.3	32.5	32.1	30.6	30.9	28.9	26.9	32.8
1976	26.2	27.3	28.4	30.5	30.7	31.6	32.4	30.1	31.7	30.1	28.1	27.1	32.4
1977	27.6	26.5	27.9	30.6	32.4	33.0	31.8	33.2	31.6	29.8	28.3	27.8	33.2
1978	27.0	26.9	29.8	31.5	32.0	31.9	32.4	32.0	31.0	29.5	28.3	27.4	32.4
1979	27.4	28.5	30.0	31.2	32.5	31.3	32.7	32.0	30.8	29.0	28.5	27.1	32.7
1980	27.2	28.1	29.8	30.7	32.2	30.8	31.8	32.4	31.0	30.2	29.6	27.5	32.4
1981	25.6	27.7	29.8	30.7	32.6	32.3	31.8	33.2	31.8	30.2	29.0	26.8	33.2
1982	26.2	27.3	29.4	30.0	31.8	33.2	32.0	32.4	32.1	30.3	28.9	28.2	33.2
1983	27.8	29.8	30.7	31.9	32.9	33.6	31.9	32.0	31.5	30.0	29.1	26.6	33.6
1984	27.1	27.9	29.8	31.7	32.2	31.5	33.1	31.4	31.1	29.0	29.7	27.3	33.1
1985	26.3	29.3	29.7	31.0	31.7	33.2	31.6	33.7	31.0	30.6	28.9	27.5	33.7
1986	25.8	26.8	28.7	30.5	33.3	33.1	32.0	31.6	30.5	29.7	29.6	28.1	33.3
1987	27.1	27.3	30.2	31.9	34.3	34.5	34.1	32.9	32.2	31.4	30.1	27.9	34.5
1988	28.5	29.4	31.1	31.6	33.4	32.7	32.9	33.5	32.7	30.5	28.5	26.9	33.5
1989	27.4	27.0	28.7	31.7	32.4	33.0	32.4	32.5	32.1	31.5	29.3	26.6	33.0
1990	27.4	29.3	29.4	33.0	33.2	32.7	32.7	32.5	32.2	29.5	29.9	27.7	33.2
1991	28.2	28.1	30.3	31.3	33.0	32.5	32.2	31.4	33.0	31.1	28.9	27.3	33.0
1992	27.8	29.1	31.0	32.9	33.7	33.7	31.7	31.7	31.8	30.1	28.5	28.4	33.7
1993	27.6	27.8	29.3	31.8	33.0	33.1	32.8	32.6	31.8	30.0	29.4	27.1	33.1
1994	27.4	28.9	29.4	31.4	33.3	32.6	31.6	33.5	31.6	30.3	29.0	27.8	33.5
1995	26.6	27.3	28.8	30.8	32.0	33.5	32.1	31.2	30.7	29.8	29.0	26.0	33.5
1996	26.6	26.9	29.3	29.7	33.3	32.2	32.2	33.9	33.2	32.2	29.9	27.7	33.9
1997	27.4	28.5	29.8	31.8	33.1	34.6	32.3	33.7	31.8	31.9	30.2	29.1	34.6
1998	30.0	31.0	-	33.2	33.3	33.9	34.1	33.6	33.2	30.6	29.9	28.4	34.1
1999	28.1	27.6	30.1	30.8	33.0	32.6	33.2	31.9	32.2	31.0	29.4	27.6	33.2
2000	28.5	28.6	29.7	32.3	32.4	33.1	31.6	33.1	31.9	30.4	29.8	28.7	33.1
Max.	30.0	31.0	31.1	33.2	34.3	34.6	34.1	33.9	33.2	32.2	30.2	29.1	34.6

Source : PAGASA

Note : - ; missing data

Table C2.3 Monthly Minimum Temperature Record at Infanta Station

Unit : ^{o}C

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Max.
1961	21.3	21.9	23.1	23.6	24.4	24.1	24.3	24.4	23.7	23.2	23.5	23.1	21.3
1962	21.5	21.5	22.6	23.7	24.2	23.8	24.3	23.7	23.5	23.5	23.2	22.3	21.5
1963	19.9	20.5	21.1	22.4	23.4	24.5	23.9	23.7	24.4	23.3	24.0	22.9	19.9
1964	22.2	22.4	22.5	23.7	24.1	24.2	23.8	24.7	23.9	23.6	23.0	22.6	22.2
1965	20.8	21.9	22.0	23.4	24.0	24.4	23.6	23.5	23.6	23.4	23.5	23.2	20.8
1966	22.0	21.8	22.4	23.8	24.1	24.3	23.6	25.2	24.3	23.8	23.6	23.6	21.8
1967	22.4	22.1	22.3	23.5	24.7	24.7	24.9	24.8	23.6	23.4	23.4	21.9	21.9
1968	21.6	21.1	22.6	22.9	23.9	24.1	24.8	24.9	24.5	22.5	22.8	22.5	21.1
1969	21.7	20.5	22.0	23.4	25.1	25.4	24.3	24.0	24.4	23.3	22.9	23.2	20.5
1970	22.0	22.2	23.1	23.8	24.6	24.6	24.5	24.9	23.7	23.6	23.5	23.6	22.0
1971	20.9	21.7	22.3	23.5	23.8	23.8	24.4	24.4	24.4	23.5	23.2	23.0	20.9
1972	22.2	22.2	21.6	23.4	24.1	24.7	24.9	24.1	23.8	24.0	24.1	23.0	21.6
1973	21.6	21.9	22.5	23.8	24.6	25.1	24.7	24.6	23.7	24.1	24.0	22.4	21.6
1974	21.3	22.0	22.5	23.8	23.9	24.5	24.3	25.3	24.1	23.8	23.6	23.7	21.3
1975	22.4	21.9	22.5	24.2	24.5	24.2	24.0	25.5	23.6	24.0	23.4	22.5	21.9
1976	21.3	21.4	22.5	23.7	24.0	23.9	24.3	23.6	24.0	23.6	23.3	22.8	21.3
1977	22.5	21.8	22.3	23.6	24.4	24.5	24.6	25.3	24.4	24.1	23.2	22.9	21.8
1978	22.2	21.8	23.3	23.8	25.0	24.5	24.9	25.0	24.0	23.4	23.3	23.0	21.8
1979	22.3	22.5	22.2	24.1	24.5	24.3	25.1	24.6	23.7	23.4	23.5	22.4	22.2
1980	22.0	21.8	23.0	23.3	24.4	24.5	24.5	24.1	24.1	23.7	23.6	22.7	21.8
1981	20.8	22.0	22.2	24.0	24.5	24.7	24.0	25.5	24.6	23.9	23.5	21.8	20.8
1982	21.0	21.5	22.9	22.9	24.1	25.0	24.7	24.8	24.1	23.6	23.1	22.5	21.0
1983	22.3	20.5	22.5	23.0	23.6	24.8	24.0	24.3	24.3	23.9	23.3	22.3	20.5
1984	22.0	22.5	23.1	23.7	23.8	24.4	23.7	24.7	23.0	23.1	23.3	22.8	22.0
1985	21.6	22.5	23.4	23.7	24.2	25.3	23.2	25.6	23.3	23.6	23.6	22.1	21.6
1986	21.5	20.6	21.8	23.9	24.7	24.3	24.0	24.8	23.8	23.8	23.6	22.9	20.6
1987	22.0	21.6	22.0	23.4	24.5	25.7	25.1	24.7	24.4	23.9	24.1	23.2	21.6
1988	23.5	22.8	22.8	23.9	25.0	24.4	24.4	24.1	23.9	23.5	23.5	22.4	22.4
1989	23.2	21.9	22.4	23.5	24.2	23.9	24.3	24.3	24.0	24.0	23.6	21.5	21.5
1990	21.6	22.4	22.2	24.7	24.8	24.7	24.5	25.1	24.3	23.2	23.4	22.8	21.6
1991	21.8	21.6	22.5	23.3	24.7	24.8	24.4	24.3	24.7	23.3	23.0	22.4	21.6
1992	21.5	21.5	22.3	23.4	24.3	25.1	23.6	24.1	24.2	23.6	22.8	22.7	21.5
1993	21.5	20.7	21.8	22.8	24.0	24.8	24.4	24.1	24.0	23.4	24.0	22.9	20.7
1994	22.2	22.2	23.3	24.3	24.7	24.6	25.6	24.7	24.1	23.6	23.9	23.5	22.2
1995	22.1	21.4	22.6	24.1	24.8	25.5	24.8	24.6	24.6	24.4	24.1	22.2	21.4
1996	22.3	22.1	23.5	23.8	25.3	24.9	24.9	25.1	25.1	24.6	23.8	22.7	22.1
1997	21.4	22.8	22.2	23.9	25.0	25.0	24.7	25.8	24.2	24.8	23.9	23.2	21.4
1998	22.8	23.1	-	24.9	25.5	25.4	25.6	25.1	25.2	24.5	24.5	23.8	22.8
1999	23.3	22.3	23.6	24.1	24.6	24.4	25.1	24.8	24.5	24.4	23.7	23.2	22.3
2000	22.7	22.7	23.8	24.3	24.9	24.9	24.8	25.0	24.6	24.1	24.2	23.8	22.7
Max.	19.9	20.5	21.1	22.4	23.4	23.8	23.2	23.5	23.0	22.5	22.8	21.5	19.9

Source : PAGASA

Note : - ; missing data

Table C2.4 Monthly Evaporation Record at Cuyambay Station

Unit : mm

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1969	-	-	-	-	-	-	-	-	-	-	-	57.9	-
1970	111.2	118.4	-	190.3	197.9	92.4	81.6	95.3	119.6	85.6	32.4	89.5	-
1971	125.3	142.8	168.0	161.2	101.4	109.2	125.4	144.2	96.9	106.8	83.6	91.2	1456.0
1972	122.9	149.1	172.1	194.9	170.0	112.4	21.9	33.8		109.3	112.8	102.4	-
1973	110.7	133.0	190.8	222.7	197.0	138.9	126.1	87.2	85.2	89.3	105.6	95.9	1582.4
1974	134.1	133.6	169.7	171.1	140.7	108.6	94.7	51.0	108.7	65.5	83.6	96.5	1357.8
1975	106.4	125.2	156.0	163.3	165.3	112.9	114.1	57.4	119.8	88.6	91.6	72.7	1373.3
1976	89.8	136.2	178.9	-	-	-	-	-	-	119.4	87.2	98.8	-
1977	100.4	93.6	186.6	202.3	148.3	124.4	81.1	88.0	58.8	123.9	83.6	133.7	1424.7
1978	-	-	-	-	157.4	-	-	-	-	-	-	-	-
Average	112.6	129.0	174.6	186.5	159.8	114.1	92.1	79.6	98.2	98.6	85.1	93.2	1423.2
per day	3.6	4.6	5.6	6.2	5.2	3.8	3.0	2.6	3.3	3.2	2.8	3.0	3.9

Source : Feasibility Report on Agos Hydropower Project, Mar.1981, JICA

Table C2.5 Monthly Relative Humidity Record at Infanta Station

Unit : %

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
1961	84	86	84	83	82	81	77	79	79	85	87	85	77
1962	88	84	85	86	81	80	82	82	87	83	86	87	80
1963	92	87	85	82	81	78	79	83	84	84	85	87	78
1964	87	85	86	84	80	79	82	78	83	87	89	85	78
1965	87	85	84	82	80	74	80	82	82	86	88	86	74
1966	86	85	81	78	82	79	85	73	77	84	86	88	73
1967	84	81	81	80	75	77	76	77	81	83	84	87	75
1968	85	83	85	81	79	79	78	78	78	82	80	85	78
1969	86	84	83	83	76	81	83	83	81	83	85	88	76
1970	88	83	85	83	77	84	79	75	85	87	89	87	75
1971	83	88	82	79	87	83	78	75	76	86	86	88	75
1972	84	81	79	81	78	76	80	77	83	83	85	85	76
1973	84	82	77	77	74	73	77	77	86	82	85	87	73
1974	83	83	78	78	80	74	76	75	78	83	84	87	74
1975	86	85	83	84	79	79	77	74	84	83	83	88	74
1976	86	82	82	78	82	80	77	83	78	85	86	86	77
1977	88	86	83	82	78	78	79	72	80	82	83	81	72
1978	81	83	83	78	81	79	79	77	82	86	84	87	77
1979	84	86	79	81	78	86	76	78	86	85	87	79	76
1980	87	84	82	82	80	86	79	80	83	87	85	85	79
1981	85	86	81	84	81	80	81	74	82	85	86	86	74
1982	84	84	82	85	81	78	78	78	80	84	88	88	78
1983	86	82	83	80	78	76	82	79	84	88	82	84	76
1984	88	86	87	84	83	81	80	79	86	88	82	85	79
1985	83	85	84	83	83	75	81	73	85	84	87	86	73
1986	84	86	83	82	78	80	82	81	85	88	88	83	78
1987	84	83	82	82	78	77	77	80	83	84	86	89	77
1988	87	87	82	84	82	81	81	80	84	88	86	79	79
1989	84	85	86	83	85	81	81	79	81	84	83	86	79
1990	87	85	82	77	81	82	81	81	84	89	87	89	77
1991	87	89	83	84	81	81	80	83	78	81	85	86	78
1992	87	85	83	80	79	80	85	81	82	87	85	88	79
1993	87	89	86	83	79	82	83	83	84	87	88	92	79
1994	91	87	86	84	82	84	80	77	86	84	84	86	77
1995	90	89	87	82	81	79	83	86	87	89	89	91	79
1996	89	85	85	87	80	85	82	78	81	85	88	86	78
1997	88	86	83	80	79	76	85	76	87	84	85	87	76
1998	85	85	-	80	83	83	82	84	78	89	91	92	78
1999	91	88	89	89	86	84	80	84	83	88	89	93	80
2000	88	90	88	85	86	85	84	82	86	90	91	91	82
Mean	81	81	77	77	74	73	76	72	76	81	80	79	72

Source : PAGASA
Note : - ; missing data

Table C2.6 Monthly Wind Speed and Direction Record at Infanta Station

Unit : m

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
1961	3/N	2/N	2/N	2/N	2/SW	2/SW	2/SW	2/SW	2/SW	2/N	3/N	3/NNE	2/N
1962	3/NNE	3/N	2/N	2/N	2/N	2/SW	2/SW	2/SW	2/NNW	2/N	3/N	3/NNE	2/N
1963	3/N	3/NNE	2/N	2/N	2/N	3/SW	2/SW	2/N	3/N	3/N	3/N	3/N	3/N
1964	3/N	4/N	3/N	3/N	2/NNW	2/SW	3/SW	3/SSW	2/SW	3/N	3/N	5/N	3/N
1965	4/N	3/N	3/N	3/N	3/N	3/SW	2/SW	2/SW	2/SW	2/N	3/N	4/N	3/N
1966	3/N	3/N	2/N	3/N	3/SW	2/SW	2/N	3/SW	3/SW	2/N	3/N	3/N	3/N
1967	4/N	3/N	3/NNE	2/N	2/N	3/SSW	2/SW	3/SW	2/SW	2/N	5/N	4/N	3/N
1968	3/N	3/N	2/N	2/N	2/N	2/SW	3/N	2/SW	2/SW	2/NNW	3/N	2/NNE	2/N
1969	2/N	2/N	2/N	2/N	2/N	2/SW	2/NW	2/N	2/SW	2/N	3/N	3/N	2/N
1970	2/N	3/N	2/N	2/N	2/N	2/N	2/S	2/S	2/S	3/N	3/N	3/N	2/N
1971	4/N	3/N	3/N	2/N	2/N	2/N	2/N	2/S	2/SW	2/NW	3/NW	3/NW	3/N
1972	3/NW	2/NNW	3/N	2/NNW	1/NW	2/N	3/S	2/SE	1/NW	2/N	2/NE	2/NNE	2/NW
1973	2/NE	2/N	2/N	2/N	1/N	2/SE	2/SW	2/SW	1/N	2/N	3/N	4/N	2/N
1974	3/N	3/N	2/N	2/N	2/N	2/SW	2/SW	2/SW	2/N	2/N	3/N	3/N	2/N
1975	3/NNE	2/NNW	2/NNW	2/NNW	1/NNW	1/SE	1/SW	2/SSW	1/NNW	2/NNW	3/NNE	4/NNE	2/NNW
1976	3/NNE	2/NNW	2/NNW	2/N	2/SSE	2/NNW	2/SW	2/NNW	2/SW	2/N	4/N	3/NNE	2/NNW
1977	3/N	4/NNE	3/NNW	2/NNE	2/SSW	1/SE	2/SE	2/SSW	2/SSW	3/N	4/N	4/N	3/N
1978	3/N	3/N	2/N	2/N	2/N	2/SE	2/N	3/S	2/S	3/N	3/N	3/N	3/N
1979	2/NNE	2/NNW	2/N	2/N	2/N	2/NNW	3/S	2/SW	2/N	2/N	4/N	4/N	2/N
1980	3/N	3/NNE	3/NNE	2/NNE	2/N	2/N	2/S	1/N	2/N	2/NNW	3/N	3/NNW	2/N
1981	4/NNE	2/NNE	2/NNE	2/N	1/N	2/S	2/N	2/SSW	2/N	2/N	4/N	4/N	2/N
1982	3/NNE	2/N	3/N	1/N	2/N	2/N	3/S	2/SW	2/N	2/N	2/N	2/N	2/N
1983	2/N	1/N	1/N	2/N	2/N	2/N	2/N	2/S	1/N	1/N	3/N	3/N	2/N
1984	1/N	2/N	2/N	1/E	2/NNE	2/SW	1/S	2/S	1/N	1/N	2/N	5/N	2/N
1985	2/N	2/N	2/N	1/N	1/NNW	2/S	1/S	2/SW	1/N	2/N	2/N	2/NNW	2/N
1986	3/N	1/N	1/N	2/NNE	1/S	1/N	2/S	2/S	1/N	2/NNW	2/N	2/N	2/N
1987	2/NE	2/NE	1/E	1/NNE	1/N	1/SW	1/SW	1/W	1/N	1/N	2/NE	2/NE	1/NE
1988	2/NE	1/NE	1/NE	1/NE	1/NE	1/W	1/W	1/W	1/S	2/NE	3/NW	3/N	2/NE
1989	3/N	2/N	2/NNW	1/N	1/N	1/N	2/N	2/SW	2/S	2/N	3/N	2/N	2/N
1990	2/N	1/N	2/N	1/NNE	1/NNE	1/S	1/SW	2/SSW	1/N	1/NNE	2/NNE	2/NNE	1/NNE
1991	1/NNE	1/NNE	1/NNE	1/N	1/N	2/N	1/S	1/WSW	1/S	2/N	2/NNE	3/NNE	1/NNE
1992	1/N	1/E	1/NNE	1/NNE	1/N	1/N	1/S	2/SW	1/N	2/N	2/NNE	2/NNE	1/N
1993	2/NNE	2/NNE	2/NNE	1/NNE	1/NNE	1/NNE	1/NNE	1/SW	1/SW	2/NNE	2/N	3/NNE	2/NNE
1994	2/NNE	1/NNE	2/NNE	1/NNE	1/ESE	1/N	2/S	1/S	1/N	2/N	3/N	3/N	2/N
1995	2/N	1/N	1/N	1/N	1/N	1/SSE	1/S	1/N	1/N	1/N	2/N	3/N	1/N
1996	2/N	2/N	2/N	1/N	1/N	1/N	1/S	1/S	1/S	1/N	2/N	2/N	1/N
1997	1/N	2/N	1/N	1/N	1/N	1/S	1/N	1/S	1/N	1/N	2/N	2/N	1/N
1998	1/NNE	1/N	-	1/N	1/N	1/N	1/NNE	1/S	1/S	2/N	1/N	2/N	1/N
1999	2/N	2/N	1/N	1/N	1/N	1/N	1/S	2/S	1/S	2/N	2/N	2/N	2/N
2000	2/N	2/N	2/N	1/N	1/N	1/N	1/S	1/S	1/N	1/N	2/N	2/N	1/N
Max.	2/N	2/N	2/N	2/N	2/N	2/N	2/S	2/SW	2/N	2/N	3/N	3/N	2/N

Source : PAGASA

Note : - ; missing data

Table C2.7 Monthly Rainfall Record (1/8)

Station : Infanta Unit : mm

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1939	475.2	265.3	27.4	291.8	491.2	299.7	96.4	46.9	332.6	395.0	712.9	788.5	4,222.9
1940	261.9	-	211.7	-	59.8	134.7	87.1	358.3	-	-	-	-	-
1950	651.4	237.4	333.3	144.0	183.3	212.7	123.8	64.7	428.4	549.6	306.5	578.7	3,813.8
1951	163.4	170.2	37.3	193.1	120.9	175.9	302.0	219.9	280.5	214.4	869.7	538.2	3,285.5
1952	389.8	-	151.4	189.2	240.6	325.3	82.7	375.8	294.7	800.5	237.3	814.2	-
1953	250.3	230.8	143.4	263.6	170.8	181.7	253.8	161.8	118.0	701.3	539.1	1,097.5	4,112.1
1954	277.5	388.5	556.5	76.0	264.1	193.9	175.1	163.8	94.3	278.7	239.0	429.0	3,136.4
1955	554.2	107.8	76.4	129.3	102.6	564.3	218.9	154.0	228.6	799.8	897.3	300.2	4,133.4
1956	447.3	418.1	370.1	641.1	209.7	395.7	242.3	460.6	206.3	497.1	541.4	887.1	5,316.8
1957	521.5	156.6	191.8	153.8	87.8	48.1	313.4	220.4	130.0	331.2	270.3	208.9	2,633.8
1958	597.7	365.4	126.9	106.3	128.8	187.6	251.4	385.4	148.7	548.9	349.0	122.0	3,318.1
1959	373.7	213.7	262.8	29.5	317.0	121.1	323.4	125.8	301.1	379.8	576.2	548.6	3,572.7
1960	494.1	-	97.0	324.2	525.9	234.7	245.5	298.6	639.6	702.7	397.8	263.1	-
1961	224.8	200.3	252.8	168.4	280.4	317.9	83.6	204.3	203.7	697.8	741.3	407.8	3,783.1
1962	382.7	168.9	105.4	216.0	278.4	202.2	264.5	212.0	827.3	281.2	541.2	308.3	3,788.1
1963	563.8	190.0	138.8	73.8	134.3	134.2	249.3	479.2	239.0	311.6	308.5	781.1	3,603.6
1964	346.1	301.4	190.5	393.6	119.2	420.9	377.5	118.6	516.1	575.5	1,052.7	465.9	4,878.0
1965	506.6	173.2	127.6	217.6	132.7	102.5	293.5	310.9	183.5	414.1	607.1	516.1	3,585.4
1966	218.7	313.9	102.0	34.5	514.3	78.3	372.8	59.6	333.8	650.5	1,149.9	820.4	4,648.7
1967	390.5	238.1	148.5	214.6	24.6	105.1	121.4	174.6	281.8	332.4	489.3	479.8	3,000.7
1968	394.0	131.3	129.5	198.9	53.8	218.7	90.3	94.3	140.2	469.3	187.0	156.2	2,263.5
1969	160.1	99.5	176.6	174.4	41.2	84.7	356.5	249.1	355.8	305.2	515.2	974.2	3,492.5
1970	364.7	137.6	172.6	149.9	158.3	313.2	113.7	94.2	423.5	778.1	957.0	619.8	4,282.6
1971	347.4	498.1	403.9	78.1	929.4	533.6	542.9	91.3	88.2	896.2	959.8	1,227.4	6,596.3
1972	316.9	80.7	359.0	96.7	188.2	195.9	612.9	242.8	422.0	451.7	489.1	503.5	3,959.4
1973	218.6	104.7	91.8	49.0	153.0	136.4	213.3	172.1	441.3	436.7	1,013.5	1,043.8	4,074.2
1974	307.8	245.1	94.0	62.9	444.4	115.1	190.5	181.8	174.0	401.8	535.0	747.3	3,499.7
1975	414.6	212.6	202.1	382.7	129.2	328.5	181.6	71.9	438.3	377.7	543.2	1,496.2	4,778.6
1976	455.9	108.1	135.9	50.6	407.9	295.6	155.7	240.8	74.7	367.3	789.6	520.4	3,602.5
1977	500.2	389.1	222.0	136.8	160.9	236.8	394.9	106.6	145.2	296.4	767.1	185.6	3,541.6
1978	144.4	236.4	145.2	73.0	263.6	327.6	140.3	211.8	446.5	1,267.0	587.9	644.7	4,488.4
1979	149.2	124.0	21.5	352.0	249.2	444.3	109.4	133.4	540.8	719.2	543.6	237.9	3,624.5
1980	388.1	118.8	323.6	142.6	321.9	485.7	129.8	205.7	271.3	931.1	426.2	646.9	4,391.7
1981	405.7	204.8	107.1	190.7	172.1	212.5	282.0	102.5	298.6	646.0	989.3	579.2	4,190.5
1982	346.9	210.8	312.0	385.9	193.4	81.8	180.8	202.0	233.3	366.8	627.1	592.6	3,733.4
1983	411.8	27.5	138.9	145.8	33.7	116.0	438.2	261.8	456.8	846.5	348.5	481.3	3,706.8
1984	421.9	101.1	116.7	158.6	218.4	276.5	199.9	69.8	182.9	1,774.9	360.7	471.7	4,353.1
1985	194.3	209.4	195.1	144.4	241.0	200.4	631.5	25.3	555.3	979.2	774.3	760.5	4,910.7
1986	377.8	245.8	89.8	245.0	71.0	189.6	452.8	421.3	244.3	837.8	724.3	289.7	4,189.2
1987	274.4	125.6	30.4	45.7	85.1	96.4	70.9	230.3	264.2	277.0	470.1	1,111.0	3,081.1
1988	508.2	381.4	98.2	334.6	196.2	372.4	192.6	107.7	160.7	1,534.2	849.6	152.3	4,888.1
1989	196.3	637.1	532.1	215.4	422.4	189.6	433.8	158.2	218.5	439.2	346.2	280.8	4,069.6
1990	357.1	80.2	95.3	18.6	280.9	304.3	209.4	262.9	250.5	1,009.4	882.8	857.5	4,608.9
1991	176.0	383.9	93.6	175.6	170.8	404.3	164.0	201.4	82.4	270.3	406.2	454.5	2,983.0
1992	233.7	122.2	103.5	133.9	164.1	104.2	494.7	266.0	171.7	535.3	636.7	233.0	3,199.0
1993	227.9	190.4	77.2	44.6	94.9	190.7	149.3	276.8	217.6	408.7	406.1	1,493.2	3,777.4
1994	468.4	147.5	187.3	116.4	161.6	415.9	63.4	104.8	274.2	422.7	165.0	412.4	2,939.6
1995	360.1	503.2	109.9	120.1	216.9	460.6	305.4	270.8	704.1	725.3	480.7	1,366.1	5,623.2
1996	395.0	181.4	174.1	809.0	122.8	356.8	222.1	64.0	101.6	419.6	899.2	366.7	4,112.3
1997	319.2	321.2	141.5	46.0	206.0	49.5	416.4	73.0	356.4	189.5	125.3	240.6	2,484.6
1998	114.1	41.3	-	39.9	109.1	232.1	207.9	203.8	126.1	783.6	476.0	1,535.5	-
1999	569.2	328.3	437.9	719.3	234.9	186.1	180.8	393.7	208.2	562.2	949.8	1,221.0	5,991.4
2000	362.3	371.8	291.9	180.1	243.4	346.7	230.5	99.9	403.1	766.4	788.6	1,020.6	5,105.3
Mean	358.0	228.8	182.0	193.8	217.5	244.1	249.7	197.9	293.5	595.3	593.2	640.0	3,987.3

Source : PAGASA, Feasibility Report on Agos River Hydropower Project, Small Hydropower Project (Kanan B1 Scheme)

Table C2.7 Monthly Rainfall Record (2/8)

Station : Bayokan Unit : mm

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1939	673.8	436.8	23.1	360.3	276.8	297.2	172.2	168.2	300.5	183.9	1,273.0	1,687.5	5,853.3
1940	-	-	-	194.1	93.4	87.8	280.5	392.7	-	-	-	-	-
1947	341.0	222.7	313.5	162.7	175.5	222.8	153.3	668.8	391.9	1,044.4	750.3	640.7	5,087.6
1948	359.6	150.2	167.0	-	128.6	109.5	449.9	433.8	544.2	645.5	747.9	547.6	-
1949	370.8	277.4	146.8	53.3	203.2	140.2	263.1	139.3	193.0	475.1	787.8	834.2	3,884.2
1950	375.7	318.2	412.7	241.4	115.4	204.4	-	157.6	312.0	675.7	448.1	649.0	-
Mean	424.2	281.1	212.6	202.4	165.5	177.0	263.8	326.7	348.3	604.9	801.4	871.8	4,941.7

Source : Feasibility Report on Agos River Hydropower Project, Small Hydropower Project (Kanan B1 Scheme)

Station : Mahabang Lalim Unit : mm

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1978	-	-	-	-	-	-	224.5	339.2	262.7	685.8	745.0	877.2	-
1979	272.3	212.6	58.8	502.7	-	476.4	162.1	294.7	-	805.6	1,040.6	-	-
Mean	272.3	212.6	58.8	502.7	-	476.4	193.3	317.0	262.7	745.7	892.8	877.2	-

Source : Feasibility Report on Agos River Hydropower Project, Small Hydropower Project (Kanan B1 Scheme)

