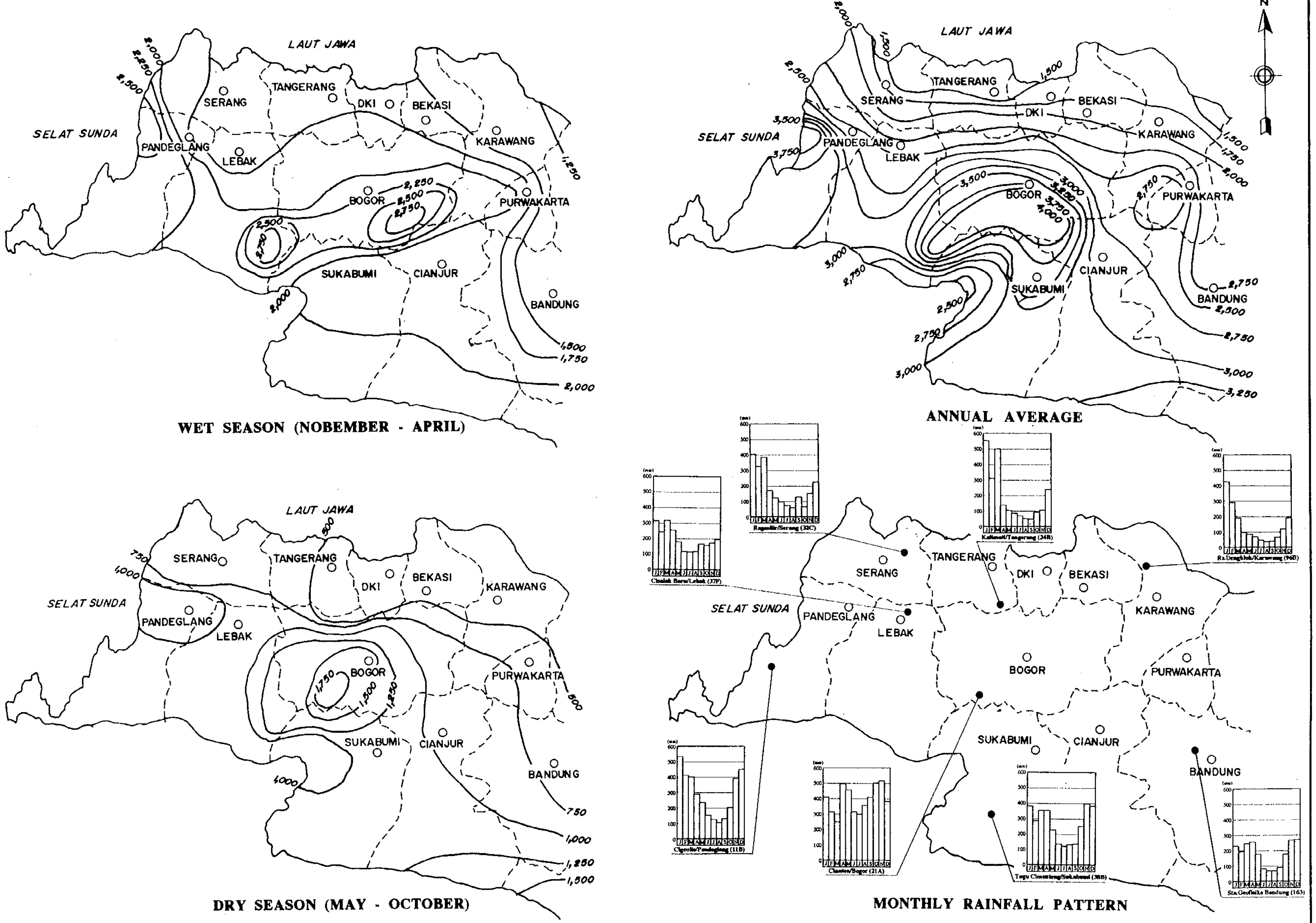


Figure 3 ISOHYETAL MAP OF ANNUAL RAINFALL IN WEST JAVA

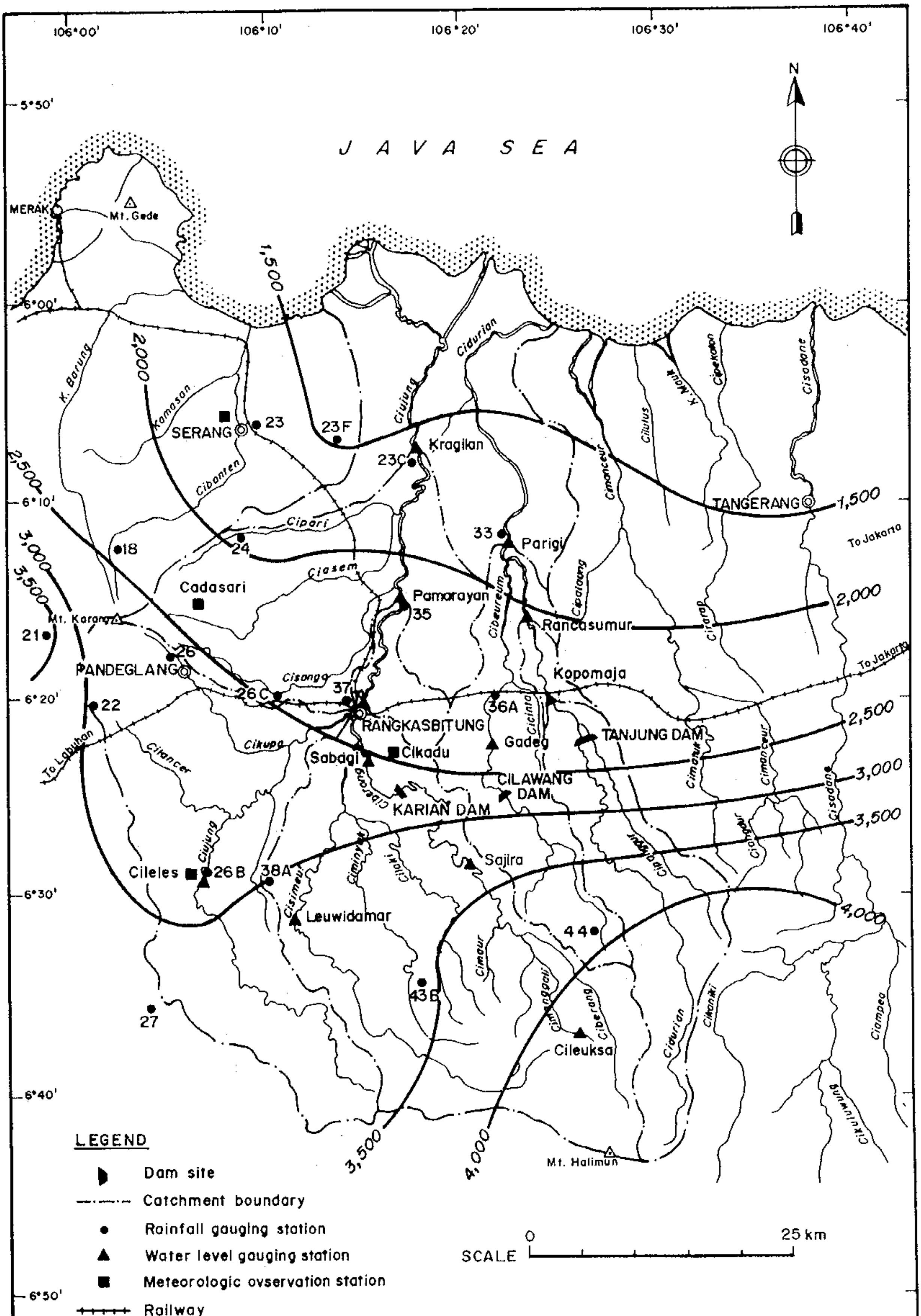


Figure 4 ISOHYETAL MAP OF ANNUAL RAINFALL IN THE CIUJUNG AND CIDURIAN RIVER BASINS

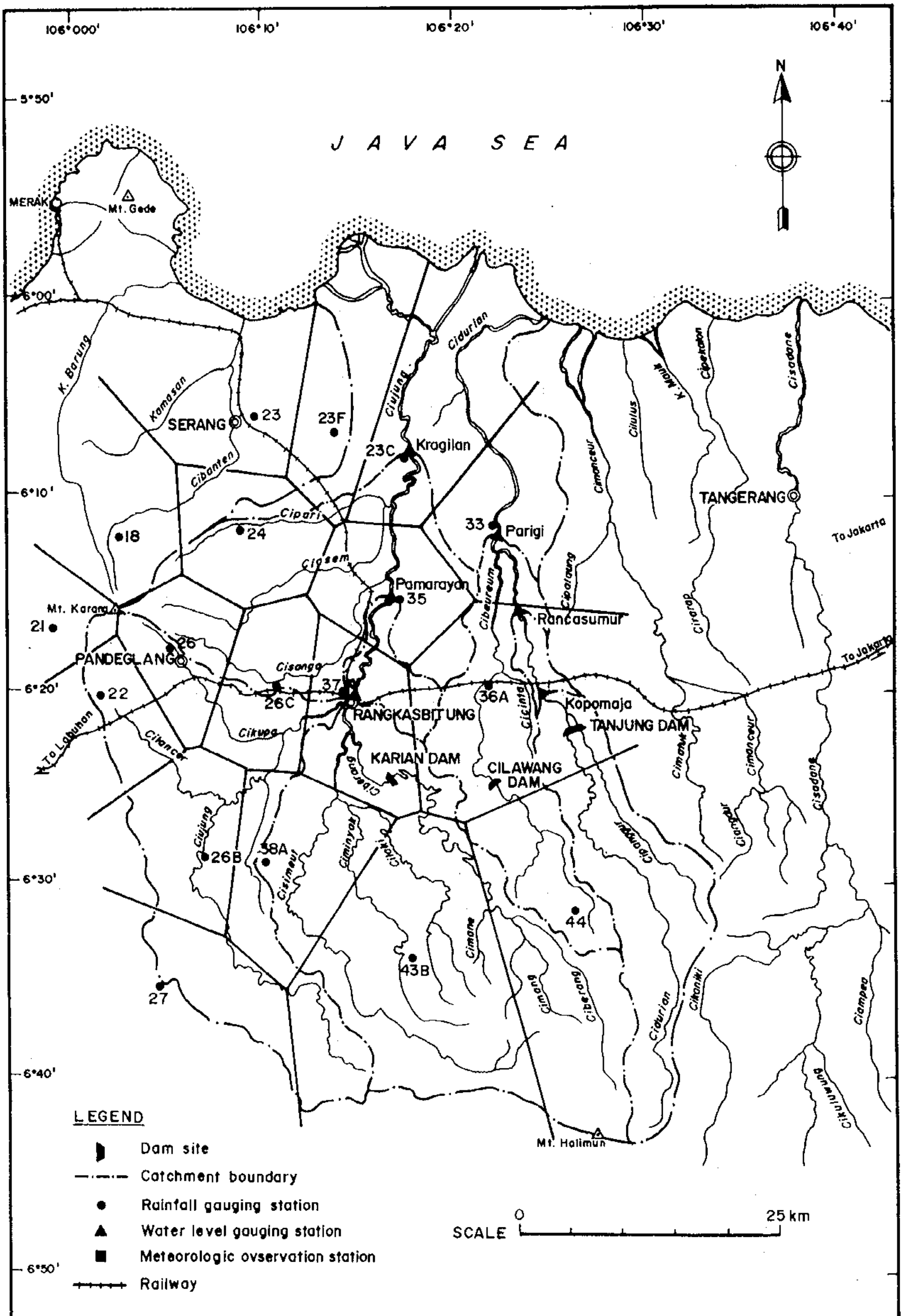
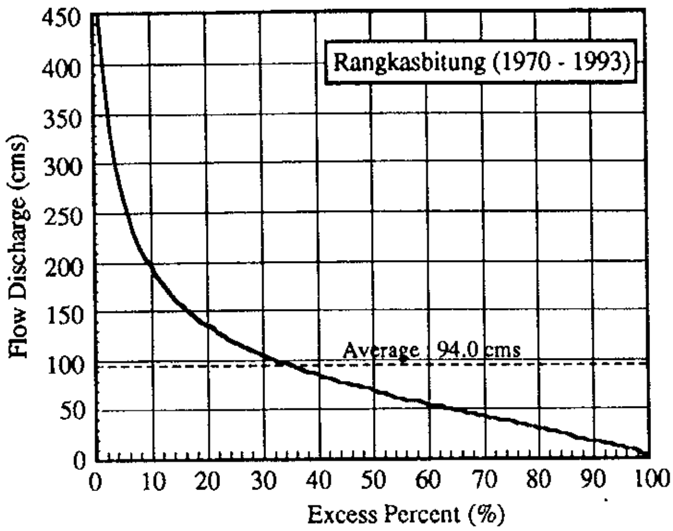
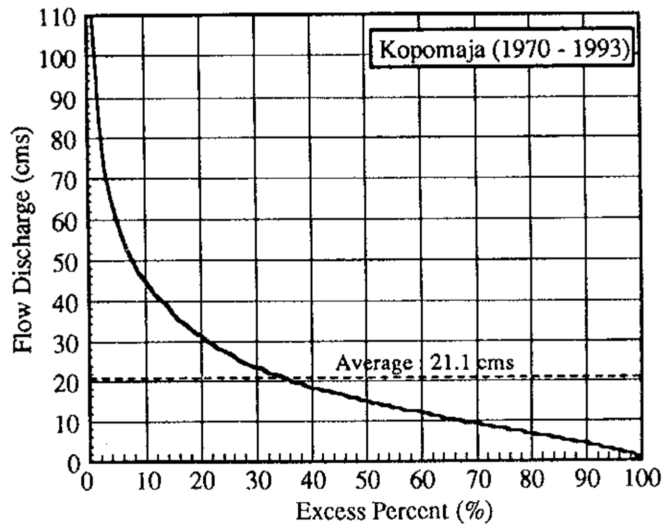


Figure 5 THIESSEN POLYGON

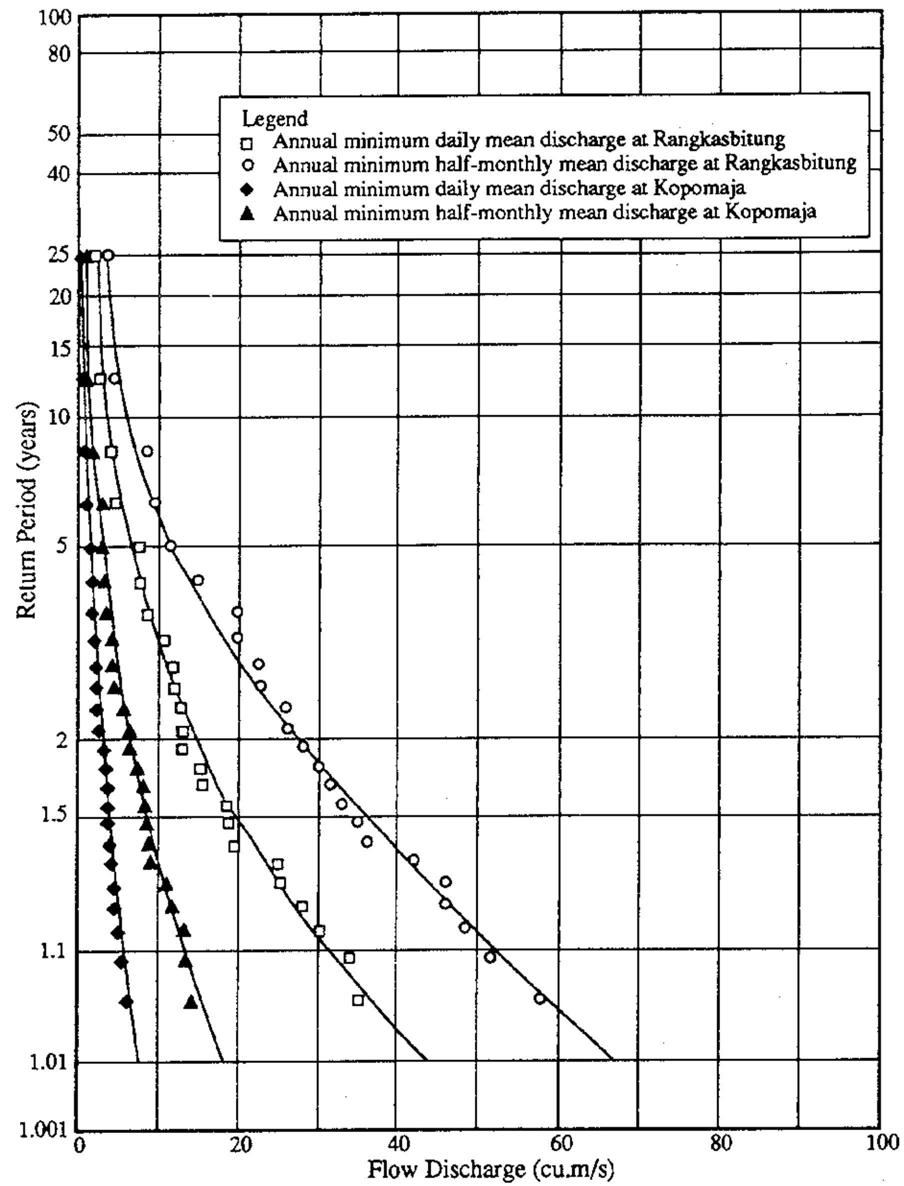


Maximum : 1010.0 cms Minmum : 2.3 cms Average : 94.0 cms	
Excess Percent (%)	Discharge (cms)
1	446.0
5	267.0
10	196.0
25	118.0
50	68.5
75	37.5
80	31.4
90	18.1
95	12.8
97	10.1
100	2.3



Maximum : 302.0 cms Minmum : 0.1 cms Average : 21.1 cms	
Excess Percent (%)	Discharge (cms)
1	105.0
5	60.1
10	45.0
25	26.6
50	14.9
75	7.9
80	6.7
90	4.2
95	2.6
97	2.0
100	0.1

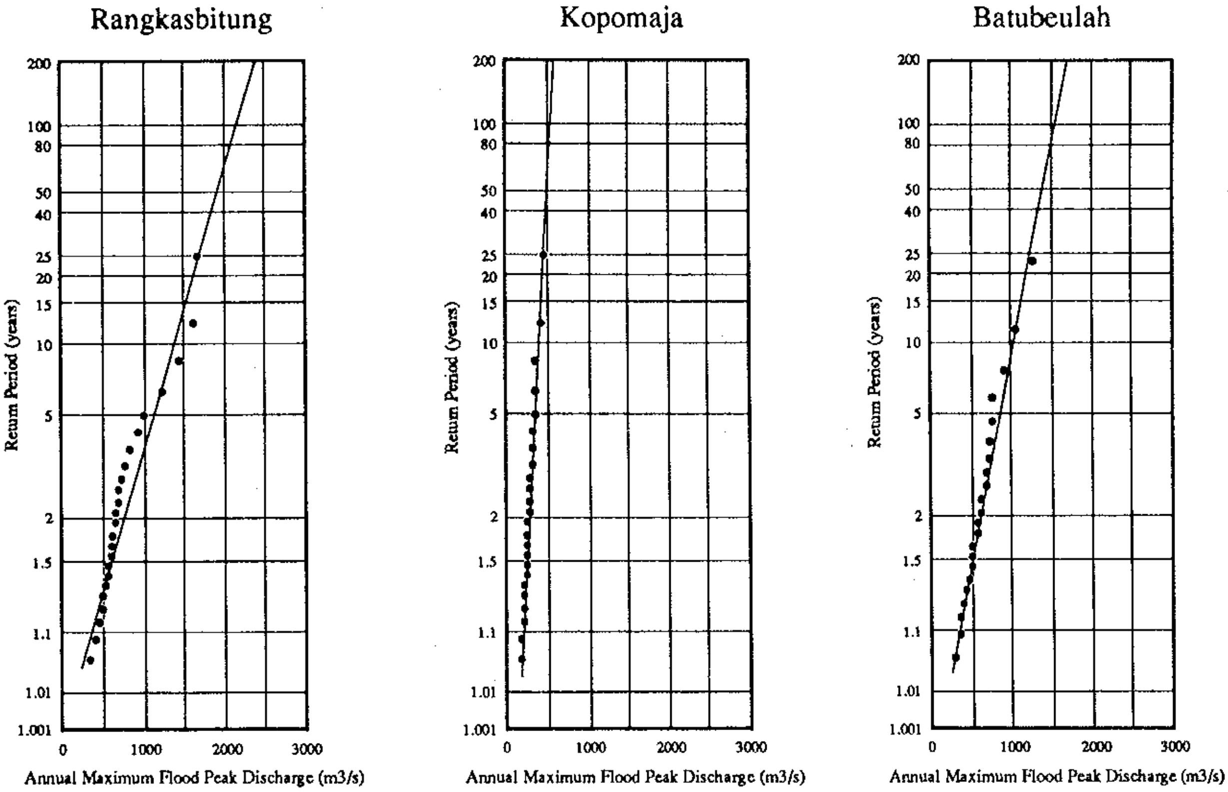
Figure 6 FLOW DISCHARGE DURATION CURVES AT RANGKASBITUNG AND KOPOMAJA



Return Period (years)	Probable Drought Discharges (cu.m/s)			
	Rangkasbitung		Kopomaja	
	Daily	Half-month	Daily	Half-month
2	14.9	26.4	2.7	6.4
5	7.0	11.7	1.3	3.5
10	3.5	5.5	0.9	1.2
20	2.4	3.8	0.4	0.7

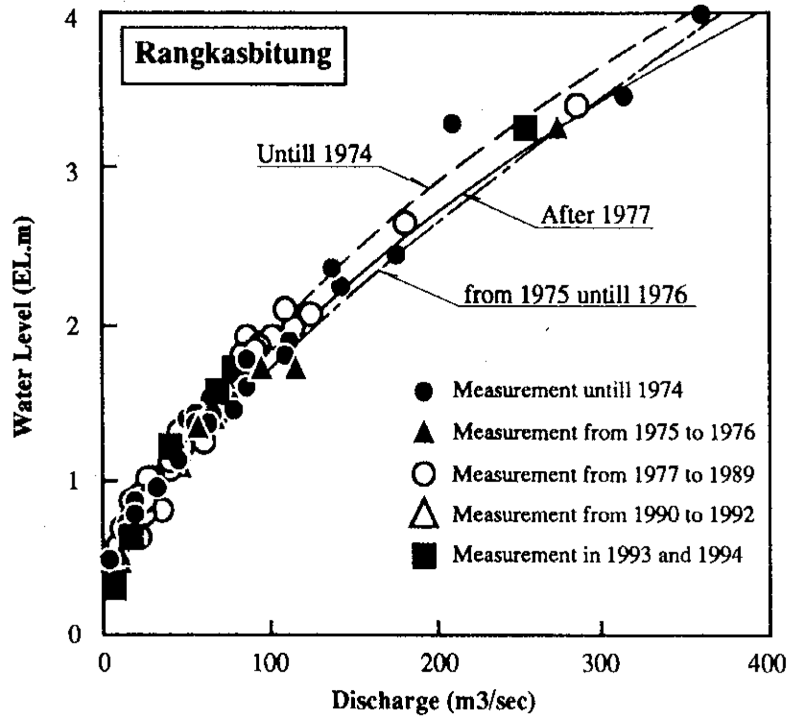
Return Period (years)	Probable Drought Discharges (cu.m/s)			
	Pamarayan Weir		Rancasumur Weir	
	Daily	Half-month	Daily	Half-month
2	15.5	27.4	3.2	7.7
5	7.3	12.1	1.6	4.2
10	3.6	5.7	1.1	1.4
20	2.5	3.9	0.5	0.8

Figure 7 FREQUENCY CURVE FOR ANNUAL MINIMUM FLOW DISCHARGESAT RANGKASBITUNG AND KOPOMAJA



Return Priod (Year)	Probable Flood Peak Discharges (cu.m/s)		
	Rangkasbitung	Kopomaja	Batubeulah
2	760	300	640
5	1,140	380	890
10	1,390	430	1,050
20	1,630	480	1,210
50	1,940	550	1,410
100	2,170	600	1,560
200	2,400	650	1,710

Figure 8 FREQUENCY CURVE FOR ANNUAL MAXIMUM FLOOD PEAK DISCHARGES BY GUMBEL METHOD



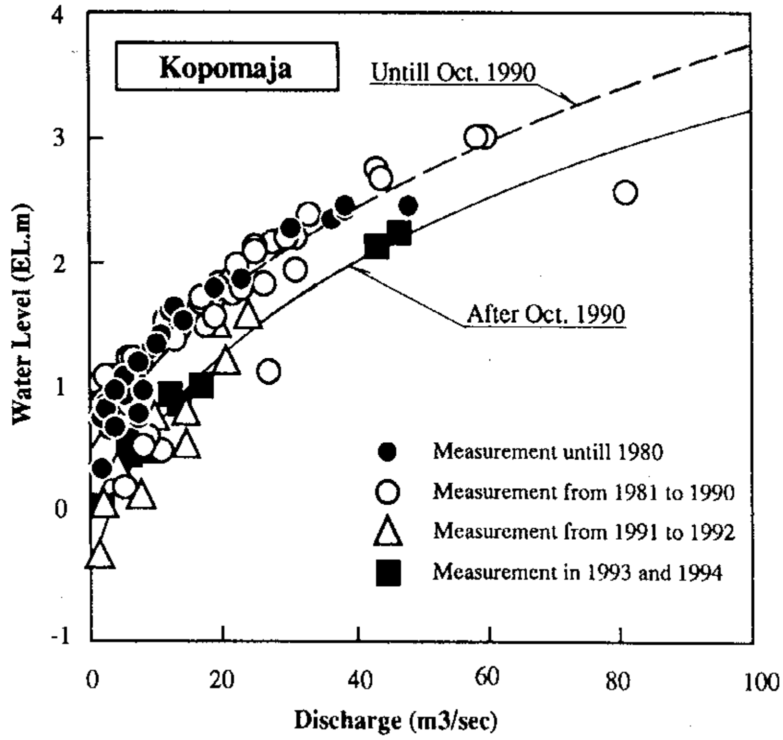
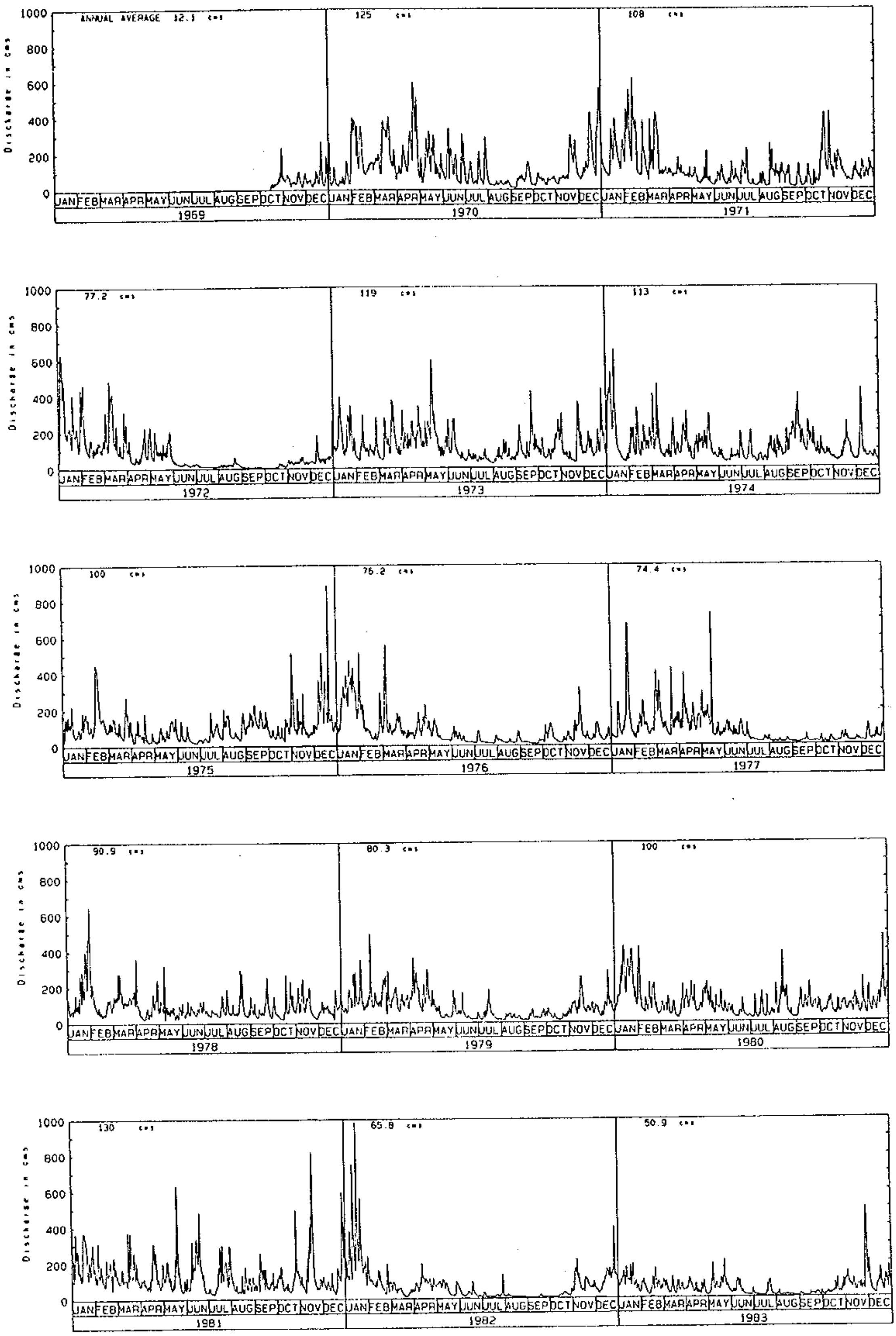
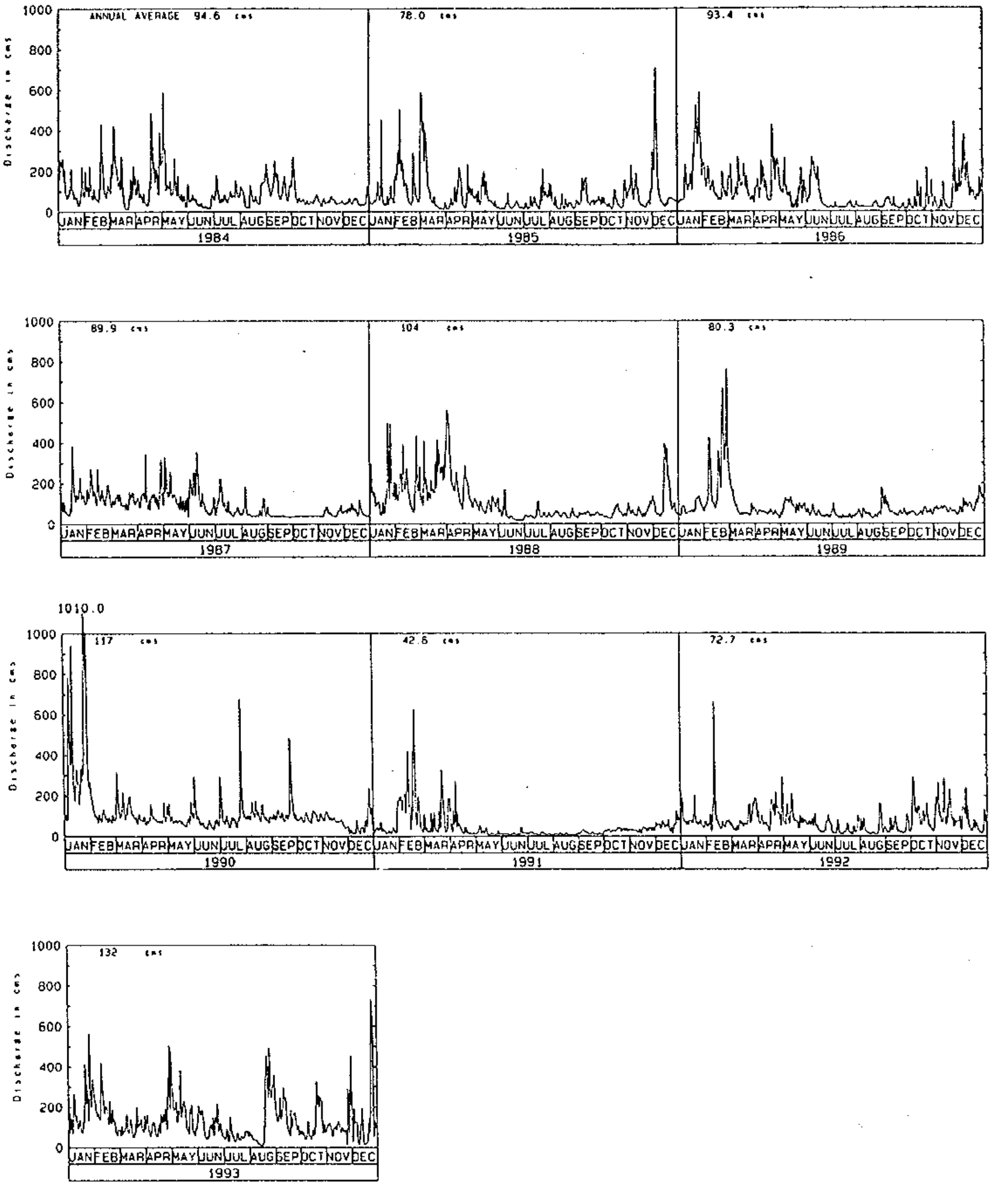


Figure 9 DISCHARGE RATING CURVES AT RANGKASBITUNG AND KOPOMAJA



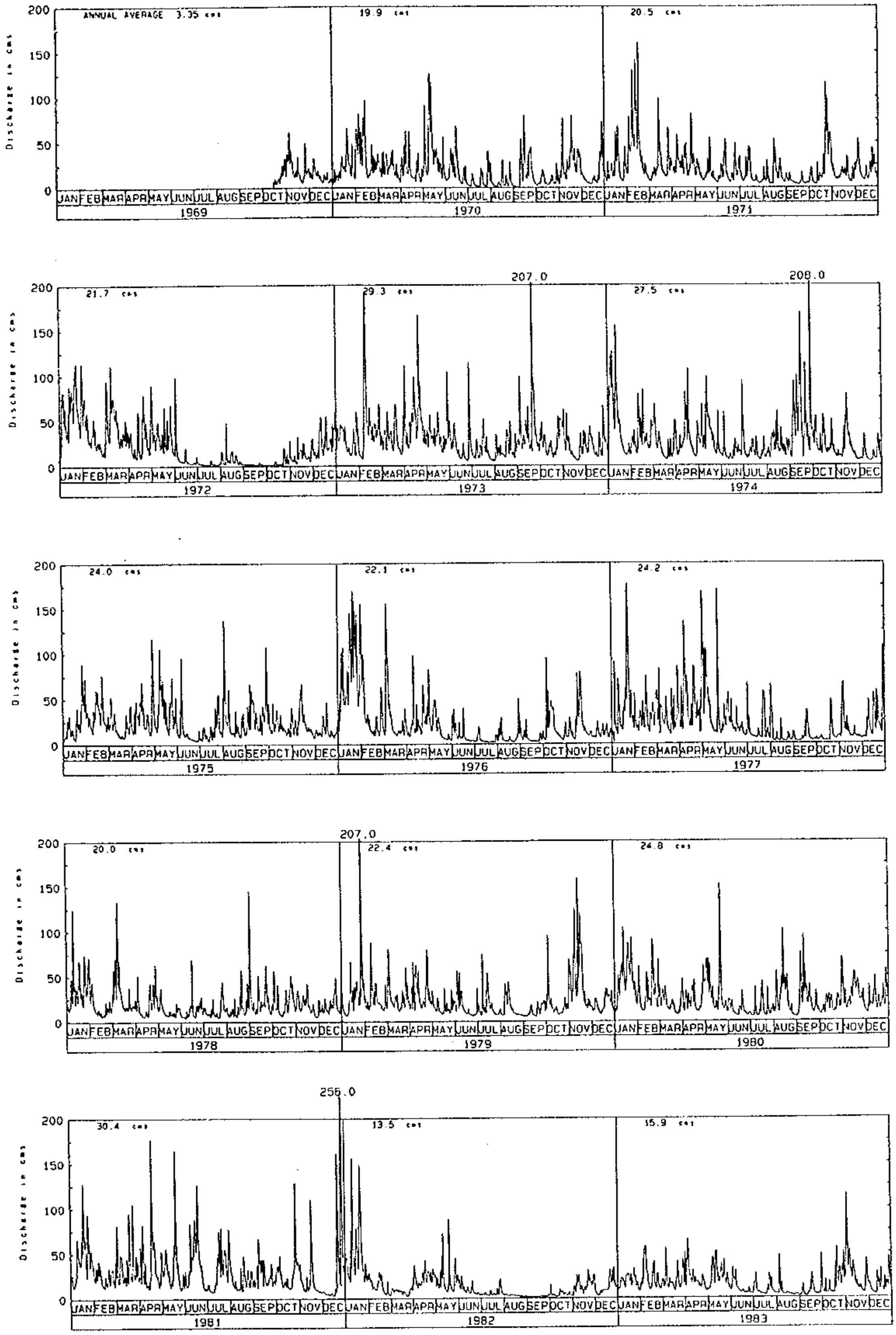
Note ; CMS shows cubic meters per second.