Station : Matatio Unit : mm

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1939	902.4	824.5	27.7	631.9	385.7	178.5	173.6	141.8	339.5	324.6	1,588.4	1,954.8	7,473.4
1940	479.3	-	214.6	193.7	93.9	172.6	287.9	385.9	-	-	-	-	-
1947	434.1	210.4	580.2	172.0	275.6	203.5	239.6	766.0	455.7	1,153.2	1,091.4	950.1	6,531.8
1948	269.2	204.2	259.6	116.4	171.6	101.4	379.7	471.5	403.7	589.8	1,149.5	797.4	4,914.0
1949	621.9	-	-	50.3	162.7	118.4	260.9	176.7	220.8	614.3	949.3	863.8	-
1950	747.5	300.8	502.3	210.1	124.3	178.2	193.1	145.9	291.2	596.0	798.4	840.9	4,928.7
Mean	575.7	385.0	316.9	229.1	202.3	158.8	255.8	348.0	342.2	655.6	1,115.4	1,081.4	5,962.0

Source : Feasibility Report on Agos River Hydropower Project, Small Hydropower Project (Kanan B1 Scheme)

Station : Upper Matatio Unit : mm

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1947	-	210.4	580.6	172.0	275.6	203.5	239.6	778.6	455.7	1,153.2	1,091.4	950.1	-
1948	269.2	204.2	230.1	116.4	171.6	101.4	379.7	471.5	403.7	589.8	1,149.5	797.4	4,884.5
1949	621.3	250.0	216.4	50.3	162.7	118.4	260.9	176.7	220.8	616.3	949.3	869.8	4,512.9
1950	747.8	300.8	502.3	211.7	170.2	178.2	193.6	149.5	291.2	586.0	798.4	893.7	5,023.4
1979	-	-	-	-	-	-	-	-	369.5	700.5	802.0	395.0	-
1980	267.0	135.0	594.5	77.0	-	-	-	148.0	297.0	-	46.0	508.5	-
1981	89.5	121.0	8.5	-	96.7	57.0	-	-	-	-	-	-	-
Mean	399.0	203.6	355.4	125.5	175.4	131.7	268.5	344.9	339.6	729.2	806.1	735.7	4,806.9

Source : Feasibility Report on Agos River Hydropower Project, Small Hydropower Project (Kanan B1 Scheme)

Station : Tuno Unit : mm

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1978	-	-	-	-	-	-	89.3	317.0	760.0	1,969.0	932.0	1,270.0	-
1979	392.0	190.0	-	612.0	204.4	493.0	105.4	232.6	343.0	1,399.7	1,187.5	719.6	-
1980	503.6	321.4	940.0	186.6	256.0	662.0	377.0	241.2	347.8	1,408.0	908.8	1,653.6	7,806.0
1981	871.6	-	105.8	123.0	315.2	354.4	444.6	-	-	1,276.5	2,078.6	477.0	-
1982	1,220.8	313.0	-	-	236.8	104.2	-	463.6	352.0	509.0	975.0	1,061.2	-
1983	-	81.0	70.0	165.0	37.0	75.0	822.0	486.2	438.0	1,169.4	575.2	1,156.8	-
1984	-	405.0	408.0	275.6	283.8	772.9	147.2	751.8	492.0	972.4	-	-	-
Mean	747.0	262.1	381.0	272.4	222.2	410.2	330.9	415.4	455.5	1,243.4	1,109.5	1,056.4	7,806.0

Source : Feasibility Report on Agos River Hydropower Project, Small Hydropower Project (Kanan B1 Scheme)

Table C2.7 Monthly Rainfall Record (3/8)

Station : Masanga — Unit : mm

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1979	-	-	-	318.2	346.6	177.2	113.7	169.1	412.3	611.9	544.1	-	-
1980	-	-	-	-	-	414.0	433.9	260.2	676.5	1,596.5	1,602.5	1,641.0	-
1981	1,669.7	1,307.5	645.8	309.5	40.6	581.2	779.0	199.8	620.1	1,634.6	1,503.1	916.4	10,207.3
1982	1,557.7	755.8	407.2	730.0	237.6	129.8	528.3	807.3	352.7	1,094.3	1,181.5	1,117.5	8,899.7
1983	1,004.4	700.5	-	-	-	-	-	-	-	-	-	-	-
Mean	1,410.6	921.3	526.5	452.6	208.3	325.6	463.7	359.1	515.4	1,234.3	1,207.8	1,225.0	9,553.5

Source : Feasibility Report on Agos River Hydropower Project, Small Hydropower Project (Kanan B1 Scheme)

Station : Lagmac — Unit : mm

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1979	-	-	-	-	-	-	-	-	-	1,198.0	-	-	-
Mean	-	-	-	-	-	-	-	-	-	1,198.0	-	-	-

Source : Feasibility Report on Agos River Hydropower Project, Small Hydropower Project (Kanan B1 Scheme)

Station : Longoy — Unit : mm

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1979	-	-	-	-	-	-	-	43.5	561.7	1,681.7	1,163.5	-	-
1980	-	-	572.6	1,994.0	385.0	-	-	117.5	206.5	797.0	87.0	-	-
1981	-	263.5	180.5	207.5	159.5	25.5	2.5	95.5	150.5	208.5	-	-	-
1982	-	-	-	-	-	-	-	-	-	-	-	-	-
Mean	-	263.5	376.5	1,100.7	272.2	25.5	2.5	85.5	306.2	895.7	625.2	-	-

Source : Feasibility Report on Agos River Hydropower Project, Small Hydropower Project (Kanan B1 Scheme)

Station : Sta. Ines — Unit : mm

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1939	44.1	10.8	21.8	118.7	272.2	255.1	501.8	644.1	227.7	181.6	382.1	482.9	3,142.9
1940	-	-	-	72.3	168.0	311.9	1,010.5	611.1	-	-	-	-	-
1978	-	-	-	-	-	114.2	571.7	1,494.9	742.3	1,752.2	130.1	129.4	-
1979	1.6	-	-	261.3	427.1	298.2	591.0	702.5	426.8	426.6	6.2	79.5	-
1980	11.3	0.1	-	-	3.5	268.4	278.0	261.9	128.2	440.8	306.1	42.1	-
1981	8.4	12.6	3.8	34.7	85.4	345.8	160.3	404.8	426.8	434.9	533.4	-	-
1982	10.3	18.2	135.7	-	194.5	322.9	905.2	-	-	-	-	134.8	-
Mean	15.1	10.4	53.8	121.7	191.8	273.8	574.1	686.5	390.4	647.2	271.6	173.7	3,142.9

Source : Feasibility Report on Agos River Hydropower Project, Small Hydropower Project (Kanan B1 Scheme)

Station : Daraitan — Unit : mm

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1939	128.0	71.9	-	117.1	226.3	198.5	230.9	305.4	296.3	153.6	618.3	695.3	-
1940	-	-	-	157.2	93.4	257.7	553.4	423.1	-	-	-	-	-
1947	69.9	22.1	82.9	60.6	104.6	174.1	309.8	851.3	331.8	604.8	685.2	175.5	3,472.6
1948	90.4	47.8	15.8	37.1	110.8	101.9	388.3	556.2	503.9	168.5	497.5	311.3	2,829.5
1949	35.8	40.4	36.4	-	-	-	-	-	-	-	-	-	-
1978	-	-	-	-	-	176.2	207.2	702.4	553.6	1,734.4	125.8	294.4	-
1979	57.6	21.0	-	77.4	258.4	105.6	235.0	106.2	196.6	176.0	172.6	106.6	-
1980	93.0	12.0	167.2	5.0	154.6	174.8	370.2	-	-	-	-	-	-
1981	99.4	47.8	15.2	13.8	61.8	881.0	507.0	-	592.8	253.0	899.2	694.8	-
1982	81.2	30.2	55.6	15.6	45.6	219.0	506.0	247.8	325.6	255.2	245.0	238.6	2,265.4
1983	179.3	-	-	21.2	-	-	161.2	323.8	499.2	-	80.6	23.4	-
1984	65.0	26.0	5.6	-	124.6	335.6	133.8	621.0	21.0	703.8	122.6	38.2	-
1985	17.2	19.6	-	23.6	60.0	134.8	154.0	131.0	149.2	320.4	126.0	-	-
Mean	83.3	33.9	54.1	52.9	124.0	250.8	313.1	426.8	347.0	485.5	357.3	286.5	2,855.8

Source : Feasibility Report on Agos River Hydropower Project, Small Hydropower Project (Kanan B1 Scheme)

Table C2.7 Monthly Rainfall Record (4/8)

Station : Lumutan Unit : mm

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1978	-	-	-	-	-	-	364.6	1,206.3	-	-	-	-	-
1979	-	-	-	-	223.0	219.1	426.7	-	461.0	646.9	381.9	187.1	-
1980	22.3	13.9	342.6	13.8	370.3	315.1	595.9	276.6	423.6	615.4	760.9	233.4	3,983.8
1981	73.4	76.9	132.2	24.9	121.2	542.2	548.4	783.1	405.5	828.7	1,071.4	624.3	5,232.2
1982	91.4	53.6	134.5	120.6	126.1	225.3	623.7	468.5	-	211.1	416.3	278.4	-
1983	191.0	18.2	31.0	25.4	18.2	135.3	762.1	595.2	385.3	570.0	197.4	243.1	3,172.2
1984	131.0	37.2	101.3	93.6	140.6	459.8	329.2	1,074.0	267.1	1,217.9	186.4	128.6	4,166.7
1985	42.6	-	-	-	37.0	1,136.8	467.2	553.5	590.2	-	-	-	-
Mean	91.9	40.0	148.3	55.7	148.1	433.4	514.7	708.2	422.1	681.7	502.4	282.5	4,138.7

Source : Feasibility Report on Agos River Hydropower Project, Small Hydropower Project (Kanan B1 Scheme)

Station : Mamuyao Unit : mm

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1979	-	1.0	0.3	227.7	292.1	215.5	480.1	604.2	348.6	274.3	161.0	82.9	-
1980	10.3	12.8	252.8	5.2	426.1	305.2	691.8	249.2	539.2	389.8	579.2	114.8	3,576.4
1981	7.0	22.4	7.8	47.2	82.8	590.8	579.4	540.6	294.6	392.0	532.6	321.4	3,418.6
1982	11.4	22.0	110.2	25.4	230.4	208.2	694.0	749.4	405.2	111.6	136.8	81.8	2,786.4
1983	79.8	7.6	11.4	7.4	63.8	118.4	529.8	715.0	345.6	370.8	79.6	29.8	2,359.0
1984	27.2	14.0	33.8	102.4	235.2	431.0	239.0	642.0	198.6	669.0	125.2	2.2	2,719.6
1985	0.0	31.6	45.4	82.6	79.2	867.0	379.8	328.4	429.8	608.4	158.0	81.8	3,092.0
1986	23.6	64.6	0.0	70.2	363.4	171.8	695.2	800.8	647.6	659.2	509.6	149.0	4,155.0
1987	52.2	9.2	13.6	61.0	182.0	269.8	358.6	479.2	400.2	166.8	241.8	234.2	2,468.6
1988	175.6	51.4	4.0	62.0	157.0	434.0	328.4	121.8	250.6	986.0	429.4	27.4	3,027.6
1989	59.0	25.9	33.7	0.0	243.8	175.9	689.0	449.4	387.7	247.4	135.2	-	-
Mean	44.6	23.9	46.6	62.8	214.2	344.3	515.0	516.4	386.2	443.2	280.8	112.5	3,067.0

Source : Manila Water Supply III, Volume 1 : Feasibility Report

Station : Laiban Damsite Unit : mm

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1983	-	-	-	-	54.0	39.6	578.1	330.4	258.6	571.4	87.1	42.3	-
1984	71.7	20.0	27.7	154.8	206.6	320.9	342.5	585.2	137.2	649.9	179.6	50.0	2,746.1
1985	28.5	48.5	54.5	37.4	74.3	819.6	465.2	198.4	328.8	777.9	48.3	56.9	2,938.3
1986	25.5	11.4	1.0	85.4	212.6	144.4	306.1	325.1	274.6	464.5	321.2	60.4	2,232.2
1987	90.6	19.5	4.2	0.0	61.8	244.8	220.4	534.0	371.0	162.3	469.9	104.6	2,283.1
1988	142.4	23.8	22.6	-	227.0	252.8	105.2	25.2	114.0	1,216.2	514.2	20.2	-
1989	108.4	121.4	133.2	18.4	256.4	125.4	590.0	274.8	364.2	302.8	182.0	-	-
Mean	77.9	40.8	40.5	59.2	156.1	278.2	372.5	324.7	264.1	592.1	257.5	55.7	2,549.9

Source : Manila Water Supply III, Volume 1 : Feasibility Report

Station : Cuyambay Unit : mm

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1977	89.9	16.8	15.1	11.9	165.2	206.2	635.0	542.6	612.0	85.6	535.9	19.5	2,935.7
1978	-	3.5	10.2	-	176.8	-	-	-	-	-	-	-	-
Mean	89.9	10.1	12.6	11.9	171.0	206.2	635.0	542.6	612.0	85.6	535.9	19.5	2,935.7

Source : Feasibility Report on Agos River Hydropower Project, Small Hydropower Project (Kanan B1 Scheme)

Table C2.7 Monthly Rainfall Record (5/8)

Station : Quezon Unit : mm

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1961	-	7.6	63.6	38.8	124.8	580.6	418.4	593.5	383.8	272.5	109.4	11.7	-
1962	31.8	0.5	7.6	83.4	94.3	189.0	989.8	343.5	484.8	50.4	92.3	10.8	2,378.2
1963	3.1	0.0	6.7	0.5	87.5	579.8	349.3	442.3	494.7	153.5	50.7	94.9	2,263.0
1964	32.2	2.1	15.5	20.1	178.1	511.4	373.2	693.7	253.2	221.0	256.1	116.9	2,673.5
1965	23.9	12.0	0.0	15.2	246.1	390.2	525.9	337.0	366.9	58.5	142.4	37.3	2,155.4
1966	16.4	34.5	6.6	8.7	670.1	27.7	308.8	279.1	660.0	107.2	356.7	94.6	2,570.4
1967	33.3	7.9	5.7	4.8	100.7	936.6	509.4	489.6	378.3	125.1	73.6	8.3	2,673.3
1968	7.1	1.3	1.1	0.8	133.7	188.8	412.3	708.7	379.8	154.7	10.7	0.0	1,999.0
1969	0.0	0.6	0.0	11.1	44.3	151.4	213.4	462.7	417.0	233.7	64.2	48.9	1,647.3
1970	8.0	0.0	6.0	46.5	38.5	146.8	445.1	514.5	872.9	435.3	-	-	-
1971	-	-	-	36.0	199.7	250.5	436.1	238.7	111.3	386.8	235.0	159.8	-
1972	39.5	2.6	40.3	42.4	176.8	492.7	1,885.3	583.7	256.5	65.2	100.8	-	-
1973	5.8	1.9	0.6	0.5	22.7	387.2	285.2	402.7	261.7	348.9	198.9	69.8	1,985.9
1974	0.3	41.9	2.1	34.6	89.5	456.1	277.9	1,129.8	60.0	301.0	372.3	107.5	2,873.0
1975	16.2	0.5	0.5	29.2	72.1	290.7	144.9	551.4	242.8	507.8	70.2	167.0	2,093.3
1976	60.9	2.0	19.1	6.9	-	-	-	-	-	-	-	-	-
1977	86.4	3.5	25.5	5.1	68.5	160.3	398.6	539.8	502.8	54.1	337.4	-	-
1978	2.0	7.4	-	31.2	196.1	174.4	269.7	712.6	562.1	576.0	78.4	47.6	-
1979	2.8	0.0	0.0	72.3	213.2	152.1	518.6	549.8	279.9	124.0	29.2	23.0	1,964.9
1980	0.0	0.0	91.7	0.0	157.1	171.9	406.4	257.5	449.3	346.7	202.0	25.0	2,107.6
1981	0.1	9.0	0.0	29.3	81.1	589.2	403.2	335.5	251.8	292.0	181.1	87.4	2,259.7
1982	1.5	0.7	28.6	48.0	75.9	191.3	612.0	423.9	321.4	107.0	109.2	50.0	1,969.5
1983	34.9	2.1	0.1	0.0	27.8	132.6	307.2	575.8	257.0	292.9	25.7	0.0	1,656.1
1984	15.4	1.7	23.0	61.0	134.4	498.3	233.9	613.2	252.7	433.0	101.4	3.6	2,371.6
1985	1.0	10.6	61.8	143.2	28.3	880.4	311.0	249.4	474.2	325.4	101.2	43.0	2,629.5
1986	0.2	3.0	0.0	25.0	242.6	161.6	797.3	796.4	616.8	649.8	241.6	74.8	3,609.1
1987	3.8	0.0	0.0	12.6	93.6	230.2	164.3	328.6	403.6	160.8	127.7	102.7	1,627.9
1988	85.5	38.4	1.2	23.4	153.6	482.7	493.1	157.1	373.2	629.1	165.4	1.8	2,604.5
1989	14.6	14.6	72.4	69.4	220.2	296.0	491.3	708.3	271.7	241.9	55.5	0.0	2,455.9
1990	5.1	1.6	2.4	18.6	194.4	468.9	582.7	603.0	580.9	252.5	303.8	99.2	3,113.1
1991	12.3	8.3	6.8	24.9	50.4	260.1	530.8	724.8	373.4	146.5	104.0	2.1	2,244.4
1992	5.2	1.0	0.0	0.0	87.6	147.0	520.0	768.8	385.3	209.1	143.4	7.3	2,274.7
1993	0.0	1.0	16.2	15.8	1.4	325.3	496.9	474.7	518.3	351.2	224.2	165.4	2,590.4
1994	49.4	24.7	42.2	29.9	184.7	421.9	799.6	345.4	426.5	155.7	7.8	113.0	2,600.8
1995	17.4	8.1	2.2	6.6	302.5	392.8	359.7	646.9	748.6	349.1	184.8	189.7	3,208.4
1996	19.4	0.0	10.6	80.3	115.5	142.4	399.9	339.9	485.5	276.7	162.0	13.1	2,045.3
1997	11.8	32.6	1.0	30.2	483.5	166.7	564.9	559.5	234.6	97.5	45.8	10.4	2,238.5
1998	17.3	0.0	5.4	1.4	185.9	289.1	200.4	273.1	618.2	486.7	179.2	444.4	2,701.1
1999	38.9	4.0	82.9	137.7	200.9	245.6	707.9	865.5	436.0	343.5	166.8	135.6	3,365.3
2000	17.3	38.1	103.5	37.5	592.2	177.3	1,003.3	520.1	604.1	537.0	255.0	187.8	4,073.2
Mean	19.0	8.4	19.8	32.1	163.3	326.6	491.0	516.4	411.6	278.5	149.1	76.5	2,455.3

Source : PAGASA

Table C2.7 Monthly Rainfall Record (6/8)

Station : Bosoboso Unit : mm

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1972	-	-	-	13.9	289.0	314.6	-	-	-	-	-	-	-
1973	-	-	-	-	-	-	-	-	-	-	-	-	-
1974	-	-	-	-	-	-	-	-	-	-	-	-	-
1975	-	-	-	-	-	-	-	-	-	-	-	-	-
1976	-	-	0.0	0.7	20.5	42.1	53.6	103.8	86.8	19.1	19.3	30.0	-
1977	20.2	17.8	1.0	0.0	6.5	11.6	24.0	20.9	28.7	8.3	3.9	-	-
1978	1.9	0.8	0.0	1.8	18.6	12.1	53.6	60.2	81.5	104.2	7.3	11.4	353.4
1979	0.0	0.0	0.0	2.3	36.1	29.8	62.8	48.9	36.8	47.2	6.7	0.0	270.6
1980	0.0	0.0	7.4	0.0	8.9	13.0	50.2	21.4	50.5	35.8	29.8	-	-
1981	0.0	0.0	0.0	1.0	6.3	51.6	76.1	30.5	54.8	60.7	68.3	21.6	370.9
1982	0.0	0.0	2.0	2.0	18.2	50.5	112.0	135.3	110.3	27.2	14.1	2.3	473.9
1983	32.2	0.5	0.0	0.0	6.4	14.5	34.2	63.2	32.0	24.1	0.0	0.0	207.1
1984	0.0	0.0	0.0	55.7	88.6	776.3	198.9	1,667.8	495.5	513.1	50.4	0.0	3,846.3
1985	0.0	0.0	0.0	12.4	15.5	282.9	169.9	318.6	444.7	560.7	5.9	9.1	1,819.7
1986	0.0	15.5	0.0	2.0	25.6	90.6	414.1	883.7	797.2	492.7	152.1	129.0	3,002.5
1987	0.0	0.0	0.0	15.6	49.9	251.3	51.5	443.8	288.0	138.6	106.1	42.5	1,387.3
1988	25.3	0.0	0.0	2.3	94.3	459.5	346.8	198.5	278.6	728.2	226.4	0.0	2,359.9
1989	0.0	40.0	88.9	65.0	191.0	275.5	373.8	584.9	314.4	219.8	49.6	0.0	2,202.9
1990	0.0	0.0	0.0	0.0	216.3	385.7	435.9	592.3	373.1	261.6	173.9	16.6	2,455.4
1991	0.0	0.0	0.0	7.5	35.2	234.6	649.8	1,089.9	662.4	107.4	26.2	0.0	2,813.0
1992	0.0	0.0	5.0	5.2	55.6	131.9	489.2	818.9	428.4	168.1	49.2	4.5	2,156.0
1993	17.5	0.0	0.0	40.0	0.0	254.3	511.2	336.0	462.6	305.3	145.7	220.9	2,293.5
1994	95.2	0.0	0.0	0.3	224.5	427.6	843.7	365.6	404.4	135.5	18.2	92.6	2,607.6
1995	23.0	0.0	0.0	0.0	140.2	306.3	570.9	452.5	505.4	215.8	159.6	205.6	2,579.3
1996	19.0	0.0	0.0	103.8	229.1	117.8	495.9	415.2	325.8	269.7	365.8	0.0	2,342.1
Mean	11.7	3.7	5.0	15.1	80.7	206.1	286.6	412.0	298.2	211.6	79.9	41.4	1,863.4

Source : PAGASA

Table C2.7 Monthly Rainfall Record (7/8)

Station : Baguio Unit : mm

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1961	0.0	0.0	119.8	63.0	189.9	575.1	1,025.6	611.8	565.5	196.6	72.1	7.6	3,427.0
1962	3.3	0.0	9.2	92.9	264.0	185.1	1,249.3	694.4	832.7	154.3	29.6	7.9	3,522.7
1963	9.6	4.3	9.8	7.9	125.5	1,092.5	489.8	383.8	1,457.9	76.2	41.6	46.1	3,745.0
1964	3.2	0.8	18.9	158.4	233.1	520.4	299.9	1,871.9	572.3	443.7	202.9	143.6	4,469.1
1965	2.6	22.4	118.6	200.1	459.9	503.3	712.6	371.3	364.8	106.6	24.5	0.0	2,886.7
1966	19.6	6.9	45.3	26.8	764.3	241.8	374.3	601.8	956.7	60.1	175.4	37.1	3,310.1
1967	1.8	4.6	12.1	230.9	197.9	1,417.9	323.8	1,141.1	440.3	1,560.3	109.1	0.8	5,440.6
1968	4.2	0.0	6.4	51.4	275.5	346.7	1,043.7	1,672.3	1,480.8	31.2	18.6	0.0	4,930.8
1969	-	0.8	7.2	85.9	344.0	382.3	1,211.8	616.3	894.9	279.1	52.0	48.6	-
1970	21.2	2.9	21.3	68.8	340.6	417.4	405.9	676.8	616.0	174.5	65.4	50.8	2,861.6
1971	12.7	12.1	4.2	144.4	162.6	489.6	1,321.1	756.6	385.5	306.4	66.7	46.8	3,708.7
1972	18.8	1.8	12.3	80.2	328.3	455.4	4,773.9	1,040.9	331.3	50.9	46.5	25.6	7,165.9
1973	0.6	0.0	1.1	51.5	106.2	372.5	418.7	537.4	225.2	816.2	54.4	13.5	2,597.3
1974	20.1	0.0	7.4	97.2	272.4	549.7	389.5	1,487.5	332.4	2,273.5	636.1	48.7	6,114.5
1975	17.1	0.0	2.3	57.9	215.2	224.4	152.5	787.9	477.4	295.5	27.5	43.1	2,300.8
1976	21.6	0.0	38.7	21.4	1,304.5	1,224.8	377.3	677.0	373.0	176.3	81.5	7.5	4,303.6
1977	30.2	0.0	5.9	30.8	294.8	159.3	694.5	784.2	1,281.4	148.8	186.6	0.0	3,616.5
1978	0.0	0.0	5.8	64.6	265.9	431.4	613.4	1,412.9	583.9	344.8	20.0	29.7	3,772.4
1979	13.0	1.4	1.4	117.1	410.1	239.1	586.7	1,078.4	250.2	206.2	20.7	48.1	2,972.4
1980	1.0	1.9	16.8	4.8	1,040.4	88.3	1,323.3	237.6	562.2	210.8	885.0	35.4	4,407.5
1981	38.6	2.8	0.0	263.2	248.2	629.5	465.2	1,165.4	634.7	196.3	206.4	-	-
1982	0.5	22.7	21.5	168.2	228.9	340.0	1,146.8	921.4	443.6	238.2	123.8	47.3	3,702.9
1983	40.4	15.4	10.4	0.0	95.6	202.9	279.3	933.0	391.7	176.4	72.2	0.8	2,218.1
1984	10.6	0.0	54.8	209.5	525.6	442.4	286.1	1,512.5	397.7	322.4	17.3	2.3	3,781.2
1985	7.4	46.0	57.5	219.7	410.7	1,540.7	189.5	1,424.6	512.1	265.2	76.3	15.4	4,765.1
1986	18.2	11.0	6.7	3.6	531.1	226.4	1,495.7	1,208.1	1,030.2	146.6	41.5	17.9	4,737.0
1987	0.0	0.0	8.2	29.4	234.5	381.6	304.6	814.7	413.9	503.5	9.5	27.7	2,727.6
1988	14.6	36.9	0.1	119.5	306.4	546.5	928.6	240.7	312.1	451.0	23.4	3.4	2,983.2
1989	50.2	64.3	113.0	51.2	334.5	343.5	1,506.6	506.0	1,539.0	355.1	106.5	0.2	4,970.1
1990	0.0	0.0	6.9	15.7	346.9	1,088.1	585.0	1,599.9	861.5	109.5	51.5	8.5	4,673.5
1991	0.0	10.4	10.6	125.6	124.0	177.8	586.4	677.2	593.8	1,735.3	15.5	1.2	4,057.8
1992	8.1	0.4	67.8	23.6	483.2	317.6	473.4	1,403.8	1,611.5	119.5	21.0	0.6	4,530.5
1993	2.0	3.6	4.0	88.4	37.8	1,024.3	410.9	431.9	492.0	584.6	172.4	25.7	3,277.6
1994	23.1	5.0	94.6	103.5	353.4	193.1	1,191.2	723.7	178.4	114.4	9.7	3.7	2,993.8
1995	0.0	4.4	0.0	32.3	227.2	151.1	470.3	704.7	288.9	139.1	102.7	59.7	2,180.4
1996	3.2	4.6	16.2	87.6	314.2	166.4	1,494.5	816.5	356.6	240.7	340.4	0.4	3,841.3
1997	2.2	0.5	24.6	89.1	388.5	218.0	287.1	1,200.0	209.0	106.0	88.3	0.0	2,613.3
1998	0.0	0.0	14.4	44.1	307.1	82.7	290.8	291.9	1,031.8	1,569.3	85.2	89.5	3,806.8
1999	5.7	0.1	121.1	245.5	293.8	541.3	724.3	1,279.3	694.5	732.5	99.5	44.5	4,782.1
2000	3.6	106.9	151.7	178.7	470.6	249.4	1,385.7	697.3	640.6	917.6	51.4	63.6	4,917.1
Mean	11.0	9.9	31.2	93.9	346.4	469.5	807.2	899.9	640.5	423.4	113.3	27.0	3,871.4

Source : PAGASA

Table C2.7 Monthly Rainfall Record (8/8)