Figure 10 DAILY DISCHARGE HYDROGRAPH AT RANGKASBITUNG (1/2)



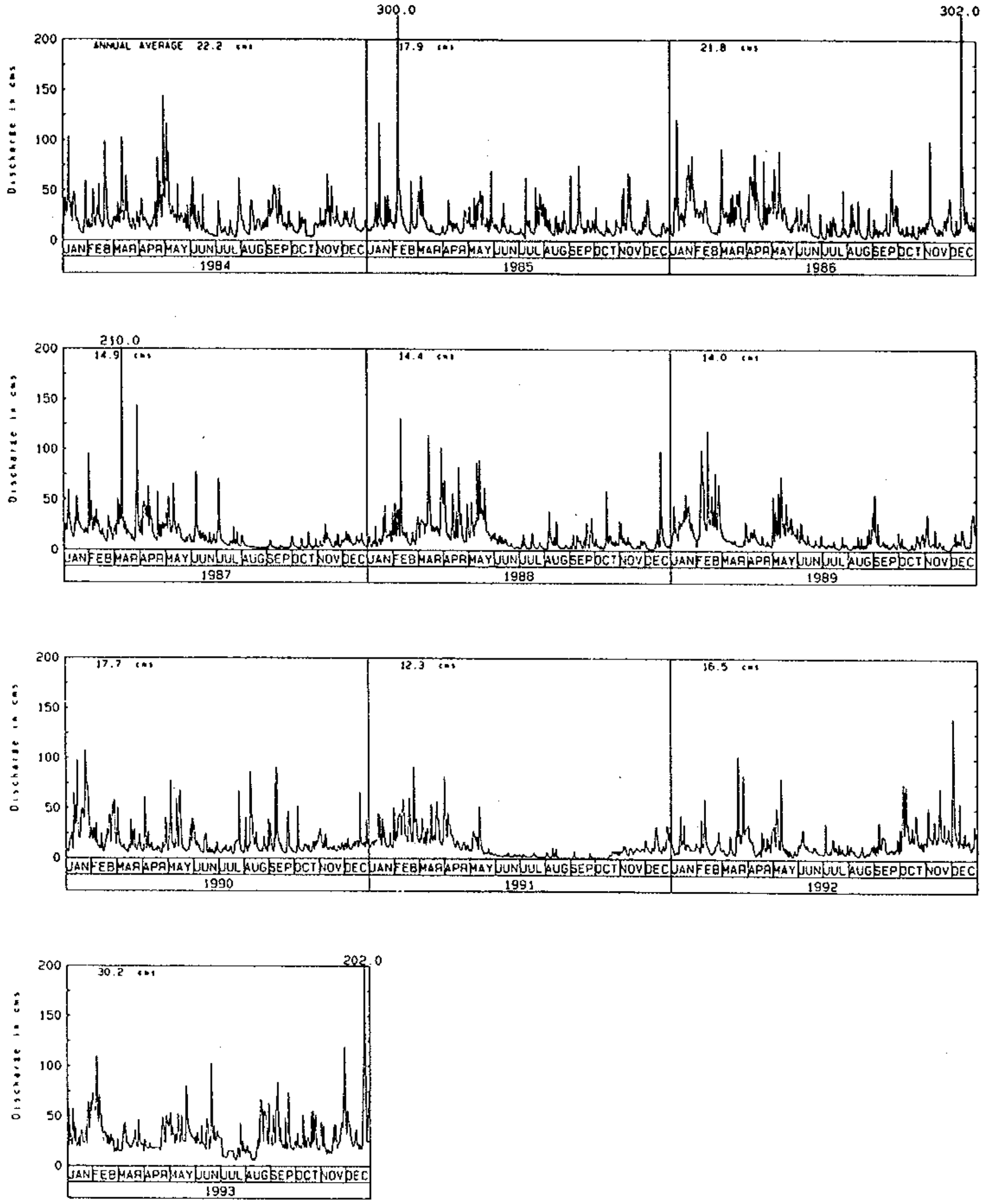
Note ; CMS shows cubic meters per second.

Figure 11 **DAILY DISCHARGE HYDROGRAPH AT RANGKASBITUNG (2/2)**



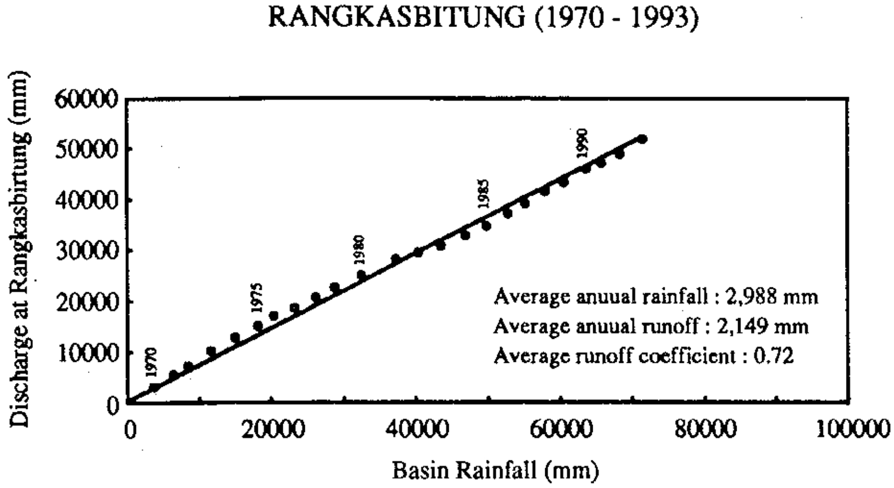
Note ; CMS shows cubic meters per second.

Figure 12 DAILY DISCHARGE HYDROGRAPH AT KOPOMAJA (1/2)



Note ; CMS shows cubic meters per second.

Figure 13 DAILY DISCHARGE HYDROGRAPH AT KOPOMAJA (2/2)



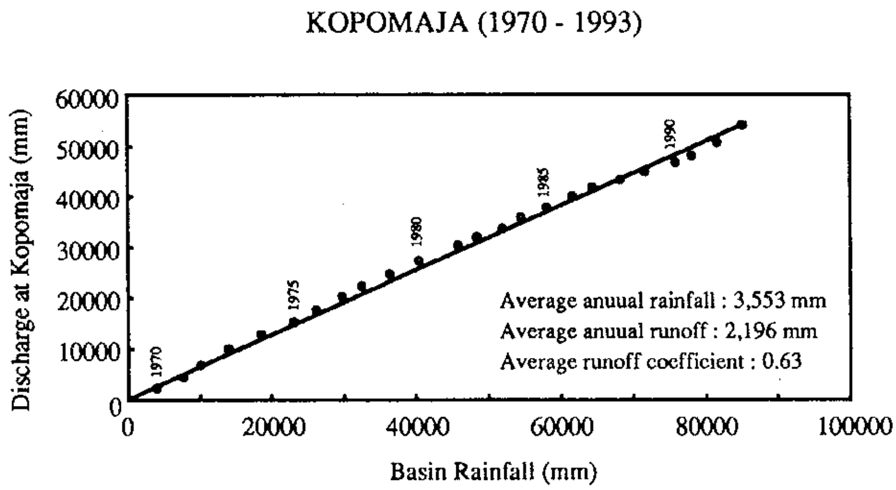


Figure 14 RELATIONSHIP BETWEEN ANNUAL RAINFALL AND RUNOFF

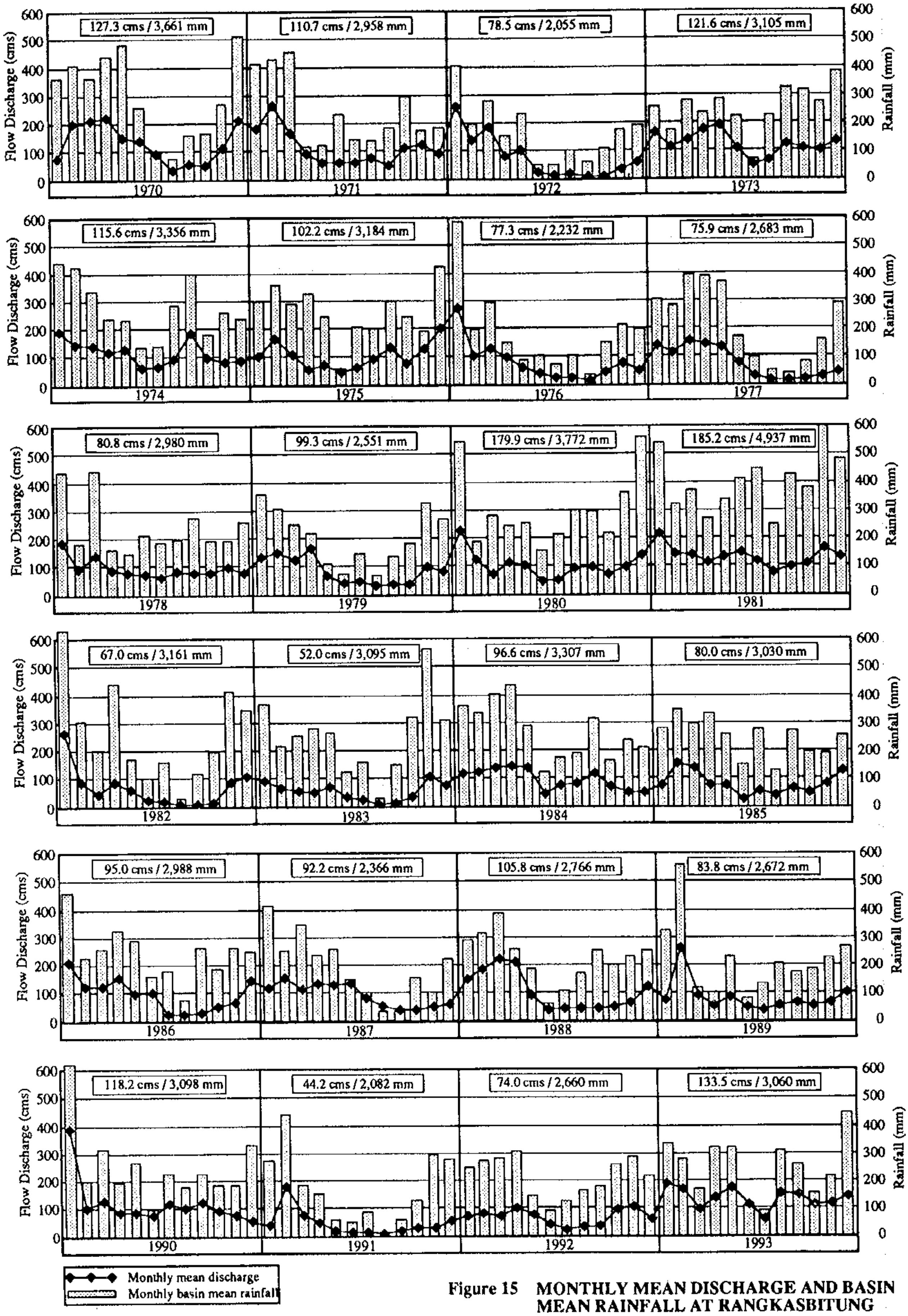


Figure 15 MONTHLY MEAN DISCHARGE AND BASIN MEAN RAINFALL AT RANGKASBITUNG

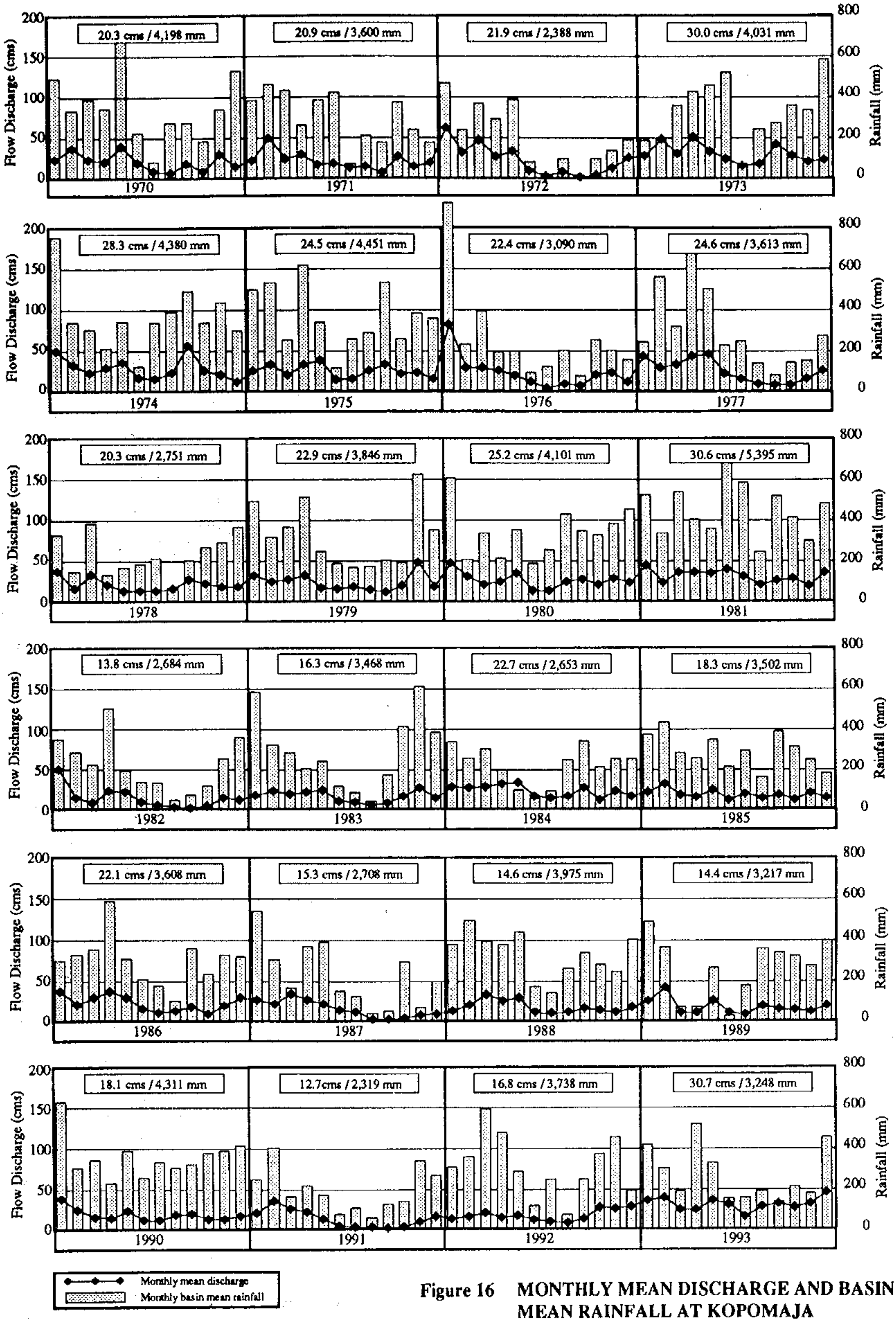
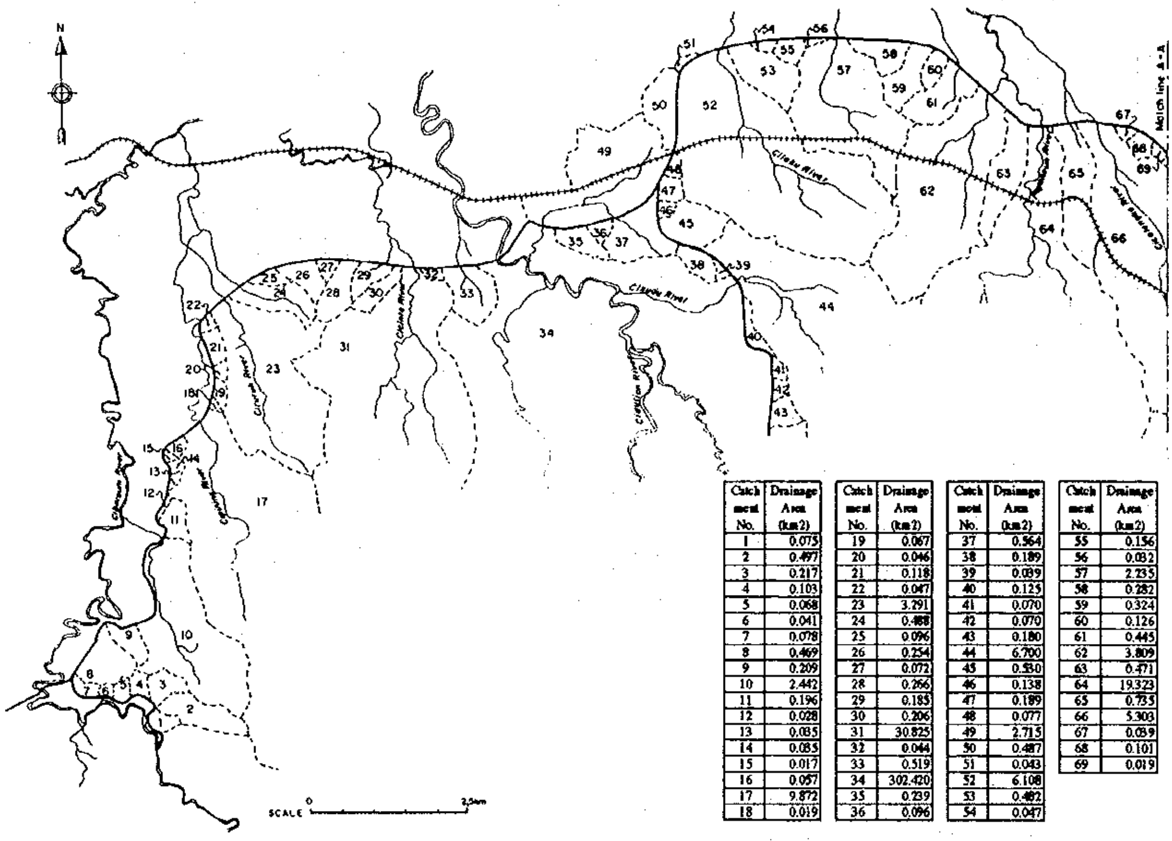


Figure 16 MONTHLY MEAN DISCHARGE AND BASIN MEAN RAINFALL AT KOPOMAJA

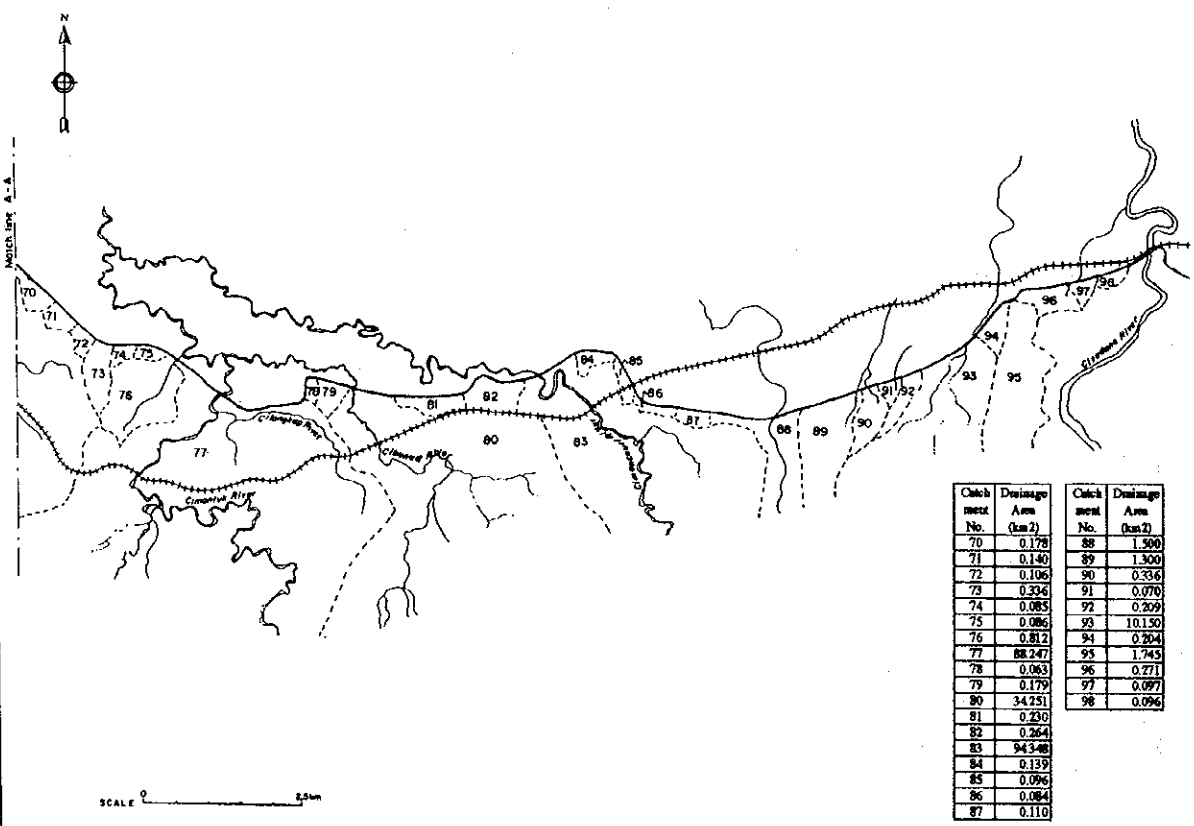


Catch ment No.	Drainage Area (km2)
1	0.075
2	0.497
3	0.217
4	0.103
5	0.068
6	0.041
7	0.078
8	0.469
9	0.209
10	2.442
11	0.196
12	0.028
13	0.035
14	0.085
15	0.017
16	0.057
17	9.872
18	0.019

Catch ment No.	Drainage Area (km2)
19	0.067
20	0.046
21	0.118
22	0.047
23	3.291
24	0.488
25	0.096
26	0.254
27	0.072
28	0.266
29	0.185
30	0.206
31	30.825
32	0.044
33	0.519
34	302.420
35	0.239
36	0.096

Catch ment No.	Drainage Area (km2)
37	0.564
38	0.189
39	0.039
40	0.125
41	0.070
42	0.070
43	0.180
44	6.700
45	0.530
46	0.138
47	0.189
48	0.077
49	2.715
50	0.487
51	0.043
52	6.108
53	0.482
54	0.047

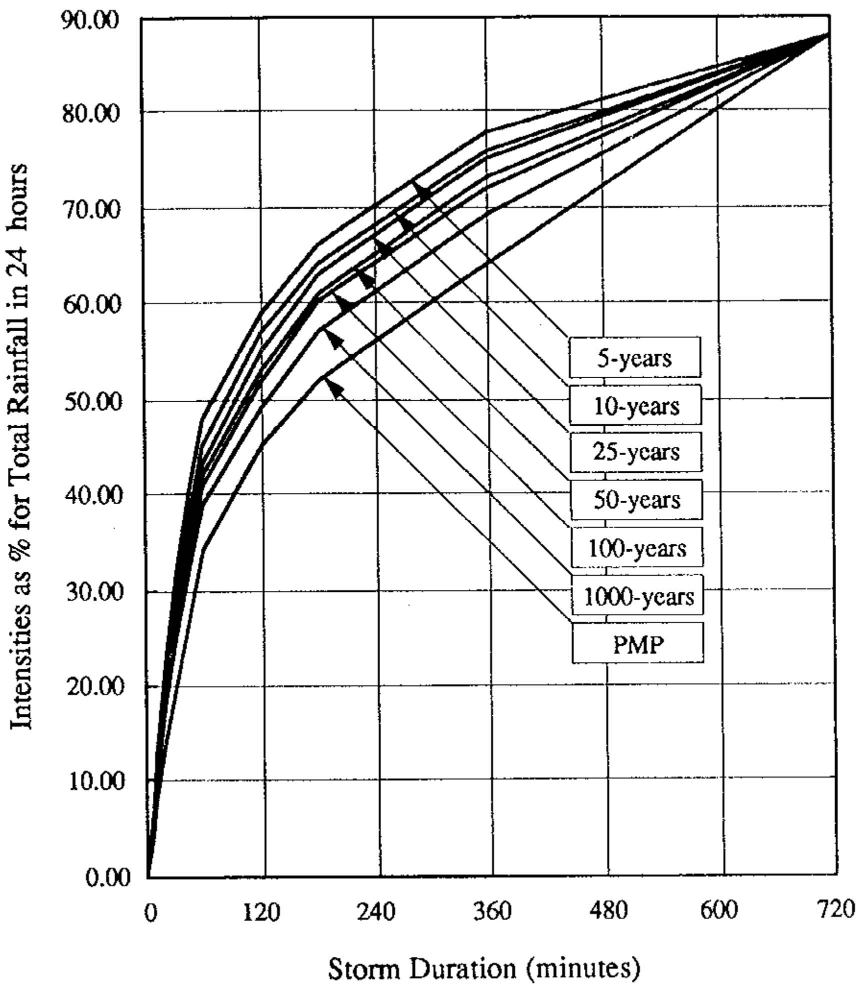
Catch ment No.	Drainage Area (km2)
55	0.156
56	0.032
57	2.235
58	0.282
59	0.324
60	0.126
61	0.445
62	3.809
63	0.471
64	19.323
65	0.735
66	5.303
67	0.039
68	0.101
69	0.019



Catch ment No.	Drainage Area (km2)
70	0.178
71	0.140
72	0.106
73	0.336
74	0.085
75	0.086
76	0.812
77	88.247
78	0.063
79	0.179
80	34.251
81	0.230
82	0.264
83	94.348
84	0.139
85	0.096
86	0.084
87	0.110

Catch ment No.	Drainage Area (km2)
88	1.500
89	1.300
90	0.336
91	0.070
92	0.209
93	10.150
94	0.204
95	1.745
96	0.271
97	0.097
98	0.096

Figue 17 CATCHMENT AREA OF CROSS DRAINAGE AREAS



Return Period (Years)	Intensities As % of Total Rainfall for 24 Hours						
	Duration						
	1/2 hr	3/4 hr	1 hr	2 hr	3 hr	6 hr	12 hr
5	32	41	48	59	66	78	88
10	30	38	45	57	64	76	88
25	28	36	43	55	63	75	88
50	27	35	42	53	61	73	88
100	26	34	41	52	60	72	88
1000	25	32	39	49	57	69	88
PMP	20	27	34	45	52	64	88

Source : Guideline for Dam Flood Safety

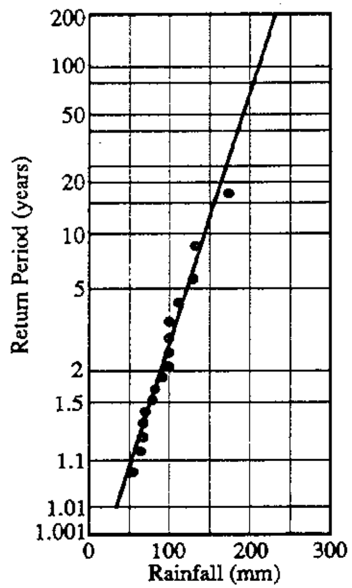
Note : This table is based on Jakarta storm intensity data (Nedeco,1972) and recently recorded storm intensity data for about 600 station-years for locations throughout Indonesia (Walker/Schenck, 1981).

Figure 18 RELATION BETWEEN RAINFALL INTENSITY AND DURATION

Annual Maximum Daily Rainfall at Maja

Year	Rainfall (mm)
1977	-
1978	113
1979	173
1980	100
1981	70
1982	100
1983	90
1984	82
1985	130
1986	100
1987	55
1988	100
1989	68
1990	68
1991	65
1992	79
1993	132

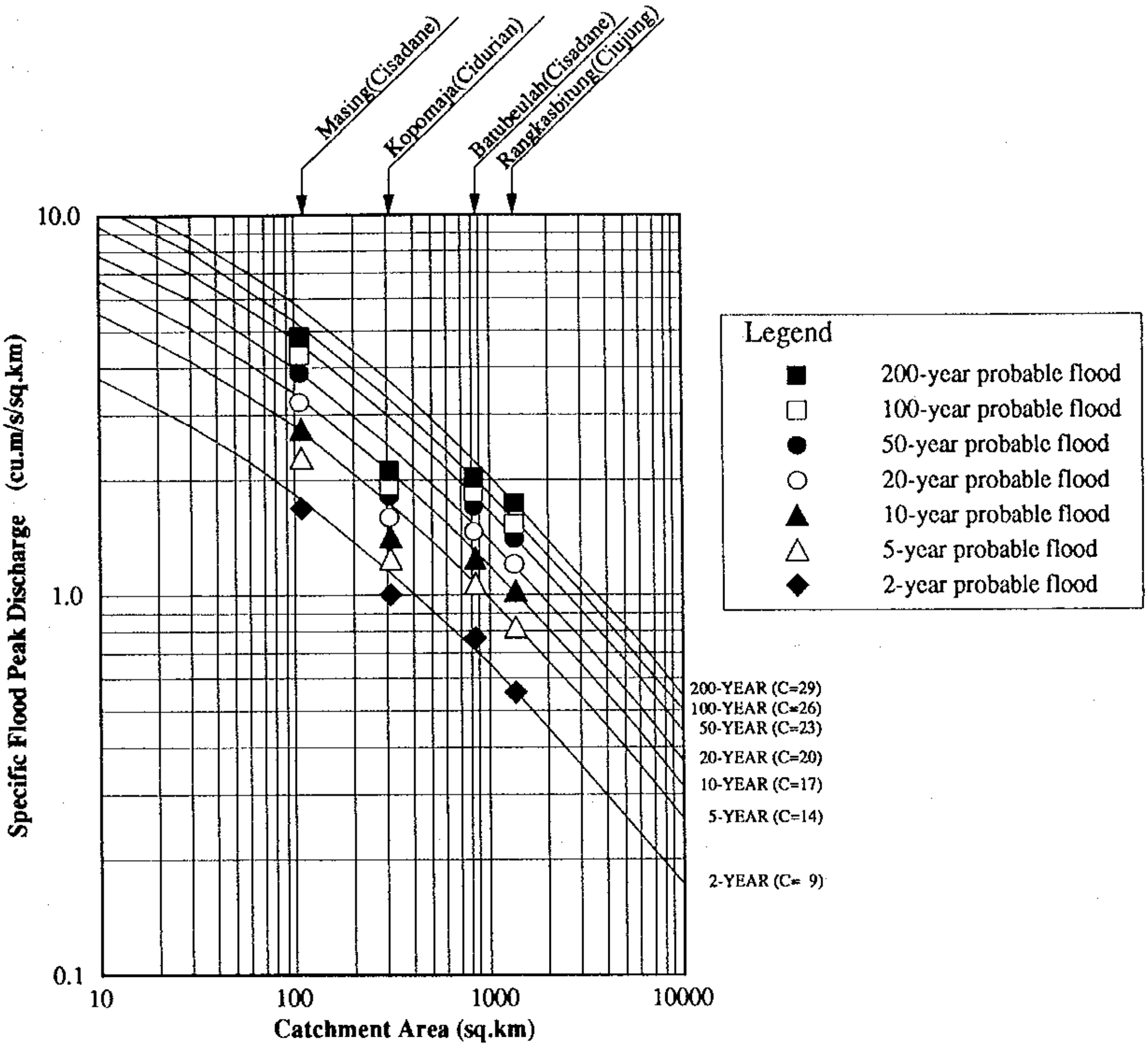
Freaquency Curve for Annual Maximum Daily Rainfall at Maja



Probable Daily Rainfall at Maja

Return Priod (Year)	Rainfall (mm)
2	100
5	130
10	150
20	170
50	200
100	220
200	240

Figure 19 ANNUAL MAXIMUM DAILY RAINFALL AND ITS FREQUENCY CURVE AND PROBABLE DAILY RAINFALL AT MAJA



Probable Flood Discharge with Excess Probability Once in 100 Years (cu.m/s)

Location	Name of River	Catchment Area (km2)	Peak Discharges (cu.m/s)
Ciuyah	Cibeureum	99.8	530
Maja	Cicinta	30.8	245
Cikasungka	Cidurian	302.4	1010
Daru	Payaheun	19.3	175
Jagabita	Cimatuk	88.3	490
Cibunar	Cibunar	34.3	265
Parungpanjang	Cimanceuri	94.4	515
Serpong	Cisadane	1,048.0	1910

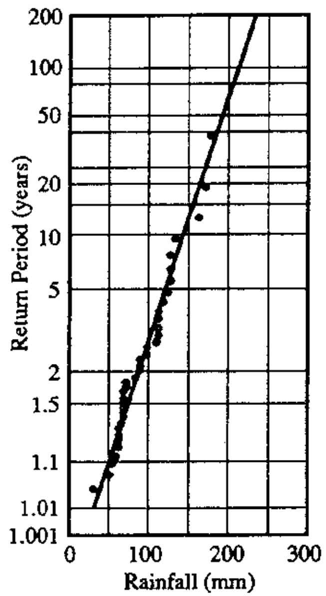
Figure 20 RELATION BETWEEN SPECIFIC FLOOD PEAK DISCHARGE AND CATCHMENT AREA AND PROBABLE FLOOD DISCHARGES AT RIVER CROSSING SECTIONS

Annual Maximum Daily Rainfall at Cilaki

Year	Rainfall (mm)
1951	-
1952	70
1953	116
1954	73
1955	70
1956	70
1957	67
1958	61
1959	64
1960	173
1961	165
1962	179
1963	70
1964	111
1965	128
1966	-
1967	99
1968	-
1969	63
1970	55
1971	-
1972	31
1973	114
1974	86
1975	114

Year	Rainfall (mm)
1976	65
1977	65
1978	70
1979	53
1980	100
1981	120
1982	136
1983	130
1984	115
1985	70
1986	90
1987	130
1988	90
1989	-
1990	-
1991	72
1992	92
1993	125

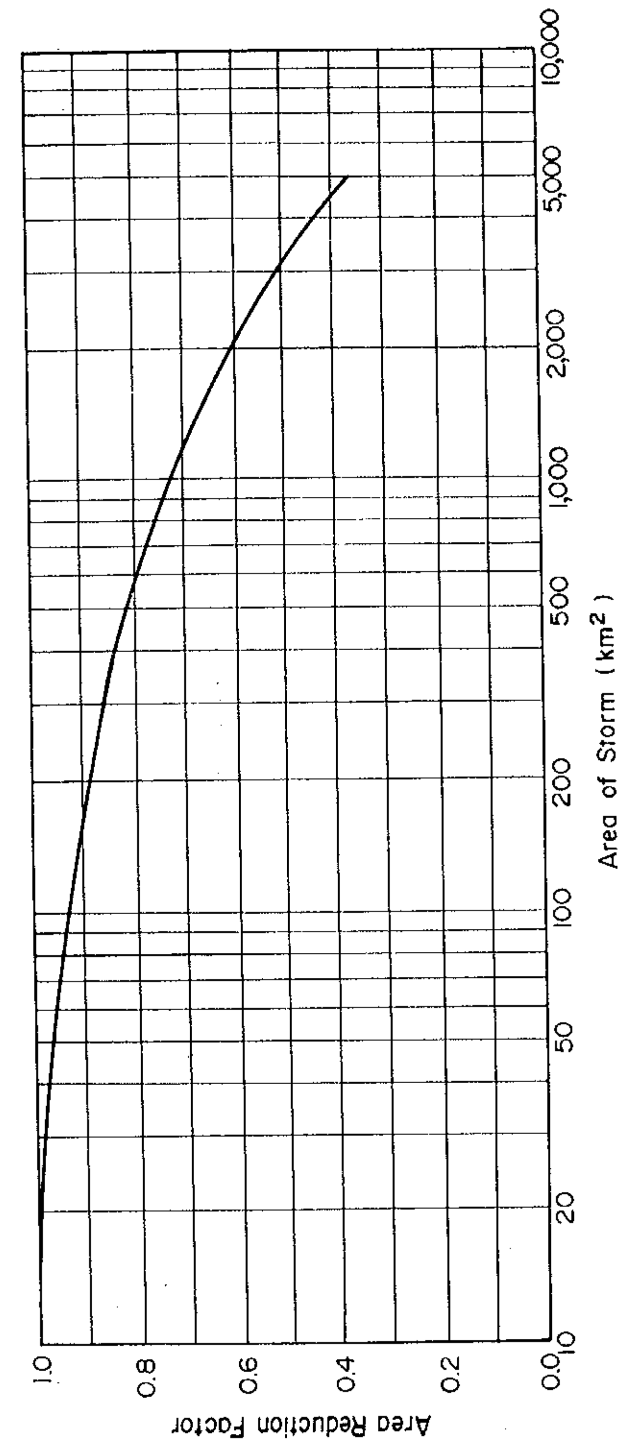
Frequency Curve for Annual Maximum Daily Rainfall at Cilaki