Station : NAIA Unit : mm

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1961	0.5	6.0	5.2	9.7	162.8	523.1	279.0	444.2	304.8	391.7	130.2	6.4	2,263.6
1962	2.6	-	2.9	53.8	76.9	144.9	661.5	360.6	544.2	20.1	91.8	0.8	-
1963	0.3	0.6	-	1.1	3.4	372.5	319.5	289.7	476.0	43.4	32.1	114.2	-
1964	12.1	6.4	1.3	11.8	52.0	437.3	270.4	409.9	261.4	197.7	208.1	77.0	1,945.4
1965	2.7	0.3	2.0	16.8	176.4	206.9	353.9	320.5	241.3	59.9	101.9	30.8	1,513.4
1966	12.1	10.9	-	1.0	436.8	100.5	242.0	195.0	675.2	61.5	190.1	105.8	-
1967	40.2	6.6	0.5	1.0	48.5	478.8	239.6	583.9	260.5	141.7	134.3	8.6	1,944.2
1968	4.8	-	2.6	-	7.6	128.3	440.6	430.3	325.2	101.9	16.3	-	-
1969	0.3	-	7.9	0.2	6.9	124.0	385.5	284.4	335.9	172.8	71.3	83.4	-
1970	58.6	0.8	1.9	-	45.9	218.7	397.4	292.1	642.0	248.5	145.0	59.5	-
1971	3.0	0.5	44.5	13.0	117.0	349.0	350.0	164.4	120.4	371.0	158.0	-	-
1972	-	-	18.3	0.0	206.4	391.9	1,814.2	604.6	206.8	55.5	38.8	24.3	-
1973	1.6	-	2.3	0.6	25.6	154.6	229.1	444.6	148.5	301.7	236.0	77.7	-
1974	0.0	0.8	8.7	0.5	110.1	374.7	268.7	713.6	55.5	194.1	272.2	111.6	2,110.5
1975	6.3	-	0.5	47.4	7.7	159.7	96.1	462.5	206.8	432.2	146.5	139.4	-
1976	2.8	-	7.4	-	660.4	205.4	165.1	558.3	302.4	46.4	45.0	66.1	-
1977	34.9	10.4	8.9	-	105.9	78.9	419.4	347.2	591.3	66.4	240.1	18.1	-
1978	-	-	-	5.8	155.9	196.4	320.5	737.0	686.4	554.3	86.4	23.3	-
1979	-	0.8	0.0	60.3	161.3	167.9	298.7	373.5	251.0	89.0	32.3	-	-
1980	-	-	43.9	-	41.9	37.5	364.6	212.0	312.4	162.5	260.4	21.6	-
1981	1.0	3.0	-	3.3	26.3	419.4	344.4	247.7	230.4	188.5	175.1	48.0	-
1982	-	-	0.1	60.0	6.6	89.2	279.2	277.8	231.4	26.3	34.8	33.4	-
1983	19.0	-	0.0	-	10.0	87.8	113.1	229.9	183.5	296.8	23.4	2.0	-
1984	4.4	5.2	3.6	1.5	49.5	412.2	141.4	577.3	164.3	329.3	23.0	5.8	1,717.5
1985	-	4.8	-	23.6	4.0	800.2	372.8	139.8	274.5	235.4	27.2	27.9	-
1986	-	2.4	-	20.2	128.5	108.1	574.5	552.7	401.2	747.3	211.1	40.8	-
1987	3.8	-	-	-	16.8	280.9	218.4	313.1	266.1	171.3	107.3	127.1	-
1988	25.4	3.2	-	15.8	174.8	399.7	273.3	154.1	88.4	617.2	148.8	-	-
1989	18.7	30.3	17.4	-	180.6	112.9	285.4	399.3	158.0	266.9	36.2	1.0	-
1990	2.4	-	13.4	0.0	197.0	340.6	341.9	549.4	360.9	243.1	161.6	33.6	-
1991	2.2	5.0	16.9	15.5	11.5	32.3	304.1	945.3	386.3	32.7	71.7	14.2	1,837.7
1992	4.4	1.0	-	68.2	39.3	98.8	451.9	635.0	318.0	246.5	168.0	9.0	-
1993	-	-	-	3.0	1.0	34.2	-	-	-	-	-	-	-
1994	-	-	-	-	-	-	-	-	-	-	-	-	-
1995	-	-	-	-	-	-	-	-	186.8	211.2	174.2	86.6	-
1996	15.3	-	3.5	14.1	82.0	37.0	377.5	159.5	244.5	38.5	128.5	6.5	-
1997	3.0	3.5	-	-	381.0	110.5	281.5	100.5	26.0	34.5	14.5	1.5	-
1998	7.5	-	2.0	1.5	21.5	57.0	15.0	136.5	-	-	56.8	280.6	-
1999	15.2	0.8	49.6	15.6	-	232.6	411.2	394.4	79.2	159.8	-	-	-
Mean	10.5	4.9	10.2	16.6	109.4	229.8	352.8	390.0	293.0	209.9	116.6	52.7	1,904.6

Source : PAGASA

Table C2.8 Monthly Discharge Record (1/3)

Banugao Gauging Station Unit : m^3/sec

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
1950	237.2	118.9	135.3	55.7	31.1	30.1	59.7	73.1	55.3	211.0	217.4	274.8	125.0
1951	198.2	118.4	44.1	36.8	94.2	49.2	54.0	163.0	67.5	81.4	405.8	386.4	141.6
1952	240.3	135.4	49.8	47.5	32.7	55.3	50.3	157.8	108.3	434.7	109.9	297.2	143.3
1953	180.0	188.1	54.8	56.2	27.9	56.1	34.4	106.8	49.3	182.1	190.3	410.1	128.0
1954	160.5	106.4	183.5	45.2	32.1	26.5	32.7	45.1	51.1	62.6	123.8	414.5	107.0
1955	333.8	74.2	47.0	50.0	32.0	65.0	56.1	37.5	71.5	160.0	282.6	191.6	116.8
1956	163.5	118.3	151.4	173.1	76.1	75.9	97.9	99.7	154.2	260.8	275.7	550.7	183.1
1957	254.1	80.0	41.2	31.4	21.7	23.7	39.5	81.9	62.0	89.0	106.2	73.5	75.3
1958	146.0	78.6	73.3	86.0	78.2	74.3	91.4	66.2	90.4	203.7	190.5	69.0	104.0
1959	140.8	92.2	137.1	33.5	21.2	26.4	41.8	60.1	69.8	86.2	220.9	205.3	94.6
1960	154.1	183.2	55.4	46.8	70.0	88.1	77.2	238.6	140.4	247.5	189.8	192.3	140.3
1961	196.1	154.7	119.0	77.4	100.7	76.3	64.7	60.6	112.2	197.5	289.5	117.5	130.5
1962	167.2	133.0	77.7	76.7	34.9	34.8	99.4	80.0	203.4	112.7	206.8	185.9	117.7
1963	147.8	161.7	81.0	69.6	25.0	48.3	61.8	103.7	143.3	113.1	106.9	192.5	104.6
1964	154.0	151.6	126.2	80.1	45.4	65.9	96.2	113.7	115.7	120.1	316.4	297.8	140.2
1965	193.8	113.7	70.9	31.2	26.6	27.3	68.1	58.4	72.6	143.9	223.9	306.7	111.4
1966	100.7	75.7	30.1	20.9	74.0	31.6	33.9	37.2	83.6	195.5	284.1	261.4	102.4
1967	201.7	77.3	74.5	55.5	45.0	65.3	51.0	105.5	79.4	64.8	223.0	183.3	102.2
1968	149.5	149.5	149.1	98.4	32.9	29.4	48.8	90.6	93.7	127.9	131.7	78.9	98.3
1969	82.1	34.5	43.1	27.4	15.5	12.6	37.4	57.7	69.1	70.1	111.9	300.8	71.8
1970	146.6	56.5	24.6	41.5	16.5	24.4	37.5	27.0	118.8	209.8	391.5	228.6	110.3
1971	128.6	175.5	161.5	48.9	195.0	239.7	267.3	103.2	53.6	233.5	256.1	343.0	183.8
1972	137.7	66.6	77.7	67.0	64.9	66.2	315.0	193.1	130.0	109.3	192.6	231.5	137.6
1973	90.9	105.3	56.5	47.1	44.7	59.8	64.3	44.8	55.4	184.7	316.0	412.6	123.5
1977	208.9	191.7	118.2	54.1	45.6	33.1	101.0	85.8	123.8	98.7	262.4	128.1	121.0
1978	96.7	72.7	42.2	19.8	32.2	43.4	45.0	130.5	148.9	326.2	224.1	285.3	122.3
Max	333.8	191.7	183.5	173.1	195.0	239.7	315.0	238.6	203.4	434.7	405.8	550.7	550.7
Min	82.1	34.5	24.6	19.8	15.5	12.6	32.7	27.0	49.3	62.6	106.2	69.0	12.6
Mean	169.6	115.9	85.6	56.8	50.6	54.9	77.9	93.1	97.0	166.4	225.0	254.6	120.6

Source : NPC

Bayokan Gauging Station Unit : m^3/sec

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
1944	328.4	177.3	123.5	58.9	37.7	32.1	52.3	96.0	58.0	374.9	225.1	-	-
1945	-	-	-	-	-	-	-	-	-	-	-	-	-
1946	-	-	96.5	55.9	40.0	45.8	65.9	63.1	99.7	245.5	168.7	252.0	-
1947	132.7	68.8	125.7	49.5	43.4	42.1	46.8	155.0	92.6	194.5	323.1	267.4	128.5
1948	131.3	90.5	57.9	42.2	32.2	29.9	79.8	132.4	192.7	147.7	196.8	248.2	115.1
1949	-	-	80.9	33.4	32.9	29.2	32.6	30.7	49.5	88.8	274.7	310.3	-
1950	-	109.2	132.4	57.0	33.6	31.3	53.9	67.7	54.4	224.5	214.7	218.9	-
Max	328.4	177.3	132.4	58.9	43.4	45.8	79.8	155.0	192.7	374.9	323.1	310.3	374.9
Min	131.3	68.8	57.9	33.4	32.2	29.2	32.6	30.7	49.5	88.8	168.7	218.9	29.2
Mean	197.5	111.5	102.8	49.5	36.6	35.1	55.2	90.8	91.2	212.7	233.9	259.4	123.0

Source : NPC

Daraitan Gauging Station Unit : m^3/sec

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
1946	-	-	5.2	-	-	-	8.6	17.5	19.7	80.8	17.5	18.9	-
1947	11.2	3.5	4.6	2.6	1.9	5.8	10.8	54.4	22.7	48.5	121.4	-	-
1948	13.0	7.8	3.1	2.4	2.8	9.0	43.6	82.4	156.1	26.4	31.6	52.8	35.9
1949	-	-	5.2	2.7	1.9	5.8	14.1	14.8	12.3	19.2	43.9	89.1	-
1950	19.6	11.6	4.7	3.1	2.1	6.3	23.4	31.7	13.4	48.2	34.4	62.7	21.8
Max	19.6	11.6	5.2	3.1	2.8	9.0	43.6	82.4	156.1	80.8	121.4	89.1	156.1
Min	11.2	3.5	3.1	2.4	1.9	5.8	8.6	14.8	12.3	19.2	17.5	18.9	1.9
Mean	14.6	7.6	4.6	2.7	2.2	6.7	20.1	40.2	44.8	44.6	49.8	55.9	24.5

Source : NPC

Table C2.8 Monthly Discharge Record (2/3)

Lenatin Gauging Station Unit : m^3/sec

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
1981	-	-	-	-	-	-	-	-	-	-	-	18.5	-
1982	1.4	1.6	3.8	1.1	6.6	7.7	22.1	-	23.5	-	-	4.9	-
1983	-	0.6	-	0.4	1.5	-	12.5	-	-	22.1	6.5	2.4	-
1984	1.7	0.8	-	-	6.5	14.1	11.8	-	12.6	30.6	-	-	-
1985	-	-	-	-	-	-	-	17.1	24.1	30.1	11.0	6.1	-
1986	1.9	3.0	0.0	1.1	4.0	3.1	22.9	35.4	34.8	39.0	-	11.7	-
1987	4.4	0.9	0.8	-	-	8.1	14.1	21.6	21.1	11.1	13.7	12.4	-
1988	9.4	3.6	0.4	2.3	4.1	10.5	13.4	7.6	13.1	36.2	21.4	2.8	10.4
1989	4.1	1.6	1.5	-	-	-	-	-	-	-	-	-	-
Max	9.4	3.6	3.8	2.3	6.6	14.1	22.9	35.4	34.8	39.0	21.4	18.5	39.0
Min	1.4	0.6	0.0	0.4	1.5	3.1	11.8	7.6	12.6	11.1	6.5	2.4	0.0
Mean	3.8	1.7	1.3	1.2	4.5	8.7	16.1	20.4	21.5	28.2	13.1	8.4	10.8

Source : Manila Water Supply III Project

Limutan Gauging Station Unit : m^3/sec

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
1983	-	-	-	-	-	-	18.0	-	-	21.0	14.8	15.4	-
1984	12.5	9.0	-	-	13.0	17.2	16.9	23.5	16.2	25.4	-	-	-
1985	-	-	-	-	-	-	17.3	20.7	20.3	23.9	16.1	14.1	-
1986	9.7	11.5	2.4	11.3	10.9	13.8	20.3	20.5	23.9	24.5	-	16.5	-
1987	13.5	7.9	7.5	-	11.7	15.1	16.5	19.4	20.5	16.8	19.4	17.0	-
1988	17.4	12.1	7.2	11.7	11.9	17.0	16.0	12.7	17.0	24.3	21.6	11.1	15.0
1989	13.6	10.1	11.4	5.3	14.1	11.1	20.6	17.9	-	-	-	-	-
Max	17.4	12.1	11.4	11.7	14.1	17.2	20.6	23.5	23.9	25.4	21.6	17.0	25.4
Min	9.7	7.9	2.4	5.3	10.9	11.1	16.0	12.7	16.2	16.8	14.8	11.1	2.4
Mean	13.3	10.1	7.1	9.4	12.3	14.8	17.9	19.1	19.6	22.6	18.0	14.8	14.9

Source : Manila Water Supply III Project

Matatio Gauging Station Unit : m^3/sec

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
1946	-	-	-	66.0	42.5	33.8	32.1	26.8	50.8	163.5	132.8	-	-
1947	110.2	79.0	104.4	-	46.2	35.9	41.8	83.6	58.5	129.4	152.0	170.8	-
1948	-	76.4	-	-	40.8	32.5	49.4	55.9	77.5	113.7	114.6	175.5	-
1949	-	-	-	27.7	21.8	13.4	18.5	12.3	41.3	81.7	176.7	168.9	-
1950	132.3	100.1	125.0	48.1	27.2	23.7	29.8	42.7	35.2	109.2	149.6	176.0	83.2
Max	132.3	100.1	125.0	66.0	46.2	35.9	49.4	83.6	77.5	163.5	176.7	176.0	176.7
Min	110.2	76.4	104.4	27.7	21.8	13.4	18.5	12.3	35.2	81.7	114.6	168.9	12.3
Mean	121.3	85.2	114.7	47.3	35.7	27.9	34.3	44.3	52.7	119.5	145.1	172.8	83.4

Source : NPC

Table C2.8 Monthly Discharge Record (3/3)

Sto. Nino Gauging Station Unit : m^3/sec

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
1962	4.2	1.8	1.0	0.9	1.1	10.7	148.5	54.7	95.2	15.2	11.0	6.5	29.2
1963	1.5	0.4	0.4	0.4	0.5	45.8	61.6	59.2	102.8	25.9	6.5	5.5	25.9
1964	2.3	0.8	0.7	0.4	6.5	57.6	34.2	140.7	53.7	36.4	40.0	76.1	37.5
1965	8.0	2.8	1.0	0.7	9.2	38.9	72.4	52.5	74.6	19.7	10.5	5.0	24.6
1966	1.2	0.5	0.2	0.2	16.0	9.1	20.8	36.2	126.6	10.3	81.7	13.7	26.4
1967	7.9	3.0	0.5	0.2	0.3	68.1	31.1	82.1	51.2	16.1	52.7	4.5	26.5
1968	0.7	0.2	0.1	0.1	0.2	1.3	36.1	98.2	86.0	38.7	7.2	2.7	22.6
1969	1.3	0.2	0.3	0.7	1.3	6.4	26.9	76.5	53.9	40.8	6.9	4.0	18.3
1985	-	-	-	-	-	-	-	-	73.5	79.2	37.7	20.9	-
1986	12.8	8.6	7.6	6.5	9.0	6.9	86.2	195.3	251.8	159.2	119.4	58.1	76.8
1987	49.6	56.6	60.9	64.3	75.9	30.6	57.9	72.2	68.2	31.0	18.6	20.9	50.6
1988	17.0	11.4	5.5	-	18.5	10.6	19.4	-	25.0	-	191.8	87.2	-
1989	21.2	6.8	5.6	2.6	11.6	20.6	103.7	230.0	190.6	104.2	51.5	9.2	63.1
1990	0.9	0.9	1.0	0.3	4.5	130.0	85.5	298.3	306.1	129.3	138.2	96.8	99.3
1991	74.7	34.5	10.3	12.3	10.3	24.9	66.0	168.9	178.9	104.8	45.1	66.3	66.4
1992	73.8	33.6	10.1	9.8	10.1	18.8	51.6	132.4	192.9	129.4	77.0	67.0	67.2
Max	74.7	56.6	60.9	64.3	75.9	130.0	148.5	298.3	306.1	159.2	191.8	96.8	306.1
Min	0.7	0.2	0.1	0.1	0.2	1.3	19.4	36.2	25.0	10.3	6.5	2.7	0.1
Mean	18.5	10.8	7.0	7.1	11.7	32.0	60.1	121.2	120.7	62.7	56.0	34.0	45.2

Source : DPWH

San Rafael Gauging Station Unit : m^3/sec

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
1956	-	-	-	-	2.6	1.6	13.5	54.8	101.8	16.9	13.5	35.0	-
1957	8.9	3.0	1.4	0.9	0.7	3.0	19.7	65.4	45.9	24.9	12.6	2.0	15.7
1962	1.2	0.7	0.3	0.2	0.2	5.4	63.3	39.7	59.7	11.8	11.0	4.0	16.5
1963	0.8	0.3	0.1	0.2	0.1	21.1	29.9	27.9	48.8	9.3	3.7	4.0	12.2
1964	1.3	0.5	0.5	0.3	1.2	17.2	26.2	91.6	52.3	20.5	26.1	34.0	22.6
1965	3.8	1.5	0.5	0.5	1.6	10.9	19.5	18.1	25.7	9.7	0.9	0.1	7.7
1966	0.1	0.0	0.0	0.0	7.8	5.0	11.9	12.0	46.8	6.5	-	-	-
1967	0.7	0.2	0.0	0.0	0.0	66.4	11.7	10.7	26.1	23.8	38.2	5.5	15.3
1968	5.2	5.1	5.6	6.0	6.6	5.0	48.5	164.9	41.1	31.2	0.8	0.4	26.7
1969	0.9	0.5	0.3	0.2	0.2	-	11.9	12.4	-	-	1.4	0.6	-
Max	8.9	5.1	5.6	6.0	7.8	66.4	63.3	164.9	101.8	31.2	38.2	35.0	164.9
Min	0.1	0.0	0.0	0.0	0.0	1.6	11.7	10.7	25.7	6.5	0.8	0.1	0.0
Mean	2.5	1.3	1.0	0.9	2.1	15.1	25.6	49.8	49.8	17.2	12.0	9.5	15.6

Source : DPWH

Table C3.1 Discharge Measurement Record

Agos River

Measurement Number	Date	Gauge Height (cm)	Discharge (m^3/sec)
1	May 20, 2001	88	44.54
2	May 27, 2001	89	46.17
3	May 28, 2001	68	28.34
4	May 29, 2001	75	34.65
5	May 31, 2001	70	31.36
6	June 08, 2001	62	32.96
7	June 09, 2001	61	28.02
8	June 09, 2001	61	28.75
9	June 11, 2001	58	25.04
10	June 18, 2001	78	34.21
11	June 21, 2001	55	24.94
12	June 22, 2001	66	27.73
13	June 28, 2001	100	66.60
14	July 03, 2001	138	118.99
15	July 04, 2001	120	83.62
16	July 05, 2001	194	205.06
17	July 07, 2001	140	125.70
18	July 08, 2001	124	99.10
19	July 11, 2001	107	61.67
20	July 13, 2001	98	59.00
21	July 14, 2001	99	55.66
22	July 16, 2001	89	50.85
23	July 17, 2001	103	62.50
24	July 19, 2001	100	57.47
25	July 21, 2001	100	63.73
26	July 21, 2001	98	55.81
27	July 22, 2001	96	47.99

Kanan River

Measurement Number	Date	Gauge Height (cm)	Discharge (m^3/sec)
1	June 01, 2001	20	17.83
2	June 06, 2001	13	15.87
3	June 19, 2001	9	12.63
4	June 20, 2001	7	10.20
5	July 03, 2001	48	30.54
6	July 07, 2001	63	39.60
7	July 09, 2001	48	29.45
8	July 10, 2001	42	25.34
9	July 11, 2001	36	22.91
10	July 12, 2001	32	21.12
11	July 14, 2001	31	20.71
12	July 16, 2001	25	17.64
13	July 17, 2001	28	19.83
14	July 18, 2001	22	16.47
15	July 19, 2001	29	15.71
16	July 19, 2001	32	17.57
17	July 20, 2001	26	16.68
18	July 21, 2001	20	17.44
19	July 22, 2001	14	15.09
20	July 25, 2001	20	17.54
21	July 25, 2001	19	17.40
22	July 26, 2001	17	16.06
23	July 26, 2001	16	14.53
24	July 27, 2001	35	22.80
25	July 27, 2001	30	20.88

Kaliwa River

Measurement Number	Date	Gauge Height (cm)	Discharge (m^3/sec)
1	May 18, 2001	29	3.86
2	May 22, 2001	26	3.32
3	June 13, 2001	21	2.25
4	June 21, 2001	21	3.39
5	June 23, 2001	34	4.87
6	June 24, 2001	27	3.03
7	June 25, 2001	30	3.81
8	June 26, 2001	41	5.70
9	June 27, 2001	37	4.88
10	June 28, 2001	44	7.02
11	June 30, 2001	53	10.39
12	July 03, 2001	79	23.76
13	July 09, 2001	70	13.00
14	July 10, 2001	80	20.25
15	July 11, 2001	69	13.55
16	July 12, 2001	64	11.39
17	July 13, 2001	60	9.61
18	July 14, 2001	62	11.17
19	July 15, 2001	58	9.81
20	July 16, 2001	54	9.36
21	July 17, 2001	66	13.22
22	July 18, 2001	59	9.90
23	July 19, 2001	76	22.59
24	July 20, 2001	116	38.61
25	July 20, 2001	100	31.11
26	July 24, 2001	72	14.73

Table C3.2 Sediment Sampling Record

Agos River

No.	Date	Gauge Height (cm)	Discharge (m^3/sec)	Sedimrnt Concentration (mg/liter)
1	May 20, 2001	88	44.54	0.95
2	May 27, 2001	89	46.17	3.20
3	May 28, 2001	68	28.34	6.50
4	May 29, 2001	75	34.65	1.80
5	May 31, 2001	70	31.36	1.60
6	June 08, 2001	62	32.96	1.05
7	June 09, 2001	61	28.02	6.25
8	June 09, 2001	61	28.75	-
9	June 11, 2001	58	25.04	1.55
10	June 18, 2001	78	34.21	4.20
11	June 21, 2001	55	24.94	2.65
12	June 22, 2001	66	27.73	4.15
13	June 28, 2001	100	66.60	5.75
14	July 03, 2001	138	118.99	285.55
15	July 04, 2001	120	83.62	22.05
16	July 05, 2001	194	205.06	584.00
17	July 07, 2001	140	125.70	8.45
18	July 08, 2001	124	99.10	3.80
19	July 11, 2001	107	61.67	4.00
20	July 13, 2001	98	59.00	1.95
21	July 14, 2001	99	55.66	2.80
22	July 16, 2001	89	50.85	4.05
23	July 17, 2001	103	62.50	17.35
24	July 19, 2001	100	57.47	21.75
25	July 21, 2001	100	63.73	15.40
26	July 21, 2001	98	55.81	8.15
27	July 22, 2001	96	47.99	17.50

Kanan River

No.	Date	Gauge Height (cm)	Discharge (m^3/sec)	Sedimrnt Concentration (mg/liter)
1	June 01, 2001	20	17.83	1.10
2	June 06, 2001	13	15.87	60.80
3	June 19, 2001	9	12.63	2.10
4	June 20, 2001	7	10.20	2.00
5	July 03, 2001	48	30.54	7.70
6	July 07, 2001	63	39.60	6.50
7	July 09, 2001	48	29.45	5.90
8	July 10, 2001	42	25.34	2.95
9	July 11, 2001	36	22.91	3.30
10	July 12, 2001	32	21.12	2.80
11	July 14, 2001	31	20.71	4.05
12	July 16, 2001	25	17.64	245.50
13	July 17, 2001	28	19.83	148.80
14	July 18, 2001	22	16.47	3.80
15	July 19, 2001	29	15.71	3.60
16	July 19, 2001	32	17.57	2.10
17	July 20, 2001	26	16.68	80.30
18	July 21, 2001	20	17.44	119.60
19	July 22, 2001	14	15.09	103.30
20	July 25, 2001	20	17.54	3.95
21	July 25, 2001	19	17.40	2.65
22	July 26, 2001	17	16.06	2.20
23	July 26, 2001	16	14.53	1.95
24	July 27, 2001	35	22.80	302.20
25	July 27, 2001	30	20.88	135.65

Kaliwa River

	Date	Gauge Height (cm)	Discharge (m^3/sec)	Sedimrnt Concentration (mg/liter)
1	May 18, 2001	29	3.86	-
2	May 22, 2001	26	3.32	100.70
3	June 13, 2001	21	2.25	3.00
4	June 21, 2001	21	3.39	2.20
5	June 23, 2001	34	4.87	2.10
6	June 24, 2001	27	3.03	4.50
7	June 25, 2001	30	3.81	4.20
8	June 26, 2001	41	5.70	72.30
9	June 27, 2001	37	4.88	14.25
10	June 28, 2001	44	7.02	20.30
11	June 30, 2001	53	10.39	14.40
12	July 03, 2001	79	23.76	56.45
13	July 09, 2001	70	13.00	6.20
14	July 10, 2001	80	20.25	25.10
15	July 11, 2001	69	13.55	6.75
16	July 12, 2001	64	11.39	8.30
17	July 13, 2001	60	9.61	12.05
18	July 14, 2001	62	11.17	7.10
19	July 15, 2001	58	9.81	7.45
20	July 16, 2001	54	9.36	14.90
21	July 17, 2001	66	13.22	65.80
22	July 18, 2001	59	9.90	6.40
23	July 19, 2001	76	22.59	37.05
24	July 20, 2001	116	38.61	223.25
25	July 20, 2001	100	31.11	234.20
26	July 24, 2001	72	14.73	54.35

Table C3.3 Result of River Water Quality Analysis

Category	Laboratory Test Item	Unit	Standard Value/ Maximum Level	Agos River	Kanan River	Kaliwa River
Inorganic Constituents	Arsenic	mg/L	0.01 mg/L	0.00130	0.00150	0.00053
	Cadmium	mg/L	0.003 mg/L	< 0.001	< 0.001	< 0.001
	Chromium	mg/L	0.05 mg/L	< 0.05	< 0.05	< 0.05
	Cyanide	mg/L	0.07 mg/L	0.002	0.002	0.002
	Flouride	mg/L	1 mg/L	< 0.02	< 0.02	< 0.02
	Lead	mg/L	0.01 mg/L	< 0.002	< 0.002	< 0.002
	Mercury	mg/L	0.001 mg/L	< 0.0002	< 0.0002	< 0.0002
	Nitrate as NO_3-	mg/L	50 mg/L	0.851	1.060	0.287
Physical and Chemical Quality	Color	PCU	5 PCU	40	15	35
	Turbidity	mg/L	5 NTU	43.0	0.6	25.0
	Chloride	mg/L	250 mg/L	2.1	2.1	2.6
	Copper	mg/L	1.0 mg/L	< 0.02	< 0.02	< 0.02
	Hardness	mg/L	300 mg/L	142	116	86
	Iron	mg/L	1.0 mg/L	9.40	6.60	0.12
	Manganese	mg/L	0.5 mg/L	0.18	0.12	< 0.02
	pH *	-	6.5-8.5	7.6	8.0	7.8
	Sodium	mg/L	200 mg/L	6.1	6.3	5.7
	Sulfate	mg/L	250 mg/L	3.9	4.9	2.1
	Zinc	mg/L	5 mg/L	0.038	0.120	0.046
	Calcium	mg/L	N.S.	47	38	28
Others	Temperature *	^oC	N.S.	28.8	28.2	29.0
	Alkalinity	mg/L	N.S.	92.5	60.9	110.0
	EC	µhos/cm	N.S.	215	150	252
	Biocarbonate	mg/L	N.S.	123	149	82
	Phosphate	mg/L	N.S.	0.23	< 0.01	0.28
	BOD_5	mg/L	N.S.	2.4	1.0	2.5
	COD	mg/L	N.S.	< 5.0	< 5.0	5.0
	Potasium Permanganate Comsumed ($KMnO_4$)	mg/LO_2	N.S.	1.9	1.1	0.7
	Anminia (NH_3)	mg/L	N.S.	0.75	< 0.01	0.57

Note : N.S. ; No Standard Provided by the Department of Health (DOH)

* ; Measured on-site

Table C5.1 Relationship between Correlation of Rainfall Stations

Nos. of Correlation

	Station Name	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1	Infanta		27	15	30	29	67	41	1	20	61	91	74	130	78	15	462	156	477	388
2	Bayokan			-	61	45	-	-	-	-	17	42	-	-	-	-	-	-	-	-
3	Mahabang Lalim				-	2	14	6	1	3	13	14	6	8	-	-	15	-	15	14
4	Matatio					45	-	-	-	-	17	41	-	-	-	-	-	-	-	-
5	Upper Matatio						16	12	1	12	15	39	17	17	-	-	17	-	17	12
6	Tuno							34	1	17	39	56	58	60	17	-	67	9	66	57
7	Masanga								1	17	33	34	38	41	-	-	41	-	40	37
8	Lagmac									1	1	1	1	1	-	-	1	-	1	1
9	Longoy										18	15	19	20	-	-	20	-	20	18
10	Sta. Ines											55	37	37	-	-	45	-	45	38
11	Daraitan												62	68	26	-	76	21	75	66
12	Lumutan													72	26	-	74	18	73	64
13	Mamuyao														78	-	130	71	129	111
14	Laiban															-	78	70	78	68
15	Cuyambay																13	-	15	12
16	Quezon																	156	156	373
17	Bosoboso																		250	114
18	Baguio																			387
19	NAIA																			