Probable Rainfall at Cilaki

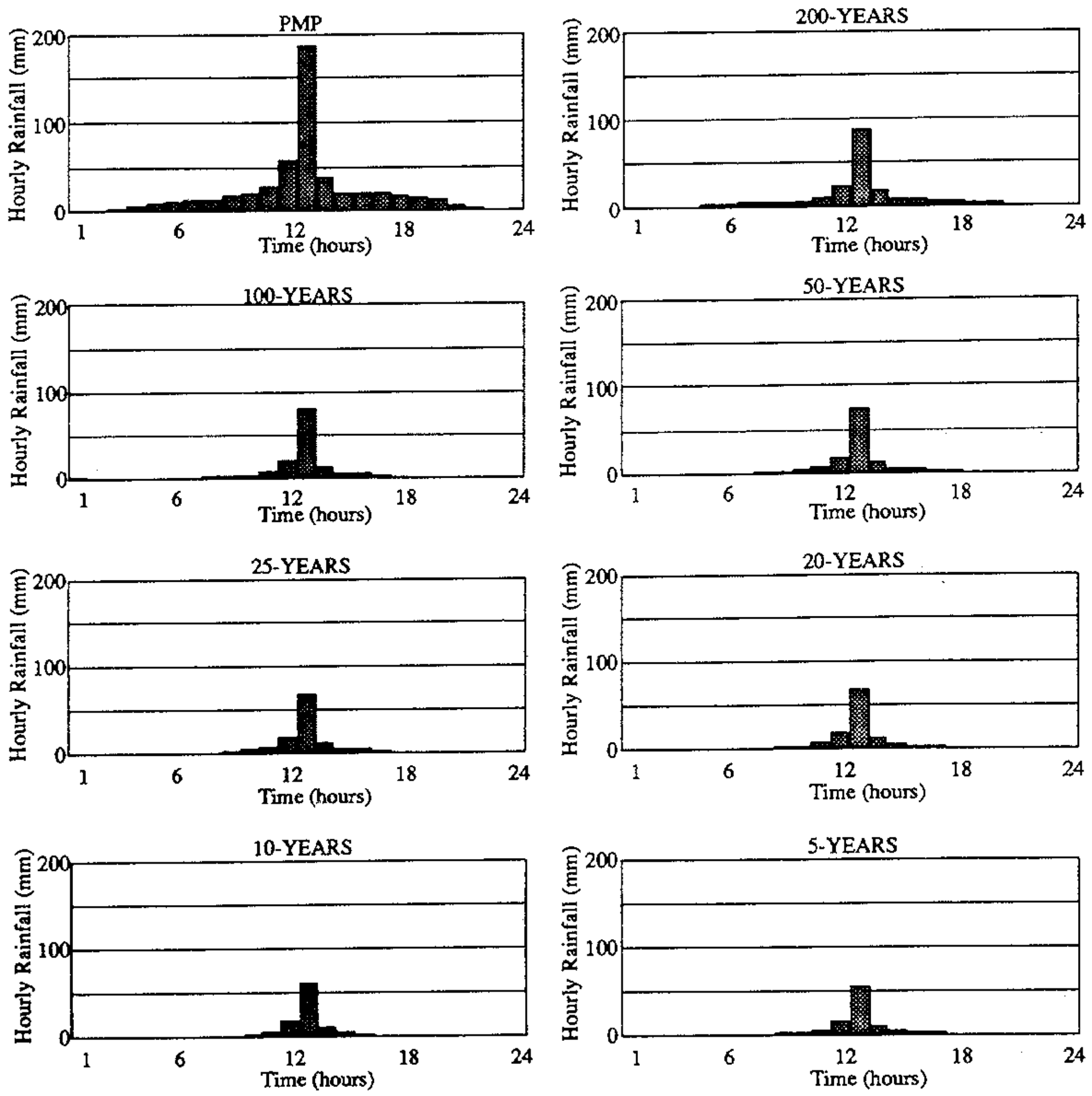
Return Priod (Year)	Rainfall (mm)
2	90
5	130
10	150
20	170
50	200
100	220
200	240

Figure 21 ANNUAL MAXIMUM DAILY RAINFALL AND ITS FREQUENCY CURVE AND PROBABLE DAILY RAINFALL AT CILAKI



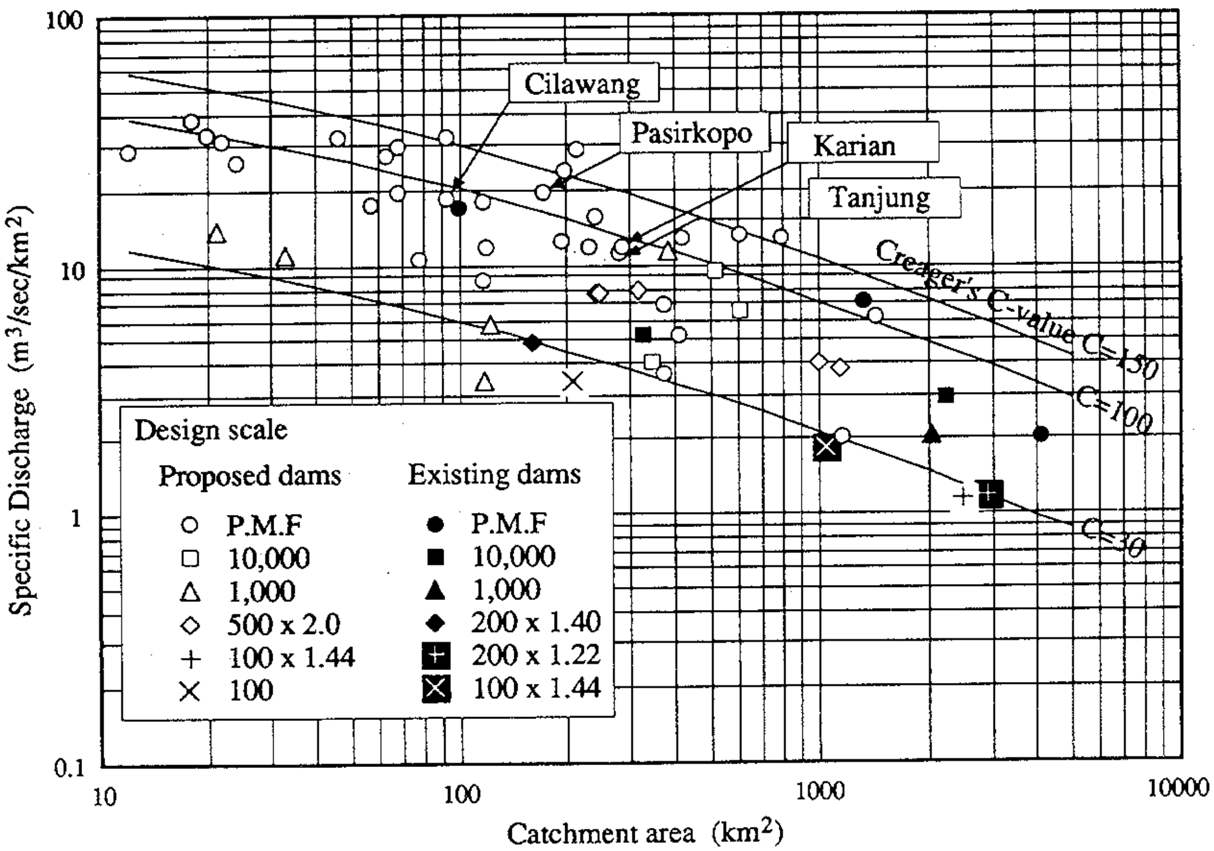
Source : Guideline for Dam Flood Safety, DGWRD, Ministry of Public Works

Figure 22 RELATION BETWEEN AREA AND REDUCTION FACTOR



Hour	Return Priod (Year)							
	5	10	20	25	50	100	200	PMP
	Probable 1-Day Rainfall (mm)							
	115	135	155	160	180	200	220	560
	Hourly Distribution (mm)							
1	1	1	1	1	1	1	1	1
2	1	1	1	1	1	1	1	2
3	1	1	1	1	1	2	2	4
4	1	1	1	1	2	2	2	7
5	1	1	1	1	2	3	3	10
6	1	2	2	2	2	3	4	12
7	1	2	2	2	3	4	5	14
8	2	3	3	3	4	5	6	16
9	3	4	4	4	5	6	7	18
10	4	4	5	5	6	6	7	21
11	6	7	8	9	9	10	11	30
12	13	16	19	20	20	22	24	60
13	55	61	67	69	76	82	88	190
14	8	10	13	14	15	16	18	40
15	5	6	7	7	8	8	9	23
16	3	3	5	5	6	7	8	22
17	2	2	4	4	5	6	6	21
18	1	2	3	3	4	4	5	20
19	1	2	2	2	2	3	4	17
20	1	2	2	2	2	3	3	15
21	1	1	1	1	2	2	2	7
22	1	1	1	1	2	2	2	5
23	1	1	1	1	1	1	1	3
24	1	1	1	1	1	1	1	2

Figure 23 HOURLY RAINFALL DISTRIBUTION OF DESIGN STORM FOR PASIR KOPO DAM



Data source : Guideline for dam flood safety, DGWRD, Ministry of Public Works

Figure 24 RELATION BETWEEN CATCHMENT AREA AND DESIGN DISCHARGE IN INDONESIA

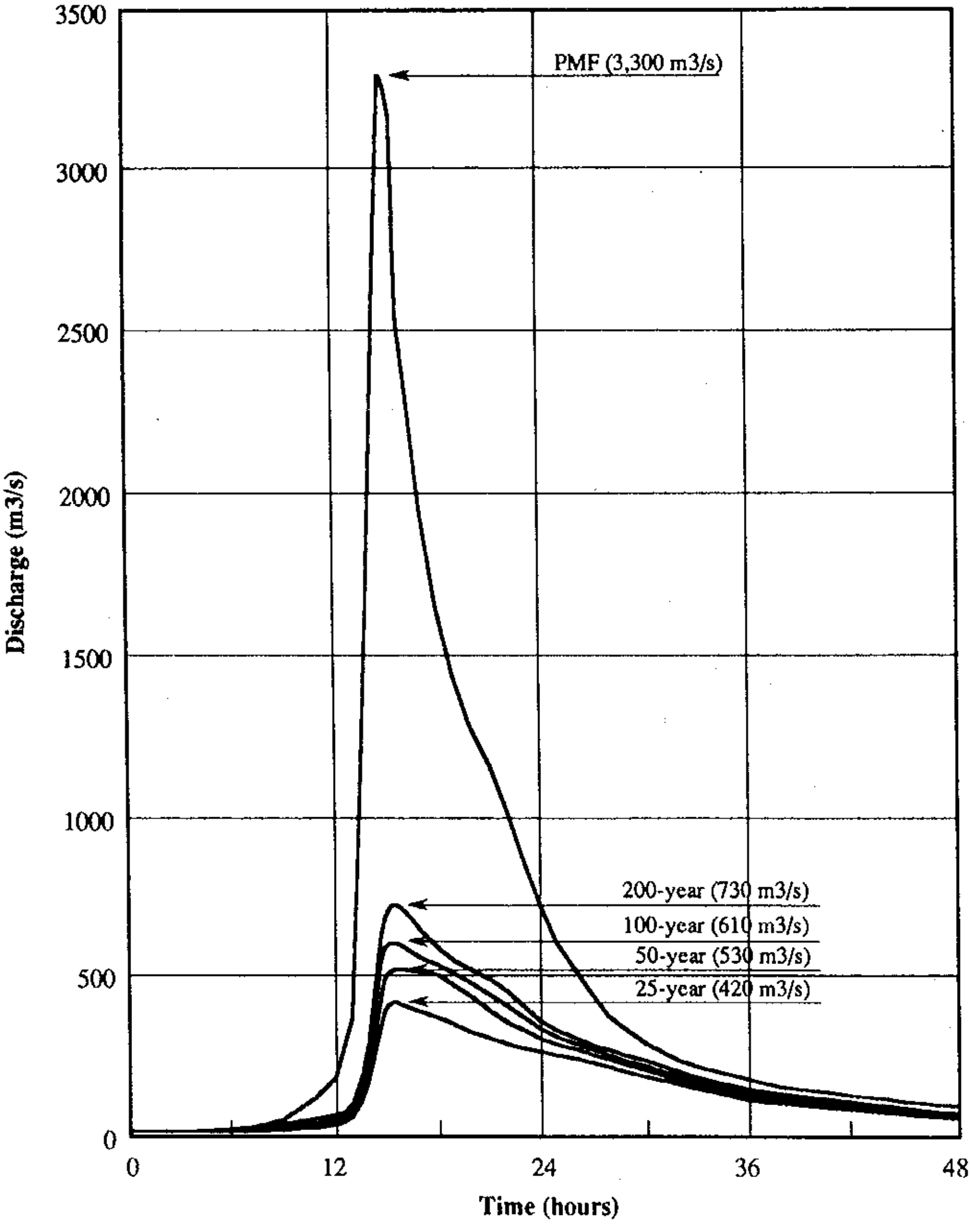


Figure 25 DISCHARGE HYDROGRAPHS FOR PMF AND PROBABLE FLOODS FOR PASIRKOPO DAM

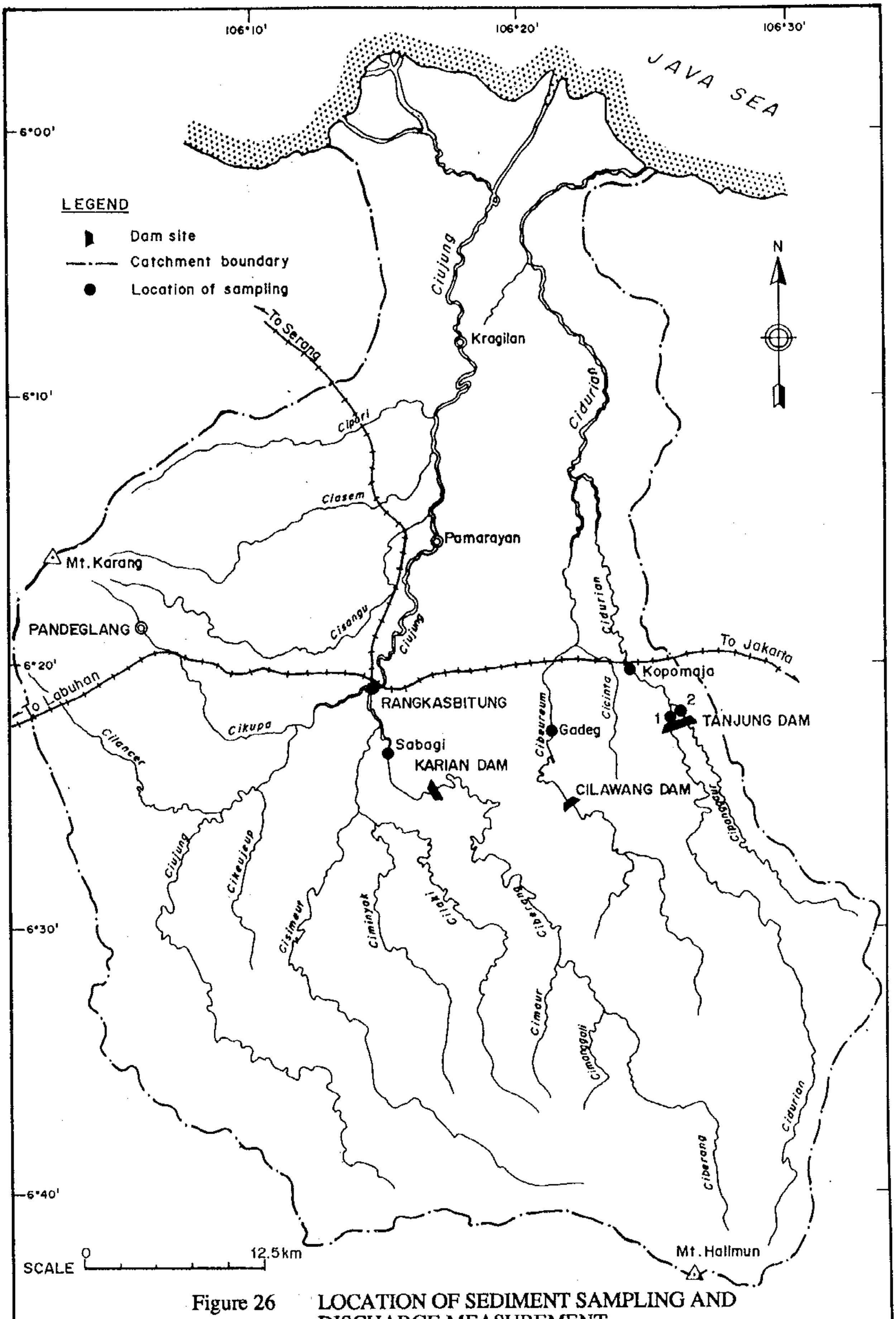


Figure 26 LOCATION OF SEDIMENT SAMPLING AND DISCHARGE MEASUREMENT

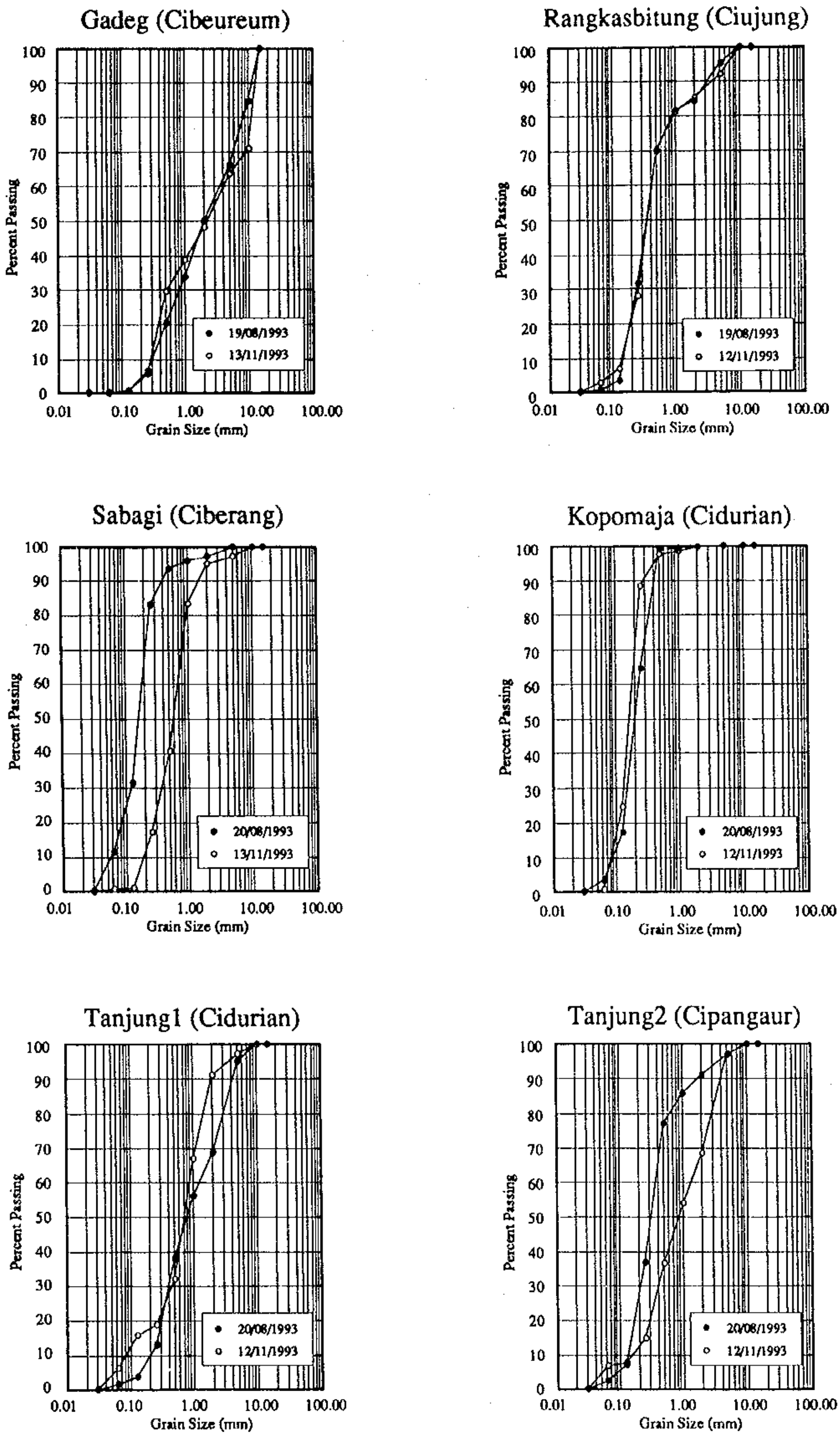
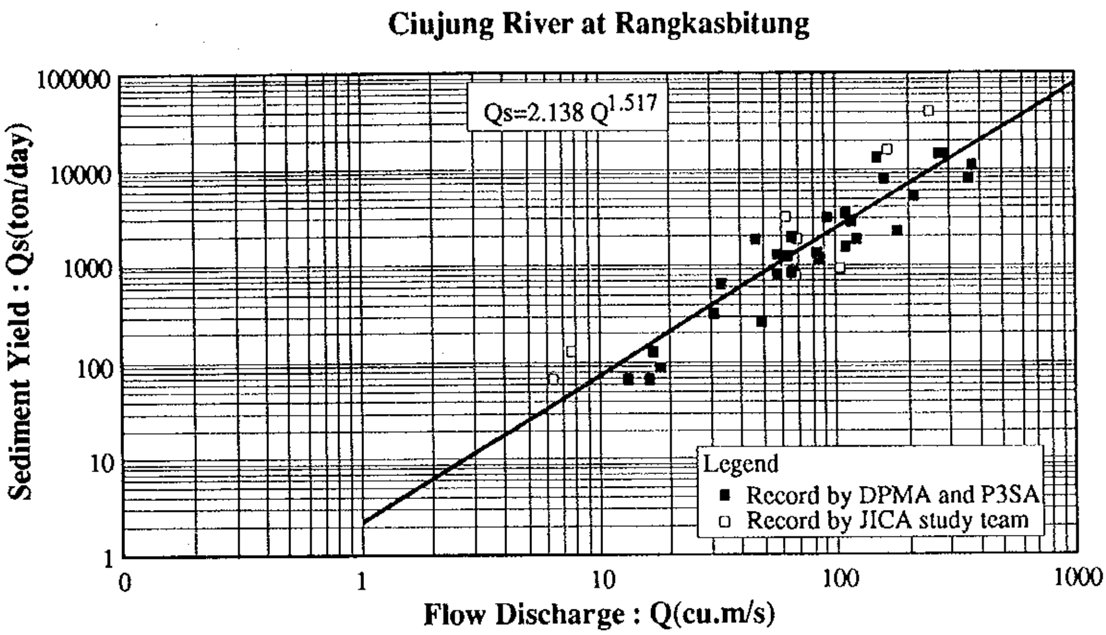


Figure 27 GRAIN SIZE DISTRIBUTION OF BED MATERIAL



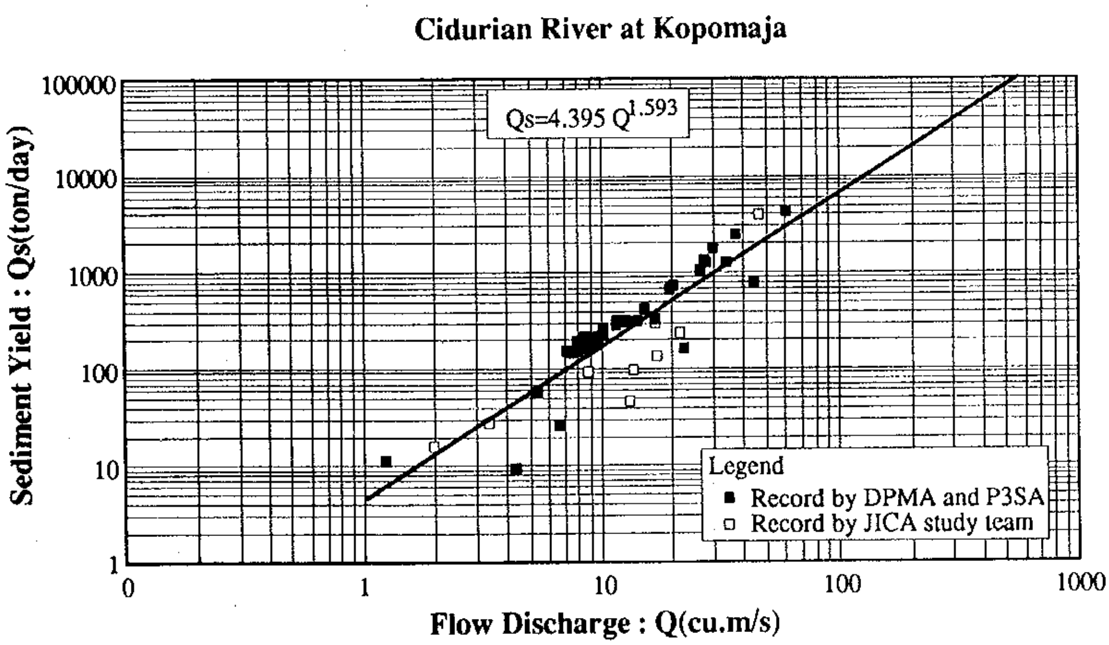


Figure 28 RELATION BETWEEN SEDIMENT AND FLOW DISCHARGES IN CIUJUNG AND CIDURIAN RIVER

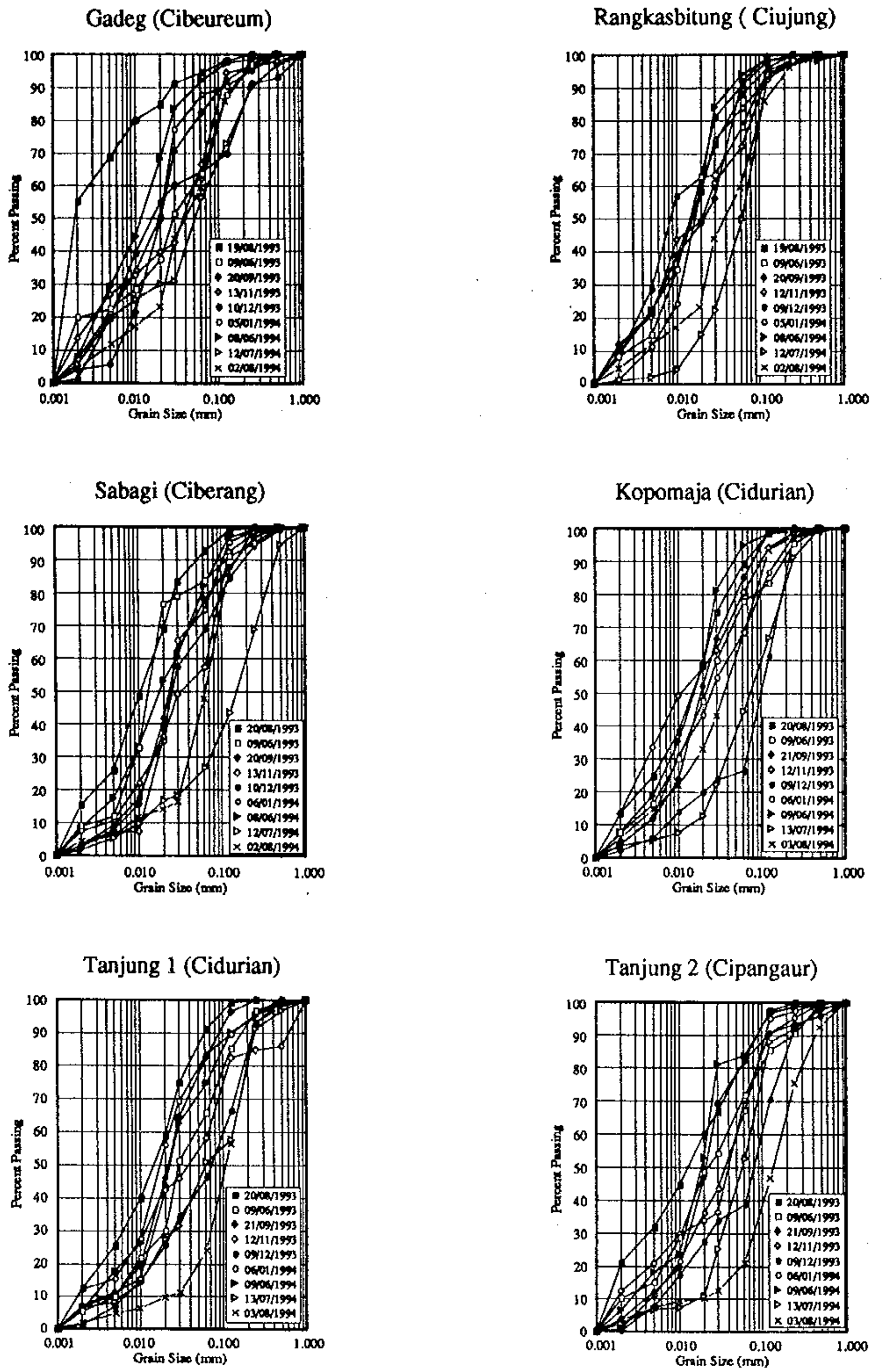


Figure 29 GRAIN SIZE DISTRIBUTION OF SUSPENDED LOAD

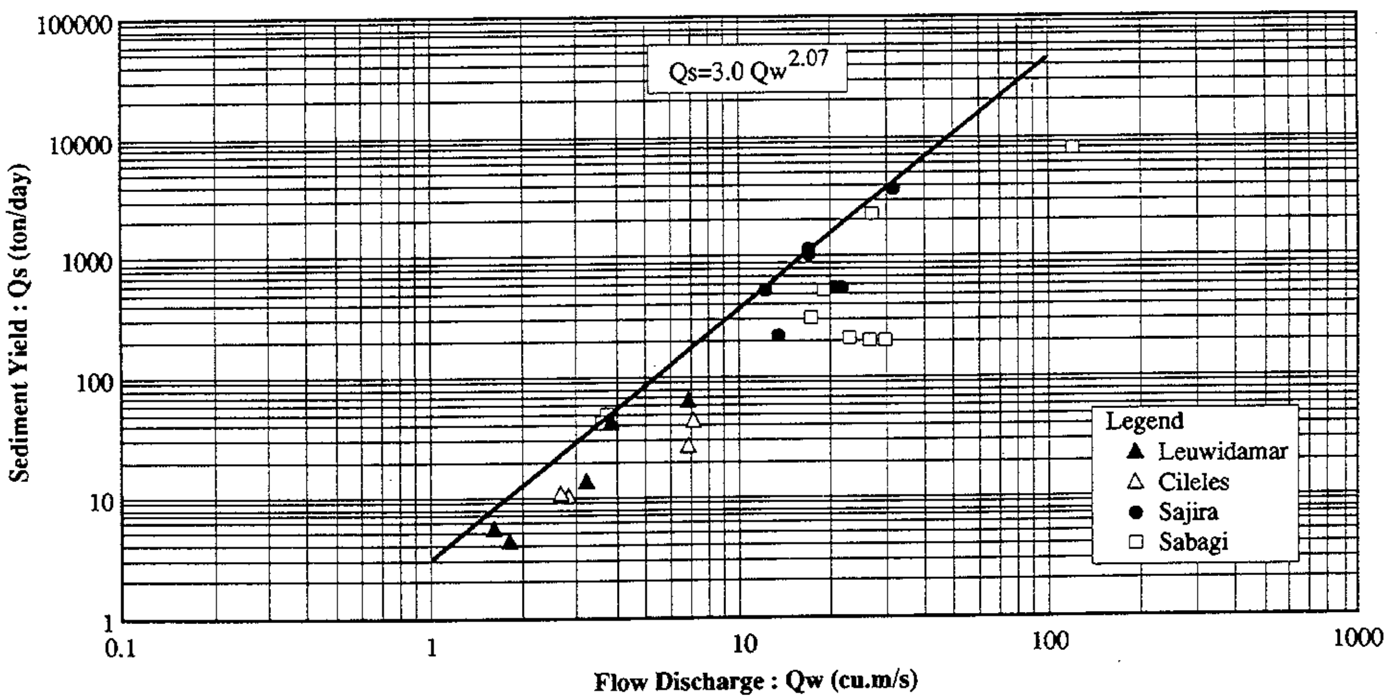
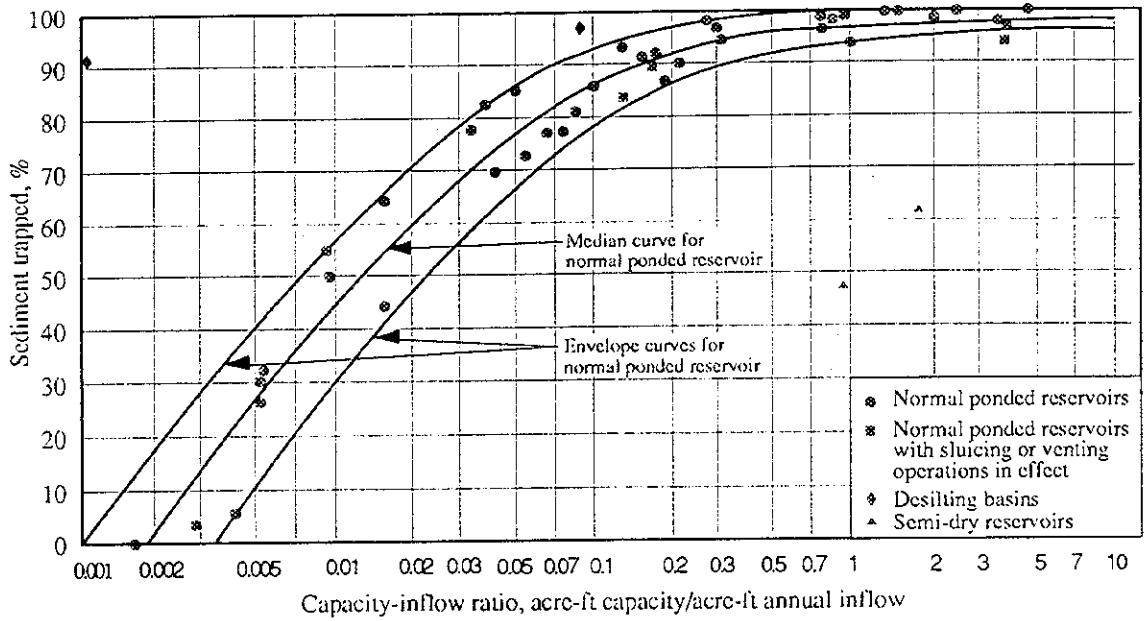


Figure 30 RELATION BETWEEN SEDIMENT AND FLOW DISCHARGE OF SMALL CATCHMENT AREA



Source: Handbook of Applied Hydrology (Ven Te Chow)

Figure 31 TRAP EFFICIENCY AS RELATED TO CAPACITY-INFLOW RATIO

ANNEX 3

WATER RESOURCES STUDY

THE STUDY ON CIUJUNG-CIDURIAN INTEGRATED WATER RESOURCES

Annex 3 : Water Resources Study

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1. INTRODUCTION

Municipal and industrial (M&I) water demands in the Jabotabek and north Banten area have been increased with a high rate due to industrialization and housing development in these areas. In order to establish the water supply master plan to cope with rapidly increasing M&I water demands, the DGWRD undertook Jabotabek Water Resources Management Study (JWRMS) from 1991 to the end of March in 1994, focusing on the M&I water supply.

The JWRMS, consequently, recommended to develop the water resources in the Ciujung and Cidurian river basins for M&I water supply in the kabpatens Serang and Tangerang and a part of DKI Jakarta. Therefore, this water resources study aimed at establishing a water resources development plan through review of the projected water demand and proposed water supply measures by the JWRMS in the aforesaid areas.

In establishing a water resources development plan, the following studies and analyses were made:

(1) grasping the present situation of water uses and water resources development in the study area,

(2) review of previous studies relevant to the water resources development in the Ciujung and Cidurian river basins,

(3) review of water demand projected by the JWRMS,

(4) review of water supply capacities of the proposed dam schemes by the JWRMS, that is the Karian, Pasir Kopo, Cilawang and Tanjung dam schemes, and

(5) priority ranking for the dam schemes in consideration of the water demand in the aforesaid areas, and water supply capacities of the dam schemes.