Correlation Coefficient

	Station Name	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1	Infanta		0.803	0.740	0.819	0.716	0.765	0.605	-	0.383	0.239	0.486	0.441	0.329	0.347	0.245	0.102	0.108	0.000	0.096
2	Bayokan			-	0.949	0.918	-	-	-	-	0.132	0.667	-	-	-	-	-	-	-	-
3	Mahabang Lalim				-	-	0.809	0.917	-	0.809	0.000	0.131	0.000	0.000	-	-	0.000	-	0.000	0.000
4	Matatio					0.999	-	-	-	-	0.025	0.584	-	-	-	-	-	-	-	-
5	Upper Matatio						0.718	0.000	-	0.493	0.109	0.506	0.319	0.047	-	-	0.000	-	0.000	0.000
6	Tuno							0.743	-	0.364	0.215	0.477	0.460	0.168	0.549	-	0.064	0.645	0.000	0.057
7	Masanga								-	0.075	0.000	0.182	0.211	0.000	-0.549	-	0.000	-	0.000	0.000
8	Lagmac									-	-	-	-	-	-	-	-	-	-	-
9	Longoy										0.023	0.000	0.000	0.000	-	-	0.000	-	0.000	0.000
10	Sta. Ines											0.763	0.753	0.721	-	-	0.787	-	0.523	0.774
11	Daraitan												0.731	0.647	0.641	-	0.579	0.776	0.354	0.572
12	Lumutan													0.862	0.919	-	0.786	0.678	0.664	0.765
13	Mamuyao														0.746	-	0.902	0.758	0.748	0.856
14	Laiban															-	0.644	0.564	0.518	0.619
15	Cuyambay																0.958	-	0.850	0.931
16	Quezon																	0.853	0.662	0.913
17	Bosoboso																		0.531	0.812
18	Baguio																			0.749
19	NAIA																			

Correlation Parameter (=P, A station = B station x P)

	Station Name	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1	Infanta		0.806	0.847	0.652	0.974	0.605	0.483	-	0.761	1.109	1.504	0.960	1.366	1.732	1.339	1.601	1.655	1.039	2.125
2	Bayokan	1.241		-	0.823	0.832	-	-	-	-	1.298	1.563	-	-	-	-	-	-	-	-
3	Mahabang Lalim	1.181	-		-	-	0.694	1.697	-	0.741	0.941	1.510	0.939	1.809	-	-	1.884	-	1.321	1.950
4	Matatio	1.534	1.214	-		0.996	-	-	-	-	1.619	1.900	-	-	-	-	-	-	-	-
5	Upper Matatio	1.027	1.202	-	1.004		0.442	0.325	-	0.473	1.884	1.885	1.001	1.411	-	-	2.181	-	1.478	2.290
6	Tuno	1.653	-	1.442	-	2.265		0.850	-	1.200	2.172	2.351	1.608	2.186	2.103	-	3.037	1.188	1.902	3.648
7	Masanga	2.071	-	0.589	-	3.080	1.176		-	2.015	2.583	2.798	2.127	2.561	-	-	3.736	-	2.108	4.769
8	Lagmac	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-	-
9	Longoy	1.314	-	1.349	-	2.114	0.834	0.496	-		1.374	2.268	1.142	1.394	-	-	1.988	-	1.097	2.076
10	Sta. Ines	0.902	0.770	1.063	0.618	0.531	0.460	0.387	-	0.728		1.172	0.737	0.873	-	-	1.476	-	0.855	1.859
11	Daraitan	0.665	0.640	0.662	0.526	0.530	0.425	0.357	-	0.441	0.853		0.596	0.768	0.658	-	1.138	0.595	0.655	1.503
12	Lumutan	1.042	-	1.065	-	0.999	0.622	0.470	-	0.875	1.357	1.679		1.342	1.495	-	1.834	1.377	1.009	2.494
13	Mamuyao	0.732	-	0.553	-	0.709	0.457	0.390	-	0.717	1.145	1.302	0.745		1.250	-	1.296	1.225	0.789	1.808
14	Laiban	0.577	-	-	-	-	0.475	-	-	-	-	1.519	0.669	0.800		-	0.952	0.966	0.619	1.297
13	Cuyambay	0.747	-	-	-	-	-	-	-	-	-	-	-	-	-		1.298	-	0.804	1.493
14	Quezon	0.625	-	0.531	-	0.459	0.329	0.268	-	0.503	0.678	0.878	0.545	0.771	1.050	0.770		1.047	0.643	1.356
15	Bosoboso	0.604	-	-	-	-	0.842	-	-	-	-	1.681	0.726	0.816	1.035	-	0.955		0.440	1.334
16	Baguio	0.962	-	0.757	-	0.677	0.526	0.474	-	0.912	1.169	1.527	0.991	1.268	1.616	1.244	1.554	2.270		2.170
17	NAIA	0.471	-	0.513	-	0.437	0.274	0.210	-	0.482	0.538	0.665	0.401	0.553	0.771	0.670	0.737	0.750	0.461	

Table C5.2 Basin Mean Rainfall at Limutan River Basin

Unit : mm

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1950	617.3	228.1	329.0	141.5	169.3	194.3	123.0	69.6	383.9	515.8	339.6	573.6	3,685
1951	152.7	159.0	34.9	180.4	113.0	164.3	282.2	205.4	262.1	200.3	812.5	502.8	3,070
1952	364.2	168.3	141.5	176.7	224.8	303.9	77.3	351.1	275.3	747.9	221.7	760.7	3,813
1953	233.8	215.6	134.0	246.3	159.6	169.7	237.1	151.2	110.3	655.2	503.6	1,025.3	3,842
1954	259.3	363.0	519.9	71.0	246.7	181.1	163.6	153.0	88.1	260.4	223.3	400.8	2,930
1955	517.8	100.7	71.4	120.8	95.8	527.2	204.5	143.9	213.6	747.2	838.3	280.4	3,862
1956	417.9	390.6	345.7	598.9	195.9	369.7	226.4	430.3	192.8	464.4	505.8	828.8	4,967
1957	487.2	146.3	179.2	143.7	82.0	44.9	292.8	205.9	121.5	309.4	252.6	195.2	2,461
1958	558.4	341.4	118.5	99.3	120.3	175.3	234.9	360.1	138.9	512.8	326.1	114.0	3,100
1959	349.1	199.7	245.5	27.5	296.1	113.1	302.1	117.5	281.3	354.9	538.3	512.5	3,338
1960	461.6	629.2	90.6	302.9	491.3	219.3	229.3	279.0	597.6	656.5	371.6	245.8	4,575
1961	26.3	33.5	119.8	74.7	210.8	869.2	609.9	874.9	573.9	470.0	240.7	62.9	4,167
1962	88.9	19.8	22.8	144.1	166.8	294.1	1,450.5	517.0	789.2	104.1	193.6	50.3	3,841
1963	68.2	21.5	25.3	9.0	140.8	847.3	529.5	688.9	737.0	255.5	107.6	224.4	3,655
1964	85.3	37.1	43.8	73.3	269.1	781.5	578.3	1,009.0	421.7	382.2	486.5	220.4	4,388
1965	91.5	36.8	14.4	46.4	368.2	571.6	788.0	518.8	547.3	130.7	273.0	111.8	3,499
1966	48.3	85.0	21.0	16.4	1,019.9	48.6	485.3	407.3	984.9	227.3	641.9	228.5	4,214
1967	91.9	38.2	25.0	31.1	147.3	1,356.1	744.8	722.4	574.8	217.1	160.9	66.1	4,176
1968	54.7	16.7	16.2	23.6	198.0	295.7	602.0	1,027.8	561.0	275.0	36.5	17.6	3,125
1969	18.1	12.1	20.0	35.7	68.2	226.9	346.6	692.2	638.7	369.9	150.3	180.3	2,759
1970	52.7	15.5	28.1	83.7	73.1	246.1	651.7	749.1	1,300.7	712.6	391.3	186.2	4,491
1971	45.1	57.2	132.5	60.5	391.6	419.8	687.2	352.9	169.7	656.4	445.7	368.0	3,787
1972	92.5	12.9	98.4	71.8	275.0	729.3	2,775.0	865.2	415.8	144.6	199.9	104.3	5,785
1973	33.0	14.6	11.2	6.2	49.8	571.1	433.5	597.4	425.5	550.1	400.0	218.1	3,311
1977	180.5	49.0	61.7	22.8	116.5	256.8	616.7	786.8	738.0	111.1	570.9	56.3	3,567
1978	19.2	37.3	30.9	53.0	311.2	280.3	325.0	1,015.3	839.4	966.6	158.5	133.0	4,170
1984	134.8	45.3	87.6	104.1	165.1	442.2	286.5	860.9	242.3	951.3	193.5	131.7	3,645
1985	48.9	75.9	86.1	76.7	71.6	964.7	471.5	412.4	540.1	977.3	168.5	157.4	4,051
1986	71.0	50.2	11.1	122.7	291.1	200.1	521.7	554.8	446.9	697.8	493.4	121.7	3,583
1987	126.1	34.3	9.8	16.9	107.2	306.8	291.9	639.5	480.7	225.9	549.3	273.5	3,062
1988	229.4	77.5	33.3	102.5	275.7	393.0	215.3	69.0	197.4	1,543.2	670.1	41.3	3,848
Mean	194.4	119.8	100.3	105.9	223.0	405.3	509.2	510.6	461.0	496.6	369.9	270.8	3,767

Table C5.3 Basin Mean Rainfall at Lenatin River Basin

Unit : mm

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1950	494.2	187.3	261.6	115.5	139.5	164.6	96.2	53.9	327.6	431.2	243.3	451.5	2,966
1951	127.0	132.2	29.0	150.0	94.0	136.7	234.7	170.9	217.9	166.6	675.8	418.2	2,553
1952	302.9	139.9	117.6	147.0	186.9	252.7	64.2	292.0	229.0	622.0	184.4	632.6	3,171
1953	194.5	179.3	111.4	204.9	132.7	141.2	197.2	125.7	91.7	545.0	418.9	852.8	3,195
1954	215.6	301.9	432.4	59.1	205.2	150.6	136.1	127.3	73.3	216.5	185.7	333.3	2,437
1955	430.6	83.7	59.3	100.4	79.7	438.5	170.1	119.6	177.6	621.5	697.2	233.2	3,211
1956	347.6	324.8	287.6	498.1	162.9	307.5	188.3	357.9	160.3	386.3	420.6	689.3	4,131
1957	405.2	121.7	149.0	119.5	68.2	37.4	243.5	171.2	101.0	257.3	210.0	162.3	2,046
1958	464.4	283.9	98.6	82.6	100.1	145.7	195.3	299.4	115.5	426.5	271.2	94.8	2,578
1959	290.3	166.0	204.2	22.9	246.3	94.1	251.3	97.8	234.0	295.1	447.7	426.3	2,776
1960	383.9	523.3	75.4	251.9	408.7	182.4	190.7	232.0	497.0	546.0	309.1	204.4	3,805
1961	10.1	17.8	90.6	55.9	168.8	744.9	530.8	756.5	492.2	372.3	168.5	31.6	3,440
1962	55.8	7.6	13.9	114.0	130.3	246.5	1,258.5	441.7	645.2	75.1	138.6	26.3	3,154
1963	27.2	7.8	14.2	3.6	115.8	736.3	450.6	577.2	633.4	206.3	76.6	151.8	3,001
1964	54.8	15.1	27.4	41.5	229.4	661.9	486.0	879.2	340.4	302.3	366.2	166.5	3,571
1965	51.0	22.3	5.3	28.1	315.6	496.0	675.0	437.6	470.0	90.8	204.5	68.3	2,865
1966	29.7	56.4	12.5	12.4	865.8	38.2	404.6	354.2	845.7	161.9	497.0	153.1	3,432
1967	58.1	19.8	13.3	14.9	127.9	1,184.8	647.1	624.3	488.5	171.4	112.9	30.3	3,493
1968	25.2	7.1	6.7	9.2	170.7	247.0	523.4	897.2	484.5	214.3	21.2	6.4	2,613
1969	6.6	4.9	7.3	21.2	57.5	194.3	283.7	593.5	540.3	307.1	102.2	101.8	2,220
1970	25.1	5.7	14.7	64.8	55.1	198.0	565.7	652.4	1,117.7	580.7	283.0	125.5	3,688
1971	19.4	21.4	91.4	48.6	290.0	337.7	572.1	304.6	143.9	524.5	335.8	252.0	2,941
1972	62.9	6.6	65.6	54.0	233.5	632.6	2,401.5	745.7	340.7	100.8	147.2	61.6	4,853
1973	16.3	6.7	4.6	2.6	34.9	493.7	368.3	514.7	348.1	457.8	292.5	131.0	2,671
1977	108.7	5.6	31.3	6.6	89.9	202.4	508.5	674.2	633.0	69.2	429.7	37.7	2,797
1978	2.6	9.1	45.3	39.4	244.4	185.0	407.7	1,087.8	715.0	1,121.3	111.2	97.1	4,066
1984	29.4	10.8	31.7	95.1	212.9	527.6	273.0	729.3	246.6	656.2	135.1	7.3	2,955
1985	2.7	25.6	59.1	122.9	64.0	970.0	395.3	323.8	503.0	547.8	148.0	69.2	3,231
1986	13.7	37.3	0.0	54.2	332.4	186.4	821.6	895.9	713.6	733.1	419.2	126.6	4,334
1987	33.4	5.7	7.5	40.0	151.5	285.0	289.7	467.4	452.7	185.7	218.8	185.7	2,323
1988	145.8	48.8	3.6	47.6	177.4	514.6	453.7	156.7	346.3	934.5	345.7	16.5	3,191
Mean	143.1	89.9	76.5	84.8	190.1	359.2	460.8	456.8	410.5	397.6	278.0	204.7	3,152

Table C5.4 Basin Mean Rainfall at Kaliwa Low Dam

Unit : mm

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1950	495.8	201.0	283.1	128.6	138.3	166.7	103.0	65.9	321.8	453.0	286.0	485.8	3,129
1951	131.1	136.6	29.9	154.9	97.0	141.2	242.3	176.4	225.1	172.0	697.8	431.9	2,636
1952	312.8	144.5	121.5	151.8	193.0	261.0	66.4	301.5	236.5	642.3	190.4	653.3	3,275
1953	200.8	185.2	115.1	211.5	137.1	145.8	203.7	129.8	94.7	562.8	432.6	880.6	3,300
1954	222.7	311.7	446.6	61.0	211.9	155.6	140.5	131.4	75.7	223.6	191.7	344.2	2,517
1955	444.7	86.5	61.3	103.7	82.3	452.8	175.6	123.6	183.4	641.8	720.0	240.9	3,317
1956	358.9	335.5	296.9	514.4	168.3	317.5	194.4	369.6	165.5	398.9	434.4	711.8	4,266
1957	418.4	125.7	153.9	123.4	70.5	38.6	251.5	176.9	104.3	265.7	216.9	167.6	2,113
1958	479.6	293.2	101.8	85.3	103.4	150.5	201.7	309.2	119.3	440.4	280.1	97.9	2,662
1959	299.8	171.5	210.9	23.7	254.3	97.2	259.5	101.0	241.6	304.8	462.3	440.2	2,867
1960	396.5	540.4	77.8	260.1	422.0	188.3	197.0	239.6	513.2	563.8	319.2	211.1	3,929
1961	37.6	41.2	111.5	70.4	183.5	691.5	474.4	687.1	456.1	414.6	242.2	79.9	3,490
1962	97.9	28.3	25.7	127.3	149.5	241.3	1,133.3	413.1	669.7	101.7	190.5	62.5	3,241
1963	96.0	31.2	30.2	12.7	118.4	660.5	425.6	565.7	584.0	220.2	106.5	232.7	3,084
1964	92.3	51.8	48.4	86.8	215.7	632.2	472.9	783.3	363.5	337.8	454.8	205.2	3,745
1965	109.5	41.7	21.0	52.5	292.7	446.5	627.3	422.1	434.1	132.4	256.5	125.8	2,962
1966	54.0	89.5	24.0	15.2	822.3	43.4	401.2	317.1	781.5	224.9	581.6	238.9	3,594
1967	100.8	47.8	30.7	40.5	114.9	1,048.5	580.8	567.7	462.8	192.3	161.4	88.0	3,436
1968	72.5	23.0	22.5	33.6	156.1	243.8	468.8	795.8	441.2	247.4	42.5	25.7	2,573
1969	26.3	17.0	29.0	40.9	55.5	180.6	293.5	550.4	517.6	307.4	155.3	213.8	2,387
1970	68.7	22.6	35.0	75.8	68.4	213.1	508.8	582.0	1,030.7	607.1	370.7	189.4	3,772
1971	61.5	82.5	131.9	52.5	372.5	363.4	569.3	277.8	137.0	573.1	416.4	377.5	3,415
1972	95.5	16.1	103.3	53.5	233.2	583.9	2,176.5	682.6	351.7	146.0	191.3	118.5	4,752
1973	42.3	19.3	15.7	8.6	50.1	448.7	349.1	471.7	360.6	455.9	385.5	248.3	2,856
1977	123.9	28.3	39.6	13.7	89.9	190.9	470.9	592.4	562.0	78.1	421.4	56.6	2,668
1978	10.6	21.2	37.1	38.7	227.7	220.7	326.5	959.8	715.9	1,078.5	131.2	138.5	3,906
1984	82.0	28.4	50.1	94.6	179.4	454.0	262.7	745.7	207.0	760.8	161.8	67.6	3,094
1985	26.7	47.3	63.3	88.0	68.6	833.6	399.3	312.9	457.4	692.4	152.5	101.2	3,243
1986	38.6	37.4	5.5	76.2	257.3	170.2	590.9	668.9	541.3	641.5	390.8	113.1	3,532
1987	69.7	18.1	7.0	22.8	107.9	268.0	240.8	501.4	416.5	186.2	340.2	199.6	2,378
1988	161.4	55.3	16.9	64.8	201.7	416.6	306.5	109.4	250.2	1,113.0	450.0	24.9	3,171
Mean	168.7	105.8	88.6	93.1	188.5	337.6	423.1	423.6	387.8	425.2	317.2	244.3	3,204

Table C5.5 Basin Mean Rainfall at Kaliwa River Confluence

Unit : mm

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1950	465.6	212.8	294.4	141.6	131.5	168.0	107.2	77.4	312.4	473.8	301.5	496.6	3,183
1951	136.9	142.6	31.3	161.8	101.3	147.4	253.1	184.2	235.0	179.6	728.7	451.0	2,753
1952	326.6	150.9	126.9	158.5	201.6	272.6	69.3	314.9	246.9	670.7	198.8	682.2	3,420
1953	209.7	193.4	120.2	220.9	143.1	152.2	212.7	135.6	98.9	587.6	451.7	919.6	3,446
1954	232.5	325.5	466.3	63.7	221.3	162.4	146.7	137.2	79.0	233.5	200.2	359.5	2,628
1955	464.4	90.3	64.0	108.3	86.0	472.8	183.4	129.0	191.5	670.2	751.8	251.5	3,463
1956	374.8	350.3	310.1	537.2	175.7	331.6	203.0	385.9	172.9	416.5	453.6	743.3	4,455
1957	437.0	131.2	160.7	128.9	73.6	40.3	262.6	184.7	108.9	277.5	226.5	175.0	2,207
1958	500.8	306.2	106.3	89.1	107.9	157.2	210.7	322.9	124.6	459.9	292.4	102.2	2,780
1959	313.1	179.1	220.2	24.7	265.6	101.5	271.0	105.4	252.3	318.2	482.8	459.7	2,994
1960	414.0	564.3	81.3	271.6	440.6	196.7	205.7	250.2	535.9	588.8	333.3	220.5	4,103
1961	69.6	68.4	135.8	87.2	200.3	629.0	408.6	606.0	413.9	463.6	327.7	135.9	3,546
1962	146.6	52.3	39.3	142.7	171.8	235.1	987.2	379.5	697.7	132.5	250.6	104.5	3,340
1963	175.9	58.3	48.8	23.1	121.3	571.9	396.3	552.0	526.2	236.1	141.1	326.6	3,178
1964	135.7	94.4	72.7	139.2	199.6	597.3	457.5	671.4	390.2	379.0	557.6	250.0	3,945
1965	177.4	64.2	39.2	80.7	266.0	388.6	571.5	403.9	392.2	180.7	316.7	192.6	3,074
1966	82.2	127.9	37.4	18.6	771.2	49.4	397.1	273.8	706.6	297.8	679.5	338.5	3,780
1967	150.4	80.3	50.8	70.3	99.7	889.5	503.5	501.7	432.8	216.5	217.6	154.9	3,368
1968	127.5	41.5	40.7	61.8	138.9	240.0	405.1	677.7	390.7	285.7	67.2	48.0	2,525
1969	49.2	31.1	54.2	63.7	53.2	164.6	304.8	500.0	490.9	307.6	216.9	343.8	2,580
1970	119.3	42.2	58.5	88.6	83.9	230.5	442.3	499.8	929.0	637.3	471.4	263.2	3,866
1971	110.3	153.5	178.5	56.9	468.1	393.1	565.8	246.5	129.0	629.2	509.8	523.1	3,964
1972	133.4	27.2	147.1	57.7	228.7	522.2	1,913.8	608.8	364.3	198.4	242.4	184.3	4,628
1973	72.4	33.9	28.7	15.5	67.7	396.3	326.5	421.4	375.0	453.4	493.2	384.3	3,068
1977	169.3	75.1	62.0	29.3	96.1	190.1	444.0	507.3	487.3	104.0	450.9	78.7	2,694
1978	27.8	48.6	50.8	41.8	224.5	237.1	302.3	868.9	686.8	1,165.0	193.9	217.2	4,065
1984	127.7	38.3	57.0	102.7	186.5	433.6	254.9	666.1	196.9	910.5	190.1	120.4	3,285
1985	48.9	68.2	78.3	93.2	92.7	729.4	426.4	270.4	461.7	726.6	235.4	184.2	3,415
1986	81.7	63.7	16.4	96.0	224.1	169.8	563.6	640.8	508.9	660.6	425.7	136.4	3,588
1987	94.5	31.6	9.8	25.2	102.3	244.9	211.6	464.7	391.8	196.4	350.9	312.9	2,437
1988	202.0	95.9	27.1	97.9	197.7	410.9	290.9	111.5	238.1	1,157.3	495.8	40.7	3,366
Mean	199.3	127.2	103.7	106.4	191.7	320.2	396.7	390.3	373.2	458.5	363.1	296.8	3,327

Table C6.1 Estimated Mean Monthly Discharge at Laiban Damsite

Unit : m^3/sec

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
1950	28.7	20.5	20.6	12.2	10.0	12.2	9.7	7.0	20.1	34.1	28.3	39.7	20.3
1951	20.9	14.6	8.8	6.6	5.4	5.9	14.9	15.2	18.3	15.7	50.6	44.0	18.4
1952	33.6	19.7	12.4	10.4	12.4	19.3	10.7	20.9	21.3	47.4	28.1	51.0	23.9
1953	29.3	21.2	12.9	14.0	10.9	11.1	15.5	12.7	9.7	37.8	40.9	70.0	23.8
1954	37.4	33.4	38.2	17.2	14.9	13.7	12.6	11.9	8.8	15.0	16.8	26.7	20.6
1955	36.4	17.7	10.0	6.4	4.7	24.9	18.9	13.4	15.3	45.5	62.8	36.1	24.3
1956	34.7	33.6	28.1	40.7	22.4	27.3	21.4	30.7	20.6	32.0	39.5	59.0	32.5
1957	46.4	24.0	16.1	11.6	8.0	5.5	12.5	14.7	10.7	19.1	20.1	16.5	17.1
1958	35.3	30.9	15.2	9.3	6.6	7.6	14.4	23.9	14.9	32.1	28.9	15.7	19.6
1959	23.0	18.0	16.4	9.2	12.8	9.2	17.4	11.8	18.0	24.4	38.0	40.5	19.9
1960	38.2	48.3	20.7	19.4	31.5	21.7	19.2	21.6	40.5	49.3	37.8	26.1	31.2
1961	13.2	7.8	4.9	3.5	5.6	44.4	49.8	25.3	55.5	44.1	28.2	14.8	24.8
1962	9.0	6.1	4.2	3.1	4.2	12.6	76.0	57.4	63.5	28.1	19.4	11.7	24.6
1963	7.2	4.8	3.5	2.6	2.3	36.3	42.0	51.2	59.6	33.5	17.8	16.4	23.1
1964	10.4	6.8	4.4	3.1	6.5	41.3	45.4	70.6	47.7	36.5	39.2	24.9	28.1
1965	13.4	8.4	5.3	3.5	10.1	14.8	51.8	24.6	46.8	22.4	21.7	13.1	19.6
1966	8.2	5.5	3.9	2.8	42.7	16.1	16.9	17.9	64.0	33.1	46.3	27.1	23.7
1967	14.3	8.9	5.5	3.5	2.7	26.8	22.3	62.0	54.3	29.9	19.0	11.4	21.7
1968	7.1	4.7	3.2	2.4	3.3	10.1	32.2	64.1	55.0	32.5	16.0	9.0	20.0
1969	5.2	3.4	2.4	2.0	1.8	3.0	15.4	40.4	49.2	35.5	19.4	14.2	16.0
1970	8.8	5.5	3.4	2.3	1.7	5.3	18.0	14.7	88.4	69.4	44.5	25.0	23.9
1971	13.3	7.7	4.7	3.5	14.0	25.5	45.1	34.4	20.3	41.8	38.1	30.7	23.3
1972	15.5	9.1	5.4	3.5	7.3	38.3	155.1	106.8	60.3	30.3	22.1	13.7	38.9
1973	8.6	5.6	3.8	2.8	2.4	20.2	29.8	19.2	22.8	42.1	35.5	22.0	17.9
1977	12.4	8.1	5.4	3.6	2.7	5.0	29.1	50.6	58.0	25.7	38.8	18.0	21.5
1978	9.5	5.7	3.7	2.6	4.2	11.6	23.2	69.9	70.9	88.6	37.7	20.0	29.0
1984	9.3	6.4	4.3	3.0	3.5	26.8	24.1	55.1	33.1	58.0	30.6	15.7	22.5
1985	9.5	5.9	3.9	3.0	2.5	46.9	42.3	35.0	44.2	58.7	31.1	17.4	25.0
1986	10.6	6.8	4.3	2.9	6.7	10.0	39.8	59.0	54.9	60.1	48.1	23.7	27.2
1987	13.2	8.4	5.3	3.3	3.2	9.3	16.5	37.7	41.0	24.8	30.2	24.4	18.1
1988	18.3	10.8	6.8	4.2	4.6	24.9	28.6	15.1	20.4	77.7	58.0	24.7	24.5
Max	46.4	48.3	38.2	40.7	42.7	46.9	155.1	106.8	88.4	88.6	62.8	70.0	38.9
Min	5.2	3.4	2.4	2.0	1.7	3.0	9.7	7.0	8.8	15.0	16.0	9.0	16.0
Mean	18.7	13.5	9.3	7.0	8.8	19.0	31.3	35.3	39.0	39.5	33.3	25.9	23.4