2. PRESENT SITUATION IN THE STUDY AREA

2.1 Existing Reservoirs and Water Conveyance Systems

2.1.1 Existing Reservoirs

In the study area, there are many river systems originating at the mountain range with an altitude more than 500 m and an average annual rainfall of 3,000 mm to 4,000 mm in the southern part of the study area. The major river systems are illustrated in Figure 1 and listed as follows:

River System	Catchment Area at Outfall (km^2)
Cimanuk	6,700
Cikarang and Bekasi	1,850
Ciliwung	1,210
Cisadane	1,640
Cimanceuri	765
Cidurian	865
Ciujung	1,850
Cibanten	
Cidanau	220

Presently, dam and reservoir for regulating river water flow and for stabilizing water supply are provided only in the Cimanuk river basin; namely the Juanda (Jatiluhur), Cirata and Saguling dams with a total gross storage volume of 5,354 million m^3, which were constructed in 1969, 1985 and 1988 respectively. Among these dams, the Juanda dam have multi-functions which are i) municipal and industrial water supply to DKI Jakarta and its surrounding areas through the Curug intake weir and the West Tarum Canal (WTC); ii) irrigation water supply to the Prosijat area; iii) hydropower generation with an installed capacity of 183 MW; iv) flood control in the downstream; and v) flushing water supply to DKI Jakarta. While, the later two dams were developed mainly for hydropower generation with a total installed capacity of 1,200 MW. The main features of these dams are as follows:

Main Features	Juanda	Cirata	Saguling
(1) Catchment area (km2)	4,500	4,119	2,100
(2) Gross storage volume (million m^3)	3,000	1,900	888
(3) Effective storage volume (million m^3)	2,100	900	640
(4) Dam height (m)	105	125	99

These dams, however, have been operated for optimal use of water resources in the Cimanuk river basin for the aforesaid purposes based on the yearly basic program issued by the Jatiluhur Authority. In case of severe drought year, this program might be adjusted through coordination meeting among such agencies concerned as West Java irrigation Committee, State Electric corporation, Jakarta Municipality Administration and Jatiluhur Authority.

Table 1 shows the recorded monthly inflow and outflow based on the reservoir operation in the Juanda dam. Comparing inflow with outflow after the completion of the dam in 1969, it is indicated that large volume of inflow discharge has been regulated and stored in the reservoir so that outflow discharge has been significantly stabilized through a year. Even in 1982 and 1987 which were the severe drought years in the previous decade, the water more than 70 m^3/sec was released for the downstream water use against the minimum inflow of 4 m^3/sec in 1982 and 2 m^3/sec in 1987.

2.1.2 Water conveyance system

The major water conveyance system in the study area, which are mainly provided for irrigation water supply, are shown in Table 2 and summarized as follows:

Conveyance System	Intake Weir/ River System	Service Area	Length (km)	Max. Design Capacity (m^3/sec)
1) West Tarum Canal	Curug/Citarum	Prosijat irrigation area and DKI Jakarta	69.5	85.0
2) Cisadane Main Canals	Pasar Baru/ Cisadane	Prosida-Cisadane irrigation area	98.4	30.0
3) Solokan Barat Main Canal (Empang)	Empang/ Cisadane	Cisadane-Empang irrigation area	22.0	6.9
4) Katulampa Main Canal	Katulampa/ Ciliwung	Ciliwung-Katulampa Irrigation area	42.7	4.5
5) Cidurian Main Canal	Rancasumur/ Cidurian	Cidurian-Rancasumur irrigation area	24.8	14.7
6) Cicinta Main Canal	Cicinta/Cicinta	Cicinta irrigation area	12.0	1.8
7) Ciujung Main Canals	Pamarayan/ Ciujung	Ciujung irrigation area	94.2	29.8

The aforesaid canals have been constructed since the beginning of the 20th century and contributed to economic development in the areas. But, since reduction of their capacities due to sedimentation in the canals and slope failure along the canals have been remarkable, the improvement and rehabilitation works were done for some of the canals.

2.2 Water Use Conditions

2.2.1 Municipal water

(1) DKI Jakarta

Municipal water has been supplied by the PAM system and private groundwater exploitation by providing deep wells. According to the PAM Jaya System Improvement Project (PJSIP) funded by the IBRD and OECF, as of 1993, the PAM system covers an area of 300 km^2 and serves drinking water for population of 2 million corresponding to 30 % of a total population in the service area. Unit water consumption is estimated at 200 l/d/capita based on the daily average consumption of 400,000 m^3/d and the aforesaid served population by the PJSIP. Also, the PJSIP identified through the project survey that rate of distribution loss is presently about 50 % for the whole service area and that it is 60 % to 80 % in Pulogadung pilot area. However, these distribution loss is planned to be reduced to 30 % by implementation of the PJSIP, of which first phase will be completed in the fiscal year of 1995/1996 and second phase is scheduled to be continued until 1998/1999.

The existing water treatment plants are listed in Table 3 and their location is shown in Figure 2. In addition to the above existing treatment plants with the total capacity of about 16 m^3/sec, Buaran II water treatment plant with a capacity of 3,000 l/sec and Serpong water treatment plant with a capacity of 3,000 l/sec are under construction in line with the recommendation of the Jakarta water supply master plan established in 1985. These treatment plants are planned to take water in from the WTC and the Cisadane river.

While, the JWRMS estimated through their simulation analyses that an amount of 7,000 l/sec is abstracted mainly for domestic water use by using shallow wells (less than 40 m) and 3,000 l/sec for industrial and large commercial use by using deep well (40 m to 300 m), though the registered water abstraction is only at about 1,000 l/sec. The later withdrawal of the groundwater significantly causes problems on saline water intrusion into groundwater aquifer and land subsidence with a rate of 4 cm/year especially in the northern part of DKI Jakarta.

(2) Other areas

Municipal water supply in the surrounding Kabupatens are undertaken by the PDAMs independently organized in each Kabupaten. The existing PDAM's water supply system are shown in Table 4. These water supply systems have mainly been provided by IKK and BNA projects, using deep groundwater, spring water and/or surface water such as river water and the water in the existing irrigation canals. But, their service factor is between 5 % and 10 % and population served by piped water supply system is rather low. Unit water consumption in the Kabupaten systems ranges between 100 to 125 litter per capita per day (lcd). Most of population presently takes a drinking water mainly through shallow or deep wells.

2.2.2 Industrial and commercial water use

According to the result of investigation data on industrial water use, especially by the JWRMS, the total water demands as of 1990 in the Jabotabek area were estimated at 9.61 m^3/sec based on water consumption of the registered manufacturing companies in Table 5:

	Areas	No. of Companies	Water Consumption (m^3/sec)	No. of Employ.	Water Consumption (l/day/emp.)
(1)	Large scale industry				
	DKI Jakarta	2,351	2.20	338,000	463
	Bogor	864	1.29	180,000	508
	Tangerang	1,159	1.23	269,200	320
	Bekasi	634	0.95	179,700	368
	Sub-total	5,009	5.67	966,900	414
(2)	Small scale industry				
	DKI Jakarta	41,902	3.42	432,400	515
	Bogor	2,021	0.20	18,400	754
	Tangerang	1,039	0.20	12,400	1102
	Bekasi	793	0.12	58,700	1424
	Sub-total	45,756	3.94	552,000	554
	Grand Total	50,764	9.61	1,488,800	491/1

Note : /1 : average water consumption.

In the north Banten area industrialized by the heavy manufacturing enterprises such as the Krakatau Steel, chemical industrial factories, coal thermal power stations and harbors, the water demands are rapidly being increased due to the industrialization. According to the water demand data in 1991/1992 in Kab. Serang as shown in Tables 6 and 7, unit water demand per an employment is calculated at about 2.9 m^3/day which is significantly higher than about 0.5 m^3/day in the Jabotabek area. Total water demand in industrial sector in Kab. Serang was estimated at 19 million m^3/year as of 1990 by the Cidanau-Cibanten water resources development project. Also, the aforesaid project estimated the water demands for hotels and resorts at the 86,000 m^3/year corresponding to 0.2 % of industrial water demands or 2 % of domestic water demands.

The main water source for the above water demands is presently groundwater which covers about 50 % to 80 % of demands in the Kabupatens as shown in Table 8. Other demands are fulfilled by the surface water, which is directly taken in by the industrial companies, or piped water system of PAM or PDAM.

As for commercial use, there are no sufficient data in order to analyze and grasp present commercial use condition even in Jabotabek area. JWRMS roughly estimated on the basis of production data provided by the water supply companies in Jabotabek area that total water demands in commercial and service sectors corresponded to about 20 % to 40 % of the municipal water demands.

2.2.3 Irrigation water use

The major existing irrigation systems in the study area are as follows:

	Irrigation System	River System/ Water Source	Irrigation Area as of 1990 (ha)	Intake Weir
a)	Prosijat area	Citarum	65,845 (WTC)	Curug
b)	Prosida-Cisadane	Cisadane	31,156	Pasar Baru
c)	Empang	Cisadane	5,791	Empang
d)	Cidurian-Rancasumur	Cidurian	10,805	Rancasumur
e)	Cicinta	Cicinta	1,371	Cicinta
f)	Ciujung	Ciujung	22,988	Pamarayan
g)	Katulampa	Ciliwung	3,853	Katulampa
	Total		141,809	

These irrigation systems have been operated mainly by the West Java Provincial Government. The intake discharge at the mentioned weir sites are shown in Table 9, but the intake records at the Cicinta is not available for the study. The average intake discharges are summarized as follows:

(unit : m^3/sec)

Irrigation System	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Mean
Prosijat	16.5	15.7	15.9	16.1	18.2	21.7	27.4	30.6	24.5	20.4	20.4	20.6	20.7
Cisadane	18.0	20.2	21.9	22.1	23.5	23.6	22.2	18.9	17.6	14.2	22.1	23.3	20.6
Empang	11.7	12.0	12.7	12.8	12.5	11.8	11.0	10.2	10.7	10.1	11.2	11.8	11.5
Rancasumur	8.1	7.5	7.5	7.3	7.2	8.0	7.1	6.5	5.7	3.3	4.0	4.0	6.3
Ciujung	13.6	12.8	15.5	17.1	16.1	16.4	16.2	15.9	14.4	15.4	15.5	14.9	15.3
Katulampa	7.7	8.1	8.8	8.6	8.1	5.6	4.8	5.5	5.7	2.7	6.6	6.0	6.5
Total	75.6	76.2	82.3	84.0	85.7	87.1	88.7	87.6	78.6	66.1	79.8	80.6	81.0

The Prosijat area has been irrigated by taking water through the WTC and Curug intake with regulating river flow discharge of the Juanda dam and therefore stable water supply for the area through a year has been made even in severe drought year in 1982 as indicated in Table 9. As for the other areas where the dam/reservoir has not been provided, the water requirements for dry season cropping have not been satisfied by the natural flow. This becomes more severe in the drought year.

The average cropping patterns in the technical irrigation areas in 1990 are summarized as follows:

Irrigation System	Irrigation Area (ha)	Cropping Pattern (%)				Cropping Intensity (%)
		Paddy-Paddy	Paddy-Palawija	Paddy	Palawija	
Prosijat	65,845	58.0	-	33.0	-	149.0
Cisadane	31,156	78.0	-	22.0	-	178.0
Empang	5,791	30.0	20.0	10.0	10.0	120.0
Rancasumur	10,805	30.0	20.0	10.0	10.0	120.0
Cicinta	1,371	30.0	20.0	10.0	10.0	120.0
Ciujung	22,988	68.0	-	32.0	-	168.0
Katulampa	3,853	30.0	20.0	10.0	10.0	120.0

Source : JWRMS, Draft Final Report, Annex 2, August 1993

Cropping patterns in the study area are mainly classified into four (4) patterns; i) paddy-paddy; ii) paddy-palawija; iii) paddy; and iv) palawija. But, intensities of these patterns are depending on availability of water. Presently, large scale irrigation areas such as Prosijat, Cisadane and Ciujung areas have higher intensities than those in other areas where the water availability in both the dry and wet seasons is rather limited comparing with their irrigation areas.

2.2.4 Fishery

Two types of inland fishery, namely fresh water fishery in paddy field and river course and brackish water fishery along the coastal area facing the Java Sea, have been carried out in the study area in order to catch . Water requirement of fresh water fishery is negligibly small comparing with irrigation and municipal and industrial water demands according to BTA-155 study. On the other hand, intensive fishery developments has been made since 1985 for shrimp production, but traditional tambak areas still occupies the major part of the sector as given in the following table showing areas of brackish water fishery in 1988:

Description	Serang	Tangerang	Bekasi	Total
Private firms (PT) in 1985	269	797	11	1,077
Semi-intensive development since 1985	250	379	150	779
Traditional tambaks	5,018	3,478	6,266	14,762
Traditional tumpang sari	-	-	800	800
Total	5,537	4,654	7,227	17,418

Source : Cisadane-Cimanuk Integrated Water Resources development (BTA-155), 1989

While, prospective brackish water fishery (intensive and semi-intensive tambaks) areas were identified in Kecamatan Kramatwasu, Kaseman, Pontang, Tirtayasa in Kabpaten Serang and Kronjo in Tangerang, of which a total net area is 4,050 ha. To develop the fishery activity, an amount of fresh water of 3.3 l/s/ha to 5.5 l/s/ha or 13.4 m^3/s to 22.3 m^3/s for dry season cropping was estimated to be required for the brackish water fishery by the BTA-155 study.

Presently, a part of water requirements in the sector is supplied through the rivers and/or existing irrigation system, using the river water or return flow from the irrigation canals.

3. PREVIOUS WATER RESOURCES DEVELOPMENT STUDIES

3.1 Previous Studies

(1) North Banten Water Resources Development Master Plan and Karian Multi-purpose Dam Construction Project

The north Banten water resources master plan executed in 1981 recommended to develop the KCC irrigation area with an area of about 11,000 ha through provision of the Karian and Cilawang dams in the Ciujung and Cidurian river basins. Based on the recommendation, the feasibility study on Karian multi-purpose dam construction project was undertaken under the technical assistance of JICA in 1985 and implementation of the following components was proposed:

a) Construction of Karian dam in the Ciberang river and Cilawang dam in the Cibeureum river,

b) Construction of Ciuyah tunnel to supply water to be stored in the Karian reservoir to KCC irrigation located at the downstream of the Cibeureum river,

c) Construction of Cicinta tunnel to connect Cilawang reservoir to Cicinta river and to supply irrigation water to the existing Cicinta irrigation area,

d) River improvement works along the middle reach of the Ciujung river, and

e) development of KCC irrigation area.

(2) Cisadane River Basin Development project

Cisadane river basin development project carried out by financial assistance of IBRD and undertook the feasibility study on the Paruungbadak and Tanjung dam schemes. However, since the former scheme requires the relocation of about 60,000 persons, DGWRD has not proceeded this dam scheme. Also, the Tanjung dam scheme was planned in order to develop Tanjung irrigation scheme with an irrigation area of 5,400 ha but not recommended due to its low economic viability with the EIRR less than __ %.

(3) Cisadane-Cimanuk Integrated Water Resources Development (BTA-155)

In 1990, the Cisadane-Cimanuk integrated water resources development (BTA-155 study) formulated the water supply plan in the Jabotabek area and Kabs. Karawang and Purwakarta, in which the existing three (3) dams in the Cimanuk river basin and the Karian dam in the Ciujung river basin and Tanjung dam in the Cidurian river basin were planned as the water sources for water supply to related sectors, taking into account rapidly increasing water demands in the areas.

In the plan, "Balanced Water Supply" comprising of the aforesaid dams was concluded to be the optimum water resources development plan in the time horizon until 2015. The proposed plan recommended to; i) supply 17.8 m^3/s to DKI Jakarta and 2.0 m^3/s to Cilegon for municipal and industrial uses from the Karian and Tanjung dams; ii) develop local source such as groundwater for water supply to other areas; iii) supply irrigation water to the KCC and Rancasumur areas and the western part (5,400 ha) of the Cisadane area.

3.2 Jabotabek Water Resources Management Study

The Jabotabek Water Resources Management Study (JWRMS) aimed to; i) estimate municipal and industrial water demand, ii) estimate agricultural water demand, iii) formulate global plan for raw water supply by developing surface water and groundwater, iv) study water quality of the aforesaid water sources, and v) formulate water resources management plan, in a time horizon till the year of 2025 in Jabotabek area. The JWRMS also covered the north Banten and Karawang/Purwakarta areas since such the main surface water resources for Jabotabek area as the Ciujung/Cidurian and the Citarum rivers are located in these areas.

The JWRMS had started its Phase 1 on June 1991 by the Dutch financing and the Phase 1 study had continued till April 1992. Then, through the bridging phase carried out by the Indonesian consultants from April 1992 to January 1993, the Phase 2 had restarted and have undertaken till the end of March 1994.

The DGWRD intended that the JWRMS established the basic master plan for raw water supply including water resources development plan for the purposes to the Jabotabek area.

On the other hand, as for the Ciujung-Cidurian Integrated Water Resources Development Study duplicating the study area and scope of the work with the JWRMS, the DGWRD carried out the study aiming to update the previous studies for the water resources development plan related to the objective rivers and establish water conveyance system plan to distribute water to such the related areas as Kabs. Serang and Tangerang and DKI Jakarta at a feasibility study level based on the results and recommendations made by the JWRMS.

The study results of the JWRMS are briefly described in the following sections:

3.2.1 Water demand projection

(1) Data and methods applied

The JWRMS established the methodology to forecast water demands in municipal and industrial (M&I) and irrigation sectors by using such the latest data as 1990 census, other statistical data and socio-economic survey result in these years. As shown in Figure 3, the JWRMS estimated the future municipal water demand based on future population, unit water consumption, and coverage rate (house connection rate). Also, industrial water demand was predicted by the similar method using number of employee in the industrial sector, average unit water consumption in this sector, and source distribution ratio to surface water, groundwater and piped system. Each water demand was derived by multiplying the aforesaid factors in the time horizon to the year of 2025.

While, irrigation water requirement was based on the existing guidelines issued by the DGWRD referring to those prepared by FAO, using the accumulated data since Cisadane-Cimanuk Integrated Water Resources Development (BTA-155) study. In estimating irrigation water requirement, the JWRMS assumed and expected decrease of irrigation area due to rapid urbanization and industrialization, and crop diversification from paddy to vegetables to meet vegetable requirement in the Jabotabek area and to save the limited water resources.

(2) Population projection

The JWRMS has used three scenarios for population projection in the Jabotabek area and related areas to the study taking into account long-term economic growth, investment and activities of the government and public in potential economic development. These scenarios have been established by the Jabotabek Metropolitan Development Plan and Review (JMDPR) being carried out by the Cipta Karya under financing of IBRD and the JWRMS was carried out the water demand projection in accordance with these scenarios. The characteristics of these scenarios are shown in Table 10 and summarized as follows:

Scenario A : a) high economic growth
b) low government involvement in water resources management
c) limited land use planning

Scenario B : a) low economic growth
b) low government involvement in water resources management
c) limited land use planning

Scenario C : a) high/medium economic growth
b) high government awareness in water resources management
c) increased land use planning

Based on the characteristics, the JMDPR forecasted the population till 2010 in the Jabotabek area and the JWRMS extrapolated that to 2025. Result of the population projection made by these studies are given in Table 11. As shown in the table, the future population was estimated by dividing into the several zones which was mainly based on availability of groundwater and administrative division. The location of these zones are shown in Figure 4.

(3) Municipal and industrial water demands

Coverage rate and unit water consumption for municipal water demand projection

The coverage rate, which means a ratio of the served population to the total population, was determined based on willingness of connection to the piped system in three income levels (high, medium and low), which was surveyed by the previous socio-economic studies in these years. The expected average willingness of the connection in each income level are given as follows:

Income Level	Willingness to Connect		
	Scenario A	Scenario B	Scenario C
High	55	45	75
Medium	40	30	70
	20	20	60

Other than the coverage rate, possibility or feasibility of provision of piped water supply system was also examined and a criteria was established. The criteria describes that the piped water supply system will not be developed in an area with low population density and rich groundwater condition.

Also, unit water consumption was determined taking into account the present water use condition at the aforesaid income levels, connecting to piped system in each zones.

Table 12 summarizes the coverage rate, unit water consumption and criteria for connecting demand zones to piped water supply system applied for municipal water demand projection.

Employment, unit water consumption and source distribution ratio

Numbers of employment was estimated by the following percentage of employment in industrial sector to total population in the zones, which was obtained from the statistical data in Indonesia, West Java and DKI Jakarta:

Description	Scenario A		Scenario B		Scenario C	
	DKI	Botabek and Outside	DKI	Botabek and Outside	DKI	Botabek and Outside
Total population (thou.)	12,902	38,570	14,902	34,570	12,902	38,570
Percentage of employment in industrial sector (%)	6.7	11.1	5.7	9.1	6.7	11.1
Number of employment in industrial sector (thou.)	858	4,287	849	3,153	858	4,287

An unit water consumption of 500 lit/day per employment in industrial sector was used for water demand projection in Jabotabek and Purwakarta/Karawang areas for each scenario, but, in Serang, about 1,000 lit/day per employment for the scenarios A and C and 700 lit/day per employment for the scenario B since heavy industries such as steel and chemical has been developed and require a higher unit consumption

The source distribution ratio to possible water sources of surface water, groundwater and piped water was defined as follows:

(unit : %)

Zones	Surface Water	Piped Water	Groundwater
DKI : North	0	75	25
DKI : South	0	50	50
Bogor	60	20	20
Tangerang	50	25	25
Bekasi	50	25	25
Serang	75	15	10
Karawang/Purwakarta	75	15	10

Commercial and services sector

As for the commercial and services sectors, since there are no sufficient data on water use, water demands were estimated by multiplying the following rate to municipal water demands:

Demand Zones		Population Density		
		< 50/ha	50-100/ha	> 100/ha
DKI Jakarta		0.40	0.40	0.40
Bogor	North	0.20	0.30	0.35
	South	0.20	0.30	0.35
	Southwest	0.20	0.25	0.30
	West	0.15	0.20	0.25
	East	0.15	0.20	0.25
Tangerang	North	0.20	0.25	0.25
	Central	0.20	0.30	0.35
	Balaraja	0.15	0.25	0.35
	South	0.15	0.20	0.30
	Cikupa	0.15	0.20	0.30
Bekasi	North	0.15	0.20	0.25
	Central	0.20	0.30	0.35
	Southeast	0.15	0.20	0.25
Serang		0.30	0.30	0.30
Karawang/Purwakarta		0.25	0.25	0.25

In-plant use and un-accounted water

In-plant use was estimated based on the actual records in the Jabotabek area and un-accounted water was expected to be less than the present situation as shown in the following table:

Demand Zones		Average In-plant Use	Un-accounted Water for 1990	2025
DKI Jakarta		0.07	0.53	0.30
Bogor		0.05	0.40	0.20
• North	: desas with density > 100/ha			0.25
• South	: desas with density > 100/ha			0.25
Tangerang		0.05	0.35	0.20
• Central	: desas with density > 100/ha			0.25
Bekasi		0.07	0.35	0.20
• Central	: desas with density > 100/ha			0.25
Serang		0.05	0.35	0.20
Karawang/Purwakarta		0.05	0.35	0.20

Total water demand

Based on the aforesaid assumptions and conditions, the total water demands were estimated and finally adjusted taking into account the availability of the groundwater resources in the demand zones. The estimated M& I water demand in the Jabotabek and the related areas are given in Table 13.

(unit : m^3/s)

Scenario/ Demand Zones	Surface Water 1990	2000	2025	Groundwater 1990	2000	2025
Scenario A						
DKI Jakarta	9.0	12.2	26.0	15.1	16.8	17.7
Bogor	1.4	3.8	13.5	6.1	9.6	18.7
Tangerang	2.3	4.4	12.5	4.4	6.4	10.9
Bekasi	1.6	2.8	8.6	3.4	5.2	9.2
Serang	2.2	4.3	11.8	2.6	4.0	8.2
Karawang/Purwakarta	1.0	2.8	11.0	3.5	4.7	9.2
Scenario B						
DKI Jakarta	9.0	12.4	23.6	15.1	17.2	19.1
Bogor	1.4	3.2	10.2	6.1	8.8	15.0
Tangerang	2.3	3.9	9.0	4.4	5.9	9.2
Bekasi	1.6	2.5	6.0	3.4	4.7	7.7
Serang	2.2	3.6	7.7	2.6	3.5	6.2
Karawang/Purwakarta	1.0	2.4	7.3	3.5	4.3	7.1
Scenario C						
DKI Jakarta	9.0	18.9	42.1	15.1	14.8	10.1
Bogor	1.4	3.8	19.5	6.1	8.8	11.5
Tangerang	2.3	4.8	22.3	4.4	6.7	8.4
Bekasi	1.6	3.1	16.2	3.4	5.5	7.3
Serang	2.2	4.4	17.3	2.6	4.0	5.3
Karawang/Purwakarta	1.0	2.9	18.1	3.5	4.7	5.6

(4) Agricultural water demand

Presently, urbanization and industrialization has occupied the land areas which were planned to be developed as new irrigation area by the previous studies. Therefore, the JWRMS intended to supplementary supply irrigation water to such the existing irrigation areas as Ciujung, Cisadane, Rancasumur, North and West Tarum areas. The following table shows the present (1990) and future (2025) irrigation areas of the aforesaid irrigation schemes assuming that the existing areas will also be reduced due to change land use condition from agriculture land to settlement or industrial areas:

Irrigation Area	River Basin	Area in 1990	Area in 2025 (ha)			Reduced Area from 1990 to 2025 (ha)		
			A	B	C	A	B	C
Ciujung	Ciujung	22,988	18,862	20,375	18,862	4,126	2,613	4,126
Rancasumur	Cidurian	10,805	9,312	9,469	8,873	1,493	1,336	1,932
Cisadane	Cisadane	31,156	2,7862	28,352	27,489	3,294	2,804	3,667
Empang	Cisadane	5,791	2,681	3,009	3,266	3,110	2,782	2,525
Katulampa	Ciliwung	3,853	2,201	2,268	2,387	1,652	1,585	1,466
West Tarum	Citarum	65,845	5,4224	55,637	52,032	11,621	10,208	13,813
North Tarum	Citarum	85,723	72,433	75,188	72,417	13,290	10,535	13,306

As shown in the table, an area from 10 % to 20 % was estimated to be reduced in the time horizon till 2025. Further, diversification of agricultural production from paddy to vegetable crop was expected in water demand projection as shown below:

Description	Present (1990)	Scenario (2025)		
		A	B	C
Extra crop hectares required for vegetables	-	117,500	103,700	254,000
Substitution of wet season crop	-	9 %	7 %	25 %
Cropping intensity of palawija and vegetables	-	29 %	26 %	55 %
Cropping intensity of technical system	172 %	194 %	191 %	218 %

Under the aforesaid exceptions and conditions, water demand in agricultural sector in Jabotabek and the related areas were estimated as shown in Figure 5. The following table indicates the present and future water demands in the aforesaid large irrigation schemes:

(unit : m^3/s)

Irrigation Area	River Basin	Water Demand	Water Demand in 2025		
			A	B	C
Ciujung	Ciujung	14.0	10.5	11.3	11.1
Rancasumur	Cidurian	4.2	3.7	3.7	3.7
Cisadane	Cisadane	18.9	16.9	17.2	17.2
Empang	Cisadane	1.4	0.7	0.7	0.8
Katulampa	Ciliwung	1.5	0.9	0.9	1.0
West Tarum	Citarum	33.6	28.2	28.7	28.6
North Tarum	Citarum	57.5	48.2	50.1	48.4

Comparing the present water demand in the Ciujung and Rancasumur irrigation areas with their future demand, water demand of about 20 % in the Ciujung and 10 % in the Rancasumur was expected to be reduced from the present ones in these schemes.

(5) Other water demands

In the Jabotabek area, flushing water for DKI Jakarta has been presently supplied from the Juanda dam through WTC. However, the JWRMS recommended to utilize residual water for flushing purpose since the constant water supply would require Rp. 200/m^3 and it would be expensive.

Also, brackish water fishery has been done along the northern coastal zones in the Jabotabek and by using residual water from the existing irrigation canals. But, no water was allocated to this sector in the JWRMS.

3.2.2 Proposed water supply plan

(1) Supply criteria

The JWRMS set up priority ranking for water allocation to various water users as follows:

a) The existing irrigation and municipal and industrial water demand
b) Additional municipal and industrial water demand
c) New irrigation development
d) Aqua-culture
e) Flushing water
f) Hydropower

Also, to evaluate the potential water resources, the study established the following supply criteria, describing severity of design drought:

a) M&I : failure 1 day in 10 years
b) Irrigation : failure 1 half month in 5 years
c) Flushing : use of residual water

(2) Potential water resources

The JWRMS reviewed the potential water resources (refer to Figure 6) identified by the previous studies and screened those by comparing the project cost, unit development cost and environmental impacts. The selected water resources are listed in Table 14. As indicated in the table, the Citarum and Ciujung was expected to have a potential to supply the water amount of 95 m^3/s and 33 m^3/s respectively under the aforesaid supply criteria.

(3) Alternative water resources development plans

Figure 7 shows the alternative water resources development plans which was prepared based on the combination of the following main alternatives and sub-options:

Main alternatives (Strategy):

1. Minimum investment cost for water resources development in the study area,

2. Balanced water supply to DKI, which provides the water supply sources both in the west (the Ciujung/Cidurian) and the east (the Citarum) to DKI Jakarta,

3. Reservation of the Karian dam for the western services area, which would support only the industrial development in Kab. Serang,

4. Safe drinking water sources, which could prevent water pollution along water conveyance system and minimize the use of polluted water in the Cisadane and Bekasi rivers passing through Bogor city area,

5. Multi-objective alternative, which was the combined alternative of the four alternatives.

Sub-options:

a. Upgrading of the existing West Tarum Canal (WTC), which aimed to improve water quality in the WTC polluted by the joining rivers passing through Bogor city area,

b. Canal 2 versus Tarum Jaya Canal (TJC). Both canals were studied in the C-J-C project and the detailed design of the later one was carried out, but presently, it has become more difficult to acquire the necessary land along the TJC due to urbanization and industrialization in Bekasi. The Canal 2 could be a preferable and possible option instead of the TJC since its alignment was designed to pass an area with the low population density.

c. Genteng reservoir versus pumping from Canal 2 for water supply to Bogor. The Genteng reservoir has possibility to supply water by gravity system and if the compensation cost for the existing railway, which is not used presently, it would be more prospective..

d. Implementation schedule of the Karian and Cilawang dams, which would be affected by growth rate of the water demands in Kab. Serang and Tangerang and DKI Jakarta.

(4) Proposed water resources development plan

The JWRMS compared; a) unit cost of raw water and treated water, b) investment cost, c) present value of project cost including operation and maintenance cost, and d) population to be resettled from the proposed reservoir area as shown below:

Alternative	Incremental Price		Expenditures		People to be replaced
	raw water (Rp/ m3)	treated water (Rp/m3)	investment cost (BRp.)	O&M cost (BRp)	
C1	279	500	5,963	2,387	59,000
C2	344	574	6,507	2,361	58,100
C3	317	562	6,887	2,630	61,100
C4	307	515	6,352	2,601	59,500
C5	310	520	6,487		63,600
C5'	294	496	5,589	2,331	43,100
A5	610	876	2,972	1,051	24,200
A5'	648	920	2,455	1,098	16,000

Note : Both alternatives of C5' and A5' shows strategy 5 without water supply to Jakarta from the west and with pipe line conveyance system between Karian-Parungpanjang.

Based on the above comparison of the costs and the following consideration, Strategy 5 (multi-object alternative) without water supply to DKI Jakarta was recommended in the Draft Final Report but the proper and appropriate scenario had not been selected among three scenarios for the water resources management in the Jabotabek area:

1) In Scenario C/ Strategy 1, the investment cost is expected to be the least but the water pollution along the existing open canal of the Cidurian irrigation scheme will occur in future since the there has been rapidly urbanized and industrialized in these years.

2) In Scenario C/ Strategies 1 to 3, water quality in the tributaries joining WTC needs high purification cost for the polluted water than strategies with upgrading of WTC.

3) In Scenario C/ Strategy 2 and 3, the Narogong dam in the Bekasi river has a disadvantage on water quality and unit cost for developing water resources.

4) In Scenarios A and C/ Strategies 2 and 5, the Genteng dam will be prospective water resources if the compensation for the existing railway, which is not utilized presently, would not be required.

5) In Scenario C/Strategy 5, the Tanjung dam requires large amount of the project cost and resettlement of about 20 thousand persons (4,000 household). Therefore, it will not be a preferable option but alternative water resources and its cost for DKI Jakarta instead of the Tanjung dam has not been identified. Also, the open channel type of conveyance system will allow water pollution in the canal by easily approaching of inhabitants and livestocks to the canal. A pipe line system with pumping-up is

necessary countermeasure to prevent the water pollution taking into account the low water head between Gadeg and Serpong.

4. REVIEW OF FOUR DAM SCHEMES

4.1 Procedure for Review of Water Supply Master Plan

The water supply master plan has been established by the Jabotabek Water Resources Management Study (JWRMS) from June 1991 to March 1994. The study allocated the role of municipal and industrial water supply as the main purpose of the water resources development to the envisaged four dam schemes, that is the Karian, Cilawang, Tanjung and Pasir Kopo dam schemes in the Ciujung and Cidurian river basins.

Review of the master plan, specially, focuses on supply capacity of the envisaged dam schemes since the JWRMS used meteorological and hydrological data for a period from 1951 to 1979 but the study area in 1980's has experienced several severe drought years in 1982, 1983 and 1991. Therefore, runoff data in these drought years were incorporated to evaluate the water resources in the Ciujung and Cidurian river basins in this study.

The procedure for review of the master plan was established as shown in Figure 8. The supply capacity of each dam scheme was evaluated in accordance with the following criteria on safety level of water supply as indicated.

Supply Priority	Water Demand Category		Criteria
(1)	M&I water supply	:	successful supply capacity to meet the water demand even in a drought year with excess probability once in 10 years,
(2)	Irrigation water supply	:	successful supply capacity to meet the water demand even in a drought year with excess probability once in 5 years,
(3)	Flushing water	:	use of remaining water only from the downstream river basin of the envisaged dams,
(4)	Aqua-culture	:	no water allocation in the Ciujung and Cidurian river basins, which means that the aqua-cultural water use is limited into the present situation utilizing return flow of irrigation water supply system.

The above criteria means that the first priority is given to M&I water supply and that the irrigation water supply is restricted in the drought years with return periods of more than 5 years in order to meet the M&I water demands. In the water balance analysis, excess probability is assumed to be expressed by occurrence rate of water supply failure from the dam/reservoirs for simulation period of 24 years from 1970 to 1993 as follows:

1) excess probability once in 10 years	:	Supply failure once for 24 years is allowed assuming that the second drought corresponds to the drought with the probability of 10 %.
2) excess probability once in 5 years	:	Supply failures of 4 times for 24 years are allowed assuming that the fifth drought corresponds to drought with the probability of 20 %.

Implementation schedule of water supply plan from the Ciujung and Cidurian river basins to Serang, Tangerang and DKI Jakarta will be also reviewed based on the result of verified supply capacity through the water demand and supply balance analysis.

4.2 Water Demand

4.2.1 Municipal and industrial water demands

The municipal and industrial (M&I) water demand and agricultural water requirement have been forecasted by the JWRMS. The applied procedure and data are reviewed and it is judged that estimation procedures on the basis of the economic data including the latest 1990 census, which has been accumulated and updated since BTA-155 study, is reasonable. From this consideration, the water demands projected by the JWRMS is incorporated into the current water demand and supply balance analysis.

The water demands to be supplied by developing the water resources in the Ciujung and Cidurian river basins are illustrated in Figures 9 and 10. The scenario A is on the basis of the past trend and while scenario C aims at diverting the main M&I water source from groundwater into surface water in order to solve the problems caused by the over-abstraction of groundwater. Future water demands in the M&I sector are expected to increase between the aforesaid two (2) scenarios A and C.

4.2.2 Irrigation water requirement

There are two large irrigation areas; one is the Ciujung scheme with an area of 22,988 ha in the Ciujung river basin, and the other is Cidurian-Rancasumur scheme with an area of 10,805 ha in the Cidurian river basin. The JWRMS suggested that the total irrigation requirement is expected to be reduced due to decrease of irrigation area for housing and industrialization, and that agricultural cropping pattern will gradually change from the paddy to vegetable for supplying necessary vegetable to Jabotabek area with large population.

Based on the above-mentioned, the irrigation water requirement is estimated taking into account the decrease of irrigation area and diversification of agricultural cropping pattern. The assumed cropping pattern in the aforesaid two irrigation areas are illustrated in Figures 11 and 12. As indicated in the figures, the irrigation areas of about 4,100 ha in the Ciujung and 1,500 ha to 2,000 ha in the Rancasumur schemes are forecasted to be decreased between the years of 1990 and 2025 by the JWRMS due to expansion of residential area for population growth.

(unit : ha)

Irrigation Area	River Basin	Area in 1990	Area in 2025 (ha)		Reduced Area from 1990 to 2025 (ha)	
			A	C	A	C
Ciujung	Ciujung	22,988	18,862	18,862	4,126	4,126
Rancasumur	Cidurian	10,805	9,312	8,873	1,493	1,932

The population growth with a high rate in the Jabotabek area also needs the year-round vegetable cropping to supply it to this area. Therefore, a part of the wet season paddy is assumed to be replaced by vegetable cropping in both scenarios.

Tables 15 to 18 show the half monthly irrigation water requirement in two (2) scenarios which are estimated in the current study with the aforesaid cropping pattern and irrigation areas, the parameters in the PU's guidelines and FAO's standard in Table 19, and half-month rainfalls observed at the station with code No. of 23c in Table 20, according to the procedures illustrated in Figure 13.

4.2.3 Flushing water

The JWRMS recommends not to provide flushing water by construction of dam/reservoir since the expensive incremental cost of Rp. 200/m^3 is required to gurantee it and residual water from the downstream basin of damsite is expected to be available for this purpose.

In the downstream river stretch far from the damsite, drastic change of river flow situation is not considered but the just downstream area will be largely affected by storing river water in the reservoir. Especially, no release from the dam will cause no flow situation with significant duration at the just downstream of the damsites, where the inhabitants utilize the river water for their living activities:

Dam/Reservoirs	Duration of No flow Situation (days/year)
Karian	130 (36%)
Cilawang	220 (60%)
Tanjung	80 (21%)
Pasir Kopo	40 (10%)

In order to cope with these adverse effect to the downstream area, the minimum released discharge from the dam is considered in this study to maintain their living activities. The minimum discharge is determined based on the specific discharge of 0.3 m^3/sec per 100 km^2 corresponding to drought discharge with excess probability once in 10 years at the damsites.

4.3 Review of Water Supply Capacities of the Envisaged Dams and Reservoirs

4.3.1 Water demand and supply balance model

(1) Water demand

As shown in the aforesaid Figure 9, the C5 requires four (4) dams/reservoirs, namely the Karian, Cilawang, Tanjung and Pasir Kopo dams/reservoirs, and the Karian-Serpong Conveyance System (KSCS) in order to meet the total M& I water demand of 26.2 m^3/s at 2025. While, the A5 needs two (2) dam/reservoirs of the Karian and Cilawang and the KSCS for the total M& I water demand of 16.5 m^3/s. As for the irrigation water requirement, the annual average requirement of 14.6 m^3/s in the scenario A and 13.9 m^3/s in the scenario C in total of the Ciujung and Rancasumur areas at 2025.

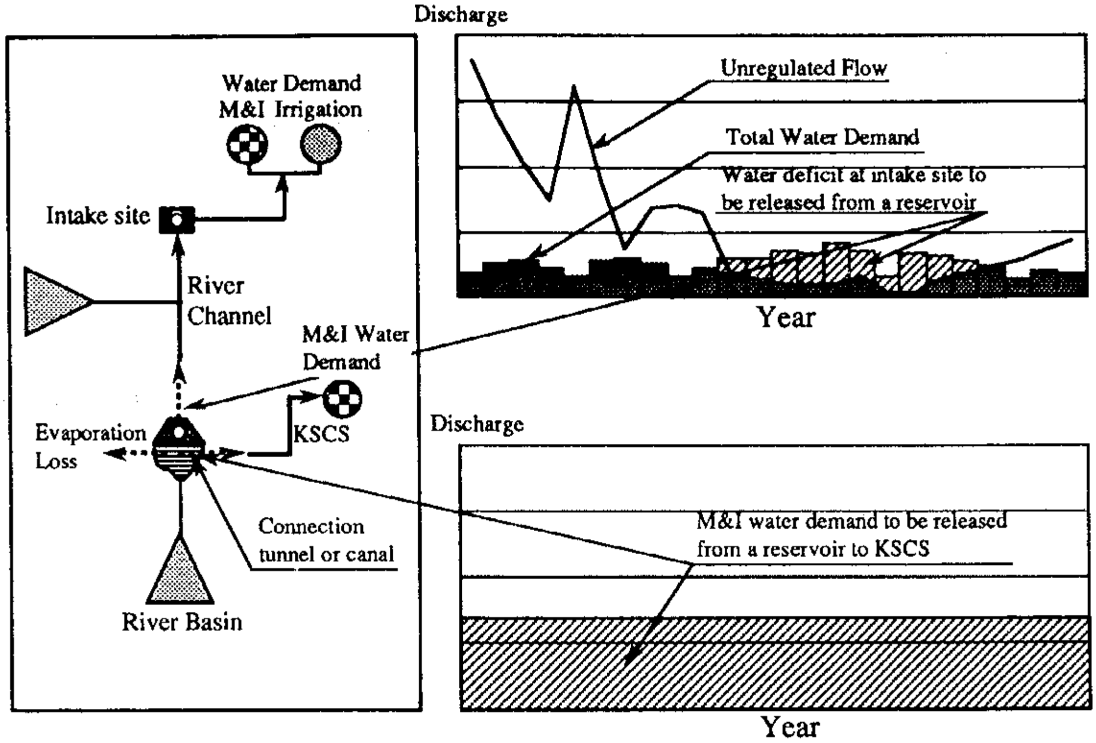
The mentioned water demands are assumed to be taken at the existing Pamarayan weir for Serang and the Ciujung area, the existing Rancasumur weir for the Rancasumur area, and the damsites to be directly connected with the KSCS for M&I water supply in Tangerang and DKI Jakarta.

(2) Dams and reservoirs

The water balance model was prepared taking into account the aforesaid facilities for water resources development and water conveyance to water users as illustrated in Figure 14. The functions of the dams/reservoirs and KSCS are described as follows:

Dam/Reservoirs			Functions
(1) Karian	:	a)	M&I water supply to Serang/Tangerang and DKI Jakarta through Ciuyah tunnel and KSCS
		b)	Flood control for a river stretch between Rangkasbitung and Pamarayan weir
		c)	Irrigation water supply to the Ciujung area
(2) Cilawang	:	a)	M&I water supply to Tangerang and DKI Jakarta through KSC
(3) Tanjung	:	a)	M&I water supply to Tangerang and DKI Jakarta through KSC
		b)	Irrigation water supply to Rancasumur area
(4) Pasir Kopo	:	a)	M&I water supply to Serang
		b)	Irrigation water supply to the Ciujung area

The envisaged dams and reservoirs are operated to meet the allocated role in the water balance model. The operation concept of each dam is illustrated as follows:



Dam schemes to be connected with the KSCS by tunnel or canal will constantly release the stored water corresponding to the allocated water amount. While, a dam with irrigation water supply and/or M&I water supply in the downstream area of the dam sites will release the stored water through river outlet in order to supplement water deficit at an intake site.

(3) Runoff model

As well as the aforesaid structural components, the balance model involves sub-basins, which are prepared by dividing the catchment area of the Ciujung and Cidurian river basins taking into account the location of the envisaged dams and the existing intakes, are listed as follows:

Ciujung River Basin		
Sub-basins	Catchment Area (km^2)	Annual Mean Rainfall (mm)
U1 (Karian)	288	3498
U2 (Pasir Kopo)	172	3101
U3	329	2902
U4	159	3143
U5	435	2614
U6	68	2253
U7	399	2070
Total	1,850	

Cidurian River Basin		
Sub-basins	Catchment Area (km^2)	Annual Mean Rainfall (mm)
D1 (Cilawang)	93	3558
D2	23	2157
D3	65	2157
D4		2157
D5	7	2157
D6	34	1944
D7 (Tanjung)	280	3673
D8	96	2157
D9	18	1670
D10	216	1045
Total	865	

The runoffs from these sub-basins are estimated by multiplying a ratio of the catchment area and annual mean rainfall to those at Rangkasbitung for the Ciujung river basin and at Kopomaja for the Cidurian river basin in Table 13 in Annex 2 : Hydrological study. The catchment area and annual rainfall at Rangkasbitung and Kopomaja are as follows:

Key Gauging Station	River Basin	Catchment Area (km^2)	Annual Rainfall (mm)
Rangkasbitung	Ciujung	1,383	2,988
Kopomaja	Cidurian	304	3,553

The estimated half monthly discharges flowing into these reservoirs are given in Tables 21 and 22. The annual mean runoff and effective storage volume of these dams/reservoirs are given as follows:

Dams/Reservoirs	Annual Mean Runoff		Effective Volume
	m^3/s	mil. m^3	mil. m^3
Karian	23.0	725	219 (30 %)
Cilawang	6.5	205	62 (30 %)
Tanjung	20.1	633	120 (19 %)
Pasir Kopo	12.2	385	131 (34 %)

Note : Figure in the parenthesis indicates a ratio of the effective storage volume to annual runoff.

(4) Evaporation loss from a reservoir

Evaporation loss from a reservoir is taken into account in the water balance analysis. Since there are no sufficient data on evaporation, potential evaporation was examined by using Penman's method. The results are shown as follows:

(unit : mm/day)

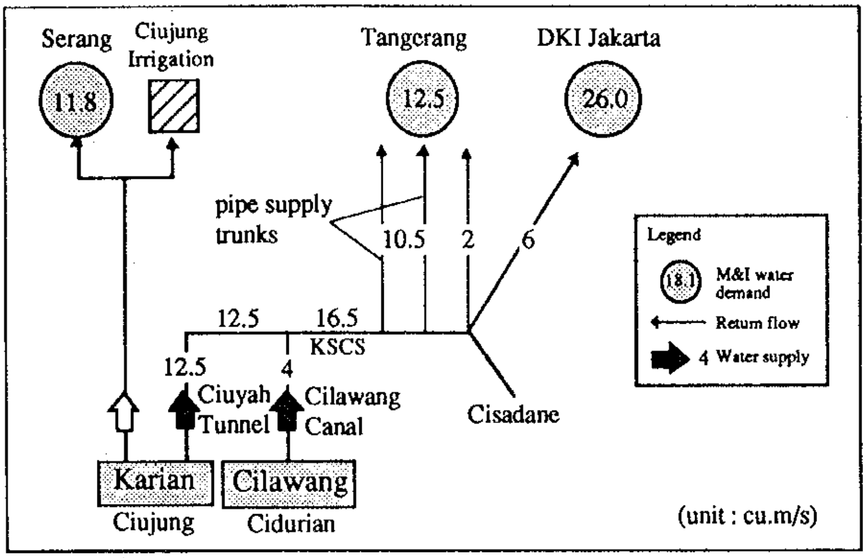
Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
4.0	4.3	4.5	4.5	4.1	4.0	4.3	4.7	5.3	5.2	5.0	4.4

4.3.2 Supply capacity of the envisaged dams and reservoirs

(1) Scenario A and Strategy 5 (A5)

Water supply plan by the JWRMS

The two (2) dams/reservoirs are proposed to be constructed in the water supply master plan by the JWRMS and to supply water for M&I and irrigation at 2025 as follows:



The Karian dam is planned to supplement water deficit at the Pamarayan weir between unregulated flow and total water demands for M&I sector in Serang and the Ciujung irrigation area. Also, the Karian dam is designed to release water of 12.5 m^3/s through the Ciuyah tunnel to the KSCS to Tangerang and DKI Jakarta. The Cilawang dam constantly releases the stored water of 4 m^3/s through an intake in the reservoir to be directly connected with the KSCS by Cilawang canal.

The water demand and supply balance analysis is made for the above supply plan to verify it by using updated runoff data. The water level hydrographs of the proposed reservoirs are illustrated in Figure 15. As shown in the figure, the water supply failure occurs at the Karian reservoir in the severe drought years of 1972, 1977, 1982, 1983 and 1991. While, the Cilawang reservoir is able to supply the allocated water even in the aforesaid drought years without draw-down to the low water level. The water deficit at the existing Pamarayan weir and the KSCS in the above drought years are as follows:

Drought Year	Pamarayan Intake (mil.m^3)	KSCS (mil.m^3)	Total (mil.m^3)
1972	96.2	66.7	162.9
1977	12.0	29.9	41.9
1982	88.8	51.8	140.6
1983	143.0	61.0	204.0
1991	166.0	89.7	255.7

As shown in the above, the water supply measures in the master plan established by the JWRMS is judged to be insufficient to meet the water demands in the scenario A since occurrence of supply failure of 5 times for 24 years is considered to correspond to safety level with excess probability once in 4 years.

Alternative structural measures

It is possible to set up three (3) alternatives; 1) Karian and Tanjung, 2) Karian and Pasir Kopo, and 3) Karian, Cilawang and Pasir Kopo, taking into account the supply capacities of the reservoirs in the master plan.

In the alternative (1), the Karian reservoir is planned to supply water to Serang mainly and the Tanjung to Tangerang and DKI Jakarta. While, in the alternative (2), the Karian reservoir is provided for water supply to Tangerang and DKI Jakarta and the Pasir Kopo reservoir for Serang. This alternative (2) is possible only when the Karian reservoir's capacity sufficiently meet the M&I water demands in Tangerang and DKI Jakarta. The alternative (3) is a countermeasure for the alternative (2) in case that the Karian reservoir is not able to cover the water demand of 16.5 m^3/s in the aforesaid areas.

From the above consideration, the Karian reservoir's supply capacity without water supply to Serang is reviewed assuming that the supply to Serang is made by the Pasir Kopo reservoir. Figure 16 indicates the relationship between required storage volume and released discharge to KSCS, established by means of mass curve and frequency analyses. The figure reveals that the Karian reservoir with a storage volume of 219 mil. m^3 has a supply capacity of 14.4 m^3/s less than 16.5 m^3/s of M&I water demands in Tangerang and DKI Jakarta under the drought condition with excess probability once in 10 years. Consequently, the alternative (2) is not adopted for selecting an optimum measure.

While, the investment costs of alternatives (1) and (3) are compared as follows:

Dam Scheme	Alternative (1)		Alternative (3)	
	Construction Cost (Bil. Rp.)	Population to be Replaced	Construction Cost (Bil. Rp.)	Population to be Replaced
Karian	153	12,124	153	12,124
Cilawang	-	-	71	3,706
Tanjung	417	15,060	-	-
Pasir Kopo	-	-	83	3,810
Total	670	27,184	307	19,640

As shown in the aforesaid table, the alternative (3) has advantage on both the investment cost and resettlement of inhabitants in the planned reservoir areas. Therefore, the alternative (3) is selected as a structural measure for the scenario A. Following to this selection, scale of the Pasir Kopo reservoir is optimized through the water balance analysis under the supply criteria.

Figure 17 shows the result of the water balance analysis. The released discharges from the dams/reservoirs in the master plan are adjusted taking into account the availability of water resources. The Karian and Pasir Kopo schemes are operated in the simulation study by applying covering ratio for water deficit at the existing Pamarayan weir. Through the simulation, covering ratios for the Karian and Pasir Kopo dams are given as 64 % and

36 %, respectively, and the Pasir Kopo dam is optimized to have effective storage volume of 44.5 mil. m^3 and normal high water level of 90.5 m in the scenario A.

As shown in the figure, the Karian and Pasir Kopo reservoirs fails water supply 4 times for 24 years. This result indicates that these schemes are able to successfully supply water to the related areas even in the drought with excess probability once in 5 years. Also, this figure shows the water level hydrograph without water supply to dry season crops in the Ciujung area. In the severe drought years with a return period more than 5 years (excess probability of 20 %), reduction of irrigation water supply to the Ciujung area is necessary in order to meet the M&I water demands. Possible cropping intensity in the Ciujung area in such drought years is assumed that the intensity is to be ratio of remaining storage volume without water supply to the dry season crop and the required storage volume with water supply to dry season crop of 100 % intensity. Results are given as follows:

Drought Year	without Second Crop (mil.m^3)	with Second Crop (mil.m^3)	Cropping Intensity in Dry Season (%)	Probability
1972	85.6	221.0	39 (7.4)	0.12
1982	87.8	144.2	61 (9.0)	0.16
1983	61.7	230.6	27 (6.4)	0.08
1991	37.7 *	-	-	0.04

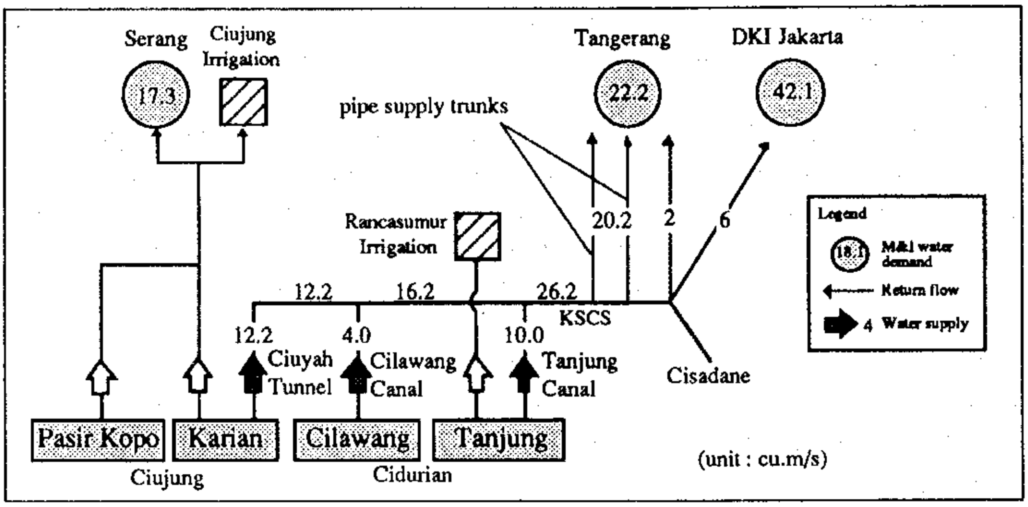
Note : Drought year with symbol of "*" means that M&I water supply is not satisfied even if irrigation water for dry season crop is restricted. Also, Figures inparenthesis indicate annual average of water supply amount for irrigation.

As indicated in the above table, the cropping intensity in the dry season in the drought year with excess probability once in 10 years (10%) is required to be reduced to about 30 % and as a result of restriction of irrigation water water supply, the water supply amount is limited to 6.4 m^3/s in terms of annual average. In the drought with a return period more than 20 years in 1991, the severest supply failure occurs due to draw-down of water level to the low water level in the Karian reservoir, even if water supply to dry season crops is completely sacrificed.

(2) Scenario C and Strategy 5

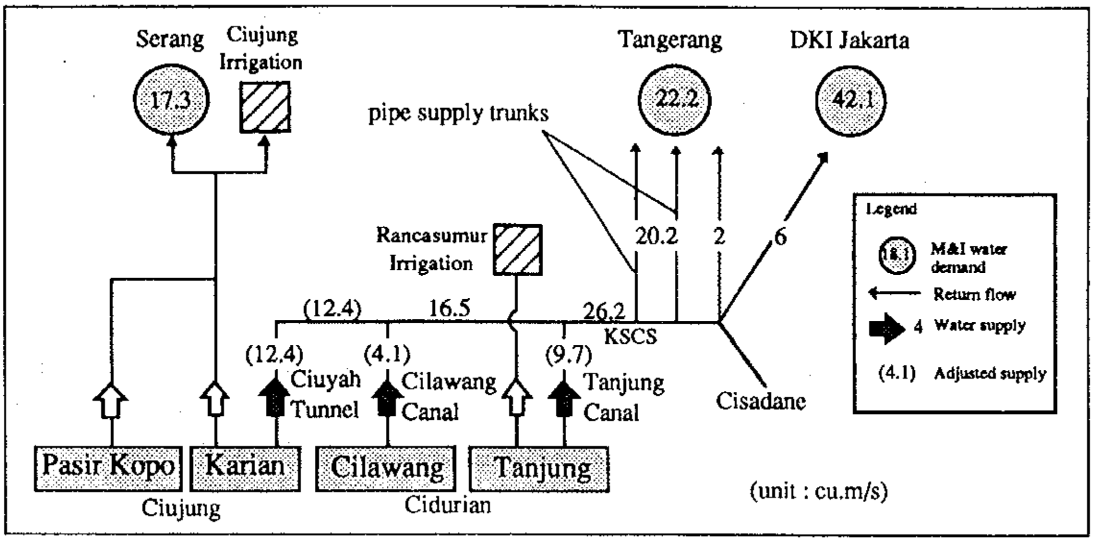
Water supply plan by the JWRMS

The four (4) dams are proposed to be constructed in the water supply master plan by the JWRMS and to supply water for M&I and Irrigation sectors at 2025 as follows:



The Karian and Pasir Kopo dams are planned to supplement water deficit at the Pamarayan weir between unregulated flow and total water demands for M&I in Serang and irrigation in the Ciujung area. The Karian dam, furthermore, is designated to supply water of 12.2 m3/s through the Ciuyah tunnel to Tangerang and DKI Jakarta. The Cilawang and Tanjung dams constantly release the stored water of 4 m^3/s and 10 m^3/s respectively through intake in the reservoir to be directly connected with KSCS by the canals. The total water of 26.2 m^3/s released from the reservoirs to KSCS is planned to be conveyed to the proposed water treatment plants at Tenjo and Parungpanjang and to supply to Balaraja/Tigaraksa and Tangerang areas through pipe trunk lines. On the other hand, raw water of 6 m^3/s is to be conveyed by the KSCS to Serpong treatment plant.

Referring to the result for the scenario A, the water supply plan above-mentioned is adjusted in accordance with the supply criteria and the availability of water in the Ciujung and Cidurian river basins estimated based on the hydrological data including those from 1980 to 1993 when severe droughts were experiencxed several times. As a result, the raw water supply plan from the river basins is revised as follows:



The water level hydrographs of the envisaged reservoirs are shown in Figure 18. As indicated in the figure, supply failures in the Karian, Pasir Kopo and Tanjung reservoirs occurs 4 times with water supply to dry season crop and once without water supply to the dry season crops. In order to maintain the M&I water supply, the following reduction of intensity of dry season crops is required during these drought years as follows:

Drought Year	without Second Crop Supply (mil.m^3)		with Second Crop Supply (mil.m^3)		Cropping Intensity in Dry Season (%)		Probability	
	Ciujung	Ranca-sumur	Ciujung	Ranca-sumur	Ciujung	Ranca-sumur	Ciujung	Ranca-sumur
1972	108.4	35.6	243.8	65.1	53 (8.1)	55 (3.3)	0.12	0.08
1982	232.9	35.6	289.3	44.5	81 (9.7)	80 (3.8)	0.16	0.12
1983	128.5	-	297.4	-	43 (7.1)	-	0.08	-
1987	-	78.8	-	83.6	-	94 (4.0)	-	0.16
1991		0.0	271.3	27.8	23*	0*	0.04	0.04

Note : Drought year with symbol of "*" means that M&I water supply is not satisfied even if irrigation water for dry season crop is restricted. Also, Figures inparenthesis indicate annual average of water supply amount for irrigation.

The cropping intensity in the dry season in the drought year with excess probability once in 10 years (10%) is required to be reduced to 43 % in the Ciujung irrigation area and 55 % in the Rancasumur irrigation area to meet M&I water demands and as a result of restriction of irrigation water water supply, the water supply amount is limited to 7.1 m^3/s and 3.3 m^3/s in terms of annual average, respectively. However, the severest drought in 1991 for 24 years which has recurrence probability once in 20 years requires the restriction of M&I water use even in reducing the irrigation water supply.

Through the simulation, the scale of Pasir Kopo reservoir is optimized to have an effective storage volume of 112.6 mil. m^3 and normal high water level of 100.5 m, assuming that the Pasir Kopo reservoir releases the stored water corresponding to 60 % of the water deficit for water demands at the Pamarayan weir and other 40 % is satisfied by the supply from the Karian reservoir.

5. STUDY ON PRIORITIES OF THE FOUR DAM SCHEMES

5.1 Four Dam Schemes

5.1.1 First priority project

The area in Kab. Serang has been rapidly industrialized and urbanized and the new harbour and connection of national highway between Jakarta and Merak under construction are considered to accelerate these activities. While, the main surface water resources to support these economic development are limited into the Ciujung and Cidurian rivers in Serang and Tangerang. The supply capacities of the Ciujung and Cidurian river without regulation by the dam/reservoir are estimated by means of statistical analysis using annual minimum daily discharge series from 1970 to 1993 as follows:

Description	Ciujung at Pamarayan	Cidurian at Rancasumur
Unregulated Flow with excess probability of 10 %	3.6	1.1

The aforesaid flow discharges are estimated to correspond to the M&I water demand between 1995 and 2000 in Serang and between 1990 and 1995 in Tangerang in both the scenarios A and C. While, the JWRMS recommends not to use the Cidurian-Rancasumur canal for M&I water conveyance due to high possibility of water pollution and therefore a new water conveyance system is proposed to be directly connected with the Tanjung reservoir. In consideration of the present situation of the areas, both the areas need the earlier construction of dams and reservoirs which enable stable water supply.

From the above-mentioned, the Karian dam scheme has large advantage on ability of water supply to both areas and furthermore this scheme can have a flood control function along the middle reach of the Ciujung river rapidly being developed and 1993 flood caused severe damage to the area. Therefore, first priority is given to the Karian dam scheme and starting time of the operation is proposed at 2002 as illustrated in Figure 19, taking into account two (2) years of detailed design, one (1) year of financial arrangement and land acquisition and construction period of four (4) years including water conveyance system after this Study.

5.1.2 Development scenario in Scenario A

The Karian reservoir is able to solely satisfy the M&I and irrigation water demands till 2015 as shown in Figure 20. However, the figure indicates that water supply of 6 m^3/s to DKI Jakarta scheduled to start in 2015 induces supply failure even in a drought year with a return period of 5 years, and that it needs supplemental water supply of 3.3 m^3/s by the Pasir Kopo to Serang and increase of water supply capacity of the Karian reservoir to Tangerang and DKI Jakarta thereby from 9.1 m^3/s to 12.4 m^3/s. In the same year, the Cilawang dam is also planned to start water supply of 0.6 m^3/s in 2015 to fulfill M&I water demand in Tangerang and DKI Jakarta and gradually increase it to 4.1 m^3/s by 2025.

5.1.3 Development scenario in Scenario C

The Karian reservoir meets the water demand by 9.1 m^3/s both in Serang and Tangerang including irrigation water supply to the Ciujung in 2011 (refer to Figure 20). Afterwards, the rapidly increasing water demands in both the areas requires the water supply from the Pasir Kopo dam to Serang and increase of water supply to Tangerang from 9.1 m^3/s to 12.4 m^3/s thereby to meet the water demands till 2014. Furthermore, growing water demands in the aforesaid areas after 2014 and water supply of 6 m^3/s to DKI Jakarta in 2015 need the start of services of the Tanjung dam with large supply capacity of 9.7 m^3/s in 2014 and the Cilawang with supply capacity of 4.1 m^3/s in 2018.

The JWRMS recommended not to implement the Tanjung scheme because of high construction cost and large population of resettlement. While, the abstraction of large amount of groundwater as a countermeasures for without-Tanjung dam scheme, might induce the problems as similar as in Jakarta and this groundwater resources might not be permanent measure. There is no alternative surface water resources for the Tanjung scheme in the Ciujung and Cidurian river basins and the scheme is indispensable to fulfill the water demand in the scenario C in the study area. Consequently, the Tanjung dam scheme is proposed in case that the M&I water demands increases along or below the scenario C, but above the scenario A.

5.2 Development Scenario for Karian-Serpong Water Conveyance System

It is recommended that the KSCS should also be developed in line with the water resources development in the Ciujung and Cidurian river basins to cope with increase of M&I water demand in Tangerang and DKI Jakarta, since there are many assumptions in estimating future M&I water demand as shown in Figure 3. The significant factors are; 1) necessity of abandoment of intake water of 3.0 m^3/s in the Cisadane river and replacement with other sources due to probable intolerable contamination at 2015, 2) success of diversification of main M&I water source from the groundwater to surface water, and 3) area reduction of the existing irrigation areas and change of agricultural cropping pattern in the Ciujung and Rancasumur areas in future. Taking into account possibility of changes of these factors from those assumed in the Study, the implementation schedule is necessary to be established with flexibility to cope with the changes in the water demand without over-investment.

From the above-mentioned, a phasing development concept for the KSCS based on the following targets is established:

a) The first phase development aims to supplying M&I water in Tangerang (Phase I).

b) The second Phase development is to be implemented for fulfilling M&I water demand in Tangerang and DKI Jakarta after around 2015 (Phase II).

Possible phasing development are shown in Figure 21 in consideration of the above-mentioned.

5.2.1 Development scenario in scenario A

In the Scenario A, the KSCS I with the maximum capacity of 7.0 m^3/s, which corresponds to water demand in Tangerang at 2015, is planned to be constructed in Phase I together with the Karian dam and reservoir and the Ciuyah tunnel. The Ciuyah tunnel is planned to have the flow capacity of 12.4 m^3/s, which is to be required for M&I water demand in Tangerang and DKI Jakarta at 2025 in consideration of difficulty of tunnel construction works by the stagewize implementation. In Phase II, capacity of KSCS is enlarged at 12.4 m^3/s (7.0+5.4 m^3/s) in the waterway between the outlet of the Ciuyah tunnel and the confluence with the Cilawang canal by providing an additional lane of waterway. The additional waterway is connected with the downstream stretch with a capacity of 9.5 m^3/s by the planned Tenjo water treatment plant (WTP) and 7.75 m^3/s by Parungpanjang WTP. Connection to Serpong WTP is also carried out in this Phase II by providing pipeline system selected from the alternative route study to Lebakbulus and R.4 distribution centers in the PAM Jaya Water Supply System.

5.2.3 Development scenario in scenario C

The first stage development is recommended to be constructed with a capacity of 12.4 m^3/s, which is larger than required for the M&I water demand in Phase I. There is a counter option for this Phase development of KSCS that is further divided to two stages; first stage providing a waterway with a capacity of 9.1 m^3/s corresponding to the supply capacity of the Karian reservoir and second stage installing additional waterway with a capacity of 3.3 m^3/s corresponding to the supply capacity of the Pasir Kopo reservoir. This option, however, needs higher construction cost in terms of their present values of the cost. As a result, the aforesaid Phase I with the maximum capacity of 12.4 m^3/s is recommended.

The Phase II is further divided into two stages, Phase II-a and II-b by the construction of the Tanjung and Cilawang dam. In the Phase II-a, the construction of the Tanjung dam enables to supply the water amount of 9.7 m^3/s to Tangerang and DKI Jakarta through KSCS II with a capacity of 13.8 m^3/s which involves the supply amount of 4.1 m^3/s to be realized by the provision of the Cilawang dam in Phase II-b. This provision of capacity of 4.1 m^3/s is concluded by the comparative study for construction cost in terms of the present value with/without a capacity of 4.1 m^3/s in Phase II. The connection to Serpong WTP is also made in Phase II-b by providing pipeline water conveyance with a capacity of 6 m^3/s.

The Phase II-b, which is implemented together with the Cilawang dam construction, requires construction of the Cilawang canal with a capacity of 4.1 m^3/s and a length of 17.1 km and connection of the Cilawang canal to KSCS II.

5.2.3 First step development among the scenarios A and C

The future water demands is judged to be between those of the scenarios A and C. The water demand in scenario A is the most realistic one between the positive case of scenario C and the pessimistic case of scenario B assuming the lower economic development in the JWRMS. The scenario C is a preffered case assuming successful diversification of water use from groundwater to surface water in order to solve the problems caused by over-abstraction of shallow and deep groundwater under higher economic growth of Indonesia. While, the scenario A is more aggressive than in the scenario C in using groundwater at high rate against surface use.

In Serang, Tangerang and DKI Jakarta, the industrialization and housing development has been carried out since the later part of 1980's and this development will be further accelerated by the full highway connection between Merak and Jakarta and provision of new harbour at Bojonegara in Serang. These activities will support the current economic growth in Indonesia and the provision of piped water supply for M&I will be needed to maintain economic development. While, the Indonesian Government has made efforts to provide safe and stable water supply with piped system and it will take much time and large amount of investment in order to reach such target in the scenario C. Therefore, the future growth trend of M&I water demand is considered to shift the realistic scenario A to the preffered scenario C.

In consideration of the above situation of M&I water demands, two implementation scenarios are possible:

Scenario 1	:	Phase IA	⇒	Phase IIC-a	⇒	Phase IIC-b
Scenario 2	:	Phase IC	⇒	Phase IIC-a	⇒	Phase IIC-b

The scenario 1 intends to implement small scale Phase IA with the construction of the Karian dam at 2002 as shown in Figure 22. While, shifting of water demand curve from scenario A to the scenario C requires earlier implementation of Phase IIC-a with additional capacity of 5.4 m^3/s at around 2010. The introduction of an additional waterway with capacity of 5.4 m^3/s needs construction of the downstream canals with full capacity at 2025 before introduction of the Tanjung and Cilawang dam construction as shown in Figure 22 since the further division of canals with more than two lanes requires higher cost than two lanes even at the same capacity.

While, the scenario 2, in which phasing development of water resources and KSCS is possible at the same time, has advantage on flexible enlargement of the supply capacity in accordance with increase of the M&I water demands in Tangerang and DKI Jakarta since this scenario 2 is able to give the sufficient time of 12 years until the provision of the Tanjung dam after introduction of the Karian dam scheme even though the M&I water demand should increase with an extremely high rate in the scenario C. This advantage in the scenario 2 will enable to make the stable financial arrangement and give sufficient time to review the effect of the investment. Further, the Karian and Pasir Kopo dam schemes, which have total supply capacity of 12.4 m^3/s, are necessary to be constructed in both the scenarios A and C and therefore the KSCS with the supply capacity of 12.4 m^3/s will be able to efficiently meet the M&I water demands in these scenarios.

Comparing the present values of construction cost for the above scenarios, the scenario 2 is considered to be cheaper solution due to appropriate provision of flow capacity against increase of M&I water demands.

Based on the above selection of the first phase development of KSCS, the proposed phasing development plan of KSCS is illustrated in Figure 23.