Table C6.2 Estimated Mean Monthly Discharge at Kaliwa Low Damsite

Unit : m^3/sec

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
1950	32.0	27.2	25.7	17.5	13.0	13.4	11.9	9.9	20.8	37.2	35.1	45.5	24.1
1951	28.4	19.2	13.4	8.6	6.9	6.9	15.7	17.2	20.4	18.4	52.4	52.0	21.6
1952	41.5	26.5	17.4	12.8	13.1	20.5	14.3	22.0	24.5	50.3	36.2	56.1	27.9
1953	38.7	27.2	18.2	15.9	13.3	12.6	17.1	15.2	12.6	38.8	46.7	76.5	27.7
1954	49.9	41.1	44.7	25.3	18.0	16.3	14.9	14.2	12.0	16.1	19.2	29.4	25.1
1955	40.6	24.8	15.7	10.0	6.9	25.5	22.3	16.5	17.6	47.6	69.8	47.4	28.7
1956	42.3	40.6	34.3	45.2	29.3	31.6	26.7	34.9	26.5	36.0	45.3	66.0	38.2
1957	57.2	33.9	22.4	16.1	11.7	8.2	13.4	16.5	13.5	20.8	23.3	20.1	21.4
1958	38.1	36.9	21.8	14.3	9.4	8.5	14.7	25.6	18.9	34.5	34.4	21.6	23.2
1959	26.1	22.0	19.4	13.5	13.5	11.4	18.3	14.8	19.8	27.2	41.8	46.8	22.9
1960	45.4	55.0	30.3	23.3	34.6	27.0	23.4	25.3	44.0	56.0	46.7	33.9	37.1
1961	20.5	13.2	8.6	6.2	6.2	44.6	51.1	25.9	61.0	53.6	40.6	24.4	29.6
1962	16.3	11.8	8.1	5.8	5.2	13.5	77.2	64.4	71.1	40.6	28.9	19.2	30.2
1963	13.2	9.9	7.1	5.3	4.3	36.6	43.3	54.3	62.9	42.4	25.7	24.9	27.5
1964	17.4	12.4	8.4	5.9	7.5	41.5	49.1	71.7	57.6	46.3	50.9	36.3	33.7
1965	22.4	15.3	10.0	6.6	11.0	15.6	52.9	25.2	50.8	31.3	29.6	21.3	24.3
1966	14.6	10.3	7.5	5.5	42.9	16.9	17.6	18.6	65.2	44.9	56.6	41.9	28.5
1967	24.5	16.2	10.5	6.8	4.9	27.3	22.9	65.3	60.0	39.1	27.4	18.6	26.9
1968	13.2	9.3	6.5	4.8	4.0	11.0	32.6	65.2	59.1	41.2	23.9	14.8	23.8
1969	8.9	6.0	4.3	3.6	3.3	4.0	16.2	40.6	51.5	41.6	27.9	24.6	19.4
1970	16.2	10.8	6.8	4.5	3.4	6.3	18.7	15.5	89.6	80.6	60.4	38.7	29.3
1971	22.5	14.2	9.6	7.6	17.8	29.8	48.5	40.0	25.5	46.5	49.4	45.5	29.7
1972	26.7	16.6	10.2	6.7	8.2	38.6	156.3	121.4	76.1	44.1	32.3	22.2	46.6
1973	15.2	10.4	7.2	5.3	4.5	20.9	30.1	19.9	23.4	47.0	46.7	36.5	22.3
1977	14.1	11.1	7.8	5.6	4.3	6.0	29.6	50.6	59.2	32.6	39.0	23.7	23.6
1978	14.2	8.8	5.8	4.2	5.3	12.4	23.8	71.0	80.6	104.8	59.1	33.2	35.3
1984	12.5	8.9	6.0	4.4	4.6	27.3	28.0	58.8	41.1	64.6	41.9	23.3	26.8
1985	14.6	9.0	6.0	4.3	3.5	47.0	47.2	39.3	46.4	64.6	40.3	23.6	28.8
1986	15.5	9.8	6.4	4.4	7.7	10.9	40.1	61.2	62.8	68.7	57.5	32.9	31.5
1987	19.9	12.8	8.0	5.3	3.9	10.2	17.2	38.0	43.8	30.3	34.4	27.7	20.9
1988	20.5	14.3	9.5	6.1	5.7	25.5	29.6	19.4	22.2	79.8	68.7	34.4	28.0
Max	57.2	55.0	44.7	45.2	42.9	47.0	156.3	121.4	89.6	104.8	69.8	76.5	46.6
Min	8.9	6.0	4.3	3.6	3.3	4.0	11.9	9.9	12.0	16.1	19.2	14.8	19.4
Mean	25.2	18.9	13.5	10.0	10.6	20.3	33.1	38.0	43.2	46.0	41.7	34.3	27.9

Table C6.3 Estimated Mean Monthly Discharge at Kaliwa River Confluence

Unit : m^3/sec

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
1950	46.7	38.6	36.2	24.7	17.9	17.7	16.0	13.6	27.3	49.6	47.3	60.1	33.0
1951	37.8	25.8	18.1	11.9	9.8	10.1	22.2	23.7	27.7	25.3	70.2	69.6	29.3
1952	55.5	35.6	23.4	17.6	18.5	28.2	19.5	30.2	33.2	67.3	48.6	74.9	37.7
1953	51.9	36.8	24.5	22.0	18.3	17.3	23.4	20.8	16.9	52.1	62.6	102.2	37.4
1954	66.8	55.1	59.9	33.8	24.6	22.4	20.3	19.3	16.1	22.0	26.0	39.5	33.8
1955	54.5	33.3	20.8	13.4	9.3	34.7	30.4	22.4	24.1	63.8	93.2	63.3	38.6
1956	56.5	54.3	46.0	60.7	39.6	42.7	35.8	46.6	35.6	48.1	60.3	87.8	51.2
1957	76.2	45.3	30.0	21.6	15.9	11.2	18.5	22.6	18.3	28.2	31.3	27.1	28.8
1958	50.9	49.4	29.0	19.0	12.7	12.1	20.5	34.5	25.5	46.3	46.1	28.8	31.2
1959	35.0	29.8	26.3	18.0	18.7	15.6	24.9	19.9	26.6	36.6	56.0	62.5	30.8
1960	60.7	73.7	40.5	31.7	46.7	36.6	31.4	34.0	58.9	74.8	62.5	45.4	49.7
1961	27.7	18.5	12.9	10.6	12.0	54.8	58.9	32.7	69.5	68.5	59.2	37.4	38.6
1962	26.7	19.6	13.6	9.4	10.0	20.1	87.7	73.9	89.6	53.3	43.2	29.2	39.7
1963	24.5	18.4	13.2	9.1	6.9	41.3	50.5	66.4	74.0	52.4	34.5	41.0	36.0
1964	28.9	20.2	14.9	10.5	13.0	52.6	61.7	82.2	71.0	61.8	74.8	55.2	45.6
1965	37.2	24.4	16.4	10.7	15.0	21.2	61.5	31.9	59.6	41.2	44.0	35.5	33.2
1966	23.1	17.7	13.9	9.7	52.6	22.7	23.5	24.6	75.2	59.4	82.1	66.4	39.2
1967	40.3	26.1	17.6	11.3	8.0	34.3	29.4	72.7	69.2	48.6	39.5	29.8	35.6
1968	22.4	16.8	11.6	8.1	6.4	15.2	37.6	71.7	65.6	51.4	30.8	19.8	29.8
1969	12.7	8.8	6.6	5.3	4.7	5.5	22.3	48.8	62.0	51.7	40.2	44.6	26.1
1970	28.9	18.9	12.3	8.0	5.8	11.7	24.8	21.1	102.0	99.5	84.2	59.3	39.7
1971	34.9	25.3	21.2	15.8	34.5	47.1	65.9	50.7	32.0	63.6	73.2	75.1	44.9
1972	44.5	26.5	16.8	12.0	13.2	46.0	176.0	137.1	90.3	57.7	46.4	35.8	58.5
1973	23.6	16.5	11.3	8.2	6.5	23.9	35.3	26.0	29.9	59.5	68.4	62.4	31.0
1977	24.8	18.5	13.7	9.4	7.0	9.2	36.9	57.6	65.8	38.5	52.1	32.2	30.5
1978	19.7	12.6	8.5	6.2	7.7	18.2	30.1	82.9	96.4	137.7	83.1	52.4	46.3
1984	20.9	15.5	10.4	7.2	7.4	34.7	35.1	68.1	48.2	92.9	61.4	35.1	36.4
1985	22.7	14.6	9.6	6.9	5.5	53.5	59.6	47.3	58.2	85.0	59.6	39.7	38.5
1986	25.3	17.2	11.4	7.7	9.7	14.3	49.5	75.1	76.4	87.4	76.6	45.1	41.3
1987	27.7	18.7	12.0	7.9	5.8	12.0	19.1	44.1	51.9	37.7	44.7	45.2	27.2
1988	34.7	22.9	15.7	10.0	9.6	34.0	37.7	25.2	28.0	105.1	93.2	47.0	38.6
Max	76.2	73.7	59.9	60.7	52.6	54.8	176.0	137.1	102.0	137.7	93.2	102.2	58.5
Min	12.7	8.8	6.6	5.3	4.7	5.5	16.0	13.6	16.1	22.0	26.0	19.8	26.1
Mean	36.9	27.6	19.9	14.8	15.3	26.5	40.8	46.1	52.4	60.2	57.9	50.0	37.4

Table C6.4 Estimated Mean Monthly Discharge at Kanan No.2 Damsite

Unit : m^3/sec

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
1950	130.5	54.2	67.4	20.8	8.4	7.9	29.7	40.8	18.3	110.2	116.3	146.7	62.6
1951	109.9	63.3	16.5	16.8	58.3	26.7	21.2	94.5	26.5	38.0	230.3	217.3	76.6
1952	126.1	67.9	17.4	20.0	9.0	17.7	20.6	89.3	50.9	252.6	40.3	152.1	72.0
1953	84.6	103.7	20.1	22.9	6.0	26.2	6.7	57.6	24.2	88.2	86.2	209.8	61.3
1954	62.4	33.4	83.5	6.6	4.2	2.0	7.8	17.2	23.7	27.4	66.9	258.6	49.5
1955	191.9	27.1	17.3	24.9	14.7	19.6	16.7	9.5	31.9	64.3	127.8	86.6	52.7
1956	72.1	42.3	71.4	75.4	23.8	21.3	41.7	35.0	81.0	145.8	149.4	317.7	89.7
1957	120.6	22.3	6.6	6.0	3.4	8.2	13.9	40.3	29.6	40.5	50.7	31.2	31.1
1958	64.0	18.3	30.0	45.8	45.0	43.8	48.4	20.6	44.1	107.5	98.5	26.8	49.4
1959	72.1	37.2	75.9	10.0	1.0	6.9	10.8	27.1	29.0	33.0	112.3	96.9	42.7
1960	62.5	73.1	8.7	9.2	14.2	35.0	30.6	134.0	54.3	117.0	85.9	100.3	60.4
1961	115.9	93.9	73.2	46.0	61.2	12.7	1.7	18.1	26.8	86.8	157.6	54.1	62.3
1962	95.2	78.0	44.0	46.4	16.8	9.4	5.7	0.6	75.5	39.1	112.4	107.7	52.6
1963	84.7	100.1	46.6	42.1	12.1	3.2	5.8	23.2	45.1	40.1	48.9	103.7	46.3
1964	85.8	90.5	76.8	47.9	22.0	7.1	21.5	18.6	28.2	37.6	164.9	166.4	63.9
1965	107.3	61.0	37.2	13.8	7.3	3.4	2.1	17.1	6.6	69.7	123.2	187.0	53.0
1966	52.5	43.2	10.7	7.4	12.7	5.3	6.3	7.8	2.8	92.2	137.0	133.0	42.6
1967	110.5	38.4	38.8	30.2	25.3	20.2	13.8	24.8	4.3	9.3	125.9	105.4	45.6
1968	87.5	95.1	95.1	62.4	18.2	9.2	6.1	10.2	16.8	51.1	70.0	40.3	46.8
1969	47.7	19.3	25.1	15.2	7.3	4.8	9.6	4.2	2.4	10.7	48.2	176.2	30.9
1970	80.6	25.4	8.1	23.0	7.2	7.8	7.8	3.2	7.6	72.6	210.1	115.2	47.4
1971	63.5	103.4	96.4	22.4	109.8	132.0	137.2	36.0	11.8	115.5	124.2	183.1	94.6
1972	62.9	24.8	40.3	35.7	33.9	10.0	106.5	33.4	23.6	32.8	107.1	134.5	53.8
1973	45.4	60.3	28.7	23.6	23.3	22.7	17.6	9.5	14.5	84.6	169.3	235.3	61.2
1977	126.9	119.5	72.1	28.5	23.8	12.9	41.4	16.0	36.9	39.8	144.0	64.9	60.6
1978	51.7	39.9	20.3	6.1	13.2	13.8	6.0	28.6	31.8	125.4	97.4	159.7	49.5
1984	51.5	32.5	20.5	4.7	2.2	13.4	15.0	36.2	20.0	63.4	95.8	109.0	38.7
1985	51.5	29.9	18.4	5.0	1.5	29.0	27.7	20.2	31.2	70.8	99.6	119.6	42.0
1986	57.9	33.6	20.0	4.1	7.5	4.0	30.9	37.3	35.7	72.2	165.3	170.0	53.2
1987	74.7	43.7	25.7	5.3	2.7	4.7	13.8	26.7	30.5	28.5	106.5	176.3	44.9
1988	106.4	57.3	32.8	6.4	3.0	11.2	20.7	5.1	13.6	99.0	199.1	177.3	61.0
Max	191.9	119.5	96.4	75.4	109.8	132.0	137.2	134.0	81.0	252.6	230.3	317.7	94.6
Min	45.4	18.3	6.6	4.1	1.0	2.0	1.7	0.6	2.4	9.3	40.3	26.8	30.9
Mean	85.7	55.9	40.2	23.7	19.3	17.8	24.0	30.4	28.4	73.1	118.4	140.7	54.8

Table C6.5 Estimated Mean Monthly Discharge at Kanan Low Damsite

Unit : m^3/sec

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
1950	160.7	66.8	83.1	25.6	10.3	9.7	36.6	50.3	22.6	135.7	143.2	180.8	77.1
1951	135.4	78.0	20.4	20.7	71.8	32.9	26.1	116.4	32.7	46.8	283.7	267.7	94.4
1952	155.3	83.7	21.4	24.6	11.1	21.8	25.4	110.0	62.7	311.1	49.7	187.4	88.7
1953	104.2	127.7	24.7	28.2	7.3	32.3	8.2	71.0	29.8	108.7	106.1	258.5	75.6
1954	76.9	41.2	102.8	8.1	5.2	2.4	9.6	21.2	29.1	33.7	82.4	318.5	60.9
1955	236.4	33.4	21.4	30.7	18.1	24.2	20.5	11.8	39.3	79.2	157.4	106.6	64.9
1956	88.8	52.1	87.9	92.8	29.3	26.3	51.4	43.1	99.7	179.6	184.1	391.3	110.5
1957	148.5	27.5	8.1	7.3	4.2	10.1	17.1	49.6	36.5	49.9	62.4	38.4	38.3
1958	78.8	22.6	37.0	56.4	55.4	53.9	59.7	25.4	54.3	132.4	121.3	33.0	60.8
1959	88.8	45.8	93.4	12.4	1.2	8.4	13.3	33.4	35.7	40.6	138.3	119.4	52.6
1960	76.9	90.1	10.7	11.3	17.5	43.2	37.7	165.1	66.8	144.1	105.9	123.5	74.4
1961	142.7	115.7	90.2	56.6	75.4	15.7	2.1	22.3	33.0	106.9	194.2	66.6	76.8
1962	117.3	96.1	54.2	57.1	20.7	11.6	7.0	0.7	93.1	48.2	138.5	132.6	64.8
1963	104.4	123.3	57.4	51.9	14.9	3.9	7.2	28.6	55.6	49.4	60.2	127.7	57.0
1964	105.7	111.5	94.6	59.0	27.1	8.8	26.5	22.9	34.7	46.3	203.1	204.9	78.7
1965	132.2	75.2	45.8	17.0	9.0	4.2	2.6	21.0	8.2	85.8	151.8	230.4	65.3
1966	64.6	53.3	13.2	9.1	15.7	6.5	7.8	9.6	3.4	113.6	168.8	163.8	52.4
1967	136.1	47.3	47.8	37.2	31.2	24.8	17.0	30.5	5.3	11.5	155.1	129.9	56.1
1968	107.8	117.1	117.1	76.9	22.4	11.3	7.5	12.6	20.8	63.0	86.2	49.6	57.7
1969	58.8	23.7	30.9	18.7	9.0	5.9	11.8	5.2	3.0	13.2	59.3	217.1	38.1
1970	99.3	31.3	10.0	28.3	8.9	9.6	9.6	4.0	9.3	89.5	258.8	142.0	58.4
1971	78.3	127.4	118.7	27.6	135.3	162.6	169.0	44.4	14.5	142.2	153.0	225.5	116.5
1972	77.4	30.5	49.7	43.9	41.7	12.4	131.2	41.2	29.0	40.5	132.0	165.7	66.3
1973	55.9	74.3	35.4	29.0	28.8	27.9	21.7	11.7	17.9	104.2	208.5	289.8	75.4
1977	156.4	147.2	88.8	35.1	29.3	15.9	51.1	19.6	45.4	49.1	177.4	80.0	74.6
1978	63.7	49.1	25.0	7.5	16.3	17.0	7.5	35.2	39.1	154.5	120.0	196.7	61.0
1984	63.4	40.1	25.2	5.8	2.8	16.5	18.4	44.7	24.7	78.1	118.0	134.3	47.7
1985	63.4	36.8	22.6	6.2	1.8	35.7	34.1	24.8	38.4	87.2	122.7	147.3	51.8
1986	71.3	41.4	24.7	5.0	9.2	5.0	38.1	46.0	44.0	88.9	203.7	209.4	65.5
1987	92.1	53.8	31.7	6.5	3.4	5.8	17.0	32.8	37.5	35.1	131.2	217.2	55.3
1988	131.1	70.5	40.4	7.9	3.7	13.8	25.4	6.3	16.8	121.9	245.2	218.4	75.1
Max	236.4	147.2	118.7	92.8	135.3	162.6	169.0	165.1	99.7	311.1	283.7	391.3	116.5
Min	55.9	22.6	8.1	5.0	1.2	2.4	2.1	0.7	3.0	11.5	49.7	33.0	38.1
Mean	105.6	68.9	49.5	29.2	23.8	21.9	29.6	37.5	34.9	90.0	145.9	173.4	67.5

Table C6.6 Estimated Mean Monthly Discharge at Kanan River Confluence

Unit : m^3/sec

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
1950	177.4	73.8	91.7	28.3	11.4	10.7	40.4	55.5	24.9	149.8	158.1	199.5	85.1
1951	149.5	86.1	22.5	22.9	79.2	36.4	28.9	128.5	36.1	51.7	313.2	295.5	104.2
1952	171.4	92.4	23.6	27.1	12.3	24.0	28.1	121.4	69.2	343.5	54.9	206.9	97.9
1953	115.1	141.0	27.3	31.1	8.1	35.7	9.1	78.4	32.9	120.0	117.2	285.4	83.4
1954	84.9	45.5	113.5	8.9	5.8	2.7	10.6	23.4	32.2	37.2	91.0	351.6	67.3
1955	260.9	36.9	23.6	33.9	19.9	26.7	22.7	13.0	43.4	87.4	173.7	117.7	71.7
1956	98.0	57.5	97.1	102.5	32.3	29.0	56.7	47.6	110.1	198.3	203.2	432.0	122.0
1957	164.0	30.3	8.9	8.1	4.6	11.2	18.8	54.8	40.3	55.1	68.9	42.4	42.3
1958	87.0	24.9	40.8	62.3	61.2	59.5	65.9	28.0	59.9	146.2	133.9	36.4	67.2
1959	98.1	50.6	103.2	13.7	1.4	9.3	14.6	36.9	39.4	44.8	152.7	131.8	58.0
1960	84.9	99.4	11.8	12.5	19.4	47.6	41.6	182.3	73.8	159.1	116.9	136.4	82.1
1961	157.6	127.7	99.6	62.5	83.2	17.3	2.3	24.6	36.5	118.0	214.4	73.5	84.8
1962	129.5	106.1	59.8	63.1	22.9	12.8	7.7	0.8	102.7	53.2	152.9	146.4	71.5
1963	115.2	136.1	63.3	57.2	16.5	4.3	7.9	31.6	61.4	54.5	66.5	140.9	63.0
1964	116.6	123.1	104.4	65.1	29.9	9.7	29.2	25.2	38.4	51.1	224.2	226.2	86.9
1965	146.0	83.0	50.6	18.7	9.9	4.6	2.9	23.2	9.0	94.7	167.5	254.4	72.0
1966	71.4	58.8	14.6	10.1	17.3	7.2	8.6	10.6	3.8	125.4	186.3	180.9	57.9
1967	150.3	52.3	52.8	41.1	34.4	27.4	18.8	33.7	5.9	12.6	171.3	143.4	62.0
1968	119.0	129.3	129.3	84.8	24.7	12.5	8.2	13.9	22.9	69.5	95.2	54.7	63.7
1969	64.9	26.2	34.2	20.6	10.0	6.5	13.0	5.7	3.3	14.5	65.5	239.7	42.0
1970	109.7	34.5	11.0	31.3	9.8	10.6	10.6	4.4	10.3	98.8	285.7	156.7	64.5
1971	86.4	140.6	131.0	30.4	149.3	179.5	186.6	49.0	16.1	157.0	168.8	249.0	128.6
1972	85.5	33.7	54.8	48.5	46.1	13.6	144.8	45.4	32.0	44.7	145.7	182.9	73.1
1973	61.7	82.0	39.1	32.0	31.7	30.8	23.9	12.9	19.7	115.0	230.2	319.9	83.3
1977	172.6	162.5	98.0	38.8	32.3	17.6	56.4	21.7	50.1	54.2	195.9	88.3	82.4
1978	70.3	54.3	27.6	8.3	18.0	18.8	8.2	38.8	43.2	170.6	132.5	217.2	67.3
1984	70.0	44.2	27.8	6.4	3.1	18.3	20.4	49.3	27.2	86.2	130.3	148.2	52.6
1985	70.0	40.6	25.0	6.8	2.0	39.4	37.7	27.4	42.4	96.3	135.5	162.6	57.1
1986	78.7	45.7	27.3	5.5	10.2	5.5	42.0	50.8	48.6	98.2	224.8	231.1	72.4
1987	101.6	59.4	35.0	7.2	3.7	6.4	18.8	36.3	41.4	38.7	144.8	239.7	61.1
1988	144.7	77.9	44.6	8.8	4.1	15.3	28.1	6.9	18.5	134.6	270.7	241.1	82.9
Max	260.9	162.5	131.0	102.5	149.3	179.5	186.6	182.3	110.1	343.5	313.2	432.0	128.6
Min	61.7	24.9	8.9	5.5	1.4	2.7	2.3	0.8	3.3	12.6	54.9	36.4	42.0
Mean	116.5	76.0	54.6	32.2	26.3	24.2	32.7	41.3	38.6	99.4	161.0	191.4	74.5

Table C6.7 Estimated Mean Monthly Discharge at Agos Damsite

Unit : m^3/sec

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
1950	227.0	113.8	129.5	53.6	29.7	28.8	57.1	70.0	52.9	201.9	208.1	263.0	119.6
1951	189.7	113.3	41.1	35.2	90.2	47.1	51.7	154.1	64.6	77.9	388.4	369.7	135.2
1952	229.9	129.6	47.7	45.4	31.2	52.9	48.1	153.5	103.6	416.0	104.8	285.4	137.3
1953	169.1	180.0	52.4	53.8	26.7	53.7	32.9	100.4	50.4	174.3	182.1	392.5	122.4
1954	153.6	101.8	175.6	43.3	30.7	25.4	31.3	43.2	48.9	59.9	118.5	396.1	102.4
1955	319.5	71.0	45.0	47.9	29.6	62.2	53.7	35.8	68.4	153.1	270.4	183.4	111.7
1956	156.5	113.2	144.9	165.3	72.8	72.6	93.7	95.4	147.6	249.5	266.9	526.5	175.4
1957	243.3	76.6	39.4	30.1	20.8	22.7	37.8	78.4	59.3	84.3	101.5	70.3	72.0
1958	139.7	75.2	70.7	82.3	74.8	72.5	87.5	63.4	86.5	195.0	182.3	66.0	99.7
1959	134.8	81.4	131.1	32.1	20.3	25.3	40.0	57.5	66.9	82.5	211.4	196.8	90.0
1960	147.5	175.3	53.0	44.8	66.9	85.3	73.9	219.1	134.4	236.9	181.6	184.0	133.6
1961	187.7	148.1	113.9	74.1	96.4	73.0	61.9	58.0	107.4	188.9	277.1	112.4	124.9
1962	158.2	127.3	74.4	73.4	33.3	33.3	96.7	75.6	194.8	107.9	198.6	177.8	112.6
1963	141.5	156.5	77.5	67.2	23.6	46.1	59.1	99.2	137.1	108.2	102.3	184.2	100.2
1964	147.4	145.1	120.8	76.6	43.5	63.1	92.1	108.8	110.7	114.4	302.8	285.0	134.2
1965	185.5	108.8	67.9	29.8	25.2	26.1	65.2	55.8	69.5	137.6	214.3	293.5	106.6
1966	95.7	77.5	28.8	20.0	70.8	30.2	32.5	35.6	80.0	187.1	271.8	250.5	98.4
1967	193.0	79.3	71.3	53.1	43.0	62.5	48.8	107.8	76.0	62.0	213.4	175.4	98.8
1968	143.3	148.0	142.7	94.2	31.5	28.0	46.4	86.7	89.7	122.4	127.6	75.5	94.7
1969	78.6	35.4	41.2	26.2	14.8	12.2	35.8	55.2	66.1	67.1	107.0	287.9	69.0
1970	140.3	54.1	23.5	39.7	15.8	22.6	35.9	25.8	113.7	200.8	374.7	218.8	105.5
1971	122.8	168.0	154.2	46.8	186.1	229.4	255.7	101.0	48.7	223.5	245.1	328.3	175.8
1972	131.7	61.0	72.5	61.3	60.0	60.4	324.9	184.9	123.9	103.6	194.6	221.5	133.4
1973	86.3	99.8	51.0	40.8	38.8	55.4	60.0	39.4	50.2	176.8	302.4	387.2	115.7
1977	199.9	183.4	113.1	48.8	39.8	27.1	94.5	80.3	117.4	93.9	251.1	122.0	114.3
1978	91.1	67.7	36.6	14.6	26.0	37.5	38.9	123.3	141.4	312.2	218.3	273.0	115.0
1984	92.1	60.5	38.8	13.7	10.6	53.7	56.2	118.9	76.4	181.4	194.2	185.6	90.2
1985	93.9	55.9	35.0	13.9	7.6	94.1	98.6	75.7	101.9	183.6	197.6	204.9	96.9
1986	105.3	63.7	39.1	13.4	20.1	20.0	92.7	127.5	126.5	188.0	305.3	279.8	115.1
1987	131.0	79.1	47.5	15.3	9.6	18.6	38.4	81.4	94.5	77.4	191.9	288.6	89.4
1988	181.8	102.0	61.1	19.0	13.9	49.9	66.7	32.5	47.1	242.8	368.6	291.9	123.1
Max	319.5	183.4	175.6	165.3	186.1	229.4	324.9	219.1	194.8	416.0	388.4	526.5	175.8
Min	78.6	35.4	23.5	13.4	7.6	12.2	31.3	25.8	47.1	59.9	101.5	66.0	69.0
Mean	155.4	104.9	75.5	47.6	42.1	51.3	74.5	88.5	92.2	161.6	221.8	244.4	113.3

Table C6.8 Estimated Mean Monthly Discharge at Agos River Confluence

Unit : m^3/sec

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
1950	224.1	112.4	127.8	52.9	29.3	28.4	56.4	69.1	52.3	199.4	205.4	259.7	118.1
1951	187.3	111.9	40.5	34.8	89.0	46.5	51.0	152.1	63.8	76.9	383.5	365.0	133.5
1952	227.0	127.9	47.1	44.8	30.8	52.3	47.5	151.6	102.3	410.8	103.5	281.8	135.6
1953	167.0	177.7	51.8	53.1	26.4	53.0	32.5	99.1	49.8	172.1	179.8	387.5	120.8
1954	151.7	100.5	173.4	42.7	30.3	25.0	30.9	42.6	48.3	59.2	117.0	391.1	101.1
1955	315.4	70.1	44.4	47.2	29.2	61.4	53.0	35.3	67.6	151.2	266.9	181.0	110.2
1956	154.5	111.8	143.1	163.2	71.9	71.7	92.5	94.2	145.7	246.3	263.5	519.8	173.2
1957	240.2	75.6	38.9	29.7	20.5	22.4	37.3	77.4	58.6	83.2	100.3	69.5	71.1
1958	138.0	74.3	69.8	81.3	73.9	71.6	86.4	62.6	85.4	192.5	180.0	65.2	98.4
1959	133.0	80.4	129.5	31.7	20.0	24.9	39.5	56.8	66.1	81.5	208.7	194.3	88.9
1960	145.6	173.1	52.3	44.2	66.1	84.2	72.9	216.3	132.7	233.9	179.3	181.7	131.9
1961	185.3	146.2	112.4	73.1	95.2	72.1	61.1	57.3	106.0	186.5	273.6	110.9	123.3
1962	156.2	125.7	73.4	72.5	32.9	32.9	95.4	74.6	192.3	106.5	196.1	175.6	111.2
1963	139.7	154.5	76.5	66.3	23.3	45.5	58.4	98.0	135.4	106.9	101.0	181.9	99.0
1964	145.5	143.3	119.3	75.6	42.9	62.3	90.9	107.4	109.3	112.9	299.0	281.4	132.5
1965	183.1	107.4	67.0	29.4	24.9	25.8	64.4	55.1	68.6	135.9	211.6	289.8	105.2
1966	94.5	76.5	28.4	19.7	69.9	29.9	32.1	35.2	79.0	184.7	268.4	247.3	97.1
1967	190.6	78.3	70.4	52.4	42.4	61.7	48.2	106.4	75.0	61.2	210.7	173.2	97.6
1968	141.5	146.1	140.9	93.0	31.1	27.7	45.8	85.6	88.5	120.9	126.0	74.6	93.5
1969	77.6	35.0	40.7	25.9	14.6	12.0	35.3	54.5	65.3	66.2	105.6	284.2	68.1
1970	138.5	53.4	23.2	39.2	15.6	22.3	35.4	25.5	112.3	198.2	369.9	216.0	104.1
1971	121.2	165.8	152.2	46.2	183.8	226.5	252.5	99.7	48.1	220.6	242.0	324.1	173.6
1972	130.0	60.2	71.6	60.5	59.2	59.6	320.8	182.6	122.4	102.3	192.1	218.7	131.7
1973	85.2	98.6	50.4	40.3	38.3	54.7	59.2	38.9	49.6	174.5	298.6	382.3	114.2
1977	197.4	181.0	111.7	48.2	39.3	26.7	93.3	79.3	115.9	92.7	248.0	120.5	112.8
1978	90.0	66.8	36.1	14.5	25.7	37.0	38.4	121.7	139.6	308.2	215.5	269.6	113.6
1984	90.9	59.7	38.3	13.6	10.4	53.0	55.5	117.4	75.5	179.1	191.7	183.3	89.0
1985	92.7	55.2	34.6	13.7	7.5	92.9	97.3	74.7	100.6	181.2	195.1	202.3	95.7
1986	104.0	62.9	38.6	13.2	19.8	19.8	91.5	125.9	124.9	185.6	301.4	276.3	113.7
1987	129.3	78.1	46.9	15.1	9.5	18.3	37.9	80.4	93.4	76.5	189.5	284.9	88.3
1988	179.5	100.7	60.4	18.8	13.7	49.3	65.8	32.1	46.5	239.7	363.9	288.2	121.5
Max	315.4	181.0	173.4	163.2	183.8	226.5	320.8	216.3	192.3	410.8	383.5	519.8	173.6
Min	77.6	35.0	23.2	13.2	7.5	12.0	30.9	25.5	46.5	59.2	100.3	65.2	68.1
Mean	153.4	103.6	74.6	47.0	41.5	50.7	73.5	87.4	91.0	159.6	219.0	241.3	111.9

Table C6.9 Flow Duration Curve (1/3)

Laiban Damsite

Duration (%)	Discharge (m^3/sec)	Duration (%)	Discharge (m^3/sec)	Duration (%)	Discharge (m^3/sec)	Duration (%)	Discharge (m^3/sec)
1	88.62	26	33.52	51	17.80	76	8.39
2	70.85	27	32.52	52	17.17	77	7.98
3	69.37	28	31.50	53	16.47	78	7.25
4	63.50	29	30.73	54	16.13	79	7.03
5	60.13	30	30.21	55	15.72	80	6.70
6	58.72	31	29.13	56	15.44	81	6.41
7	57.43	32	28.28	57	15.06	82	5.92
8	55.01	33	28.06	58	14.87	83	5.57
9	51.23	34	26.76	59	14.70	84	5.46
10	49.76	35	25.69	60	14.29	85	5.34
11	48.34	36	24.97	61	13.97	86	5.24
12	46.93	37	24.77	62	13.35	87	4.74
13	45.51	38	24.35	63	13.09	88	4.43
14	44.44	39	23.69	64	12.61	89	4.24
15	43.96	40	22.77	65	12.43	90	3.88
16	41.99	41	22.05	66	12.18	91	3.63
17	40.85	42	21.56	67	11.55	92	3.51
18	40.45	43	21.20	68	11.09	93	3.45
19	39.52	44	20.59	69	10.66	94	3.32
20	38.23	45	20.27	70	10.12	95	3.08
21	37.77	46	20.04	71	9.99	96	2.92
22	37.70	47	19.42	72	9.54	97	2.74
23	36.29	48	19.20	73	9.26	98	2.54
24	35.25	49	18.28	74	9.03	99	2.32
25	34.14	50	17.97	75	8.77	100	1.73

Kaliwa Low Damsite

Duration (%)	Discharge (m^3/sec)	Duration (%)	Discharge (m^3/sec)	Duration (%)	Discharge (m^3/sec)	Duration (%)	Discharge (m^3/sec)
1	104.75	26	40.55	51	22.33	76	12.37
2	79.82	27	39.33	52	22.02	77	11.74
3	71.71	28	38.73	53	20.87	78	10.95
4	69.83	29	38.07	54	20.52	79	10.45
5	65.28	30	36.62	55	20.14	80	10.18
6	64.57	31	35.99	56	19.41	81	9.87
7	61.20	32	34.49	57	19.17	82	9.41
8	60.03	33	34.35	58	18.60	83	8.93
9	58.75	34	33.22	59	18.21	84	8.58
10	56.63	35	32.26	60	17.60	85	8.21
11	54.98	36	31.27	61	17.35	86	7.84
12	52.44	37	29.79	62	16.90	87	7.46
13	50.89	38	29.37	63	16.33	88	6.91
14	49.92	39	28.04	64	16.19	89	6.71
15	48.46	40	27.39	65	15.90	90	6.40
16	47.03	41	27.21	66	15.50	91	6.05
17	46.70	42	26.65	67	15.20	92	5.97
18	46.38	43	26.08	68	14.75	93	5.84
19	45.36	44	25.60	69	14.31	94	5.33
20	44.67	45	25.30	70	14.23	95	5.22
21	43.83	46	24.83	71	13.53	96	4.54
22	42.43	47	24.47	72	13.40	97	4.37
23	41.83	48	23.74	73	13.20	98	4.26
24	41.24	49	23.30	74	12.95	99	3.93
25	40.62	50	22.52	75	12.58	100	3.27

Table C6.9 Flow Duration Curve (2/3)

Kanan No.2 Damsite

Duration (%)	Discharge (m^3/sec)	Duration (%)	Discharge (m^3/sec)	Duration (%)	Discharge (m^3/sec)	Duration (%)	Discharge (m^3/sec)
1	252.57	26	80.96	51	35.65	76	16.84
2	210.10	27	75.86	52	33.59	77	15.95
3	187.05	28	73.24	53	32.85	78	14.49
4	176.30	29	72.19	54	31.93	79	13.84
5	166.36	30	71.39	55	30.58	80	13.24
6	157.63	31	67.93	56	29.86	81	12.11
7	145.82	32	64.30	57	28.73	82	10.70
8	137.00	33	63.42	58	28.48	83	10.05
9	131.96	34	62.40	59	27.11	84	9.51
10	126.07	35	60.31	60	26.73	85	9.20
11	124.17	36	57.63	61	26.25	86	8.68
12	119.52	37	54.05	62	25.13	87	7.90
13	115.45	38	51.50	63	24.17	88	7.81
14	110.49	39	48.90	64	23.57	89	7.43
15	109.81	40	47.86	65	23.24	90	7.23
16	107.35	41	45.97	66	22.38	91	6.65
17	106.42	42	45.01	67	21.31	92	6.34
18	103.65	43	43.75	68	20.65	93	6.05
19	99.65	44	42.16	69	20.29	94	5.70
20	96.91	45	40.82	70	20.04	95	5.01
21	95.10	46	40.28	71	19.62	96	4.23
22	93.89	47	39.96	72	18.56	97	3.42
23	88.24	48	38.80	73	18.16	98	2.78
24	86.17	49	37.32	74	17.40	99	1.98
25	84.63	50	36.25	75	17.05	100	0.57

Kanan Low Damsite

Duration (%)	Discharge (m^3/sec)	Duration (%)	Discharge (m^3/sec)	Duration (%)	Discharge (m^3/sec)	Duration (%)	Discharge (m^3/sec)
1	311.13	26	99.73	51	43.92	76	20.75
2	258.81	27	93.44	52	41.37	77	19.65
3	230.41	28	90.22	53	40.46	78	17.85
4	217.17	29	88.93	54	39.33	79	17.05
5	204.93	30	87.94	55	37.67	80	16.31
6	194.18	31	83.68	56	36.78	81	14.92
7	179.63	32	79.21	57	35.40	82	13.18
8	168.76	33	78.12	58	35.08	83	12.38
9	162.56	34	76.87	59	33.39	84	11.71
10	155.29	35	74.29	60	32.93	85	11.33
11	152.95	36	70.99	61	32.33	86	10.70
12	147.23	37	66.58	62	30.95	87	9.73
13	142.22	38	63.44	63	29.77	88	9.62
14	136.11	39	60.23	64	29.03	89	9.15
15	135.26	40	58.96	65	28.62	90	8.91
16	132.23	41	56.62	66	27.56	91	8.19
17	131.09	42	55.44	67	26.25	92	7.82
18	127.68	43	53.89	68	25.44	93	7.45
19	122.75	44	51.94	69	25.00	94	7.02
20	119.37	45	50.29	70	24.69	95	6.17
21	117.14	46	49.61	71	24.17	96	5.21
22	115.66	47	49.22	72	22.86	97	4.21
23	108.70	48	47.80	73	22.37	98	3.43
24	106.15	49	45.97	74	21.44	99	2.44
25	104.25	50	44.65	75	21.01	100	0.71

Table C6.9 Flow Duration Curve (3/3)

Agos Damsite

Duration (%)	Discharge (m^3/sec)	Duration (%)	Discharge (m^3/sec)	Duration (%)	Discharge (m^3/sec)	Duration (%)	Discharge (m^3/sec)
1	396.12	26	154.08	51	82.31	76	48.81
2	374.68	27	148.06	52	80.01	77	47.66
3	324.92	28	147.39	53	78.38	78	46.80
4	305.27	29	143.27	54	77.52	79	45.36
5	291.86	30	140.30	55	76.43	80	43.45
6	285.01	31	134.75	56	75.51	81	41.25
7	271.80	32	131.00	57	74.08	82	39.81
8	263.00	33	127.57	58	73.02	83	39.43
9	249.50	34	123.94	59	72.54	84	38.75
10	236.87	35	122.02	60	70.73	85	36.56
11	227.01	36	118.48	61	69.48	86	35.79
12	218.78	37	113.79	62	67.18	87	35.04
13	211.41	38	113.12	63	66.67	88	32.54
14	200.79	39	108.82	64	64.60	89	31.30
15	197.60	40	107.86	65	63.07	90	30.24
16	194.57	41	105.32	66	61.92	91	29.57
17	189.69	42	103.65	67	60.47	92	27.08
18	187.68	43	101.88	68	60.01	93	26.22
19	185.48	44	100.39	69	59.13	94	25.36
20	183.56	45	96.66	70	57.14	95	23.64
21	182.13	46	94.55	71	55.41	96	21.68
22	181.40	47	93.89	72	53.79	97	20.00
23	175.62	48	92.07	73	53.12	98	15.28
24	169.11	49	87.47	74	52.45	99	13.72
25	156.48	50	85.27	75	50.25	100	7.58

Table C7.1 Maximum Discharge Record at Banugao Gauging Station

Year	Date	Time	Max. Gauge Height (m)				Max. Discharge (CMS)		
			DPWH *1		Corrected *2		DPWH *1	Corrected *2	
1949	Dec. 20	17:00	4.69	*3			1,095	1,140	
1950	Dec. 31	7:00	7.42				3,622	4,250	
1951	Nov. 28	17:00	6.23				2,388	2,590	
1952	Oct. 17	17:00	5.62				1,798	1,960	
1953	Dec. 08	7:00	4.96				1,273	1,380	
1954	Dec. 27	7:00	5.12				1,388	1,520	
1955	Nov. 29	17:00	5.94				2,088	2,290	
1956	Dec. 10	12:00	6.92				3,076	3,510	
1957	Jan. 10	12:00	4.29				867	867	
1958	Oct. 22	7:00	4.74		4.89	*4	1,126	1,180	
1959	Jan. 25	1:00	3.93				688	688	
1960	Oct. 07	17:00	5.64		4.89	*5	1,815	1,980	
1961	Nov. 22	18:30	6.49		8.44	*6	2,628	2,900	
1962	Sep. 25	1:30	5.56				1,746	1,900	
1963	Dec. 12	5:10	4.74		4.77	*7	1,126	820	
1964	Nov. 14	7:00	6.00		4.76	*8	2,144	2,350	
1965	Dec. 18	6:00	4.95		5.88	*9	1,265	1,320	
1966	Dec. 28	12:00	6.05				2,192	6,070	
1967	Jan. 04	7:00	4.56				1,013	1,030	
1968	Sep. 29	7:00	4.17				791	1,210	
1969	Dec. 12	7:00	4.75				1,133	1,200	
1970	Oct. 14	6:00	6.05				2,192	2,230	
1973	Nov. 22	7:00	6.28				2,418	2,640	*10
1974	Jan. 01	7:00	3.29				408	408	*10
1976	Nov. 26	7:00	3.76				610	610	*10
1977	Nov. 14	7:00	4.15				795	795	*10

Note : *1 Extracted from "Water Resources Bulletin" published by DPWH.
*2 Corrected by means of revised rating curve in Agos Hydropower Project, JICA Study in 1981.
*3 No observation before May 1949, but it was confirmed by rainfall record at Infanta that the flood on Dec. 20 was the maximum of this year.
*4 Misreading of recording chart, actual time of the flood peak was 4:25.
*5 Misreading of recording chart, actual time of the flood peak was 8:00.
*6 Actual maximum flood was omitted by mistake in the Bulletin by DPWH. It occurred at 22:40 on Nov. 20.
*7 Misreading, actual time of the flood peak was 8:00.
*8 Misreading.
*9 Misreading.
*10 Added by Small Hydropower Projects (Luzon Contract A), NPC in 1992

Table C7.2 Probable Flood at Proposed Damsites

Unit : m^3/sec

Return Period	Banugao Gauging Station	Creager's C	Agos River Basin		Kanan River Basin		Kaliwa River Basin	
			Agos Dam	Afterbay Weir	Kanan No.2 Dam	Kanan Low Dam	Laiban Dam	Kaliwa Low Dam
Drainage Area (km^2)	908		860	889	289	356	276	366
2	1,535	23	1,495	1,519	848	951	827	965
5	2,651	39	2,582	2,624	1,465	1,642	1,429	1,667
10	3,530	52	3,438	3,494	1,951	2,186	1,902	2,219
20	4,474	66	4,357	4,428	2,473	2,771	2,411	2,812
50	5,845	86	5,693	5,785	3,231	3,620	3,150	3,674
100	6,988	103	6,806	6,916	3,863	4,328	3,766	4,393
200	8,230	121	8,015	8,146	4,549	5,097	4,435	5,174
500	10,039	148	9,777	9,937	5,549	6,218	5,410	6,311
1,000	11,542	170	11,241	11,424	6,380	7,148	6,220	7,256
2,000	13,169	194	12,825	13,034	7,279	8,156	7,096	8,278
5,000	15,525	229	15,120	15,366	8,582	9,615	8,366	9,759
10,000	17,472	257	17,016	17,294	9,658	10,821	9,415	10,983

Table C8.1 Sediment Sampling Record of Agos River Hydropower Project

Agos River (Mahabang Lalim G.S.)

No.	Date			W.L. (m)	Discharge (m3/sec)	Sedimrnt (ppm)	Sedimrnt (ton/day)
1	Nov	16	1978	1.28	153.0	19.5	258
2	Nov	17	1978	1.19	134.0	15.0	174
3	Nov	18	1978	1.07	112.0	20.6	199
4	Jan	30	1979	0.52	44.6	37.8	146
5	Jan	31	1979	0.53	45.4	8.9	35
6	Jun	8	1979	0.20	24.2	40.9	86
7	Sep	2	1979			10.0	
8	Sep	12	1979			111.0	
9	Sep	26	1979			132.0	
10	Oct	5	1979	2.55	629.0	713.0	38,748
11	Oct	6	1979	2.30	515.0	162.0	7,208
12	Oct	21	1979	1.55	219.0	136.0	2,573
13	Oct	21	1979	1.21	137.0	132.0	1,562
14	Nov	14	1979	1.70	270.0	235.0	5,482
15	Nov	14	1979	1.97	371.0	348.0	11,155
16	Nov	16	1979	2.04	400.0	177.0	6,117
17	Nov	19	1979	1.53	213.0	29.0	534
18	Nov	20	1979	1.70	270.0	38.5	898
19	Nov	27	1979	2.04	400.0	246.0	8,502
20	Nov	30	1979	1.85	324.0	43.8	1,226
21	Dec	4	1979	1.36	170.0	6.7	99
22	Feb	27	1980	0.40	36.0	3.3	10
23	Feb	28	1980	0.37	34.2	4.8	14
24	Mar	11	1980	0.26	27.7	28.5	68
25	Mar	11	1980	0.22	25.4	12.7	28
26	Mar	17	1980	0.24	26.5	39.2	90
27	Mar	23	1980	0.26	27.7	13.5	32
28	Mar	24	1980	1.52	209.0	231.0	4,171
29	Mar	25	1980	2.83	758.0	1,759.0	115,199
30	Mar	25	1980	3.65	1180.0	1,935.0	197,277
31	Mar	26	1980	2.50	604.0	915.0	47,750
32	Apr	20	1980	0.80	70.4	10.2	62
33	May	2	1980	0.11	19.3	16.5	28
34	May	7	1980	0.10	19.0	23.6	39
35	May	19	1980	0.10	19.0	35.4	58
36	May	26	1980	1.27	151.0	1,059.0	13,816

Kanan River (Binugawan G.S.)

No.	Date			W.L. (m)	Discharge (m3/sec)	Sedimrnt (ppm)	Sedimrnt (ton/day)
1	Dec	3	1978	1.35		25.2	
2	Dec	4	1978	1.55		73.3	
3	Dec	5	1978	1.65		80.6	
4	Jan	10	1979	0.26		14.2	
5	Sep	18	1979			9.4	
6	Nov	17	1979	6.00		63.0	
7	Nov	20	1979	5.88		17.1	
8	Apr	17	1980	0.51		10.0	
9	May	6	1980	1.30		20.8	
10	May	7	1980	1.25		14.2	
11	May	18	1980	1.22		12.0	

Kaliwa River (Nio G.S.)

No.	Date			W.L. (m)	Discharge (m3/sec)	Sedimrnt (ppm)	Sedimrnt (ton/day)
1	Feb	1	1979	0.69		5.5	
2	Feb	2	1979	0.67		13.0	
3	Jun	7	1979	0.91		9.8	
4	Jun	7	1979	1.04		10.7	
5	Oct	6	1979	2.30		222.0	
6	Nov	14	1979	4.05		270.0	
7	Nov	14	1979	3.85		346.0	
8	Nov	16	1979			309.0	
9	Nov	16	1979			65.0	
10	Nov	19	1979	3.55		20.2	
11	Nov	20	1979	3.88		275.0	
12	Nov	22	1979	4.80		212.0	
13	Mar	23	1980	2.65		11.2	
14	Mar	25	1980			2,181.0	
15	Apr	15	1980	2.74		18.6	
16	Apr	18	1980	2.74		23.2	
17	Apr	29	1980	2.68		7.3	
18	May	8	1980	2.64		14.8	
19	May	27	1980	3.59		166.0	

Source : Feasibility Report on Agos River Hydropower Project, JICA, 1981

Table C8.2 Annual Sediment Yield Estimated in Dam Projects in Luzon Island

Name of Dam	Stream	River System	Drainage Area (km2)	Annual Sediment Yield (m3/km2/year)	Data Source
Existing Dam					
Ambuklao	Agno	Agno	617	5,337	*1
Binga	Agno	Agno	860	4,900	*2
Pantabangan	Pampanga	Pampanga	916	1,500	*3
Angat	Pampanga	Pampanga	568	4,500	*3
Magat	Cagayan	Cagayan	4,143	1,600	*3
Caliraya	Caliraya	Caliraya	92	800	*3
Proposed Dam					
Tina	Labugaon	Laoag	99	10	*3
Gosgos	Solsana	Laoag	71	10	*3
Cura	Cura	Laoag	63	10	*3
Paleiguan	Beleiguan	Ilocos	153	1,500	*3
Binongan	Binongan	Abra	377	2,000	*3
Chico IV	Chico	Cagayan	1,410	2,000	*3
Matuno	Matuno	Cagayan	593	600	*3
Casccnan	Casccnan	Cagayan	1,150	1,800	*3
Diduyon	Diduyon	Cagayan	477	1,107	*4
San Roque	Agno	Agno	1,250	6,500	*3
Balog-Balog	Bulao	Bulao	283	2,600	*3
Agos	Agos	Agos	867	557	*5

Note : Data Source

*1 : Ambuklao Rehabilitation, JICA 1988

*2 : Binga Dam Rehabilitation, JICA 1988

*3 : Study on Hydropower Project in Luzon Island, JICA 1987

*4 : Diduyon Hydroelectric Project, JICA 1980

*5 : Agos River Hydropower Project, JICA 1981

Table C9.1 Result of Water Balance Study

Item	Unit	Scenario A			Scenario B			Scenario C			Scenario D			Scenario E			Scenario F			Scenario G			Scenario H		
		1st St.	2nd St.	F. Dev.	1st St.	2nd St.	F. Dev.	1st St.	2nd St.	F. Dev.	1st St.	2nd St.	F. Dev.	1st St.	2nd St.	F. Dev.	1st St.	2nd St.	F. Dev.	1st St.	2nd St.	F. Dev.	1st St.	2nd St.	F. Dev.
		*1	*2	*3	*4	*5	*6	*7	*8	*9	*10	*11	*12	*13	*14	*15	*16	*17	*18	*19	*20	*21	*22	*23	*24
WATER TRANSFER																									
Laiban - Taytay 1st Waterway																									
Dependable discharge	m^3/sec	21.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	21.2	-	-	-	-	-	-	-	-
- do -	MLD	1,830	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1,830	-	-	-	-	-	-	-	-
Laiban - Taytay 1st and 2nd Waterway																									
Dependable discharge	m^3/sec	-	59.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
- do -	MLD	-	5,110	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Kaliwa - Angono 1st Waterway																									
Dependable discharge	m^3/sec	-	-	-	6.4	-	-	17.4	-	-	6.4	-	-	6.4	15.3	-	-	17.4	-	6.4/22.3	-	-	-	-	-
- do -	MLD	-	-	-	550	-	-	1,500	-	-	550	-	-	550	1,320	-	-	1,500	-	550/1,930	-	-	-	-	-
Kaliwa - Angono 1st and 2nd Waterway																									
Dependable discharge	m^3/sec	-	-	-	-	34.7	-	-	34.7	-	-	41.7	-	-	47.0	-	-	-	-	-	39.7	-	-	-	-
- do -	MLD	-	-	-	-	3,000	-	-	3,000	-	-	3,600	-	-	4,060	-	-	-	-	-	3,430	-	-	-	-
Laiban - Angono 1st Waterway																									
Dependable discharge	m^3/sec	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3.9	-	-
- do -	MLD	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	340	-	-
Laiban - Angono 1st and 2nd Waterway																									
Dependable discharge	m^3/sec	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	39.6	-
- do -	MLD	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3,420	-
Kanan - Laiban Water Transfer																									
Dependable discharge	m^3/sec	-	38.3	-	-	-	-	-	-	-	-	38.3	-	-	-	-	-	-	-	-	-	-	-	38.3	-
- do -	MLD	-	3,310	-	-	-	-	-	-	-	-	3,310	-	-	-	-	-	-	-	-	-	-	-	3,310	-
Kanan - Kaliwa Water Transfer																									
Dependable discharge	m^3/sec	-	-	-	-	-	-	-	-	-	-	-	-	-	43.6	-	-	-	-	-	-	-	-	-	-
- do -	MLD	-	-	-	-	-	-	-	-	-	-	-	-	-	3,770	-	-	-	-	-	-	-	-	-	-
POWER GENERATION																									
Pantay P/S (Base power operation)																									
Plant maximum discharge	m^3/sec	21.2	59.1	-	-	-	-	-	-	-	-	-	-	-	-	-	21.2	-	-	-	-	-	-	-	-
Installed capacity	MW	22.6	54.1	-	-	-	-	-	-	-	-	-	-	-	-	-	22.6	-	-	-	-	-	-	-	-
95% guarantee power output	MW	17.8	40.6	-	-	-	-	-	-	-	-	-	-	-	-	-	17.8	-	-	-	-	-	-	-	-
Annual energy	GWh	179.0	417.9	-	-	-	-	-	-	-	-	-	-	-	-	-	179.0	-	-	-	-	-	-	-	-
Laiban P/S (Base power operation)																									
Plant maximum discharge	m^3/sec	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	22.3	-	-	-	-	-
Installed capacity	MW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	17.6	-	-	-	-	-
95% guarantee power output	MW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	11.9	-	-	-	-	-
Annual energy	GWh	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	132.1	-	-	-	-	-
Laiban P/S (Peak power operation)																									
Plant maximum discharge	m^3/sec	-	-	-	-	-	89.2	-	-	89.2	-	-	239.6	-	-	89.2	-	-	-	-	89.2	-	-	-	-
Installed capacity	MW	-	-	-	-	-	69.6	-	-	69.6	-	-	188.5	-	-	69.6	-	-	-	-	69.6	-	-	-	-
95% guarantee power output	MW	-	-	-	-	-	46.9	-	-	46.9	-	-	119.5	-	-	46.9	-	-	-	-	46.9	-	-	-	-
Primary energy	GWh	-	-	-	-	-	130.0	-	-	130.0	-	-	345.0	-	-	130.0	-	-	-	-	130.0	-	-	-	-
Secondary energy	GWh	-	-	-	-	-	6.2	-	-	6.2	-	-	6.0	-	-	6.2	-	-	-	-	6.2	-	-	-	-
Annual energy	GWh	-	-	-	-	-	136.2	-	-	136.2	-	-	351.0	-	-	136.2	-	-	-	-	136.2	-	-	-	-
Agos P/S (Peak power operation)																									
Plant maximum discharge	m^3/sec	-	-	116.4	-	88.8	-	88.8	88.8	-	-	-	-	-	-	-	-	94.8	-	-	90.8	-	-	-	116.0
Installed capacity	MW	-	-	104.7	-	85.6	-	85.6	85.6	-	-	-	-	-	-	-	-	91.3	-	-	87.5	-	-	-	111.5
95% guarantee power output	MW	-	-	94.4	-	71.3	-	80.1	71.3	-	-	-	-	-	-	-	-	78.2	-	-	75.0	-	-	-	93.7
Primary energy	GWh	-	-	229.9	-	178.0	-	185.8	178.0	-	-	-	-	-	-	-	-	190.1	-	-	182.9	-	-	-	228.6
Secondary energy	GWh	-	-	144.9	-	240.9	-	313.2	240.9	-	-	-	-	-	-	-	-	236.5	-	-	230.9	-	-	-	138.4
Annual energy	GWh	-	-	374.8	-	418.9	-	499.0	418.9	-	-	-	-	-	-	-	-	426.6	-	-	413.8	-	-	-	367.0
Abuyod P/S (Base power operation)																									
Plant maximum discharge	m^3/sec	-	-	-	-	34.7	-	17.4	34.7	-	-	41.7	-	-	47.0	-	-	17.4	-	-	39.7	-	-	-	-
Installed capacity	MW	-	-	-	-	12.5	-	6.2	12.5	-	-	5.2	-	-	6.1	-	-	6.2	-	-	11.4	-	-	-	-
95% guarantee power output	MW	-	-	-	-	7.0	-	3.4	7.0	-	-	4.3	-	-	5.6	-	-	3.8	-	-	5.9	-	-	-	-
Annual energy	GWh	-	-	-	-	98.6	-	48.7	98.6	-	-	43.0	-	-	50.7	-	-	49.2	-	-	88.9	-	-	-	-
Kanan No.2 P/S (Base power operation)																									
Plant maximum discharge	m^3/sec	-	-	-	-	-	-	-	-	-	-	-	-	-	43.6	-	-	-	-	-	-	-	-	-	-
Installed capacity	MW	-	-	-	-	-	-	-	-	-	-	-	-	-	51.5	-	-	-	-	-	-	-	-	-	-
95% guarantee power output	MW	-	-	-	-	-	-	-	-	-	-	-	-	-	33.4	-	-	-	-	-	-	-	-	-	-
Annual energy	GWh	-	-	-	-	-	-	-	-	-	-	-	-	-	401.3	-	-	-	-	-	-	-	-	-	-
Kanan No.2 P/S (Peak power operation)																									
Plant maximum discharge	m^3/sec	-	-	-	-	-	179.6	-	-	179.6	-	-	-	-	-	-	-	-	179.6	-	-	179.6	-	-	-
Installed capacity	MW	-	-	-	-	-	209.5	-	-	209.5	-	-	-	-	-	-	-	-	209.5	-	-	209.5	-	-	-
95% guarantee power output	MW	-	-	-	-	-	135.3	-	-	135.3	-	-	-	-	-	-	-	-	135.3	-	-	135.3	-	-	-
Primary energy	GWh	-	-	-	-	-	406.4	-	-	406.4	-	-	-	-	-	-	-	-	406.4	-	-	406.4	-	-	-
Secondary energy	GWh	-	-	-	-	-	97.2	-	-	97.2	-	-	-	-	-	-	-	-	97.2	-	-	97.2	-	-	-
Annual energy	GWh	-	-	-	-	-	503.6	-	-	503.6	-	-	-	-	-	-	-	-	503.6	-	-	503.6	-	-	-
Balimbing P/S (Base power operation)																									
Plant maximum discharge	m^3/sec	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	39.6	-
Installed capacity	MW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	22.4	-
95% guarantee power output	MW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	22.4	-
Annual energy	GWh	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	196.1	-
Malabito P/S (Base power operation)																									
Plant maximum discharge	m^3/sec	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	38.3	-
Installed capacity	MW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	12.3	-
95% guarantee power output	MW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5.0	-
Annual energy	GWh	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	87.1	-

Remarks :