TABLES

Table 1 INFLOW AND OUTFLOW DISCHARGE RECORDS AT JUANDA DAM

(1) Inflow discharge (unit : cu.m/sec)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Mean
1965	457	466	186	171	121	55	38	15	9	15	75	298	159
1966	261	235	346	178	152	96	33	22	27	167	202	315	170
1967	234	281	217	347	134	35	15	9	13	19	90	247	137
1968	238	167	302	257	270	238	236	244	125	82	161	255	215
1969	382	361	265	334	138	128	50	32	101	83	176	147	183
1970	252	214	516	299	324	170	93	36	56	83	301	227	214
1971	292	297	178	299	196	110	57	38	12	170	309	355	193
1972	322	282	351	254	185	35	24	18	6	12	94	182	147
1973	296	357	339	358	371	136	96	84	151	165	162	231	229
1974	161	191	127	375	299	59	104	177	151	292	274	256	206
1975	348	337	317	287	203	93	57	52	128	258	334	173	216
1976	326	196	198	246	122	35	17	25	16	78	209	203	139
1977	283	399	370	269	215	209	30	16	38	6	108	161	175
1978	253	140	343	178	206	230	220	171	182	170	265	440	233
1979	247	351	228	345	257	134	47	56	98	116	268	361	209
1980	229	137	197	267	127	65	66	88	68	112	266	366	166
1981	225	154	321	242	205	123	145	62	66	105	193	164	167
1982	321	193	174	424	98	53	20	10	9	18	36	230	132
1983	290	374	241	239	224	62	33	9	4	100	300	187	172
1984	341	321	278	370	264	92	50	106	234	192	175	256	223
1985	256	242	118	118	105	156	120	35	103	139	120	198	143
1986	295	223	423	304	148	111	131	141	178	168	281	229	219
1987	246	276	294	254	140	102	71	66	6	2	63	134	138
1988	85	95	154	163	162	147	162	141	56	73	209	120	131
1989	173	174	173	183	173	221	161	104	75	104	187	154	157
1990	191	194	232	146	160	140	119	142	139	124	113	132	153
1991	177	150	207	258	160	154	103	77	87	83	113	242	151
1992	198	204	320	328	205	182	143	122	125	266	280	344	226
1993	329	359	241	385	197	148	142	-	-	-	-	-	-
Mean	266	254	264	272	192	121	89	75	81	114	192	236	179
Min.	85	95	118	118	98	35	15	9	4	2	36	120	131
Max.	457	466	516	424	371	238	236	244	234	292	334	440	233

(2) Outflow discharge (unit : cu.m/sec)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Mean
1965	443	484	150	65	81	83	71	59	47	28	67	133	143
1966	264	131	98	79	121	104	82	75	49	66	191	388	137
1967	301	266	138	126	101	139	186	96	110	73	80	84	142
1968	102	127	137	240	171	270	242	232	248	260	132	261	202
1969	246	367	205	294	165	133	157	144	126	111	91	110	179
1970	238	228	304	314	301	194	173	153	143	125	104	295	214
1971	343	217	166	134	134	162	176	158	154	156	131	263	183
1972	339	355	178	247	174	198	180	166	116	52	59	104	181
1973	115	118	140	340	380	162	158	163	169	265	198	227	203
1974	144	126	77	188	312	135	135	140	229	254	293	250	190
1975	262	266	268	258	207	142	138	146	254	182	351	239	226
1976	240	132	121	207	169	128	116	121	126	121	140	158	148
1977	158	162	300	274	214	228	140	141	134	137	157	160	184
1978	130	113	97	115	125	215	210	246	294	200	294	321	197
1979	263	279	184	302	280	179	162	151	145	147	194	268	213
1980	195	152	146	153	187	158	165	156	161	132	192	187	165
1981	178	129	222	229	240	157	171	163	182	182	191	185	186
1982	164	157	158	194	188	148	131	128	111	103	135	126	145
1983	108	122	164	163	192	153	141	146	129	116	162	167	147
1984	147	194	223	353	316	164	158	150	182	164	163	212	202
1985	178	217	120	139	131	139	155	176	156	167	203	168	162
1986	176	178	207	321	172	175	196	212	124	181	242	236	202
1987	229	225	206	247	178	165	167	126	67	107	137	98	163
1988	97	106	110	136	167	187	168	142	76	102	148	133	131
1989	108	103	115	118	133	182	194	128	112	149	194	198	145
1990	136	119	120	127	146	178	189	163	115	134	181	192	150
1991	125	109	104	142	175	201	194	143	110	169	176	211	155
1992	128	126	127	285	238	196	194	207	196	167	211	324	200
1993	294	371	196	387	260	184	207	-	-	-	-	-	-
Mean	202	196	165	213	195	168	164	151	145	145	172	204	175
Min.	97	103	77	65	81	83	71	59	47	28	59	84	131
Max.	443	484	304	387	380	270	242	246	294	265	351	388	226

Table 2 EXISTING WATER CONVEYANCE SYSTEM IN THE STUDY AREA

Conveyance System	Intake Weir/ River System	Service Area	Length (km)	Design Capacity (m^3/sec)
1) West Tarum Canal	Curug/Citarum	Prosijat irrigation area and Jakarta	69.5	Curug-Cibeet : 77 to 85 Cibeet-Cikarang : 48 to 90 Cikarang-Bekasi : 21 to 45 Downstream of Bekasi : 11 to 14
2) Cisadane irrigation canals	Pasar Baru/Cisadane	Prosida-Cisadane irrigation area	Barat : 39.5 Barat Laut : 13.3 Timur : 14.6 Utara : 15.1 Tana Tingi : 15.9 Total : 98.4	Barat : 0.7 to 30 Barat Laut : 11.5 Timur : 14.6 Utara : 15.1 Tana Tingi : 15.9
3) Solokan Barat Main Canal (Empang)	Empang/Cisadane	Cisadane-Empang irrigation area	22.0	1.4 to 6.9
4) Katulampa Main Canal	Katlumpa/ Ciliwung	Ciliwung-Katulampa irrigation area	42.7	4.5
5) Cidurian Main Canal	Rancasumur/ Cidurian	Cidurian-Rancasumur irrigation area	Intake to Cimanceuri : 14.0 Cimanceuri to E.P. : 10.8 Total : 24.8	Intake to Cimanceuri : 4.6 to 14.7 Cimanceuri to E.P. : 0.4 to 4.4
6) Cicinta irrigation canal	Cicinta/Cicinta	Cicinta irrigation area	12.0	1.8
7) Ciujung irrigation canals	Pamarayan/ Ciujung	Ciujung irrigation area	Barat : 46.7 Timur : 31.4 Utara : 16.1 Total : 94.2	Barat : 0.7 to 29.8 Timur : 0.9 to 7.4 Utara : 2.1 to 7.9

Table 3 EXISTING WATER TREATMENT PLANT IN PAM SYSTEM

Treatment Plant	Capacity (lit./sec)	Water Source	Commissioned Year	Remarks
(1) Pejompongan I	2,000	Banjir Canal	1957	
(2) Pejompongan II	3,000	Banjir Canal	1970	
Pejompongan II	4,000	Banjir Canal	1986	Addition of 4 units
(3) Pulogadung	4,000	Sunter River	1982	
(4) Buaran I	2,000	WTC	1992	
(5) Ciburial	300	Spring water in Bogor	1922	
(6) Muara Karang	100	Banjir Canal	1982	
(7) Taman Kota	50		1982	
	200		1992	Upgraded
(8) Cilandak	100	Krukut River	1977	
	200	Krukut River	1979	Upgraded
(9) Condet	50	Ciliwung River	1983	
(10) Cakung	25	WTC	1982	
(11) Pesing	5	Angke River	1980	
(12) Pejaten	5	Ciliwung	1982	
(13) Sunter	50	Sunter River	1982	
Total	15,935			

Table 4 EXISTING PIPED WATER SYSTEM IN KABUPATENS IN THE STUDY AREA

Kecamatan	Population		Water	Capacity	Type of	Commencement
	Total	Served	Source	(l/sec)	Development	Year of Service
Bekasi						
Pondokgede	282,126	-	-	-	-	-
Bantargebang	58,200	-	-	-	-	-
Setu	60,889	2,597	DGW	6.0	IKK	1986
Cibarusah	54,884	-	-	(2.5)	(IKK)	-
Serang	65,898	-	-	-	-	-
Lemahabang	116,290	3,220	DGW	5.0	IKK	1987
Cikarang	137,874	-	WTC	20.0	BNA	-
Cibitung	132,469	-	WTC	20.0	BNA	-
Tambun	159,690	1,561	WTC	27.0	BNA	1984/1985
Tarumajaya	37,560	-	-	-	-	-
Babelan	71,032	3,780	DGW	5.0	IKK	1988
Tambelang	56,450	-	-	-	-	-
Sukatani	77,482	6,500	Cikarang	20.0	IKK	1988
Pebayuran	68,814	-	-	-	-	-
Cabangbungin	39,910	-	-	-	-	-
Muaragembong	21,500	-	-	-	-	-
Bekasi Timur	218,677	-	-	-	-	-
Bekasi Selatan	177,115	53,956	Bekasi	100.0	BNA	1980
			DGW	40.0	BNA	1980
		-	(Bekasi)	(100.0)	(BNA)	-
Bekasi Barat	164,449	-	-	-	-	-
Bekasi Utara	103,083	-	(Bekasi)	(150.0)	(BNA)	-
Total	2,104,392	71,614		243.0		
Bogor						
Citeureup	165,074	-	(Cilengi)	(40.0)	(IKK)	-
Cibinong	125,104	(47000)	(Cikeas)	(65.0)	(BNA)	-
Gunung Putri	88,323	-	(Cikeas)	(20.0)	(IKK)	-
Cimanggis	220,308	-	-	-	-	-
Kedunghalang	185,464	6,226	DGW	10.0	BNA	1974
		-	Ciliwung	60.0	BNA	-
Jonggol	128,638	2,114	Cipatujah	5.0	IKK	1988
Cariu	73,825	-	-	-	-	-
Cileungsi	137,108	-	(Cileungsi)	(20.0)	(IKK)	-
Leuwiliang	123,084	9,100	Cianten	20.0	BNA	1982
Rumpin	81,486	-	-	-	-	-
Ciampea	130,518	476	Spring	15.0	BNA	1974
Cibungbulang	173,149	2,500	Cianten	20.0	BNA	1989
Jasinga	79,994	-	-	-	-	-
Cigudeg	109,283	-	-	-	-	-
Parungpanjang	91,797	350	Cimanceuri	10.0	IKK	1989
Nanggung	52,444	-	-	-	-	-
Ciawi	120,217	(40,000)	(Ciliwung)	(40.0)	(BNA)	-
Cijeruk/Cigombong	123,388	750	Spring	30.0	BNA	1974
Cisarua	136,479	5,922	Spring	50.0	BNA	1974
Caringin	72,204	-	-	-	-	-
Ciomas	295,104	-	Spring	15.0	IKK	-
Parung	130,488	-	-	-	-	-
Gunungsindur	49,589	-	-	-	-	-
Sawangan	165,835	-	-	-	-	-
Semplak	160,127	-	-	-	-	-
Bojonggede	138,898	-	-	-	-	-
Pancoran Mas	111,380	151,515 /1	Ciliwung	340.0	BNA	1,977
Beji	71,034		DGW			
Sukmajaya	198,526		Tap			
Total	3,738,868	178,953		760.0		

Kecamatan	Population		Water	Capacity	Type of	Commencement
	Total	Served	Source	(l/sec)	Development	Year of Service
Tangerang						
Tangerang	223,355	142,272	Cisadane	140.0	BNA	1980
Ciledug	191,112	-	-	500.0	BNA	1986
Cipondoh	140,767	-	-	-	-	-
Jatiuwung	203,627	-	-	-	-	-
Batu Ceper	162,987	-	-	-	-	-
Teluk Naga	72,741	2,982	Cisadane	5.0	IKK	1985
				(40.0)	Private	
Mauk	117,005	1,414	NW Cisadane C	5.0	IKK	1990
Rajeg	62,356	1,442	West Cisadane C	2.5	IKK	1986
Sepatan	154,860	-	-	-	-	-
Pasar Kemis	91,378	1,400	SGW	10.0	IKK	1987
Balaraja	100,005	3,269	DGW	5.0	IKK	1990
Kresek	71,214	-	Cidurian	5.0	IKK	-
Kronjo	64,929	3,052	Cipasilian	5.0	IKK	1986
Curug	96,951	3,000	SGW	20.0	IKK	1986
Cikupa	118,480	1,100	SGW	5.0	IKK	1987
Legok	108,356	2,300	SGW	20.0	IKK	1986
Tiga Raksa	72,741	1,463	DGW	2.5	IKK	1986
Serpong	131,479	8,127	Cisadane	40.0	BNA	1982
			Cisadane	(200.0)	BNA	
Ciputat	318,763	-	-	-	-	-
Cisoka	86,918	-	-	-	-	-
Pondok Aren	113,029	-	-	-	-	-
Total	2,703,053	171,821		765.0		
Serang						
Cinangka	45,034	-	-	-	-	-
Padarincang	49,252	-	Spring	10.0	IKK	-
Ciomas	28,005	-	DGW	5.0	IKK	-
Pabuaran	39,115	-	Tap	5.0	IKK	-
Baros	34,856	3,780	Spring	10.0	IKK	1985
Petir	63,641	-	-	-	-	-
Cikeusal	77,045	2,034	West	5.0	IKK	1987
Pamarayan	52,455	-	DGW	10.0	IKK	-
Kopo	60,763	-	-	-	-	-
Cikande	70,451	1,575	Cidurian	2.5	IKK	1987
Kragilan	45,310	-	DGW	10.0	IKK	-
Walantaka	43,982	-	DGW	5.0	IKK	-
Serang	155,296	45,122	Spring	110.0	BNA	1980
Taktakan	40,400	-	-	-	-	-
Wr. Kurung	27,334	-	-	-	-	-
Mancak	31,703	5,296	Spring	5.0	IKK	1987/1988
Anyer	33,519	1,900	Spring	10.0	IKK	1988
Bojonegara	50,415	-	Small river	2.5	IKK	-
Kramat Watu	46,720	-	Spring	15.0	BNA	-
Kasemen	55,645	-	DGW	5.0	IKK	-
Ciruas	43,099	1,421	West	2.5	IKK	1985
Pontang	42,814	1,470	Pontang C	2.5	IKK	1985
Carenang	49,250	1,442	East Pamarayan C	2.5	IKK	1984
Tirtayasa	58,651	784	East Pamarayan C	5.0	IKK	1986
Ciwandan	63,552	-	-	-	-	-
Cilegon	77,601	5,586	Tap	20.0	BNA	1985
Pulomerak	84,930	(27,000)	Tap	35.0	BNA	-
Total						

Kecamatan	Population		Water	Capacity	Type of	Commencement
	Total	Served	Source	(l/sec)	Development	Year of Service
Lebak						
Rangkasbitung	133,762	18,109	DGW	48.0	BNA	1985
Maja	55,182	-	-	-	-	-
Sajira	33,208	1,008	Cibeureum	2.7	IKK	1985
Wrung Gunung	65,439	-	-	-	-	-
Cipanas	47,640	-	-	-	-	-
Leuwidamar	34,868	-	-	-	-	-
Muncang	47,065	-	-	-	-	-
Cimarga	42,708	-	-	-	-	-
Bojongmanik	37,434	-	-	-	-	-
Cileles	31,989	-	-	-	-	-
Total	529,295	19,117		50.7		
Pandegrang						
Pandeglang	61,195	17,444	Spring	45.0	BNA	1983
Cadasari	55,459	1,365	Tap	2.5	IKK	1985
Banjar	50,961	-	-	-	-	-
Cimanuk	30,444	1,701	Cilancar	2.5	IKK	1986
Mandalawangi	5,639	-	-	-	-	-
Labuhan	11,989	12,110	Cidangu	20.0	BNA	1982
Total	215,687	32,620		70.0		

Source: IWACO, 1988 and/or PDAM 1990

Note:

/1 Total of Pancoran Mas, Beji and Sukmajaya

/2 Total of Tangerang, Ciledug, Cipondoh, Jatiuwung and Batu Ceper

/3 Existing supply system but in the study area

Remarks:
Spring : Spring water
DGW : Deep groundwater
SGW : Shallow groundwater
Tap : Tapping

Table 5 WATER CONSUMPTION OF REGISTERED INDUSTRIES

Category	Small Industries					Large Industries				
	No. of	No. of	Water Consumed			No. of	No. of	Water Consumed		
	Industry	Employ.	(m3/mon.)	(m3/day)	(l/d/empl.)	Industry	Employ.	(m3/mon.)	(m3/day)	(l/d/empl.)
(1) DKI Jakarta										
1. Animal food	-	-	-	-	-	1	210	1,135	46	178
2. Food products	242	2,135	43,834	1,755	675	134	13,869	309,234	20,358	1,207
3. Textiles	405	4,676	45,485	1,820	320	733	81,645	698,276	27,935	281
4. Wood Products	135	1,406	859	34	20	89	8,250	5,537	222	22
5. Paper	548	4,436	150,011	6,001	1,112	90	7,755	374,928	14,997	1,589
6. Chemicals	348	3,432	43,240	1,728	414	239	23,894	1,139,779	45,593	1,568
7. Non-metal	22	213	4,344	174	671	26	13,689	163,363	6,534	392
8. Basic metal	2	13	756	30	1,911	14	2,542	132,889	5,323	1,719
9. Metal products	454	4,257	41,679	1,667	322	291	77,030	298,305	11,939	127
10. Hard products	58	596	1,024	41	56	29	7,684	5,490	220	23
Total	2,214	21,164	331,232	13,250	515	1,646	236,568	3,128,936	133,167	463
(2) Tangerang and Bekasi										
1. Animal food	-	-	-	-	-	101	21,160	114,661	4,659	178
2. Food products	32	275	13,012	275	1,555	101	15,981	320,603	12,882	660
3. Textiles	8	112	1,703	112	498	263	137,890	1,164,861	47,008	278
4. Wood Products	1	19	50	19	85	129	27,851	70,313	2,841	83
5. Paper	4	14	375	14	863	55	10,860	296,595	11,891	898
6. Chemicals	36	380	17,550	380	1,519	197	35,998	702,055	28,346	641
7. Non-metal	1	10	135	10	444	46	7,759	81,108	3,254	344
8. Basic metal	2	21	935	21	1,452	12	1,964	65,882	2,656	1,103
9. Metal products	10	144	2,088	144	476	321	54,222	447,807	18,055	272
10. Hard products	-	-	-	-	-	7	688	4,502	181	215
Total	94	975	35,848	975	1,208	1,232	314,373	3,268,387	131,773	342
(3) Bogor										
1. Animal food	-	-	-	-	-	14	2,933	15,894	646	178
2. Food products	58	529	11,417	462	709	93	8,808	230,698	9,304	861
3. Textiles	4	53	542	22	338	97	46,656	528,127	21,169	372
4. Wood Products	-	-	-	-	-	32	6,483	24,104	970	122
5. Paper	1	3	90	4	863	24	4,803	190,494	7,697	1,304
6. Chemicals	17	193	5,796	232	985	133	17,965	328,427	13,199	601
7. Non-metal	2	24	438	18	612	57	13,573	402,167	16,101	974
8. Basic metal	-	-	-	-	-	-	-	-	-	-
9. Metal products	4	30	308	12	332	103	16,070	138,010	5,548	282
10. Hard products	-	-	-	-	-	7	610	6,048	242	326
Total	86	832	18,591	750	734	560	117,901	1,863,969	74,876	520
(4) Kotamadya Bogor										
1. Animal food	-	-	-	-	-	14	2,933	15,894	646	178
2. Food products	20	123	3,740	152	1,000	3	81	3,813	153	1,548
3. Textiles	-	-	-	-	-	7	898	1,381	56	51
4. Wood Products	1	20	46	2	76	-	-	-	-	-
5. Paper	-	-	-	-	-	4	137	3,598	146	863
6. Chemicals	-	-	-	-	-	10	3,700	57,725	2,311	513
7. Non-metal	-	-	-	-	-	1	33	328	13	327
8. Basic metal	-	-	-	-	-	-	-	-	-	-
9. Metal products	-	-	-	-	-	6	328	1,812	73	182
10. Hard products	-	-	-	-	-	-	-	-	-	-
Total	21	143	3,786	154	871	45	8,110	84,551	3,398	343

Source : JWRMS, Annex 1 Municipal and Industrial Water Demand, 1993

Table 6 WATER CONSUMPTION INDUSTRIEL SECTOR IN KAB. SERANG (1/2)

Name of Manufacturing	Kecamatan	No. of Employ.	Water Demand (l/s)	Water Demand (l/d/emp.)	Kind of Manufacturing
SERANG BARAT					
(1) PT. Cilegon Fabricator	Bojonegara	242	0.09	31	Steel
(2) PT. Dias Raya Shipyard	Bojonegara	-	-	-	Steel
(3) PT. Graha Swakarsa Prima	Bojonegara	-	0.93	-	Chemical
(4) PT. Silvetera (RSA)	Bojonegara	-	-	-	Crushing stone
(5) PT. Hampararan Rejeki	Bojonegara	350	53.82	13,286	Chemical
(6) CV. Mahera	Bojonegara	8	0.01	63	Fish processing
(7) PT. Continental Carbon Black	Bojonegara	209	46.30	19,139	Chemical
(8) PT. Yasa Ganesha Pura	Bojonegara	-	2.08	-	Chemical
(9) PT. Sulfindo Adi Usaha	Bojonegara	149	4.17	2,416	Chemical
(10) PT. Styrene Monomer Indonesia	Bojonegara	155	2.20	1,226	Chemical
(11) PT. Intieverspring Indonesia	Bojonegara	-	0.89	-	Chemical
(12) PT. Redeco Petrolin Utama	Bojonegara	-	-	-	Chemical
(13) PT. Promit Engineering Cont.	Bojonegara	-	-	-	Steel
(14) PT. Meisei Sarana Ind.	Bojonegara	-	-	-	Workshop
(15) PT. Polychem Indo	Bojonegara	212	5.79	2,358	Chemical
(16) PT. Banten Bay Fabyard	Bojonegara				Steel
(17) PT. Sriwijaya Pakuan Sejati	Bojonegara	155	0.69	387	Chemical
(18) PT. Indochlor Prakarsa Industries	Bojonegara	510	15.05	2,549	Chemical
(19) PT. Multisida Agro Indo	Bojonegara	52	1.16	1,923	Chemical
(20) PT. Abdhi Praya Insan Perkasa	Bojonegara	-	-	-	-
(21) PT. Sarana Trimukti Swadaya	Bojonegara	-	-	-	-
(22) PT. Trans-Bakrie	Bojonegara	154	0.09	52	Steel pipe
(23) PT. Indofist Nusantara Syntetic	Bojonegara	505	1.50	257	Rubber
(24) PT. Suralaya Perkasa Wood	Bojonegara	210	2.43	1,000	Packaging
(25) PT. Petrolindo Citra Ind.	Bojonegara	-	0.65	-	Chemical
(26) PT. Continental Carbon Restu	Bojonegara	209	23.15	9,569	Chemical
(27) PT. Kru Aquarry	Bojonegara	-	-	-	Crushing stone
(28) JSI	Bojonegara	-	-	-	Construction
(29) PT. Rotana Sejati	Bojonegara	-	-	-	-
(30) PLTU Suralaya	Bojonegara	8,776	50.00	492	Electricity
(31) PT. Guna Nusa Utama Fabricator	Bojonegara	375	0.67	154	Packaging
Sub-total of Bojonegara		12,271	211.65	1,458	
(32) PT. Agung Module Engineering	Ciwandan	-	-	-	Steel
(33) PT. Polytama Karsa Agung	Ciwandan	-	2.78	-	Chemical
(34) PT. Brown and Boot	Ciwandan	-	-	-	-
(35) PT. Karyamas Hardanusa	Ciwandan	-	1.39	-	Chemical
(36) PT. Sankyu Indonesia International	Ciwadan	405	0.05	11	Production of construction material
(37) PT. Satya Raya Indah	Ciwandan	1,428	4.63	280	Wood
(38) PT. Lautan Otsuka Chemical	Ciwandan	144	0.15	90	Chemical
(39) PT. Chandra Asri	Ciwandan	-	12.50	-	Chemical
(40) PT. Indocast Sarana Jaya	Ciwandan	36	0.01	28	Brick
(41) PT. Tripolita	Ciwandan	-	-	-	Wood
(42) PLTU 400 MW	Ciwandan	-	38.00	-	Electricity
(43) Perlabuhan Barang Banten	Ciwandan	100	0.38	328	Shipping
(44) Perlabuhan Khusus Cigading/KS	Ciwandan	-	5.00	-	Shipping
Sub-total of Ciwandan		2,113	64.89	214	
(45) PT. Ranul Nusa Indo	Kramatwatu	-	-	-	Wood
(46) PT. Unggul Indha Corporation	Pulomerak	205	2.31	976	Chemical
(47) PT. Mulya Adhi Paramita	Pulomerak	50	0.02	30	Chemical
(48) PT. Dover Chemical	Pulomerak	101	0.03	30	Chemical
(49) PT. Inti Cellulose Utama Indo.	Pulomerak	-	1.13	-	Chemical
(50) PT. Petrokimia Nusantara Interido	Pulomerak	143	0.14	84	Chemical
(51) PT. Prontal	Pulomerak	-	-	-	Chemical
(52) PT. Standar Toyo Polimer	Pulomerak	202	2.72	1,163	Chemical
(53) PT. Trisindra Mahkota Samudra	Pulomerak	14	0.01	50	Workshop
(54) PT. Petrocarb Indonesia	Pulomerak	84	46.30	47,619	Chemical

Name of Manufacturing	Kecamatan	No. of Employ.	Water Demand (l/s)	Water Demand (l/d/emp.)	Kind of Manufacturing
(55) PT. Bakrie Kasei Corporation	Pulomerak	-	3.06	-	Chemical
(56) PT. Gunung Sugih Jaman	Pulomerak	-	-	-	-
(57) PT. Pasific Indomas Astik Indo	Pulomerak	527	37.62	6,167	Chemical
(58) PT. Bintang Adiprestasi	Pulomerak	-	-	-	Crushing stone
(59) CV. Kurnia Alam	Pulomerak	-	-	-	Crushing stone
(60) PT. Baroid	Pulomerak	-	0.14	-	-
(61) PT. Indokor Eneltisindo	Pulomerak	48	0.035	63	Chemical
(62) PT. Santafe Pomeroy	Pulomerak	-	0.035	-	Office equipment
(63) PT. Berian Laju Tanker	Pulomerak	-	0.035	-	Workshop
(64) PT. Batu Mulia Utama	Pulomerak	12	0.005	33	Crushing stone
(65) PD. Agung Jaya	Pulomerak	12	0.005	33	Crushing stone
(66) PT. Sinar Equator Utama	Pulomerak	17	0.009	47	Workshop
(67) PT. Asean Polymers	Pulomerak	-	0.007	-	Chemical
(68) PT. Bekasi Metal Intimegah	Pulomerak	6			Steel pipe
(69) PT. Statomer PVC Resin Factory	Pulomerak	200	6.60	2,851	PVC pipe
(70) PT. Dover Chemical	Pulomerak	-	-	-	Chemical
(71) PT. Petro Kimia (ARSETO)	Pulomerak	-	0.14	-	Chemical
(72) PT. Krakatau Steel	Pulomerak	7,274	800.00	9,502	Steel
(73) Perlabuhan Ferry Merak	Pulomerak	300	0.26	75	Harbor
Sub-total of Pulomerak		9,195	900.60	8,420	
Krakatau Industrial Estate Cilegon (KIEC)					
(74) PT. Krakatau Prima Dharma Sentana	Pulomerak	63	-	-	
(75) PT. Dava Swahasta Cipta	Pulomerak	153	-	-	
(76) PT. Lautan Otsuka	Ciwadan	144	-	-	
(77) PT. Garuda Mahakam Prahasta	Pulomerak	20	4.11	17,755	
(78) PT. Hoechst Cilegon	Pulomerak	81	1.50	1,600	
(79) PT. Latinusa	Pulomerak	482	-	-	
(80) PT. Industri Mesin Perkakas Ind.	Pulomerak	61	-	-	
(81) PT. Cpold Rooling Mill Indonesia ut	Pulomerak	2,171	-	-	
(82) PT. Distinct Indonesia Cement	Ciwadan	51	-	-	
(83) PT. CBI Indonesia	Pulomerak	51	-	-	
(84) PT. Multi Fabrindo Gemilang	Ciwadan	61	-	-	
(85) PT. Cigading Habban Center	Ciwadan	441	-	-	
(86) PT. Samudera Ferro Engineering	Pulomerak	25	-	-	
(87) PT. Aneka Gas Industri	Pulomerak	7	-	-	
(88) PT. Kratama Belindo International	Ciwadan	183	-	-	
(89) PT. Tjokro Putra Persada	Pulomerak	85	-	-	
(90) PT. Kapurindo Sentana Baja	Pulomerak	33	-	-	
(91) PT. Barata Indonesia	Pulomerak	93	-	-	
(92) PT. Indonesia Asri Refractories	Pulomerak	18	-	-	
(93) PT. Asahimas Subentra	Ciwadan	536	31.96	5,152	
(94) PT. Santika Pramesti	Pulomerak	425	-	-	
(95) PT. Siemens Indonesia	Ciwadan	82	-	-	
(96) PT. Tiksna Yasa	Pulomerak	16	-	-	
		5,282	321.50	5,259	
SERANG BARAT					
(97) PT. Windu Anyer	Cinangka	-	-	-	Seeding of Shrimp
(98) PT. Tramandu Graha Manungsal	Cinangka	-	-	-	Seeding of Shrimp
(99) PT. Windu Sakti Ekatama	Cinangka	-	-	-	Seeding of Shrimp
(100) PT. Gramina	Cinangka	-	-	-	Seeding of Shrimp
(101) PT. Bumi Lintang Sanga	Cinangka	-	-	-	Mineral water
(102) PT. Windu Nurimusa Utama	Cinangka	-	-	-	Seeding of Shrimp
(103) PT. Windu Natasapi	Cinangka	-	2.00	-	Seeding of Shrimp
(104) Dep. Pertaman Dipjen Perkanan	Cinangka	-	-	-	Brachish Fishery
Sub-total of Cinangka		-	2.00	-	

Table 7 WATER CONSUMPTION INDUSTRIEL SECTOR IN KAB. SERANG (1/2)

Name of Manufacturing	Kecamatan	No. of Employ.	Water Demand (l/s)	Water Demand (l/d/emp.)	Kind of Manufacturing
SERANG TENGAH					
(105) PT. Sinar Krakatau Indah	Serang	-	-	-	
(106) PT. Benua Harapan	Serang	26	0.58	1,923	Ice
(107) PT. Central Windu Glass	Serang	127	0.075	51	Reinforced glass
(108) Oviniy	Serang	28	0.008	25	Printing
(109) PT. Bengkel Bubut Surya	Serang	112	0.035	27	Machenery
(110) PT. Durper-U	Serang	9	0.006	56	Food production
Sub-total of Serang		302	0.70	201	
SERANG TIMUR					
(111) PT. Citra Mutiara Permai	Kragilan	90	0.03	33	Chemical
(112) PT. Serang Kharisuma Raya	Kragilan	-	28.94	-	Food processing
(113) FA. Setuju	Kragilan	9	0.01	56	Palm oil
(114) PT. Sinar Dunia Makmur	Kragilan	600	125.58	18,083	Paper
(115) PT. International Warna Warm	Kragilan	120	5.79	4,167	Chemical
(116) PT. Warna Manoasia	Kragilan	-	-	-	Chemical
(117) PT. Sugih Brother Sakti	Kragilan	-	-	-	Clothing
(118) PT. Serang Inti Perkasa	Kragilan	-	-	-	Wood
(119) PT. Pican Jaya	Kragilan	20	0.007	30	Leather
(120) PT. Kawassido Tunggal Perkasa	Kragilan	-	41.67	-	Textile
Sub-total of Kragilan		839	202.02	13,533	
(121) CV. Inti Sari Kencana	Walantaka	59	0.023	34	Metal
(122) PT. Walantaka Makmur	Walantaka		26.62	-	Food processing
(123) PT. Inti Sari Kencana	Walantaka	71	0.023	28	Chemical
(124) PT. Setia Gemilang Sentona	Walantaka	80	0.029	31	Timber
(125) PT. Sentosa Gapura Sejahtera	Walantaka	-	21.99	-	Food processing
Sub-total of Walantaka		210	48.69	31	
(126) PT. Panca Multi Daksaino	Kopo	-	-	-	Paper production
(127) PT. Sabut Mas	Kopo	-	-	-	Food processing
(128) PT. Patimsan Tunas Perkakas	Kopo	-	-	-	Paper production
(129) PT. Charoen Pokpan Jaya Farm	Kopo	121	0.07	50	Food processing
(130) PT. Buouaya Primula	Kopo	-	-	-	Wood
(131) PT. Poukrik Chemical Company	Kopo	-	7.52	-	Chemical
(132) PT. Alkindo Mitraraya	Kopo	-	0.012	-	Chemical
(133) PT. Ika Reburindo Muda	Kopo	-	-	-	Timber
(134) PT. Duta Eratama	Kopo	-	0.04	-	Chemical
(135) PT. Budi Muaratex	Kopo	-	18.00	-	Textile
(136) PT. Trisula Sarana Pratama	Kopo	-	0.32	-	Cotton processing
(137) PT. Mexindo Tunngal Prakarsa	Kopo	-	40.00	-	Textile
(138) PT. Marisco Kurnia	Kopo	-	8.13	-	Food production
(139) PT. Alphacon Valfindo	Kopo	-	0.18	-	Machienery
(140) PT. Jaya Lestari Plastik	Kopo	-	-	-	Chemical
(141) PT. Indo Surya Perkasa	Kopo	-	-	-	Food processing
(142) PT. Budi Vata Primula	Kopo	150	0.05	30	Wood
(143) PT. Maulana Makmur	Kopo	-	0.27	-	Clothing
(144) PT. Sekawan Maju Pesat	Cikande	161	0.73	391	Paper
(145) PT. Cikande Raya Chemicals	Cikande	-	-	-	Palm oil
(146) PT. Onward Paper UtamA	Cikande	-	4.69	-	Paper
(147) PT. Esbipee Saprita Bunca	Cikande	-	4.70	-	Paper
(148) PT. Yason Persada	Cikande	-	0.59	-	Chemical
(149) PT. Gaya Reksa Keramik Masindah	Cikande	168	0.06	30	Ceramic
(150) PT. Indochor Tata Warna	Cikande	109	0.81	642	Chemical
(151) PT. Propan Jaya	Cikande	-	1.22	-	Chemical
(152) PT. Permata Buana Duta Mandiri	Cikande	-	0.40	-	Furniture (wood)
(153) PT. Inti Selulose Utama	Cikande	-	1.19	-	Chemical
(154) PT. Cikande Gas Murni	Cikande	-	-	-	Gas
(155) PT. Colorindo Chemicals	Cikande	505	5.84	1,000	Chemical
(156) PT. Abdi Kaskindo Cemerlang	Cikande	-	-	-	Timber
(157) PT. Billion Knitting Factory	Cikande	-	0.93	-	Textile
(158) PT. Salim Tirta Makmur	Cikande	-	-	-	-
(159) PT. Genteng Press Indah	Cikande	-	-	-	Metal
(160) PT. Frans Putranstek	Cikande	-	10.42	-	Textile
(161) PT. Tunas Sumber IKK	Cikande	-	0.03	-	Chemical
(162) PT. Colorindo Aneka Chemical	Cikande	-	-	-	Chemical
(163) PT. Cikande Jaya	Cikande	-	0.01	-	Leather
(164) PT. Lindolen Sari Nabati Murni	Cikande	20	-	-	Rubber oil
(165) PT. Eka Nindia Karsa	Cikande	-	0.01	-	Chemical
(166) PT. Tunas Inti	Cikande	-	-	-	-
(167) PT. Lipong Sporting Goods	Cikande	114	0.04	31	Equipment
(168) PT. Pelita Cengkareng Paper	Cikande	-	3.70	-	Paper
(169) PT. Pohon Besar	Cikande	-	-	-	Timber
(170) PT. Benua Indah Perkasa	Cikande	-	0.36	-	Clothing
(171) PT. Mulia Spindo Mill	Cikande	418	0.14	29	Cotton
(172) PT. Usaha ganda Makmur	Cikande	-	7.66	-	Electronics
(173) PT. Sukses Jaya Bumi Indo	Cikande	16	0.14	750	Furniture (wood)
(174) PT. Pintalan Mas Inter Nusa	Cikande	-	0.17	-	-
(175) PT. Ramashinta Citra Kencana	Cikande	542	0.17	28	Furniture
(176) PT. Cahaya Jambi Raya	Cikande	-	0.12	-	Ceramic
(177) PT. Budi Mulya Lestari	Cikande	-	-	-	-
(178) PT. Saptindo Surbicap	Cikande	-	0.37	-	Cotton
(179) PT. Kurniawan Delta Raya	Cikande	-	-	-	-
(180) PT. Pancana Citra Wira Brother	Cikande	-	0.98	-	Cotton
(181) PT. Diptanamas Utama	Cikande	-	-	-	-
(182) PT. Yaan Pastisindo	Cikande	244	0.19	69	Chemical
(183) PT. Multi Elok Modern Cosmetic	Cikande	-	0.69	-	Chemical
(184) PT. Ancol Tepang Metal Printing	Cikande	-	0.94	-	Printing
(185) PT. Gedesco Sejahtera	Cikande	-	0.21	-	Furniture
(186) PT. Prakarsa Satria Internua	Cikande	-	0.10	-	Chemical
(187) PT. Fajarina Unggul Ind.	Cikande	187	0.06	30	Metal
(188) PT. Honoris Percana Industri	Cikande	-	-	-	Electronics
(189) PT. Eropa	Cikande	-	-	-	-
(190) PT. Sung HWA Dunia	Cikande	5,077	0.12	2	Sport shoes
(191) PT. Liverwort Wood Industry	Cikande	120	0.05	33	Wood
(192) PT. Ratanesia Megah	Cikande	80	0.02	25	Furniture
(193) PT. Rapindo Pacific Mas	Cikande	621	0.20	27	Rattan
(194) PT. Garingging Bhartama	Cikande	-	0.02	-	Sport shoes
(195) PT. Intan Wijaya	Cikande	-	-	-	-
(196) PT. Citra Mandiri Cakhawala	Cikande	-	0.06	-	Ceramic
(197) PT. Pencak Ardimulia	Cikande	-	140.89	-	Electronics
(198) PT. Cikande Farma	Cikande	-	0.08	-	Agro-industry
(199) PT. Pariilaju Sakti	Cikande	55	0.08	127	Chemical
(200) PT. Singlong Industrial	Cikande	-	5.67	-	Cotton
(201) PT. Panca Plaza Indo Textile	Cikande	300	34.72	10,000	Cotton
(202) PT. Panca Inter Brother	Cikande	-	-	-	Brick
(203) PT. MRC	Cikande	-	-	-	Paper
(204) PT. Teguh Apisinatava	Cikande	-	-	-	Furniture
(205) PT. Cipta Pareria	Cikande	-	4.22	-	Paper
(206) PT. Katana Furindo	Cikande	-	0.03	-	Furniture
(207) PT. Duta Putra Karsa Peroana	Cikande	-	-	-	-
(208) PT. Lingga Jaya Group	Cikande	-	-	-	-
(209) PT. Indo Aloy Duta Nusa	Cikande	-	9.61	-	Sttel
(210) PT. Rodamas	Cikande	-	-	-	Textile
(211) PT. Panca Dhana Jaya sakti	Cikande	-	0.06	-	Rattan
(212) PT. Panca Brother Prima	Cikande	-	-	-	-
Sub-total of Cikande		9,008	318.08	417	
Grand Total		39,220	2,068.13	2,912	