*1 : Laiban Dam with Laiban-Taytay 1st Waterway
*2 : Kanan No.2 Dam with Kanan-Laiban Water Transfer Tunnel and Laiban-Taytay 2nd Waterway
*3 : Agos Dam (for Hydropower)
*4 : Kaliwa Low Dam with Kaliwa-Angono 1st Waterway
*5 : Agos Dam and Kaliwa-Angono 2nd Waterway
*6 : Laiban Dam (for Hydropower) and Kanan No.2 Dam (for Hydropower)
*7 : Agos Dam with Kaliwa-Angono 1st Waterway
*8 : Kaliwa-Angono 2nd Waterway
*9 : Laiban Dam (for Hydropower) and Kanan No.2 Dam (for Hydropower)
*10 : Kaliwa Low Dam with Kaliwa-Angono 1st Waterway
*11 : Kanan No.2 Dam with Kanan-Laiban Water Transfer Tunnel and Kaliwa-Angono 2nd Waterway
*12 : Laiban Dam (for Hydropower)
*13 : Kaliwa Low Dam with Kaliwa-Angono 1st Waterway
*14 : 1) Kanan Low Dam with Kanan-Kaliwa Water Transfer Tunnel, 2) Kanan No.2 Dam with Kaliwa-Angono 2nd Waterway
*15 : Laiban Dam (for Hydropower)
*16 : Laiban Dam with Laiban-Taytay 1st Waterway
*17 : Agos Dam with Kaliwa-Angono Waterway
*18 : Kanan No.2 Dam (for Hydropower)
*19 : Kaliwa Low Dam with Kaliwa-Angono 1st Waterway
*20 : 1) Laiban Dam with Kaliwa-Angono 1st Waterway, 2) Agos Dam with Kaliwa-Angono 2nd Waterway
*21 : Kanan No.2 Dam (for Hydropower)
*22 : Laiban Low Dam with Laiban-Angono 1st Waterway
*23 : 1) Kanan No.2 Dam with Kanan-Laiban Water Transfer Tunnel and Laiban-Angono 1st Waterway, 2) Laiban-Angono 2nd Waterway
*24 : Agos Dam (for Hydropower)

Figures

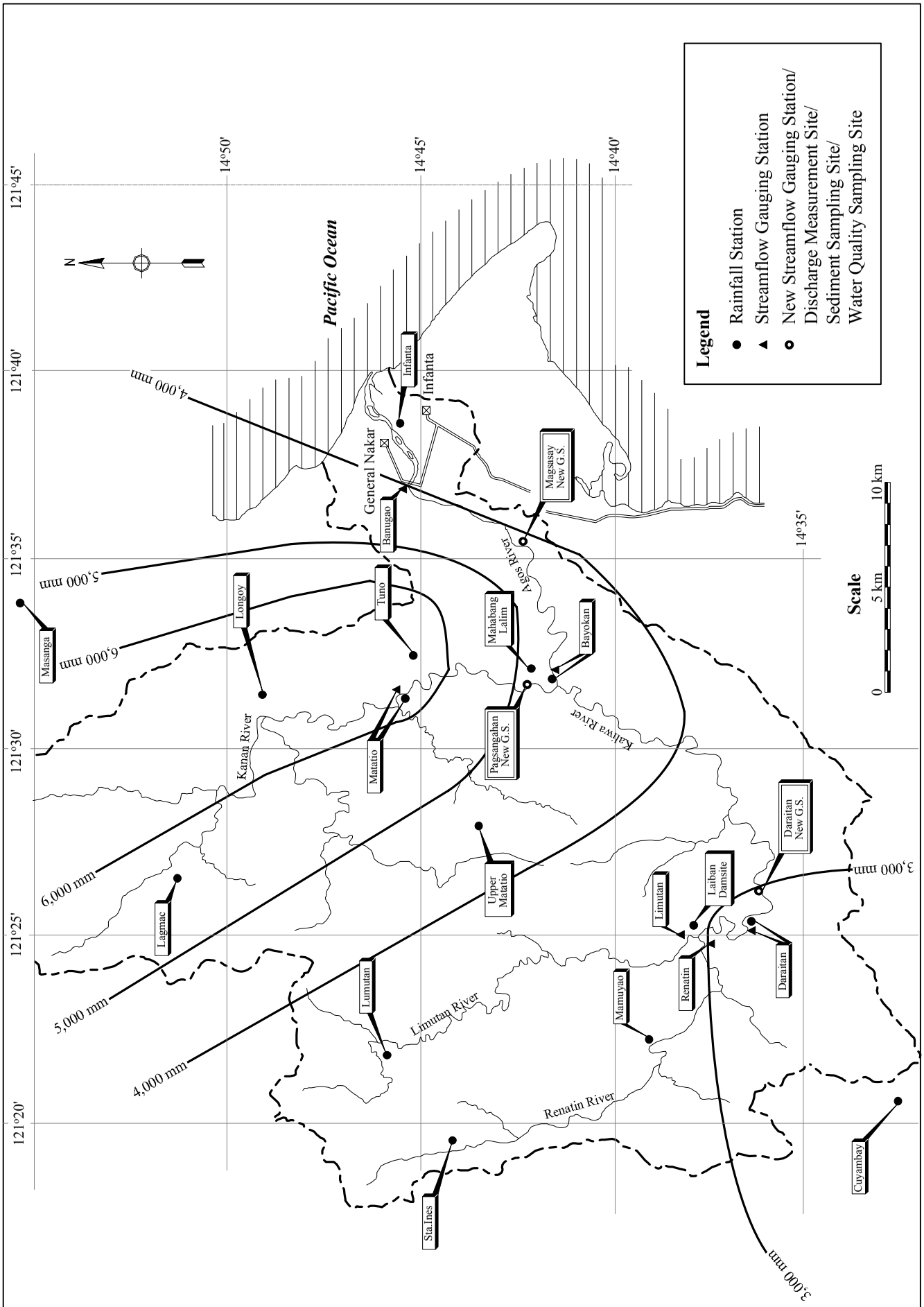
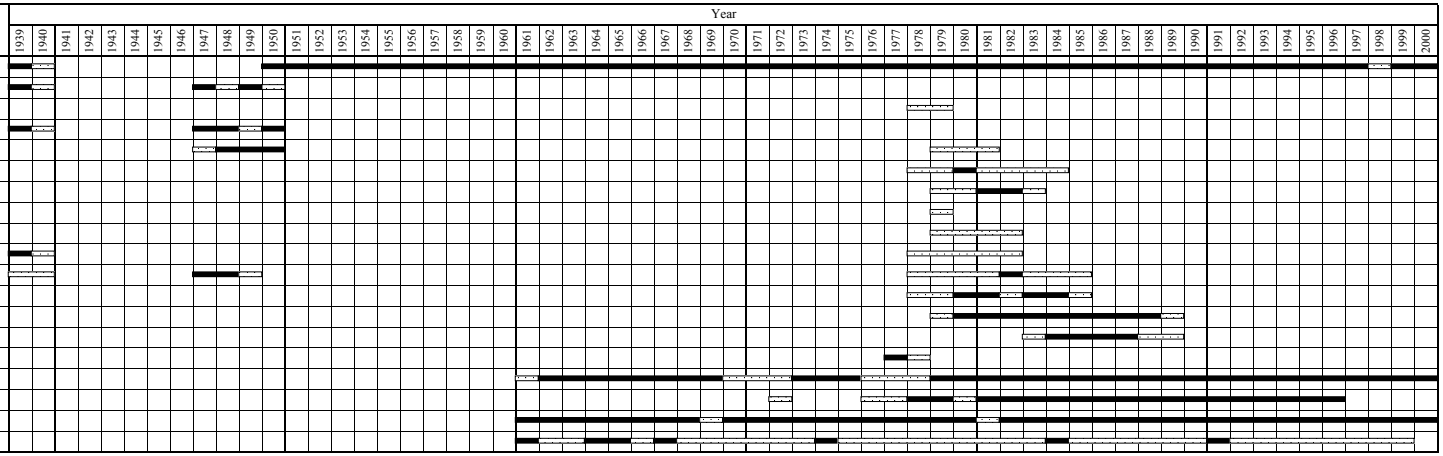


Figure C2.1
Location Map of Hydrological Station

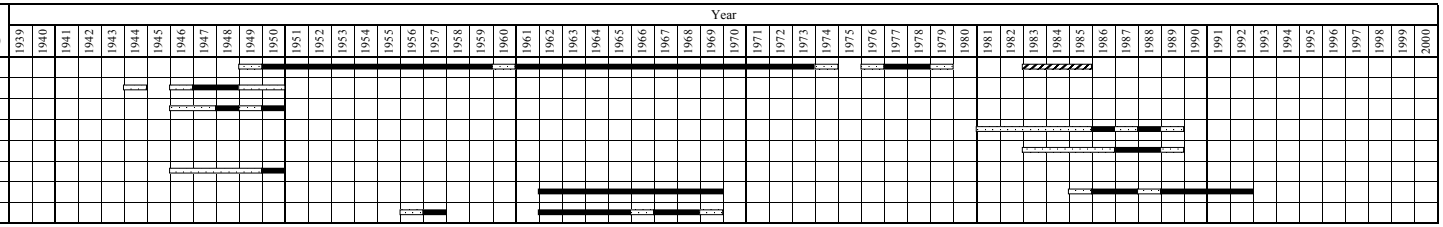
Rainfall

No.	Station Name	Location		River Basin	Elevation (El.m)
		Latitude	Longitude		
1	Infanta	N 14°45'00"	E 121°39'00"	Agos	7
2	Bayokan	N 14°42'00"	E 121°33'00"	Agos	140
3	Mahabang Lalim	N 14°42'00"	E 121°32'00"	Agos	60
4	Matatio	N 14°46'00"	E 121°31'00"	Kanan	130
5	Upper Matatio	N 14°43'10"	E 121°28'00"	Kanan	170
6	Tuno	N 14°45'50"	E 121°32'30"	Kanan	500
7	Masanga	N 14°59'36"	E 121°32'06"	Kanan	300
8	Lagmac	N 14°51'24"	E 121°27'06"	Kanan	260
9	Longoy	N 14°49'10"	E 121°31'20"	Kanan	610
10	Sta. Ines	N 14°44'00"	E 121°19'00"	Kaliwa	500
11	Daraitan	N 14°36'30"	E 121°25'40"	Kaliwa	170
12	Lumutan	N 14°45'00"	E 121°21'00"	Kaliwa	508
13	Mamuyao	-	-	Kaliwa	-
14	Laiban Damiste	-	-	Kaliwa	-
15	Cuyambay	N 14°35'00"	E 121°21'00"	Kaliwa	550
16	Quezon	N 14°39'00"	E 121°03'00"	Pasig-Laguna	43
17	Bosoboso	N 14°38'00"	E 121°14'00"	Pasig-Laguna	0
18	Baguio	N 16°25'00"	E 120°36'00"	Agno	1,500
19	NAIA	N 14°31'00"	E 121°01'00"	Pasig-Laguna	11



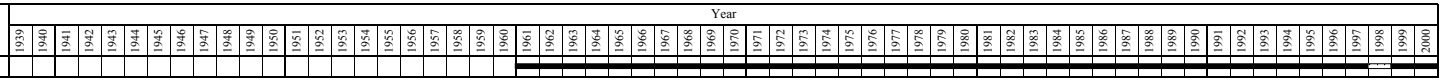
Discharge

No.	Station Name	Location		River Basin	Drainage Area (km^2)
		Latitude	Longitude		
1	Banugao	N 14°45'15"	E 121°36'45"	Agos	879
2	Bayokan	N 14°42'00"	E 121°32'00"	Agos	869
3	Daraitan	N 14°36'00"	E 121°26'00"	Kaliwa	326
4	Lenatin	N 14°37'40"	E 121°25'00"	Kaliwa	131
5	Limutan	N 14°38'00"	E 121°25'00"	Kaliwa	145
6	Matatio	N 14°46'00"	E 121°31'00"	Kanan	361
7	Sto. Nino	N 14°38'15"	E 121°05'30"	Marikina	499
8	San Rafael	N 14°44'00"	E 121°10'20"	Marikina	282



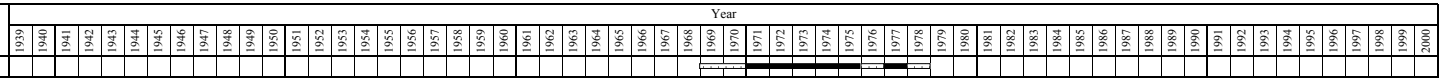
Temperature

No.	Station Name	Location		River Basin	Elevation (El.m)
		Latitude	Longitude		
1	Infanta	N 14°45'00"	E 121°39'00"	Agos	7



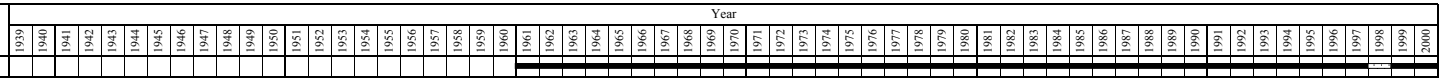
Evaporation

No.	Station Name	Location		River Basin	Elevation (El.m)
		Latitude	Longitude		
1	Cuyambay	N 14°35'00"	E 121°21'00"	Kaliwa	550



Relative Humidity

No.	Station Name	Location		River Basin	Elevation (El.m)
		Latitude	Longitude		
1	Infanta	N 14°45'00"	E 121°39'00"	Agos	7



Wind Speed/Direction

No.	Station Name	Location		River Basin	Elevation (El.m)
		Latitude	Longitude		
1	Infanta	N 14°45'00"	E 121°39'00"	Agos	7

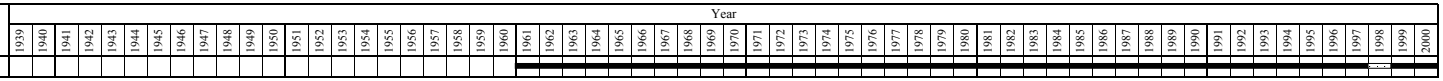


Figure C2.2 Available Hydrological Data

Figure C3.1
Hydrological Investigation Works

Automatic Water Level Recorder (Agos River)

Discharge Measurement (Kaliwa River)

Staff Gauge (Kaliwa River)

Cable System (Kanan River)

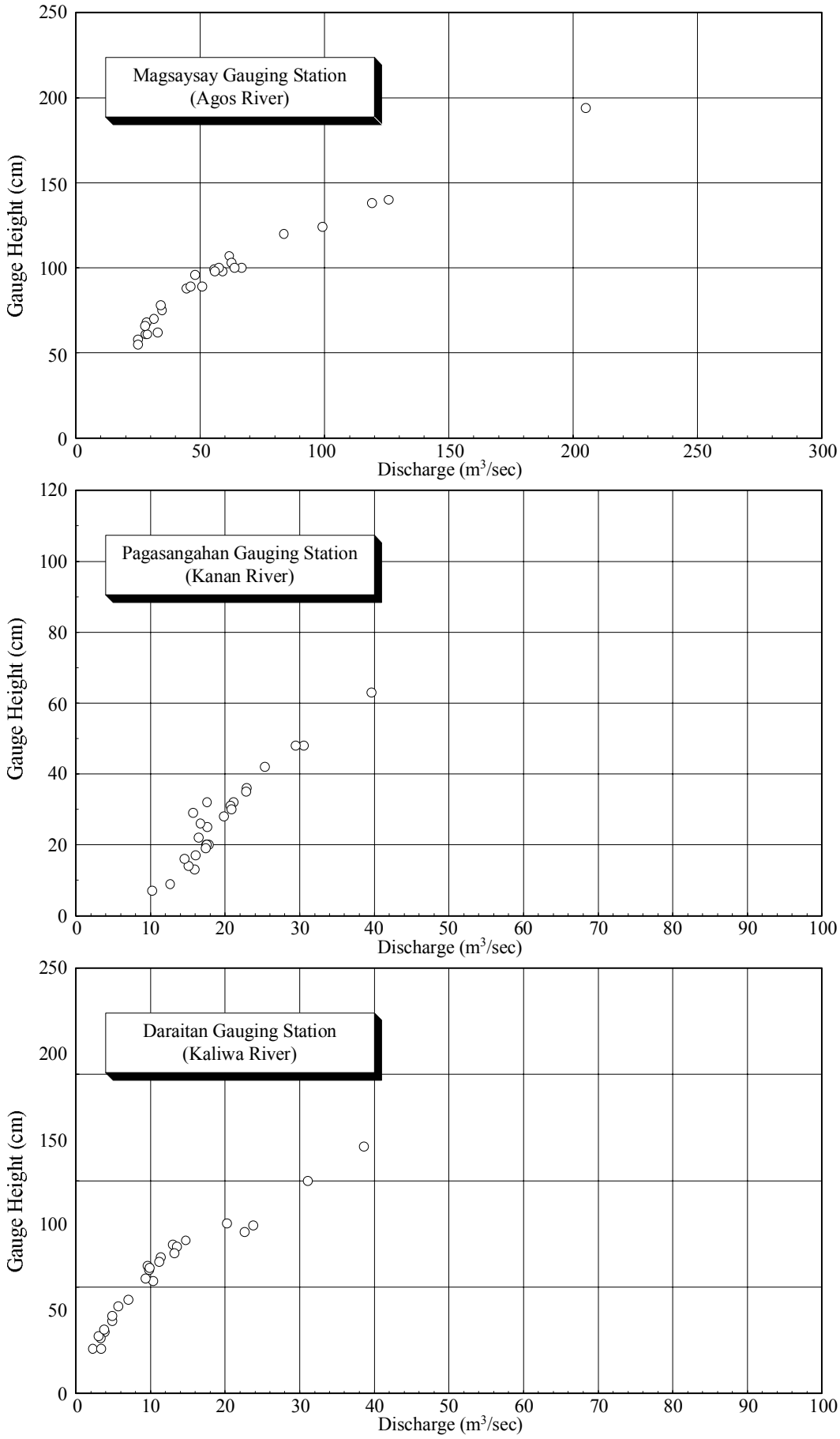


Figure C3.2
Discharge Measurement Record

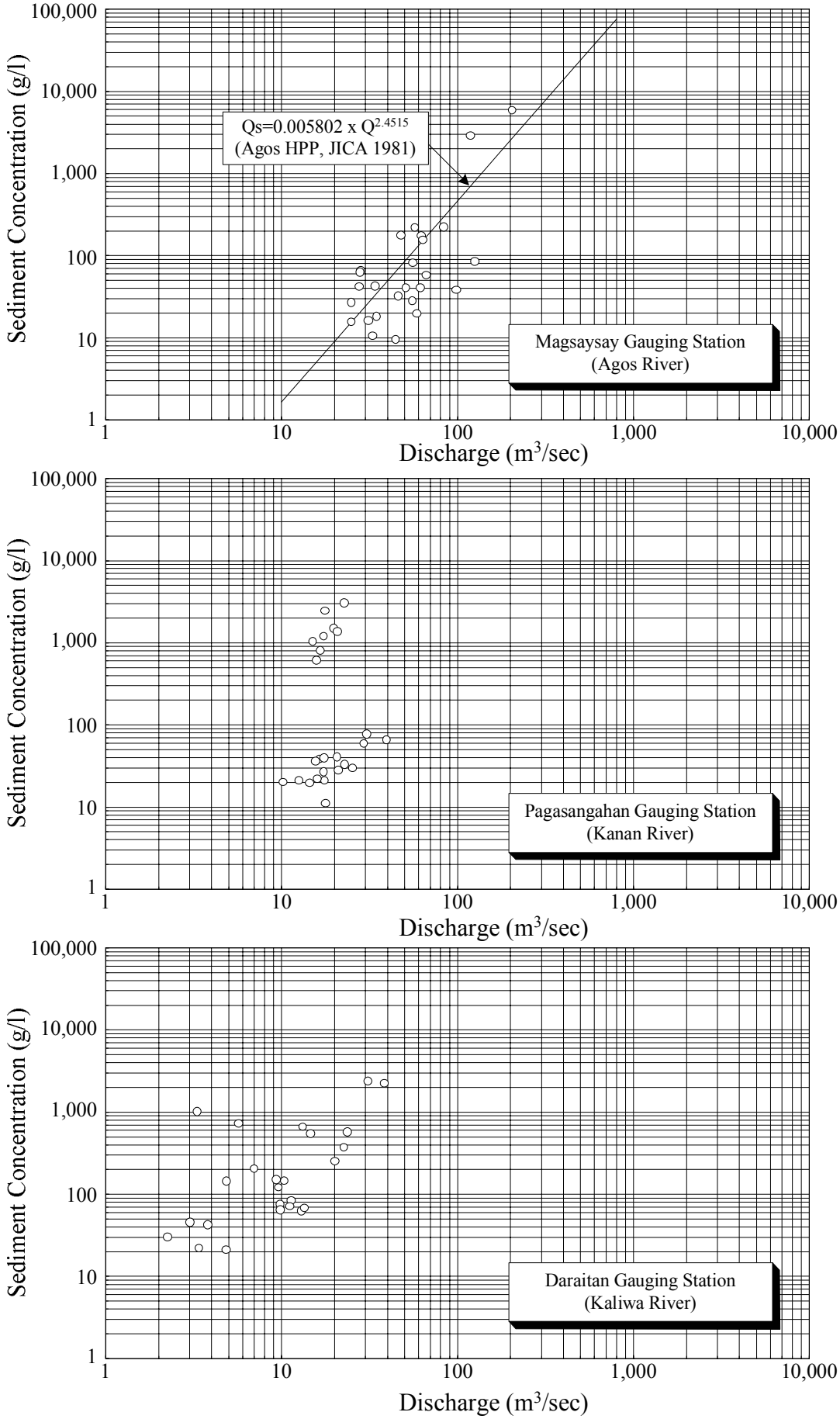


Figure C3.3
Sediment Sampling Result

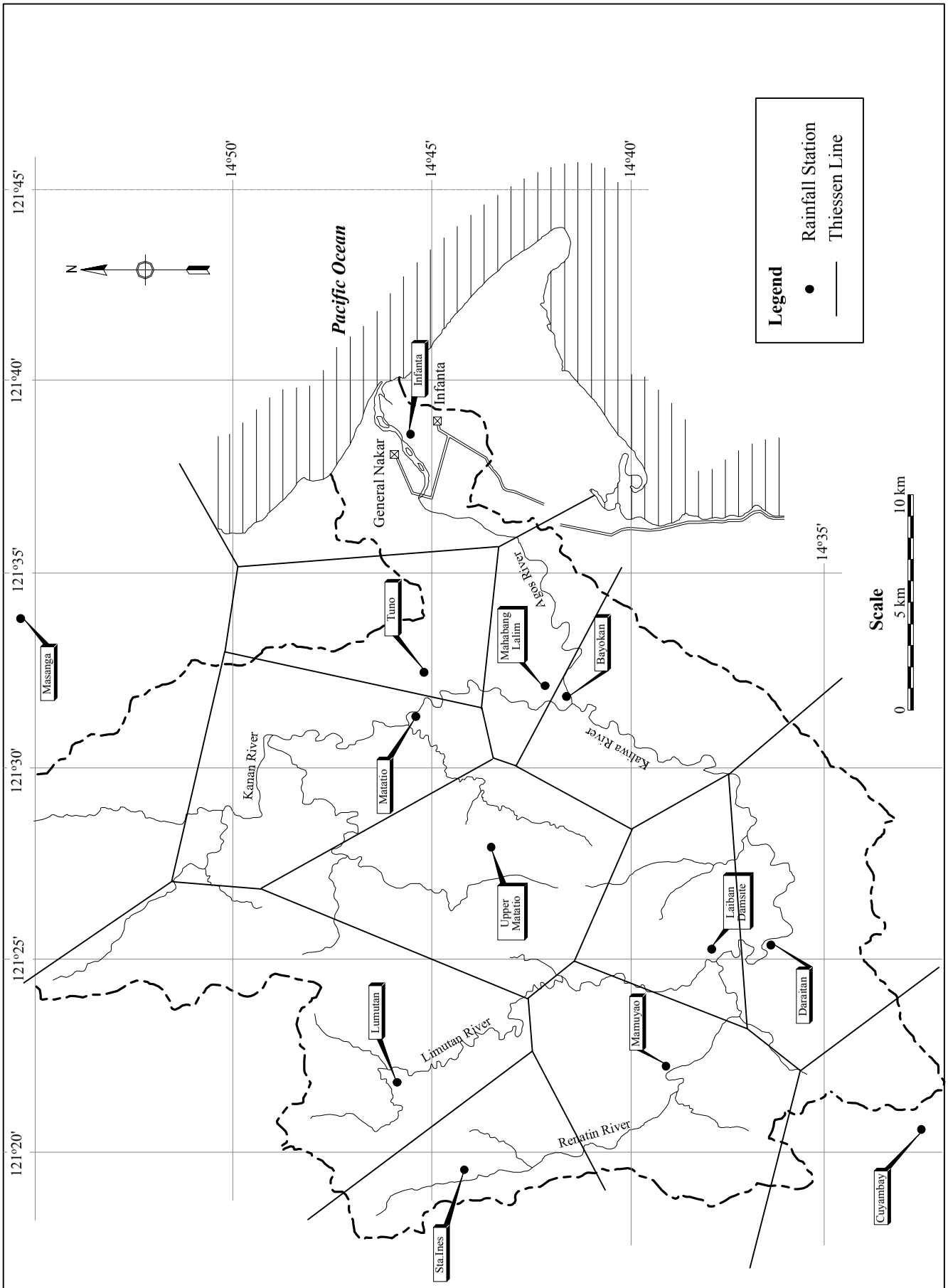


Figure C5.1
Thiessen Polygon in the Agos River Basin

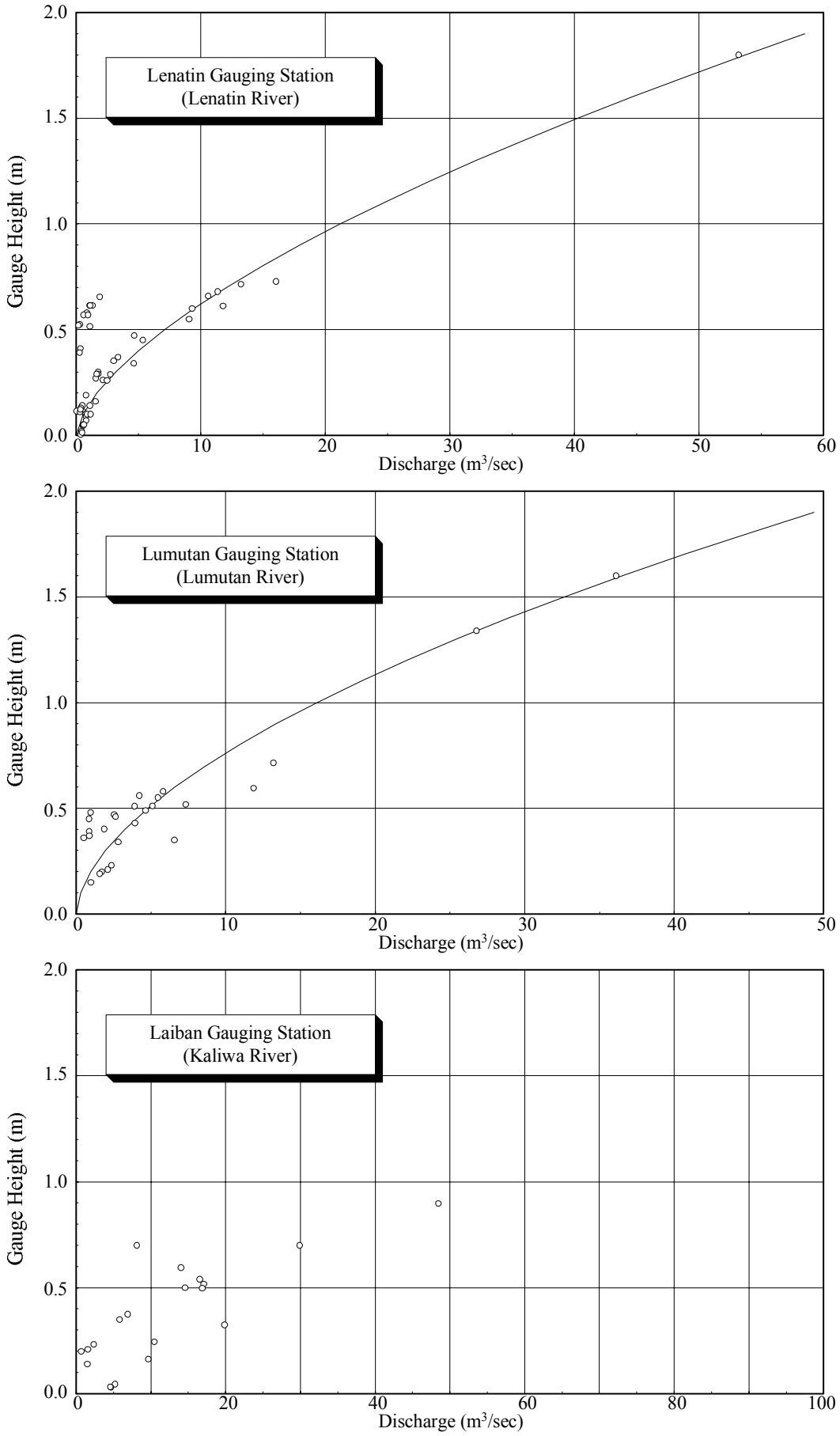


Figure C6.1
Rating Curve at Lenatin G.S. and Limutan G.S.
and Discharge Measurement Record at Laiban G.S.

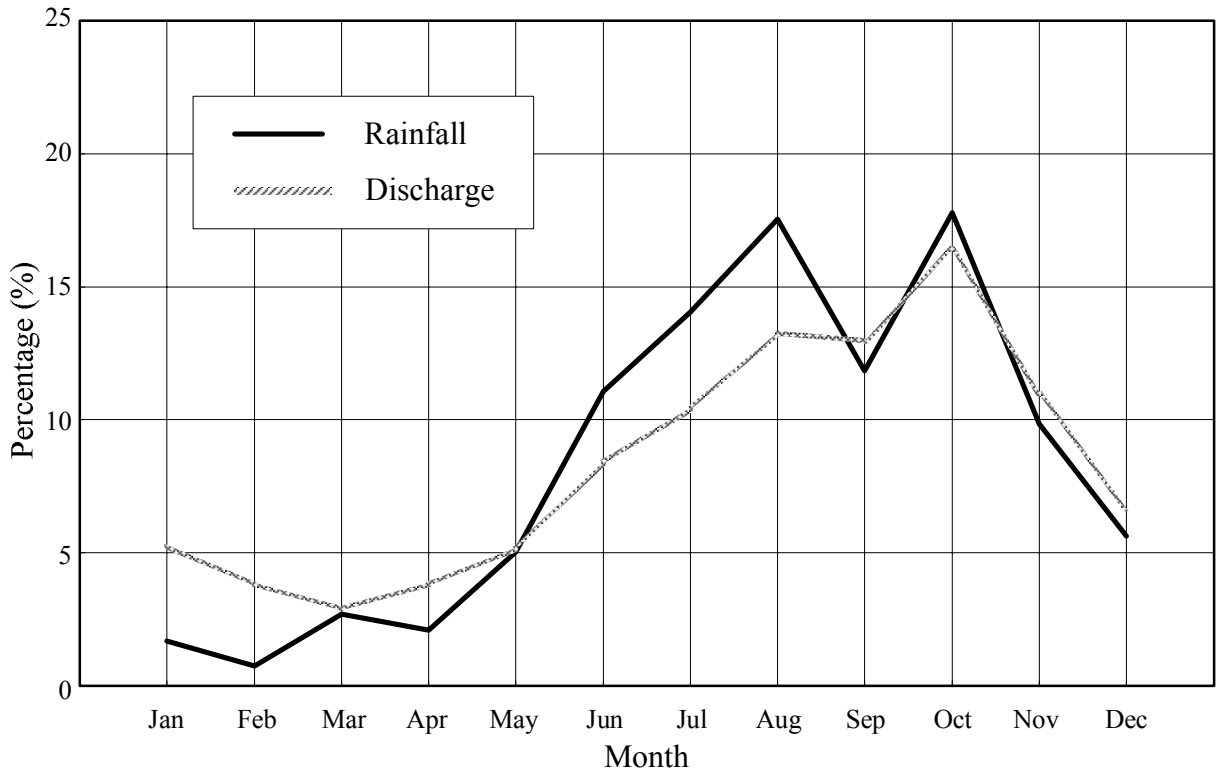


Figure C6.2 Monthly Discharge Pattern and Mean Monthly Rainfall Pattern at Laiban Damsite

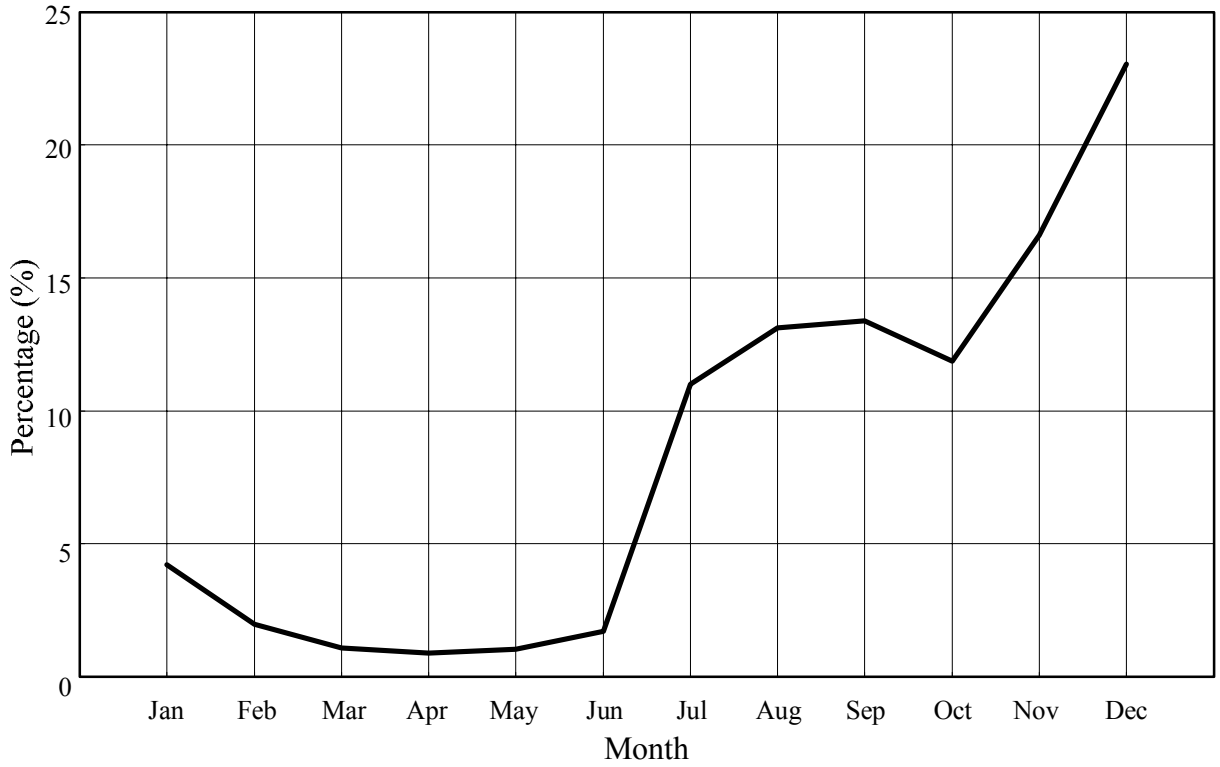
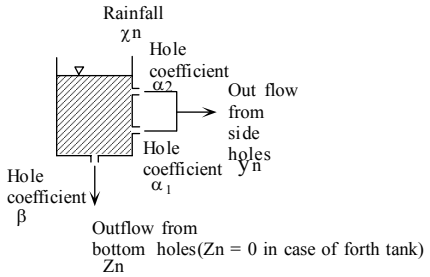
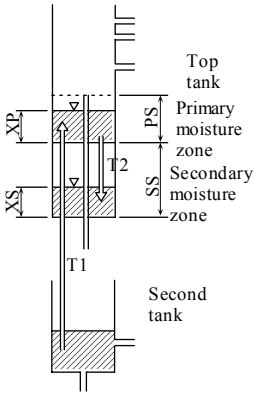


Figure C6.3 Monthly Discharge Pattern at Daraitan Gauging Station



Tank model for Secondary to Forth Tanks



Soil Moisture Model for Top Tank

Parameters for Soil Moisture Model

PS : Primary soil moisture capacity (=150 mm)

SS : Secondary soil moisture capacity (=500 mm)

XP : Primary soil moisture depth

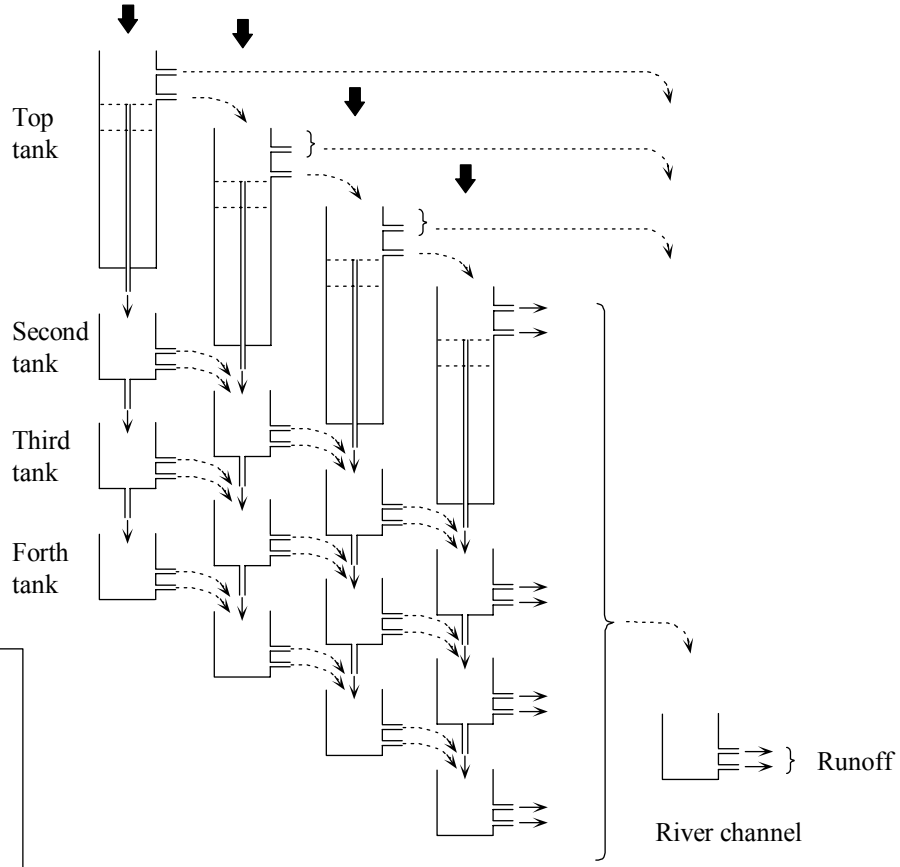
XS : Secondary soil moisture depth

T1 : Transfer by capitary action from lower tanks

$T1 = TB \times (1 - \frac{XP}{PS})$: TB = constant

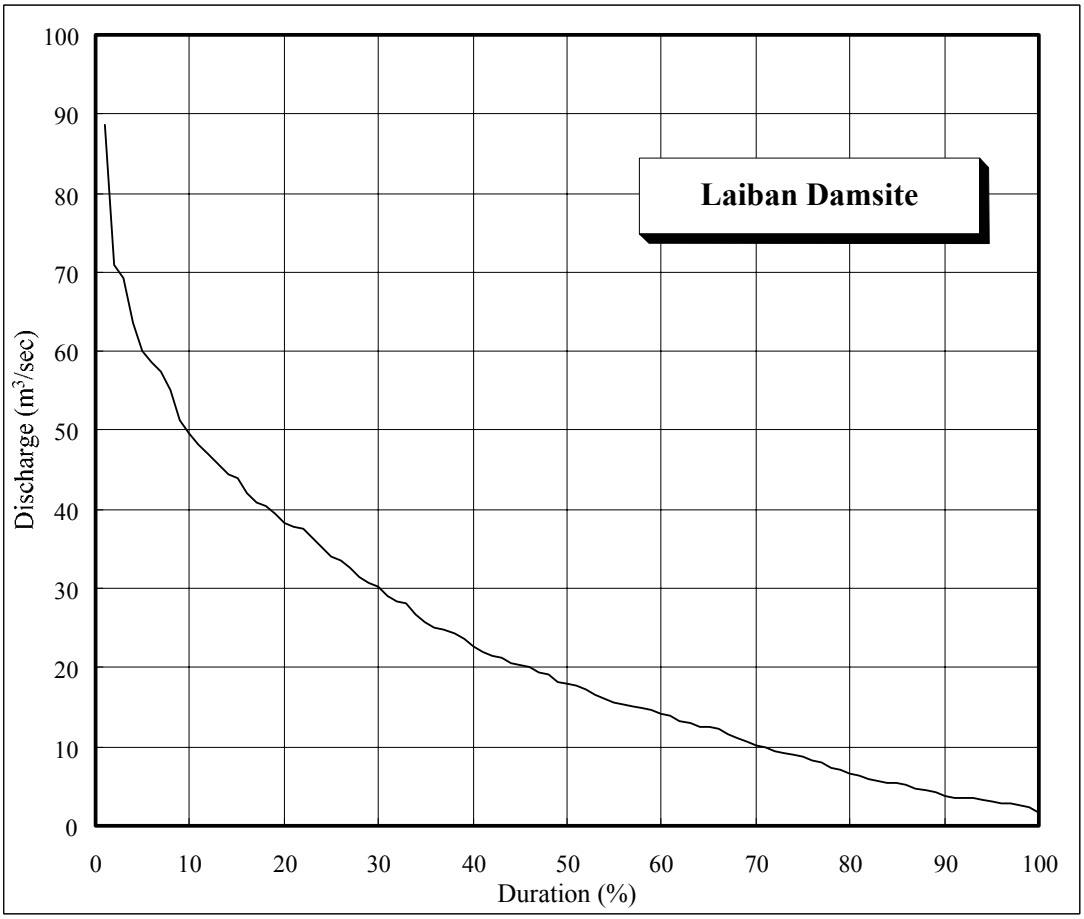
T2 : Transfer of moisture between primary and secondary zones

$T2 = TC \times (\frac{XP}{PS} - \frac{XS}{SS})$: TC = constant



Structure of Composite Tank Model

Figure C6.4 Concept of Composite Tank Model



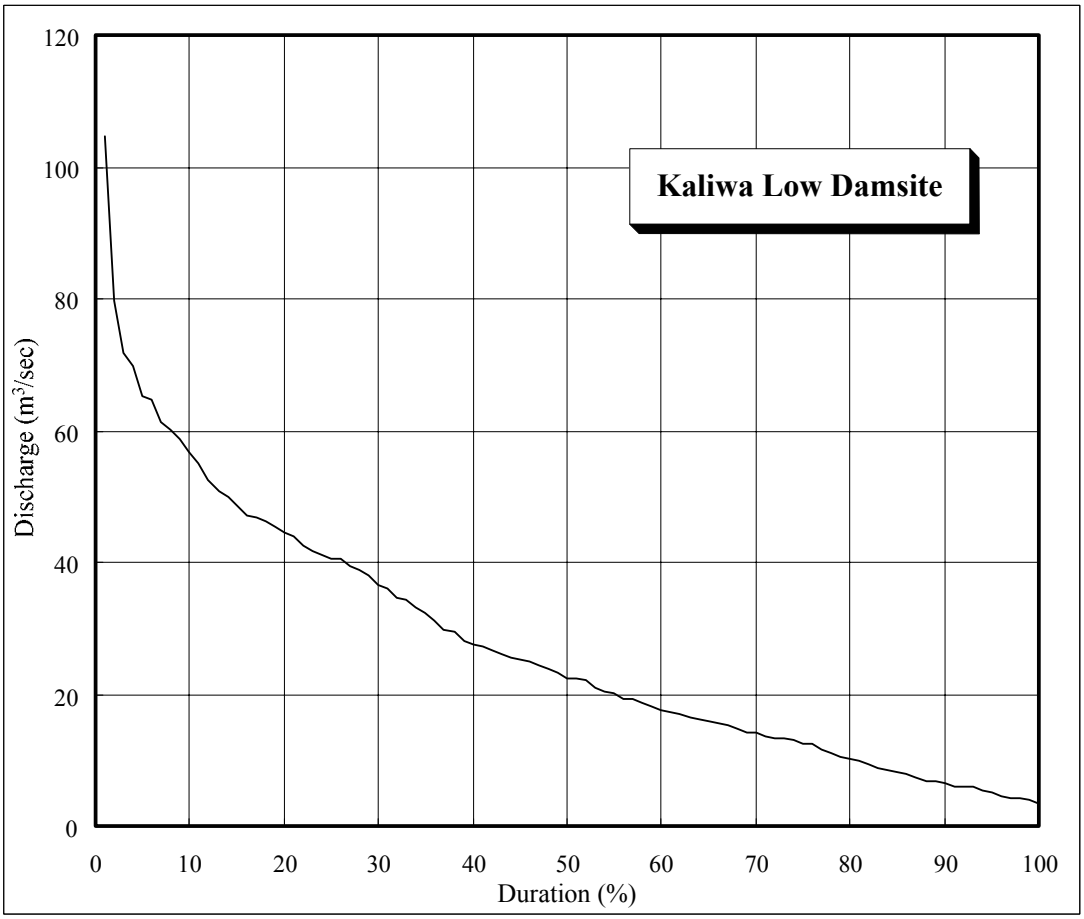
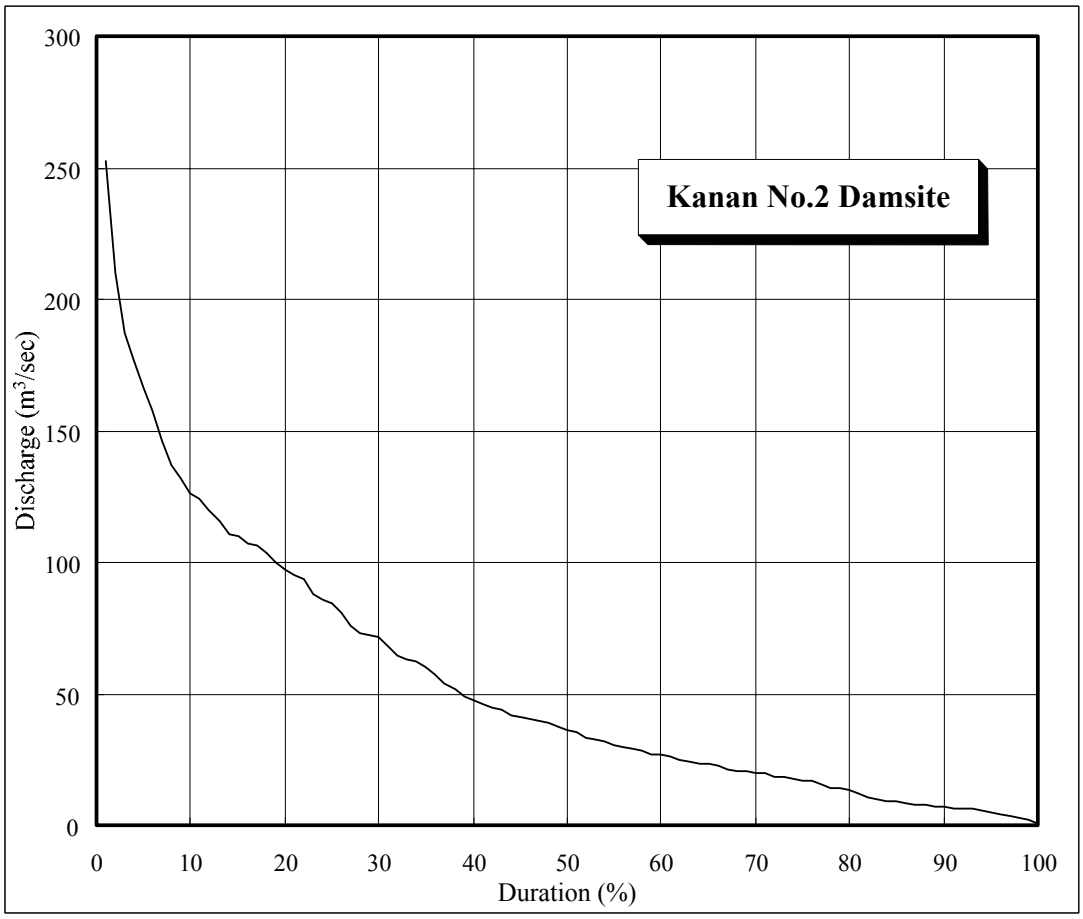


Figure C6.5
Flow Duration Curve (1/3)



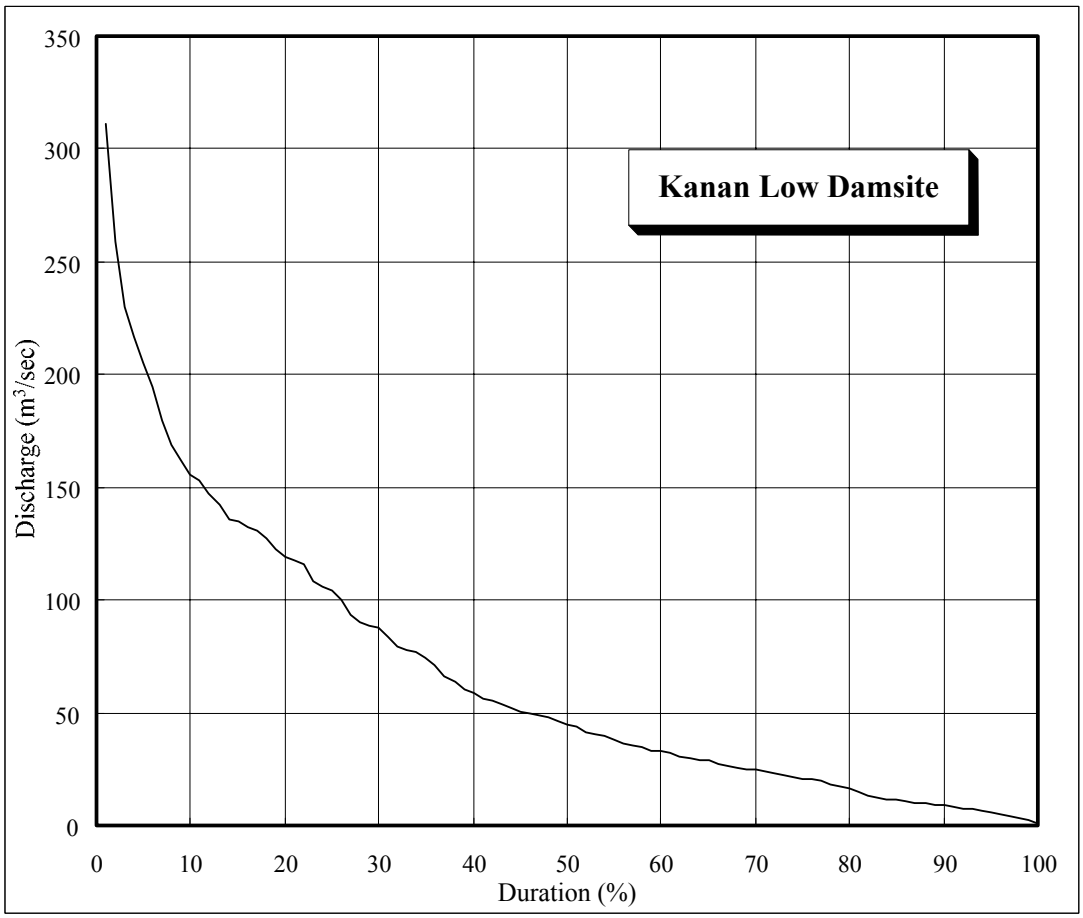


Figure C6.5
Flow Duration Curve (2/3)

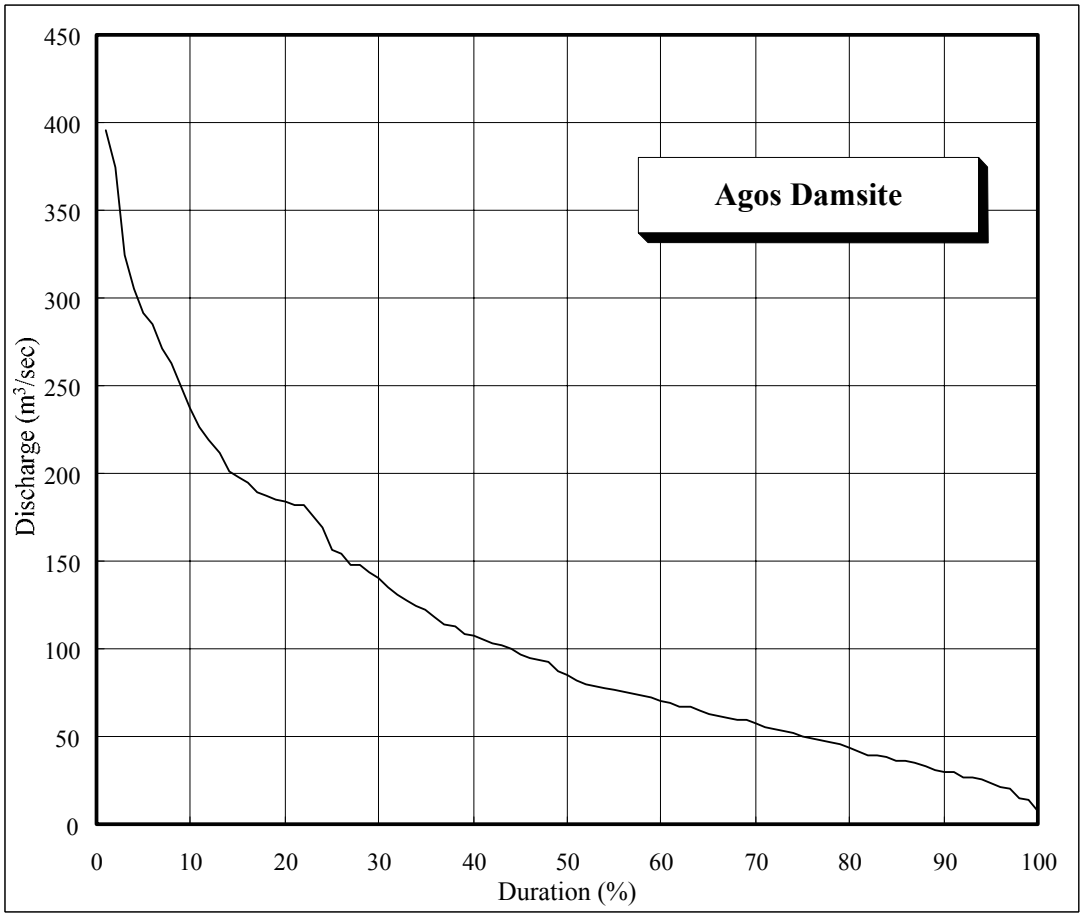


Figure C6.5
Flow Duration Curve (3/3)

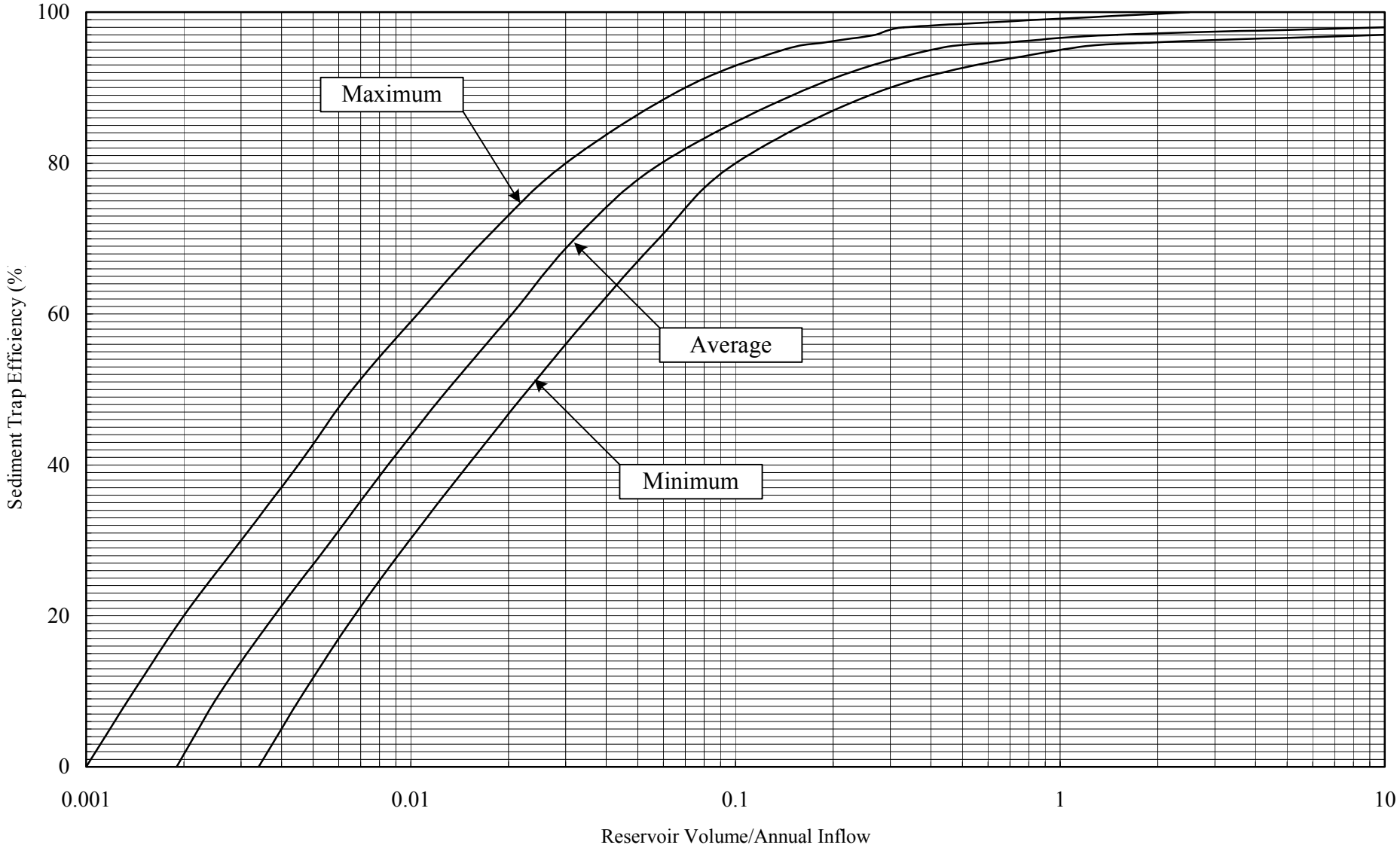


Figure C8.1 Sediment Trap Efficiency in Reservoir