Table 8 INDUSTRIAL AND NON-INDUSTRIAL WATER USE

Kabupaten/ Kecamatan		Industrial			Non-industrial			Grand Total
		Ground-water	Surface water	Total	Ground-water	Surface water	Total	
Bekasi								
Pondokgede		-	-	-	-	-	-	-
Bantargebang		903.1	-	903.1	-	-	-	903.1
Setu		20.0	-	20.0	-	-	-	20.0
Cibarusah		-	-	-	-	-	-	-
Serang		-	-	-	-	-	-	-
Lemahabang		18.0	-	18.0	-	-	-	18.0
Cikarang		122.7	-	122.7	-	-	-	122.7
Cibitung		1,062.4	12.0	1,074.4	-	-	-	1,074.4
Tambun		2,373.6	-	2,373.6	-	-	-	2,373.6
Tarumajaya		-	-	-	-	-	-	-
Babelan		39.9	-	39.9	-	-	-	39.9
Tambelang		-	-	-	-	-	-	-
Sukatani		-	-	-	-	-	-	-
Pebayuran		-	-	-	-	-	-	-
Cabangbungin		-	-	-	-	-	-	-
Muaragembong		-	-	-	-	-	-	-
Bekasi Timur		312.0	-	312.0	-	-	-	312.0
Bekasi Selatan		8.4	-	8.4	-	-	-	8.4
Bekasi Barat		9,868.7	4,432.3	14,301.0	15.0	-	15.0	14,316.0
Bekasi Utara		-	29.2	29.2	-	-	-	29.2
Unknown		481.6	100.0	581.6	163.6	-	163.6	581.6
Total	cu.m/day	15,210.4	4,573.5	19,783.9	178.6	-	178.6	19,962.5
	l/sec	176.0	52.9	229.0	2.1	-	2.1	231.0
Bogor								
Citeureup		5,122.0	7,637.0	12,759.0	102.0	-	102.0	12,861.0
Cibinong		3,715.0	4,338.0	8,053.0	240.0	153.0	393.0	8,446.0
Gunung Putri		-	-	-	38.0	-	38.0	38.0
Cimanggis		7,229.0	487.0	7,716.0	113.0	-	113.0	7,829.0
Kedunghalang		1,153.0	-	1,153.0	12.0	-	12.0	1,165.0
Jonggol		-	-	-	-	-	-	-
Cariu		-	-	-	-	-	-	-
Cileungsi		1,476.0	-	1,476.0	-	-	-	1,476.0
Leuwiliang		-	-	-	-	-	-	-
Rumpin		-	-	-	-	-	-	-
Ciampea		-	-	-	-	-	-	-
Cibungbulang		-	-	-	-	-	-	-
Jasinga		-	-	-	-	-	-	-
Cigudeg		-	-	-	-	-	-	-
Parungpanjang		-	-	-	-	-	-	-
Nanggung		-	-	-	-	-	-	-
Ciawi		118.0	4,560.0	4,678.0	75.0	10.0	85.0	4,763.0
Cijeruk/Cigombong		-	-	-	-	-	-	-
Cisarua		-	137.0	137.0	168.0	69.0	237.0	374.0
Caringin		-	-	-	-	-	-	-
Ciomas		20.0	-	20.0	32.0	24.0	56.0	76.0
Parung		70.0	-	70.0	86.0	124.0	210.0	280.0
Gunungsindur		2,504.0	491.0	2,995.0	103.0	-	103.0	3,098.0
Sawangan		15.0	-	15.0	88.0	-	88.0	103.0
Semplak		480.0	-	480.0	8.0	-	8.0	488.0
Bojonggede		-	-	-	-	-	-	-
Pancoran Mas		-	-	-	-	-	-	-
Beji		-	-	-	-	-	-	-
Sukmajaya		1,206.0	-	1,206.0	1.0	-	1.0	1,207.0

Kecamatan		Industrial			Non-industrial			Grand Total
		Ground-water	Surface water	Total	Ground-water	Surface water	Total	
Tangerang								
Tangerang		3,701.3	5,362.8	9,064.1	24.0	-	24.0	9,088.1
Ciledug		-	-	-	-	-	-	-
Cipondoh		1,133.4	1,774.0	2,907.4	-	-		2,907.4
Jatiuwung		5,147.9	-	5,147.9	64.6	-	64.6	5,212.5
Batu Ceper		3,527.8	352.0	3,879.8	216.0	-	216.0	4,095.8
Teluk Naga		-	-	-	-	-	-	-
Mauk		-	-	-	-	-	-	-
Rajeg		-	-	-	-	-	-	-
Sepatan		3.6	-	3.6		-		3.6
Pasar Kemis		687.4	-	687.4	110.0	-	110.0	797.4
Balaraja		-	-	-	-	-	-	-
Kresek		-	-	-	-	-	-	-
Kronjo		-	-	-	-	-	-	- -
Curug		267.6		267.6	128.3	-	128.3	395.9
Cikupa		451.2		451.2	160.8	-	160.8	612.0
Legok		-	-	-	216.0	-	216.0	216.0
Tiga Raksa		-	-	-	-	-	-	-
Serpong		53.0	-	53.0	200.0	-	200.0	253.0
Ciputat		514.6	-	514.6	430.8	-	430.8	945.4
Cisoka		-	-	-	-	-	-	-
Pondok Aren		-	-	-	20.0	-	20.0	20.0
Total	cu.m/day	15,487.8	7,488.8	22,976.6	1,570.5	-	1,570.5	24,547.1
	l/sec	179.3	86.7	265.9	18.2	-	18.2	284.1
Serang								
Cinangka		12.0	-	12.0	-	-	-	12.0
Padarincang		-	-	-	-	-	-	-
Ciomas		-	-	-	-	-	-	-
Pabuaran		-	-	-	-	-	-	-
Baros		-	-	-	-	-	-	-
Petir		-	-	-	-	-	-	-
Cikeusal		-	-	-	-	-	-	-
Pamarayan		-	-	-	-	-	-	-
Kopo		61.4	-	61.4	-	-	-	61.4
Cikande		-	-	-	-	-	-	-
Kragilan		-	-	-	33.2	-	33.2	33.2
Walantaka		2.8	-	2.8	-	-		2.8
Serang		59.4	-	59.4	127.8	-	127.8	187.2
Taktakan		4.5	-	4.5	-	-	-	4.5
Wr. Kurung		-	-	-	-	-	-	-
Mancak		-	-	-	-	-	-	-
Anyer		573.3	27,893.0	28,466.3	503.9	-	503.9	28,970.2
Bojonegara		284.0	-	284.0	-	-	-	284.0
Kramat Watu		-	-	-	-	-	-	-
Kasemen		-	-	-	-	-	-	-
Ciruas		-	-	-	-	-	-	-
Pontang		-	-	-	20.9	-	20.9	20.9
Carenang		-	-	-	-	-	-	-
Tirtayasa		-	-	-	-	-	-	-
Ciwandan		-	-	-	-	-	-	-
Cilegon		55.0	-	55.0	101.2	-	101.2	156.2
Pulomerak		1,519.3	-	1,519.3	179.8	-	179.8	1,699.1
Total	cu.m/day	2,571.7	27,893.0	30,464.7	966.8	-	966.8	31,431.5
	l/sec	29.8	322.8	352.6	11.2	-	11.2	363.8

Kecamatan		Industrial			Non-industrial			Grand Total
		Ground-water	Surface water	Total	Ground-water	Surface water	Total	
Lebak								
Rangkasbitung		224.0	-	224.0	57.0	-	57.0	281.0
Maja		-	-	-	-	-	-	-
Sajira		-	-	-	-	-	-	-
Wrung Gunung		-	-	-	-	-	-	-
Cipanas		-	-	-	-	-	-	-
Leuwidamar		-	20.0	20.0	-	17.0	17.0	37.0
Muncang		-	-	-	-	-	-	-
Cimarga		-	-	-	-	23.0	23.0	23.0
Bojongmanik		-	-	-	-	-	-	-
Cileles		-	-	-	43.0	-	43.0	43.0
Total	cu.m/day	224.0	20.0	244.0	100.0	40.0	140.0	384.0
	l/sec	2.6	0.2	2.8	1.2	0.5	1.6	4.4
Pandegrang								
Pandeglang		-	-	-	14.0	-	14.0	14.0
Cadasari		220.0	-	220.0	-	-	-	220.0
Banjar		-	-	-	-	-	-	-
Cimanuk		-	-	-	-	-	-	-
Mandalawangi		-	-	-	-	-	-	-
Labuhan		-	-	-	-	-	-	-
Total	cu.m/day	220.0	-	220.0	14.0	-	14.0	234.0
	l/sec	2.5	-	2.5	0.2	-	0.2	2.7

Source: Badan Pengelola Air (BAPAIR) Propinsi DT. Java Barat, and West Java Provincial Water Sources Master Plan for Water Supply

Table 9 INTAKE DISCHARGE RECORDS IN THE STUDY AREA

(1) Katulampa in the Ciliwung

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Mean
1975	7.3	8.0	8.1	8.7	8.3	3.0	6.4	7.8	6.8	3.4	3.7	7.2	6.6
1976	7.7	7.3	7.7	7.5	7.3	6.5	5.1	5.2	5.2	2.7	7.9	8.3	6.5
1977	8.4	9.2	8.6	7.7	7.6	8.1	4.9	3.3	8.0	1.9	6.4	3.2	6.4
1978	8.5	6.7	6.8	5.6	6.9	5.2	4.9	5.9	6.2	3.8	7.7	8.1	6.4
1979	8.4	1.3	1.3	1.2	1.2	0.9	0.8	0.8	0.8	2.7	1.4	1.2	1.8
1980	1.1	9.7	11.0	7.8	10.0	8.7	6.1	7.7	4.9	2.7	5.7	5.3	6.7
1981	13.0	14.0	14.0	13.0	15.0	2.4	4.1	7.7	8.2	2.7	10.0	9.3	9.4
1982	7.7	7.3	13.0	14.0	7.7	5.8	3.9	4.3	5.1	1.8	3.5	5.6	6.6
1983	6.1	7.6	7.9	7.6	7.7	6.6	5.1	3.6	3.9	2.7	9.9	11.0	6.6
1984	9.0	9.6	9.6	13.0	9.7	8.9	7.0	8.5	8.0	2.7	10.0	0.4	8.0
Mean	7.7	8.1	8.8	8.6	8.1	5.6	4.8	5.5	5.7	2.7	6.6	6.0	6.5
Min.	1.1	1.3	1.3	1.2	1.2	0.9	0.8	0.8	0.8	1.8	1.4	0.4	-
Max.	13.0	14.0	14.0	14.0	15.0	8.9	7.0	8.5	8.2	3.8	10.0	11.0	-

(2) Rancasumur in the Cidurian

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Mean
1987	8.0	8.0	7.6	7.9	8.0	8.2	6.7	3.3	3.0	4.7	4.8	7.9	6.5
1988	8.0	7.9	9.9	7.9	7.8	-	-	6.6	-	-	-	-	-
1989	10.8	7.3	6.5	6.3	9.6	8.1	6.2	7.1	5.7	1.0	-	4.0	6.6
1990	5.5	6.6	6.1	7.2	3.4	7.6	8.5	9.1	8.4	4.2	3.1	0.0	5.8
Mean	8.1	7.5	7.5	7.3	7.2	8.0	7.1	6.5	5.7	3.3	4.0	4.0	6.3
Min.	5.5	6.6	6.1	6.3	3.4	7.6	6.2	3.3	3.0	1.0	3.1	0.0	-
Max.	10.8	8.0	9.9	7.9	9.6	8.2	8.5	9.1	8.4	4.7	4.8	7.9	-

(3) Pamarayan in the Ciujung

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Mean
1975	20.5	14.1	20.5	21.8	16.0	26.9	19.8	32.1	20.0	20.1	19.2	15.6	20.6
1976	8.6	11.5	15.0	18.7	20.4	19.3	13.1	12.3	11.9	-	-	-	14.5
1977	-	-	-	21.4	22.3	24.2	20.4	14.7	15.6	13.4	25.0	18.8	19.5
1978	18.4	21.2	19.2	-	-	-	-	-	-	-	-	-	19.6
1979	11.6	21.6	17.7	22.3	20.5	19.5	19.6	18.3	18.1	19.7	-	19.1	18.9
1980	14.5	16.0	21.3	19.2	17.8	18.6	22.8	18.8	17.7	18.0	17.9	17.5	18.3
1981	-	-	16.1	18.7	16.1	15.2	15.8	16.0	15.9	10.5	11.0	15.5	15.1
1982	10.0	11.8	15.9	17.6	15.3	14.6	13.3	7.7	3.3	20.5	23.9	23.9	14.8
1983	21.0	19.7	21.4	21.1	19.2	19.7	13.8	12.1	15.2	19.4	-	-	18.3
1984	19.2	13.9	15.4	23.9	18.9	18.9	17.8	17.5	20.6	13.3	14.9	11.2	17.1
1985	10.1	13.5	11.9	15.8	13.8	10.6	14.5	17.0	17.3	16.0	-	15.1	14.1
1986	10.2	9.6	14.6	14.6	16.5	12.1	12.7	15.8	14.9	14.9	-	9.3	13.2
1987	11.7	7.2	7.7	11.3	15.5	14.4	14.9	15.1	11.5	13.3	-	13.0	12.3
1988	16.8	10.8	16.6	14.6	13.7	13.8	15.1	14.5	15.8	14.0	-	13.0	14.4
1989	16.8	7.3	14.8	-	-	13.8	19.0	17.0	-	-	10.7	13.8	14.2
1990	4.2	10.3	8.1	10.2	11.5	12.4	15.2	16.4	11.6	-	12.5	13.7	11.5
1991	12.8	6.0	14.0	8.6	7.9	10.7	10.6	8.3	8.4	10.4	9.5	9.4	9.7
1992	10.7	10.4	12.9	13.8	12.1	14.2	16.2	16.9	12.3	11.4	10.8	15.1	13.1
Mean	13.6	12.8	15.5	17.1	16.1	16.4	16.2	15.9	14.4	15.4	15.5	14.9	15.3
Min.	4.2	6.0	7.7	8.6	7.9	10.6	10.6	7.7	3.3	10.4	9.5	9.3	-
Max.	21.0	21.6	21.4	23.9	22.3	26.9	22.8	32.1	20.6	20.5	25.0	23.9	-

(4) Empang in the upstream Cisadane

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Mean
1973	14.3	14.9	15.5	15.3	15.5	15.5	13.7	13.6	14.8	15.0	*	12.5	14.6
1974	13.4	15.4	15.5	15.5	15.0	13.3	12.8	15.5	14.3	13.0	*	12.4	14.2
1975	14.6	15.5	15.5	15.3	13.0	10.0	13.1	14.0	14.8	*	*	14.4	14.0
1976	14.2	14.9	15.3	15.5	12.7	12.2	10.3	10.4	9.6	*	12.6	15.1	13.0
1977	15.5	15.5	15.5	15.5	15.5	15.5	13.6	10.5	11.6	*	15.2	15.2	14.5
1978	15.5	15.5	15.5	15.4	15.5	15.4	15.5	15.5	15.0	*	15.4	15.5	15.4
1979	11.7	14.3	14.0	14.0	14.1	11.4	12.9	9.4	9.7	*	13.7	13.0	12.6
1980	13.0	13.0	13.0	13.7	13.1	11.6	9.6	10.2	*	*	11.3	12.2	12.1
1981	11.2	11.7	11.7	11.7	12.1	12.1	12.0	11.5	11.5	*	11.6	12.5	11.8
1982	10.3	10.3	12.5	12.0	12.0	11.3	8.3	6.9	6.9	*	*	11.8	10.2
1983	11.6	11.7	12.7	13.2	12.6	10.1	7.5	5.2	6.1	*	9.4	12.6	10.2
1984	12.9	12.6	13.7	13.4	13.5	12.9	10.1	9.2	11.5	*	12.4	12.2	12.2
1985	11.4	13.1	12.7	12.2	11.4	11.2	11.3	9.8	10.9	*	10.4	10.8	11.4
1986	11.2	11.3	12.1	12.6	12.4	12.3	10.6	10.8	12.0	11.8	*	10.6	11.6
1987	12.2	11.6	11.8	11.4	11.6	11.7	10.6	7.3	8.6	9.2	10.0	10.7	10.5
1988	10.6	10.9	10.7	9.8	10.3	10.5	8.9	8.2	*	9.6	10.3	9.2	9.9
1989	8.2	7.9	9.8	11.0	*	*	10.4	9.4	9.6	9.5	10.4	9.8	9.6
1990	8.7	9.3	9.6	9.6	9.8	10.1	9.7	9.7	9.8	5.0	9.3	9.6	9.2
1991	9.3	9.2	9.6	9.7	9.2	7.9	7.1	6.3	6.7	6.3	5.7	6.5	7.8
1992	5.0	4.4	8.5	10.9	8.7	9.2	11.0	9.6	10.4	11.7	11.1	9.2	9.1
1993	10.3	10.0	10.7	10.7	-	-	-	-	-	-	-	-	-
Mean	11.7	12.0	12.7	12.8	12.5	11.8	11.0	10.2	10.7	10.1	11.2	11.8	11.5
Min.	5.0	4.4	8.5	9.6	8.7	7.9	7.1	5.2	6.1	5.0	5.7	6.5	-
Max.	15.5	15.5	15.5	15.5	15.5	15.5	15.5	15.5	15.0	15.0	15.4	15.5	-

(5) Pasar Baru in the Cisadane

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Mean
1981	17.0	-	20.8	27.0	29.4	28.8	28.7	25.8	19.0	7.9	-	18.9	22.3
1982	13.0	19.1	21.2	24.9	17.3	-	-	13.3	8.1	28.2	-	-	-
1983	16.0	27.3	26.1	22.3	24.4	26.1	21.7	8.7	17.6	10.6	25.3	26.1	21.0
1984	16.9	20.2	19.4	25.2	26.6	24.2	27.6	23.1	14.7	6.5	25.1	24.3	21.2
1985	18.4	23.5	24.6	19.5	24.1	25.0	25.6	25.2	22.1	12.1	24.6	29.6	22.9
1986	16.6	21.9	17.5	20.2	22.7	28.2	26.5	22.3	23.0	14.2	24.5	23.5	21.8
1987	18.7	18.0	26.4	23.7	22.2	25.7	30.7	18.5	17.7	22.1	24.0	-	-
1988	23.5	21.2	24.8	20.3	23.5	18.8	11.2	19.0	19.0	16.1	18.2	21.0	19.7
1989	22.6	18.4	19.4	19.8	22.5	21.2	16.4	21.0	22.3	14.5	18.0	21.7	19.8
1990	18.6	19.5	21.4	22.2	23.2	24.6	23.0	22.2	20.4	14.9	17.9	22.6	20.9
1991	17.3	12.5	19.1	17.5	22.8	13.0	10.9	9.1	9.5	9.3	21.6	21.9	15.4
Mean	18.0	20.2	21.9	22.1	23.5	23.6	22.2	18.9	17.6	14.2	22.1	23.3	20.6
Min.	13.0	12.5	17.5	17.5	17.3	13.0	10.9	8.7	8.1	6.5	17.9	18.9	-
Max.	23.5	27.3	26.4	27.0	29.4	28.8	30.7	25.8	23.0	28.2	25.3	29.6	-

(6) Curug (WTC) in the Citarum

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Mean
1973	13.0	13.0	13.0	13.0	13.0	14.0	21.0	23.0	23.0	7.3	7.0	13.5	14.5
1974	13.0	13.0	13.0	13.0	13.0	17.0	23.0	23.4	20.0	*	*	11.5	16.0
1975	10.0	11.0	11.0	11.0	13.6	21.0	26.0	29.0	25.0	18.9	8.2	10.9	16.3
1976	17.5	11.0	12.0	13.5	14.0	17.0	25.0	39.5	32.5	18.4	15.0	17.1	19.4
1977	15.0	15.0	13.0	10.0	17.0	13.6	21.5	30.0	30.0	7.3	1.1	14.5	15.7
1978	22.5	22.1	19.0	15.0	15.0	19.5	26.5	32.0	24.5	16.0	15.0	17.6	20.4
1979	11.7	18.9	21.5	18.5	25.0	25.0	26.0	29.0	35.0	29.5	30.0	27.4	24.8
1980	19.9	14.5	15.5	17.0	20.5	18.0	30.2	36.5	27.0	23.7	25.0	24.0	22.7
1981	18.5	17.0	15.0	20.0	22.1	17.5	25.0	21.9	9.6	2.3	17.0	18.0	17.0
1982	19.0	16.1	16.0	18.0	16.1	24.0	32.5	37.5	9.7	23.1	28.0	21.0	21.7
1983	15.5	13.0	14.1	20.0	21.1	29.5	36.0	33.0	30.5	29.5	31.5	26.0	25.0
1984	19.0	17.5	17.5	17.5	20.1	31.0	28.9	23.5	33.5	39.5	36.5	35.2	26.6
1985	19.0	18.0	25.0	19.5	26.1	29.0	29.0	36.5	14.5	27.1	31.0	26.0	25.1
1986	17.5	19.4	17.5	20.0	18.9	28.0	32.5	34.0	29.0	23.0	19.5	26.4	23.8
Mean	16.5	15.7	15.9	16.1	18.2	21.7	27.4	30.6	24.5	20.4	20.4	20.6	20.7
Min.	10.0	11.0	11.0	10.0	13.0	13.6	21.0	21.9	9.6	2.3	1.1	10.9	-
Max.	22.5	22.1	25.0	20.0	26.1	31.0	36.0	39.5	35.0	39.5	36.5	35.2	-

(7) Bekasi in WTC

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Mean
1974	9.3	10.9	12.2	11.6	12.2	13.0	13.6	13.1	13.9	14.0	14.3	12.5	12.5
1975	10.5	8.6	12.6	13.1	13.6	8.4	6.0	6.7	9.9	10.3	11.1	10.8	10.1
1976	6.4	8.0	8.5	8.4	8.6	5.2	2.2	2.7	4.2	7.0	9.5	10.4	6.8
1977	8.7	5.0	6.9	10.6	11.6	10.4	3.6	8.1	5.5	5.8	9.0	9.5	7.9
1978	6.9	7.3	8.1	11.6	12.1	11.9	9.8	12.2	10.8	8.3	10.6	10.7	10.0
1979	6.1	9.6	10.6	11.4	11.8	11.0	12.1	11.1	8.1	9.5	7.4	6.6	9.6
1980	4.3	6.3	8.3	8.7	9.2	8.0	6.3	6.6	9.3	10.6	10.4	11.4	8.3
1981	4.9	3.4	6.1	8.5	8.2	9.6	10.0	12.0	9.9	11.0	11.3	10.0	8.7
1982	9.4	7.3	11.4	8.8	11.8	6.9	4.0	1.5	4.7	2.9	5.7	8.8	6.9
1983	10.6	13.3	14.1	11.7	9.3	7.9	5.2	1.0	2.6	4.2	6.7	7.5	7.8
1984	6.6	10.7	6.6	6.7	4.6	7.7	7.7	7.3	4.0	2.8	4.5	6.1	6.3
1985	9.6	8.2	8.0	9.4	9.9	9.6	8.4	7.1	5.0	5.6	6.5	6.6	7.8
1986	-	-	-	-	-	-	-	-	-	-	-	-	-
1987	6.9	2.1	6.2	8.0	8.5	7.8	4.2	0.4	2.9	4.3	7.2	8.6	5.6
1988	8.6	6.1	5.5	7.5	12.1	9.0	4.4	9.8	4.7	6.9	9.7	4.5	7.4
1989	5.5	6.9	8.4	4.4	10.7	9.9	9.3	3.9	2.3	4.8	8.5	11.6	7.2
1990	9.9	8.4	8.6	11.2	13.5	13.0	15.3	14.2	10.7	11.4	12.8	13.3	11.9
1991	13.9	11.5	13.8	11.2	5.6	5.7	3.8	3.7	4.1	6.8	9.5	12.1	8.5
1992	14.7	13.0	8.3	12.8	13.4	12.5	8.7	5.5	9.3	10.1	14.0	17.0	11.6
1993	14.2	3.1	11.2	-	-	-	-	-	-	-	-	-	-
Mean	8.8	7.8	8.9	8.7	9.4	8.7	7.2	6.1	5.1	6.1	8.2	8.9	7.8
Min.	4.3	2.1	5.5	4.4	4.6	5.7	3.8	0.4	2.3	2.8	4.5	4.5	-
Max.	14.7	13.3	14.1	11.7	13.5	13.0	15.3	14.2	10.7	11.4	12.8	13.3	-

Note: Symbol of "-" shows missing data or no discharge during a month for maintenance.
Symbol of "*" shows no discharge during a month for maintenance.

Table 10 OVERVIEW OF CHARACTERISTICS OF BASIC SCENARIOS

Item/Variable	Scenario A (high growth)	Scenario B (low growth)	Scenario C (managed growth)
I. GENERAL CONDITIONS			
a) Economic Growth Rate	High (>6.5%)	High (<6.5%)	High (=6.5%)
b) Unemployment	Low	High	Low or Medium
c) Focus of Government Policy	High economic growth	High economic growth	equity, environment
d) Government Budget	Medium	Low	High
e) Attitude to Subsidies	No	No (can not)	Yes
f) Government Investments	Medium	Low	High
g) Income Distribution	skewed	skewed	more equal
II. POPULATION			
a) Effect of Urban Planning	No	No	Yes
b) General Trend *)	JMDPR - 2nd	JMDPR - 2nd	JMDPR - 3rd
c) Growth of DKI	Low	High	Medium
d) Growth Botabek	around DKI	Low	west-east corridor
e) Outside Jabotabek	High	Low	High
III. DOMESTIC WATER DEMANDS			
a) Cost Recovery PWS	Full	Full	Subsidized
b) Price Development	High	High	Low
c) Willingness to Connect	Medium	Low	High
IV. INDUSTRY			
a) Industry Development	High	Low	Medium or high
b) Per Unit Water Demend	As present	As present	inclease of 25 %
c) Industrial Pollution Loads	High	Medium	Low
V. AGRICULTURE			
a) Area	<< Present	= Present	<< Present
b) Consumption Pattern	other / paddy	Present	Change
c) Government Policy	Present	Present	Diversified
d) Production	paddy and vegetables	paddy	intensified, vegetables
e) Water Demand	< Present	Present	<< Present
VI. WATER QUALITY			
a) Government Policy	Present	Present	Intensified
b) Sewerage / Treatment	No	No	Yes
c) Discharges	High	Medium	Low

*) Trend of spatial development according to analyses of Jabotabek Metropolitan Development Plan and Review Second and Third Planning Report

Source : Jabotabek Water Resources Management Study in 1994

Table 11 FUTURE POPULATION PROJECTED BY JWRMS

(unit : thousand)

Areas		Senario	Year 1990	1995	2000	2005	2010	2015	2020	2025	Average Growth Rate (%)	Groundwater Availability
Jakarta	North	A	4,062	4,470	4,888	5,293	5,666	6,000	6,310	6,598	1.40	1
		B	4,062	4,644	5,239	5,817	6,348	6,825	7,266	7,677	1.84	
		C	4,062	4,470	4,888	5,293	5,666	6,000	6,310	6,598	1.40	
	South	A	4,145	4,492	4,848	5,193	5,511	5,795	6,059	6,304	1.21	3
		B	4,145	4,640	5,148	5,640	6,094	6,499	6,875	7,225	1.60	
		C	4,145	4,492	4,848	5,193	5,511	5,795	6,059	6,304	1.21	
	Total	A	8,207	8,962	9,736	10,486	11,177	11,795	12,369	12,902	1.30	
		B	8,207	9,284	10,387	11,457	12,442	13,324	14,141	14,902	1.72	
		C	8,207	8,962	9,736	10,486	11,177	11,795	12,369	12,902	1.30	
Tangerang	North	A	558	664	759	853	955	1,059	1,162	1,265	2.37	1
		B	558	650	734	817	907	1,001	1,095	1,188	2.18	
		C	558	668	768	866	971	1,080	1,188	1,295	2.43	
	Central	A	1,809	2,387	2,988	3,589	4,163	4,693	5,176	5,625	3.29	2
		B	1,809	2,339	2,888	3,435	3,956	4,437	4,874	5,281	3.11	
		C	1,809	2,468	3,152	3,836	4,490	5,094	5,643	6,155	3.56	
	Balaraja	A	83	106	133	172	212	254	296	334	4.06	1
		B	83	104	129	164	201	240	279	314	3.87	
		C	83	114	150	202	256	311	368	419	4.73	
	South	A	180	216	255	304	361	423	490	558	3.29	4
		B	180	212	246	291	343	400	461	524	3.10	
		C	180	239	301	381	474	575	683	793	4.33	
	Cikupa	A	94	120	149	193	243	294	340	385	4.11	2
		B	94	117	144	185	231	278	320	361	3.92	
		C	94	135	183	255	335	418	492	565	5.26	
	Total	A	2,724	3,493	4,284	5,111	5,934	6,723	7,464	8,167	3.19	
		B	2,724	3,422	4,141	4,892	5,638	6,356	7,029	7,668	3.00	
		C	2,724	3,624	4,554	5,540	6,526	7,478	8,374	9,227	3.55	
Bekasi	North	A	415	470	523	578	642	712	784	857	2.09	1
		B	415	457	499	545	599	658	721	785	1.84	
		C	415	490	561	638	724	819	917	1,017	2.59	
	Central	A	1,523	1,972	2,445	2,934	3,430	3,901	4,324	4,703	3.27	2
		B	1,523	1,920	2,336	2,764	3,197	3,608	3,976	4,305	3.01	
		C	1,523	2,049	2,601	3,173	3,754	4,305	4,800	5,243	3.60	
	Southeast	A	135	159	183	211	242	275	312	349	2.75	1
		B	135	155	175	199	225	255	287	319	2.49	
		C	135	177	220	270	324	384	448	514	3.89	
	Total	A	2,073	2,601	3,151	3,723	4,314	4,888	5,420	5,909	3.04	
		B	2,073	2,532	3,010	3,508	4,021	4,521	4,984	5,409	2.78	
		C	2,073	2,716	3,382	4,081	4,802	5,508	6,165	6,774	3.44	
Bogor	North	A	983	1,294	1,634	1,981	2,336	2,672	2,983	3,259	3.48	3
		B	983	1,260	1,561	1,866	2,178	2,471	2,743	2,984	3.22	
		C	983	1,158	1,348	1,543	1,742	1,930	2,104	2,259	2.41	
	South	A	1,319	1,754	2,241	2,749	3,254	3,729	4,161	4,537	3.59	2
		B	1,319	1,708	2,140	2,589	3,033	3,449	3,826	4,154	3.33	
		C	1,319	1,697	2,119	2,560	2,998	3,411	3,785	4,112	3.30	
	Southwest	A	846	1,007	1,170	1,352	1,551	1,756	1,963	2,162	2.72	3
		B	846	981	1,118	1,274	1,446	1,624	1,805	1,979	2.46	
		C	846	980	1,116	1,268	1,433	1,603	1,776	1,942	2.40	
	West	A	396	455	514	574	643	719	798	879	2.30	4
		B	396	443	491	541	600	665	733	805	2.05	
		C	396	444	491	539	595	655	719	784	1.97	
	East	A	405	472	540	619	709	807	905	1,004	2.63	4
		B	405	460	516	584	661	746	832	919	2.37	
		C	405	457	508	569	638	713	788	864	2.19	
	Total	A	3,949	4,982	6,099	7,275	8,493	9,683	10,810	11,841	3.19	
		B	3,949	4,852	5,826	6,854	7,918	8,955	9,939	10,841	2.93	
		C	3,949	4,736	5,582	6,479	7,406	8,312	9,172	9,961	2.68	
Outside Jabotabek	Serang	A	1,471	1,827	2,387	3,147	3,831	4,439	4,978	5,518	3.85	2
		B	1,471	1,739	2,161	2,733	3,248	3,706	4,111	4,518	3.26	
		C	1,471	1,827	2,387	3,147	3,831	4,439	4,978	5,518	3.85	
	Purwakarta/ Karawang	A	2,055	2,413	3,071	3,871	4,730	5,575	6,356	7,136	3.62	2
		B	2,055	2,343	2,870	3,514	4,204	4,882	5,510	6,137	3.18	
		C	2,055	2,413	3,070	3,871	4,730	5,575	6,356	7,137	3.62	
	Grand Total	A	20,479	24,278	28,728	33,613	38,479	43,103	47,397	51,473	2.67	
		B	20,479	24,172	28,395	32,958	37,471	41,744	45,714	49,475	2.55	
		C	20,479	24,278	28,711	33,604	38,472	43,107	47,414	51,519	2.67	

Remarks : Groundwater availability

1 : very poor with serious brackish and polluted condition　2 : medium condition　3 : reasonable aquifer

4 : abundant aquifer

Table 12 OVERVIEW OF COVERAGE RATES AND UNIT CONSUMPTION AND CRITERIA FOR CONNECTING DEMAND ZONES

	Zone	PRESENT		SENARIO A		SENARIO B		SENARIO C	
	class	cov. rate	lcd	cov. rate	lcd	cov. rate	lcd	cov. rate	lcd
DKI JAKARTA	2	19 %	147	42 %	165	36 %	150	71 %	155
- North	1	27 %	151	56 %	165	47 %	150	88 %	154
- South	3	11 %	141	28 %	164	25 %	149	53 %	158
BOGOR									
- North	3	-	-	30 %	140	25 %	120	60 %	140
- South	2	10 %	124	37 %	153	31 %	131	70 %	143
- Southwest	3	-	-	30 %	140	25 %	120	60 %	140
- West	4	-	-	-	-	-	-	-	-
- East	4	-	-	-	-	-	-	-	-
TANGERANG									
- North	1	-	-	50 %	140	40 %	120	85 %	140
- Central	2	10 %	124	37 %	153	31 %	131	70 %	143
- Balaraja	1	-	-	50 %	140	40 %	120	85 %	140
- South	4	-	-	-	-	-	-	-	-
- Cikupa	2	-	-	50 %	140	40 %	120	85 %	140
BEKASI									
- North	1	-	-	50 %	140	40 %	120	85 %	140
- Central	2	5 %	100	36 %	153	30 %	131	70 %	143
- Southeast	1	-	-	50 %	140	40 %	120	85 %	140
OUTSIDE									
- Serang	2	-	-	35 %	140	30 %	120	65 %	140
- Kav. / Purw.	2	-	-	35 %	140	30 %	120	65 %	140

Demand Zone Classification	Description
1	very poor groundwater conditions, brackish groundwater or serious groundwater pollution
2	medium groundwater conditions, problems will rather soon occur with rising densities
3	reasonable groundwater aquifer, some problems encountered with very high densities
4	groundwater aquifer

Groundwater conditions	Density criterion
• limited groundwater availability • saline groundwater	density > 30/ha
• limited groundwater availability • possible groundwater quality problems	density > 50/ha
• good groundwater availability	density > 100/ha

Source : Jabotabek Water Resources Management Study in 1994

Table 13 FUTURE MUNICIPAL AND INDUSTRIAL WATER DEMAND PROJECTED BY JWRMS

(unit : cu.m/s)

Areas		Senario	Surface Water Source								Groundwater Source							
			Year								Year							
			1990	1995	2000	2005	2010	2015	2020	2025	1990	1995	2000	2005	2010	2015	2020	2025
Jakarta	North	A	6.6	7.6	8.4	10.8	12.3	13.9	15.3	18.1	7.2	7.5	7.8	7.8	7.7	7.5	7.2	6.6
		B	6.6	7.6	8.4	10.4	11.5	12.8	14.1	16.2	7.2	7.7	8.1	8.3	8.4	8.3	8.1	7.9
		C	6.6	9.1	11.9	18.5	23.9	24.3	24.6	26.2	7.2	7.1	6.7	5.2	3.3	3.0	2.7	2.5
	South	A	2.4	3.0	3.8	5.0	5.9	6.5	7.2	7.9	7.9	8.4	9.0	9.5	9.9	10.3	10.6	11.1
		B	2.4	3.1	4.0	4.8	5.6	6.2	6.7	7.4	7.9	8.5	9.1	9.7	10.1	10.5	10.8	11.2
		C	2.4	4.6	7.0	9.4	12.1	13.2	13.9	15.9	7.9	8.1	8.1	8.2	7.8	7.7	7.7	7.6
	Total	A	9.0	10.6	12.2	15.8	18.2	20.4	22.5	26.0	15.1	15.9	16.8	17.3	17.6	17.8	17.8	17.7
		B	9.0	10.7	12.4	15.2	17.1	19.0	20.8	23.6	15.1	16.2	17.2	18.0	18.5	18.8	18.9	19.1
		C	9.0	13.7	18.9	27.9	36.0	37.5	38.5	42.1	15.1	15.2	14.8	13.4	11.1	10.7	10.4	10.1
Tangerang		A	2.3	3.2	4.4	5.7	7.3	9.0	11.0	12.5	4.4	5.4	6.4	7.4	8.5	9.3	10.1	10.9
		B	2.3	3.0	3.9	4.9	6.0	7.0	8.1	9.0	4.4	5.2	5.9	6.7	7.4	8.0	8.6	9.2
		C	2.3	3.4	4.8	7.3	11.1	15.1	19.1	22.3	4.4	5.6	6.7	7.6	7.9	8.1	8.2	8.4
Bekasi		A	1.6	2.1	2.8	3.7	4.8	5.9	7.4	8.6	3.4	4.3	5.2	6.1	7.0	7.8	8.6	9.2
		B	1.6	2.0	2.5	3.1	3.9	4.6	5.4	6.0	3.4	4.1	4.7	5.4	6.0	6.6	7.2	7.7
		C	1.6	2.2	3.1	4.2	7.4	10.2	13.6	16.2	3.4	4.5	5.5	6.5	6.8	7.1	7.2	7.3
Bogor	North	A	0.4	0.6	1.2	1.7	2.4	3.1	3.7	4.6	1.6	2.1	2.6	3.2	3.7	4.2	4.7	5.0
		B	0.4	0.5	1.0	1.5	1.9	2.4	2.8	3.2	1.6	2.0	2.4	2.8	3.1	3.5	3.8	4.1
		C	0.4	0.7	1.2	1.9	2.7	3.7	4.4	5.3	1.6	1.8	2.1	2.3	2.4	2.4	2.4	2.4
	South	A	0.7	1.2	1.9	2.6	3.5	4.4	5.5	6.5	2.0	2.7	3.5	4.4	5.2	5.9	6.6	7.2
		B	0.7	1.1	1.6	2.3	3.1	3.8	4.7	5.3	2.0	2.6	3.2	3.8	4.4	4.8	5.3	5.6
		C	0.7	1.2	2.0	3.2	5.5	7.5	9.5	10.9	2.0	2.6	3.3	3.7	3.8	3.9	4.0	4.0
	South-west	A	0.3	0.5	0.7	1.0	1.2	1.7	2.0	2.4	1.3	1.6	1.9	2.2	2.5	2.7	3.1	3.3
		B	0.3	0.4	0.6	0.8	1.0	1.2	1.5	1.7	1.3	1.5	1.7	1.9	2.1	2.3	2.5	2.7
		C	0.3	0.5	0.6	0.8	1.4	2.0	2.6	3.3	1.3	1.5	1.8	2.1	2.1	2.2	2.2	2.2
	West	A	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.7	0.8	0.9	1.0	1.2	1.3	1.5
		B	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.6	0.7	0.8	0.9	1.0	1.1	1.2
		C	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.4
	East	A	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.7	0.8	1.0	1.1	1.3	1.5	1.7
		B	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.4
		C	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.7	0.8	0.9	1.0	1.2	1.4	1.5
	Total	A	1.4	2.3	3.8	5.3	7.1	9.2	11.2	13.5	6.1	7.8	9.6	11.7	13.5	15.3	17.2	18.7
		B	1.4	2.0	3.2	4.6	6.0	7.4	9.0	10.2	6.1	7.4	8.8	10.2	11.5	12.7	13.9	15.0
		C	1.4	2.4	3.8	5.9	9.6	13.2	16.5	19.5	6.1	7.3	8.8	9.9	10.3	10.8	11.2	11.5
Outside Jabotabek	Serang	A	2.2	3.2	4.3	5.8	7.1	8.7	10.2	11.8	2.6	3.2	4.0	5.1	6.0	6.8	7.5	8.2
		B	2.2	2.9	3.6	4.6	5.4	6.4	7.0	7.7	2.6	3.0	3.5	4.2	4.8	5.3	5.7	6.2
		C	2.2	3.3	4.4	6.9	9.1	12.2	14.3	17.3	2.6	3.2	4.0	4.6	5.0	5.1	5.2	5.3
	Purwakarta/ Karawang	A	1.0	1.5	2.8	4.1	5.5	7.2	8.9	11.0	3.5	4.0	4.7	5.7	6.8	7.7	8.5	9.2
		B	1.0	1.3	2.4	3.3	4.3	5.4	6.3	7.3	3.5	3.8	4.3	4.9	5.5	6.1	6.6	7.1
		C	1.0	1.5	2.9	4.9	7.7	11.4	14.6	18.1	3.5	4.0	4.7	5.4	5.7	5.7	5.6	5.6
Grand Total		A	17.5	22.9	30.3	40.4	50.0	60.4	71.2	83.4	35.1	40.6	46.7	53.3	59.4	64.7	69.7	73.9
		B	17.5	21.9	28.0	35.7	42.7	49.8	56.6	63.8	35.1	39.7	44.4	49.4	53.7	57.5	60.9	64.3
		C	17.5	26.5	37.9	57.1	80.9	99.6	116.6	135.5	35.1	39.8	44.5	47.4	46.8	47.5	47.8	48.2

Table 14 SURFACE WATER AVAILABILITY FOR M&I FROM VARIOUS SOURCES

Water Sources	Unreglated river		Regulated river		Max potential
	with *) agriculture	without agriculture	with agriculture	without agriculture	with agriculture
Ciujung (Pamarayan)	9	13			
+ Karian			24	31	
+ Pasirkopo			31		
+ Bojongmanik			33		33
Cidurian (Rancasumur)	3	3			
+ Tanjung			10	12	
+ Cilawang			4	4	14
Cisadane **)					
present					
* upstream (Bogor)	1.5				
* downstream (Serpong)	5				
future					
* upstream					
+ Salak canal			2		
+ Genteng			8		
* downstream			4		14
Ciliwung **)					
* upstream (Bogor)	1				
* downstream (Depok)	2				3
Bekassi river					
+ Narogong				6	6
Citarum system					
present			50		
+ Oprational management			90		
+ Cipunegara reservoir			95		95
Less attractive supply options					
Pasiranji			11		(11)
Nameng				5	(5)
Difficult / impossible options					
Parungbadak					
Sodong					
Pangkalan					
Depok					
Total					
Existing	21.5		50		71.5
Potential					155 (16)

*) future agricultural situation

**) water availability is strongly dependant on return flow

Source : Jabotabek Water Resources Management Study in 1994

Table 15 IRRIGATION WATER REQUIREMENT FOR CIUJUNG AREA (1/2)

Present Condition (unit : cu.m/s)

Year	Jan.		Feb.		Mar.		Apr.		May		June		July		Aug.		Sept.		Oct.		Nov.		Dec.		Annual
	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	Mean
1970	13.1	9.0	8.2	16.1	11.6	17.6	0.0	18.2	4.8	7.2	6.9	12.2	10.2	21.5	20.0	22.8	20.0	13.7	17.9	6.9	4.9	2.6	3.8	4.5	11.4
1971	8.1	18.0	10.6	11.4	1.5	23.6	0.0	22.0	9.1	3.8	7.4	10.6	22.2	21.9	22.8	17.1	18.9	17.1	17.6	2.1	6.3	1.6	3.4	7.2	11.8
1972	8.1	18.1	19.9	13.2	2.9	17.8	21.9	17.7	1.0	14.1	16.8	18.4	22.2	21.9	23.4	22.8	0.0	22.4	17.9	13.6	7.8	0.3	5.7	5.8	13.9
1973	12.2	10.0	4.1	26.6	11.2	8.6	23.6	7.4	7.5	9.0	7.7	5.9	20.5	17.3	14.4	16.8	19.0	6.3	11.8	12.9	7.6	1.1	5.2	7.6	11.4
1974	3.8	26.2	6.0	21.1	3.7	25.6	11.1	15.0	7.3	9.2	13.1	5.9	16.8	21.6	18.6	13.1	14.3	15.7	5.4	10.1	1.2	2.5	4.1	8.6	11.7
1975	11.1	11.8	6.7	19.5	24.5	14.8	26.5	10.3	9.3	9.6	13.2	18.1	22.2	21.9	22.0	15.9	20.2	16.2	8.3	7.5	4,3	1.9	4.9	5.7	13.6
1976	9.8	13.1	16.7	16.9	9.5	15.9	26.5	7.2	3.8	16.8	9.8	18.4	13.8	18.3	14.6	19.8	21.1	21.2	14.2	13.3	4.2	1.0	5.2	9.6	13.4
1977	11.2	11.2	17.0	5.3	3.5	16.9	14.9	12.1	8.6	12.5	4.8	14.3	2.4	21.9	21.1	19.2	19.3	20.3	17.9	13.6	6.8	3.6	5.6	2.7	11.9
1978	16.2	12.5	18.2	8.9	10.9	14.0	29.0	12.0	7.4	10.6	9.3	10.2	10.0	13.1	11.1	6.0	23.1	8.1	9.4	5.9	5.3	3.4	3.3	5.9	11.0
1979	9.8	13.1	32.9	9.3	1.8	28.0	7.1	14.1	9.2	14.1	13.1	16.7	22.2	11.6	17.7	17.9	16.9	13.3	9.5	13.6	4.0	1.3	2.4	6.3	12.7
1980	10.2	12.6	15.7	7.5	11.4	10.6	7.5	11.4	12.0	10.8	13.6	6.5	14.4	13.4	3.3	22.8	18.0	20.1	15.9	4.0	2.5	2.6	4.9	3.2	10.6
1981	10.2	12.6	11.7	9.9	1.8	21.7	17.7	17.4	16.9	6.1	4.6	9.8	9.6	18.2	23.4	22.8	12.0	13.2	1.2	8.8	1.0	1.9	3.2	5.3	10.9
1982	9.9	13.0	5.0	36.3	13.2	29.0	10.0	20.5	12.1	16.2	5.7	17.9	17.6	10.1	0.3	22.8	23.1	15.4	12.5	9.9	4.5	2.5	6.0	8.3	13.4
1983	13.4	12.2	19.9	14.6	26.3	8.0	14.0	2.5	13.8	11.0	4.4	18.4	9.7	15.9	23.4	22.8	23.1	22.4	14.9	4.6	7.9	2.6	4.4	7.8	13.3
1984	6.6	18.4	12.9	15.9	6.1	19.6	22.9	4.4	12.9	16.7	6.8	18.4	19.8	16.3	10.8	21.4	10.9	19.6	9.0	12.4	3.3	1.0	3.4	5.1	12.3
1985	9.3	21.9	15.8	12.9	8.6	24.4	12.6	10.9	15.4	10.7	15.0	4.7	18.9	16.2	15.7	22.8	17.6	17.6	12.0	11.3	5.0	2.7	5.4	4.8	13.0
1986	14.3	7.7	21.4	29.1	19.5	22.5	16.9	15.5	4.1	13.4	10.9	15.8	17.3	14.2	20.7	20.7	9.1	14.4	15.7	10.3	3.3	2.0	3.4	6.1	13.7
1987	5.7	20.0	20.6	7.7	18.1	25.2	0.0	19.6	16.1	11.9	0.3	18.4	15.2	18.0	23.4	22.8	23.1	0.0	15.2	11.9	6.9	2.9	4.3	5.4	13.0
1988	11.2	11.2	25.1	25.6	21.5	5.4	11.0	10.2	7.7	7.0	13.6	16.4	20.7	15.5	17.9	13.1	20.2	12.8	11.7	6.7	5.4	0.3	2.5	6.2	12.5
1989	15.6	8.9	7.5	17.6	25.3	24.7	21.1	13.2	13.9	10.3	12.6	12.4	17.1	18.5	10.4	4.6	13.7	20.8	13.4	8.5	2.2	2.8	3.6	8.9	12.8
1990	9.6	13.5	12.9	8.5	14.9	24.7	8.0	7.3	13.2	13.0	12.9	15.6	17.7	10.6	21.6	16.4	17.0	21.6	17.9	10.0	7.9	3.1	5.2	9.1	13.0
1991	11.6	10.8	6.2	20.7	21.9	22.9	15.4	16.5	13.4	17.2	16.8	18.4	22.2	21.9	23.4	22.8	23.1	22.4	17.9	11.1	5.1	1.4	5.1	5.5	15.6
1992	14.9	18.0	8.9	15.9	15.2	4.9	2.9	17.1	5.6	10.0	11.4	18.4	22.2	21.9	21.6	18.3	11.1	21.6	6.3	5.1	3.5	2.6	1.9	7.0	11.9
1993	6.4	19.8	7.3	29.1	29.6	22.0	7.7	7.7	2.9	13.6	12.6	12.4	22.2	18.4	5.7	17.2	14.3	17.7	15.7	10.7	6.8	1.6	4.3	6.0	13.0
Mean	10.5	14.3	13.8	16.7	13.1	18.7	13.7	12.9	9.5	11.5	10.1	13.9	17.0	17.5	17.0	18.4	17.0	16.4	12.9	9.4	4.9	2.1	4.2	6.4	12.6
Min.	3.8	7.7	4.1	5.3	1.5	4.9	0.0	2.5	1.0	3.8	0.3	4.7	2.4	10.1	0.3	4.6	0.0	0.0	1.2	2.1	1.0	0.3	1.9	2.7	10.6
Max.	16.2	26.2	32.9	36.3	29.6	29.0	29.0	22.0	16.9	17.2	16.8	18.4	22.2	21.9	23.4	22.8	23.1	22.4	17.9	13.6	7.9	3.6	6.0	9.6	15.6

Scenario A

Year	Jan.		Feb.		Mar.		Apr.		May		June		July		Aug.		Sept.		Oct.		Nov.		Dec.		Annual
	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	Mean
1970	9.8	6.6	6.0	12.2	8.5	13.1	0.0	13.3	3.6	5.5	5.4	10.1	8.3	20.9	19.5	22.2	19.5	11.9	16.1	5.7	4.0	2.1	2.9	3.4	9.6
1971	5.9	13.5	7.9	8.6	1.1	17.6	0.0	16.1	6.7	2.9	5.8	8.7	20.3	21.4	22.6	16.2	18.3	14.9	15.8	1.7	5.1	1.3	2.6	5.3	10.0
1972	5.9	13.6	15.0	9.7	2.1	13.3	16.0	13.0	0.8	10.9	13.7	16.5	20.3	21.4	23.2	22.2	3.3	19.9	16.1	11.1	6.4	0.3	4.4	4.3	11.8
1973	9.1	7.3	3.0	20.3	8.4	6.3	17.3	5.5	5.6	6.8	6.1	4.8	18.5	16.1	13.2	15.8	18.4	5.2	10.3	10.6	6.2	0.9	4.0	5.7	9.4
1974	2.8	20.0	4.4	16.1	2.7	19.1	8.1	11.0	5.4	7.0	10.5	4.7	14.6	21.1	17.9	11.9	13.4	13.7	4.4	8.3	1.0	2.1	3.1	6.5	9.6
1975	8.2	8.6	4.9	14.9	18.5	10.9	19.4	7.5	6.9	7.3	10.5	16.2	20.3	21.4	21.7	14.8	19.6	14.1	7.1	6.1	3.5	1.5	3.8	4.2	11.3
1976	7.2	9.7	12.5	12.6	7.0	11.8	19.4	5.3	2.8	13.1	7.7	16.5	11.5	17.3	13.4	19.1	20.7	18.7	12.6	10.9	3.4	0.8	3.9	7.5	11.1
1977	8.2	8.2	13.0	3.9	2.6	12.6	10.9	8.9	6.4	9.5	3.8	12.2	3.8	21.4	20.7	18.4	18.7	17.9	16.1	11.1	5.6	3.0	4.3	2.0	10.1
1978	12.2	9.1	13.7	6.5	8.1	10.4	21.2	8.8	5.5	8.0	7.3	8.3	8.2	11.8	10.5	5.6	22.8	6.7	8.2	4.8	4.3	2.8	2.5	4.4	8.8
1979	7.2	9.7	25.4	6.8	1.3	20.8	5.2	10.4	6.8	10.8	10.5	14.7	20.3	9.9	16.9	17.0	16.2	11.5	8.1	11.1	3.3	1.0	1.8	4.7	10.5
1980	7.4	9.3	11.9	5.5	8.6	7.9	5.5	8.3	8.9	8.2	10.9	5.2	12.1	11.9	2.7	22.2	17.3	17.8	14.2	3.3	2.1	2.1	3.7	2.4	8.7
1981	7.4	9.3	8.8	7.4	1.3	16.2	12.9	12.7	12.5	4.7	3.6	8.2	7.8	17.2	23.2	22.2	11.0	11.4	1.0	7.2	0.8	1.6	2.4	4.0	9.0
1982	7.2	9.6	3.6	27.9	9.7	21.6	7.4	15.0	9.0	12.6	4.5	16.0	15.5	8.4	3.6	22.2	22.8	13.4	11.0	8.1	3.7	2.1	4.6	6.2	11.1
1983	10.0	9.0	15.0	10.7	19.9	5.9	10.2	1.9	10.2	8.3	3.5	16.5	7.9	14.6	23.2	22.2	22.8	19.9	13.3	3.8	6.5	2.1	3.4	5.8	11.1
1984	4.8	13.9	9.6	12.0	4.5	14.6	16.7	3.2	9.6	13.0	5.8	16.5	17.7	14.9	9.3	20.7	9.7	17.2	7.6	10.1	2.7	0.8	2.6	3.7	10.1
1985	6.8	16.4	11.9	9.5	6.3	18.1	9.2	8.0	11.4	8.1	12.1	3.8	16.8	14.8	14.6	22.2	16.9	15.4	10.5	9.3	4.1	2.2	4.1	3.6	10.7
1986	10.7	5.6	16.1	22.1	14.6	16.7	12.4	11.4	3.1	10.3	8.6	13.7	15.1	12.7	20.2	19.9	8.1	12.5	14.0	8.5	2.7	1.6	2.6	4.5	11.2
1987	4.2	15.1	15.7	5.6	13.4	18.7	0.0	14.4	11.9	9.0	0.6	16.5	12.9	16.9	23.2	22.2	22.8	1.1	13.5	9.8	5.6	2.4	3.3	4.0	11.0
1988	8.3	8.2	19.1	19.3	16.2	4.0	8.0	7.5	5.7	5.3	10.9	14.3	18.7	14.0	17.1	11.9	19.7	11.0	10.2	5.5	4.4	0.2	1.9	4.6	10.3
1989	11.8	6.5	5.5	13.4	19.1	18.3	15.4	9.7	10.3	7.8	10.0	10.3	14.9	17.5	10.0	4.4	12.7	18.4	11.8	7.0	1.8	2.3	2.8	6.8	10.4
1990	7.0	10.0	9.8	6.3	11.0	18.4	5.9	5.4	9.8	9.9	10.3	13.5	15.6	9.0	21.2	15.4	16.2	19.1	16.1	8.2	6.5	2.5	4.0	7.0	10.8
1991	8.6	7.9	4.5	15.8	16.5	17.0	11.3	12.1	9.9	13.4	13.7	16.5	20.3	21.4	23.2	22.2	22.8	19.9	16.1	9.1	4.2	1.2	3.9	4.0	13.1
1992	11.1	13.3	6.6	12.0	11.5	3.6	2.2	12.5	4.2	7.6	8.9	16.5	20.3	21.4	21.2	17.4	10.0	19.1	5.6	4.2	2.8	2.1	1.4	5.2	10.0
1993	4.7	14.9	5.3	22.2	22.5	16.3	5.6	5.6	2.2	10.4	10.0	10.3	20.3	17.3	4.7	16.4	13.4	15.5	14.0	8.8	5.6	1.3	3.3	4.4	10.6
Mean	7.8	10.6	10.4	12.6	9.8	13.9	10.0	9.5	7.1	8.8	8.1	12.1	15.1	16.4	16.5	17.7	16.5	14.4	11.4	7.7	4.0	1.7	3.2	4.8	10.4
Min.	2.8	5.6	3.0	3.9	1.1	3.6	0.0	1.9	0.8	2.9	0.6	3.8	3.8	8.4	2.7	4.4	3.3	1.1	1.0	1.7	0.8	0.2	1.4	2.0	8.7
Max.	12.2	20.0	25.4	27.9	22.5	21.6	21.2	16.1	12.5	13.4	13.7	16.5	20.3	21.4	23.2	22.2	22.8	19.9	16.1	11.1	6.5	3.0	4.6	7.5	13.1

Table 16 IRRIGATION WATER REQUIREMENT FOR CIUJUNG AREA (2/2)

Scenario C (unit : cu.m/s)

Year	Jan.		Feb.		Mar.		Apr.		May		June		July		Aug.		Sept.		Oct.		Nov.		Dec.		Annual
	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	Mean
1970	8.6	5.6	5.0	10.6	7.3	12.1	0.0	12.1	3.1	5.0	5.1	10.4	8.1	20.3	18.7	20.3	17.9	11.7	17.6	6.5	5.4	4.3	3.7	2.9	9.3
1971	5.0	11.3	6.6	7.4	0.9	16.8	0.0	14.7	6.2	2.6	5.4	8.9	20.9	20.7	21.5	14.8	16.8	15.1	17.3	1.7	7.8	1.8	2.4	4.9	9.6
1972	5.0	11.4	12.6	8.1	1.8	12.6	15.2	11.5	0.7	10.4	14.1	17.1	20.9	20.7	22.1	20.3	1.6	20.8	17.6	15.4	10.4	0.3	6.2	3.6	11.7
1973	8.0	6.2	2.5	18.2	7.5	6.0	16.5	4.6	4.9	6.2	5.8	4.7	19.0	15.9	12.9	14.5	17.0	5.2	10.7	14.4	10.0	0.9	5.2	5.2	9.3
1974	2.4	17.1	3.7	14.1	2.2	18.0	7.0	9.6	4.7	6.4	10.5	4.6	14.9	20.4	17.2	11.2	12.4	13.7	4.5	10.8	1.1	4.4	3.2	6.2	9.2
1975	7.1	7.3	4.1	13.0	16.7	9.7	18.7	6.4	6.1	6.6	10.4	16.8	20.9	20.7	20.7	13.6	18.0	14.1	7.2	7.6	4.6	2.7	4.8	3.5	10.9
1976	6.2	8.1	10.4	10.8	6.0	11.0	18.8	4.4	2.5	12.6	7.2	17.1	11.7	17.0	13.1	17.5	19.0	19.4	13.4	15.0	5.1	1.5	5.1	7.3	10.8
1977	7.2	6.9	10.9	3.3	2.1	11.9	9.9	7.6	5.5	8.7	3.6	12.7	4.5	20.7	19.8	16.9	17.2	18.4	17.6	15.4	8.6	6.8	6.3	1.6	10.2
1978	10.8	7.7	11.5	5.4	7.1	9.7	20.7	7.5	4.8	7.3	6.9	8.3	8.1	11.7	10.2	5.2	20.9	6.7	8.5	5.9	6.0	6.2	2.8	4.0	8.5
1979	6.2	8.1	22.2	5.7	1.1	19.8	4.4	9.2	5.9	10.2	10.4	15.2	20.9	9.9	16.3	15.6	14.9	11.3	8.2	15.4	4.8	1.9	1.6	4.4	10.2
1980	6.4	7.8	10.0	4.6	7.6	7.3	4.9	7.3	8.0	7.5	10.9	5.1	12.3	11.9	2.7	20.3	15.9	18.3	15.4	3.3	2.2	4.4	5.2	2.0	8.4
1981	6.4	7.8	7.4	6.4	1.1	15.4	11.9	11.3	11.9	4.2	3.4	8.5	7.6	16.9	22.1	20.3	10.2	11.2	1.1	9.7	1.2	3.5	2.8	3.6	8.6
1982	6.2	8.1	3.1	25.3	8.1	20.5	6.2	13.5	8.1	12.1	4.2	16.5	15.9	8.4	2.7	20.3	20.9	13.2	11.5	10.3	4.7	4.1	6.6	5.9	10.7
1983	8.8	7.5	12.5	9.0	18.2	4.9	9.9	1.6	9.5	7.6	3.3	17.1	7.7	14.5	22.1	20.3	20.9	20.8	14.3	3.8	10.5	4.2	3.8	5.4	10.8
1984	4.0	11.6	8.0	10.3	3.8	13.7	16.0	2.7	8.8	12.5	6.6	17.1	18.2	14.8	9.2	19.0	9.1	17.7	7.7	13.7	4.2	1.8	3.1	3.3	9.9
1985	5.8	13.7	9.9	8.0	5.3	17.0	8.4	6.9	10.7	7.4	12.3	3.6	17.2	14.8	14.2	20.3	15.6	15.6	10.9	12.2	5.6	4.6	5.6	3.0	10.4
1986	9.6	4.7	13.5	19.6	12.8	15.6	11.3	10.0	2.7	9.6	8.2	14.2	15.4	12.7	19.3	18.2	7.6	12.4	15.1	10.9	3.4	3.1	2.8	4.1	10.7
1987	3.5	12.6	13.3	4.7	11.7	17.6	0.0	13.1	11.3	8.2	1.6	17.1	13.2	16.7	22.1	20.3	20.9	1.6	14.5	13.1	8.7	5.1	4.1	3.5	10.8
1988	7.2	6.9	16.3	16.8	14.8	3.3	7.3	6.5	5.1	4.8	10.9	14.8	19.2	14.0	16.5	11.2	18.1	10.8	10.6	6.3	7.0	0.2	1.9	4.2	9.8
1989	10.5	5.5	4.6	11.7	17.3	17.2	14.6	8.4	9.6	7.1	9.9	10.5	15.3	17.2	9.7	4.0	11.8	19.0	12.5	8.5	1.8	4.9	2.4	6.5	10.0
1990	6.0	8.4	8.1	5.3	9.4	17.3	7.4	5.8	9.0	9.2	10.2	14.0	16.0	9.0	20.3	14.2	15.0	19.9	17.6	10.4	10.6	5.4	5.2	6.8	10.9
1991	7.5	6.6	3.8	13.9	14.7	15.8	10.2	10.7	9.1	13.0	14.1	17.1	20.9	20.7	22.1	20.3	20.9	20.8	17.6	11.9	6.1	1.7	5.0	3.4	12.8
1992	9.7	11.2	5.5	10.5	10.5	3.4	1.8	11.2	3.6	7.0	8.6	17.1	20.9	20.7	20.3	15.9	9.4	19.9	5.7	5.4	3.2	4.3	1.2	4.9	9.7
1993	4.0	12.5	4.5	19.8	20.7	15.1	5.3	5.0	1.9	9.9	9.9	10.5	20.9	17.0	4.7	15.0	12.4	15.7	15.1	11.4	8.6	1.8	3.9	3.9	10.4
Mean	6.8	8.9	8.8	10.9	8.7	13.0	9.4	8.4	6.4	8.2	8.1	12.5	15.4	16.1	15.9	16.2	15.2	14.7	12.2	10.0	5.9	3.3	4.0	4.3	10.1
Min.	2.4	4.7	2.5	3.3	0.9	3.3	0.0	1.6	0.7	2.6	1.6	3.6	4.5	8.4	2.7	4.0	1.6	1.6	1.1	1.7	1.1	0.2	1.2	1.6	8.4
Max.	10.8	17.1	22.2	25.3	20.7	20.5	20.7	14.7	11.9	13.0	14.1	17.1	20.9	20.7	22.1	20.3	20.9	20.8	17.6	15.4	10.6	6.8	6.6	7.3	12.8

Table 17 IRRIGATION WATER REQUIREMENT FOR CIDURIAN-RANCASUMUR AREA (1/2)

Present Condition

(unit : cu.m/s)

Year	Jan.		Feb.		Mar.		Apr.		May		June		July		Aug.		Sept.		Oct.		Nov.		Dec.		Annual
	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	Mean
1970	6.3	3.4	3.4	7.6	5.5	7.9	0.0	7.8	2.2	2.9	2.3	3.9	2.9	6.5	6.1	7.0	5.9	3.9	5.1	1.9	1.4	0.8	2.4	3.1	4.2
1971	3.7	7.3	4.5	5.4	0.7	10.6	0.0	9.4	4.1	1.4	2.5	3.3	6.6	6.6	7.0	5.3	5.6	4.9	5.0	0.6	1.8	0.5	2.2	5.0	4.3
1972	3.7	7.4	8.8	6.2	1.3	8.0	9.5	7.6	0.5	5.9	6.1	6.0	6.6	6.6	7.2	7.0	0.0	6.4	5.1	3.8	2.2	0.1	3.5	4.0	5.1
1973	5.9	3.7	1.7	12.4	5.3	3.8	10.2	3.2	3.4	3.7	2.6	1.7	6.0	5.2	4.4	5.2	5.6	1.8	3.3	3.6	2.1	0.3	3.2	5.3	4.3
1974	1.8	11.1	2.4	9.9	1.7	11.5	4.8	6.4	3.3	3.8	4.7	1.7	4.9	6.5	5.7	4.0	4.2	4.5	1.5	2.8	0.4	0.8	2.5	5.9	4.5
1975	5.3	4.5	2.7	9.2	11.4	6.7	11.5	4.4	4.2	3.9	4.7	5.9	6.6	6.6	6.8	4.9	6.0	4.6	2.3	2.1	1.2	0.6	3.0	3.9	5.1
1976	4.6	5.1	7.3	7.9	4.5	7.1	11.5	3.1	1.7	6.9	3.4	6.0	4.0	5.5	4.5	6.1	6.2	6.1	4.0	3.7	1.2	0.3	3.1	6.6	5.0
1977	5.3	4.2	7.5	2.5	1.6	7.6	6.4	5.2	3.9	5.2	1.5	4.6	0.6	6.6	6.5	5.9	5.7	5.8	5.1	3.8	1.9	1.1	3.4	1.8	4.3
1978	7.9	4.8	8.0	4.2	5.1	6.3	12.5	5.2	3.4	4.3	3.3	3.2	2.9	3.9	3.4	1.9	6.8	2.3	2.6	1.6	1.5	1.0	2.1	4.1	4.3
1979	4.6	5.1	14.8	4.4	0.8	12.6	3.0	6.1	4.2	5.9	4.7	5.4	6.6	3.5	5.5	5.5	5.0	3.8	2.7	3.8	1.1	0.4	1.6	4.4	4.8
1980	4.8	4.8	6.9	3.6	5.4	4.8	3.2	4.9	5.4	4.4	4.9	1.9	4.2	4.0	1.1	7.0	5.3	5.8	4.5	1.1	0.7	0.8	3.0	2.2	3.9
1981	4.8	4.8	5.0	4.7	0.8	9.8	7.6	7.5	7.6	2.4	1.4	3.1	2.7	5.5	7.2	7.0	3.6	3.8	0.3	2.4	0.3	0.6	2.0	3.7	4.1
1982	4.6	5.0	2.0	16.9	6.2	13.0	4.3	8.8	5.5	6.7	1.8	5.8	5.2	3.0	0.1	7.0	6.8	4.4	3.5	2.7	1.3	0.8	3.6	5.7	5.2
1983	6.5	4.7	8.8	6.9	12.2	3.6	6.0	1.1	6.3	4.5	1.4	6.0	2.8	4.8	7.2	7.0	6.8	6.4	4.2	1.3	2.2	0.8	2.7	5.4	5.0
1984	3.0	7.5	5.6	7.5	2.9	8.8	9.9	1.9	5.9	6.9	2.3	6.0	5.8	4.9	3.3	6.6	3.2	5.6	2.5	3.4	0.9	0.3	2.1	3.5	4.6
1985	4.4	9.1	6.9	6.1	4.1	11.0	5.4	4.7	6.9	4.4	5.4	1.3	5.6	4.9	4.8	7.0	5.2	5.0	3.4	3.1	1.4	0.8	3.2	3.3	4.9
1986	6.9	2.8	9.5	13.5	9.1	10.1	7.3	6.7	1.9	5.6	3.9	5.1	5.1	4.3	6.3	6.3	2.7	4.1	4.4	2.9	0.9	0.6	2.2	4.2	5.3
1987	2.6	8.2	9.1	3.7	8.4	11.3	0.0	8.4	7.3	4.9	0.1	6.0	4.4	5.4	7.2	7.0	6.8	0.0	4.3	3.3	1.9	0.9	2.7	3.8	4.9
1988	5.3	4.2	11.2	11.9	10.0	2.4	4.7	4.4	3.5	2.8	4.9	5.3	6.1	4.7	5.5	4.0	6.0	3.7	3.3	1.9	1.5	0.1	1.6	4.3	4.7
1989	7.6	3.3	3.1	8.3	11.8	11.1	9.1	5.7	6.3	4.2	4.5	4.0	5.0	5.6	3.2	1.5	4.1	6.0	3.8	2.4	0.6	0.9	2.3	6.1	5.0
1990	4.5	5.2	5.6	4.1	7.0	11.1	3.5	3.2	6.0	5.4	4.6	5.0	5.2	3.2	6.6	5.0	5.0	6.2	5.1	2.8	2.2	0.9	3.2	6.3	4.9
1991	5.5	4.0	2.5	9.7	10.2	10.3	6.7	7.1	6.1	7.1	6.1	6.0	6.6	6.6	7.2	7.0	6.8	6.4	5.1	3.1	1.5	0.4	3.1	3.8	5.8
1992	7.2	7.3	3.7	7.5	7.1	2.2	1.2	7.3	2.5	4.1	4.0	6.0	6.6	6.6	6.6	5.6	3.3	6.2	1.8	1.4	1.0	0.8	1.3	4.8	4.4
1993	3.0	8.1	3.0	13.6	13.8	9.9	3.3	3.3	1.3	5.6	4.5	4.0	6.6	5.5	1.8	5.3	4.3	5.1	4.4	3.0	1.9	0.5	2.6	4.1	4.9
Mean	5.0	5.7	6.0	7.8	6.1	8.4	5.9	5.6	4.3	4.7	3.6	4.5	5.0	5.3	5.2	5.7	5.0	4.7	3.6	2.6	1.4	0.6	2.6	4.4	4.7
Min.	1.8	2.8	1.7	2.5	0.7	2.2	0.0	1.1	0.5	1.4	0.1	1.3	0.6	3.0	0.1	1.5	0.0	0.0	0.3	0.6	0.3	0.1	1.3	1.8	3.9
Max.	7.9	11.1	14.8	16.9	13.8	13.0	12.5	9.4	7.6	7.1	6.1	6.0	6.6	6.6	7.2	7.0	6.8	6.4	5.1	3.8	2.2	1.1	3.6	6.6	5.8

Scenario A

(unit : cu.m/s)

Year	Jan.		Feb.		Mar.		Apr.		May		June		July		Aug.		Sept.		Oct.		Nov.		Dec.		Annual
	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	Mean
1970	5.0	2.6	2.7	6.1	4.3	6.3	0.0	6.1	1.7	2.3	1.9	3.5	2.5	7.2	6.8	7.5	6.5	3.7	5.0	1.7	1.2	0.7	1.9	2.5	3.7
1971	2.9	5.9	3.6	4.4	0.5	8.5	0.0	7.4	3.3	1.1	2.1	3.0	6.8	7.4	7.9	5.4	6.0	4.7	5.0	0.5	1.5	0.4	1.7	3.9	3.9
1972	2.9	5.9	7.1	4.9	1.1	6.4	7.4	6.0	0.4	4.9	5.5	6.0	6.8	7.4	8.2	7.5	1.4	6.3	5.0	3.2	1.9	0.1	2.7	3.2	4.7
1973	4.6	2.9	1.3	10.1	4.2	3.1	8.0	2.5	2.7	3.0	2.2	1.5	6.2	5.4	4.5	5.3	6.1	1.6	3.2	3.1	1.8	0.3	2.5	4.1	3.8
1974	1.4	9.1	1.9	8.1	1.3	9.2	3.8	5.1	2.6	3.0	4.1	1.5	4.8	7.3	6.2	4.0	4.4	4.3	1.3	2.4	0.3	0.7	2.0	4.7	3.9
1975	4.2	3.5	2.1	7.5	9.2	5.2	9.0	3.5	3.4	3.2	4.1	5.8	6.8	7.4	7.6	5.0	6.5	4.4	2.2	1.8	1.0	0.5	2.4	3.1	4.6
1976	3.6	4.0	5.9	6.3	3.5	5.7	9.0	2.4	1.4	5.9	2.8	6.0	3.6	5.9	4.6	6.4	6.8	5.9	3.9	3.2	1.0	0.3	2.5	5.4	4.4
1977	4.2	3.3	6.1	1.9	1.3	6.0	5.1	4.1	3.1	4.2	1.3	4.3	1.5	7.4	7.2	6.2	6.2	5.6	5.0	3.2	1.7	0.9	2.7	1.4	3.9
1978	6.4	3.7	6.5	3.3	4.1	5.0	9.8	4.1	2.7	3.5	2.7	2.8	2.5	3.9	3.6	1.9	7.6	2.0	2.5	1.4	1.3	0.9	1.7	3.2	3.6
1979	3.6	4.0	12.2	3.5	0.6	10.0	2.4	4.8	3.3	4.8	4.0	5.3	6.8	3.2	5.8	5.7	5.3	3.6	2.5	3.2	1.0	0.3	1.2	3.4	4.2
1980	3.8	3.8	5.6	2.8	4.3	3.8	2.5	3.8	4.3	3.6	4.3	1.6	3.9	3.9	0.9	7.5	5.7	5.6	4.4	1.0	0.6	0.7	2.4	1.7	3.4
1981	3.8	3.8	4.1	3.8	0.7	7.8	6.0	5.9	6.0	2.0	1.2	2.8	2.3	5.8	8.2	7.5	3.6	3.5	0.3	2.1	0.2	0.5	1.6	2.9	3.6
1982	3.6	4.0	1.6	13.9	4.8	10.4	3.4	6.9	4.4	5.6	1.5	5.8	5.1	2.7	1.7	7.5	7.6	4.2	3.4	2.4	1.1	0.7	2.9	4.5	4.6
1983	5.1	3.7	7.1	5.4	9.8	2.8	4.7	0.9	5.0	3.6	1.1	6.0	2.4	4.9	8.2	7.5	7.6	6.3	4.1	1.1	1.9	0.7	2.2	4.2	4.4
1984	2.4	6.1	4.4	6.0	2.3	7.0	7.8	1.5	4.6	5.8	2.2	6.0	5.9	5.0	3.1	7.0	3.1	5.4	2.3	3.0	0.8	0.3	1.7	2.7	4.0
1985	3.4	7.3	5.6	4.8	3.2	8.7	4.3	3.7	5.5	3.6	4.8	1.1	5.6	5.0	5.0	7.5	5.6	4.8	3.2	2.7	1.2	0.7	2.6	2.6	4.3
1986	5.5	2.2	7.6	11.0	7.3	8.0	5.7	5.2	1.5	4.6	3.2	4.9	5.0	4.2	7.0	6.7	2.6	3.9	4.4	2.5	0.8	0.5	1.7	3.3	4.6
1987	2.1	6.7	7.4	2.9	6.7	9.0	0.0	6.6	5.7	4.0	0.4	6.0	4.2	5.7	8.2	7.5	7.6	0.6	4.2	2.9	1.7	0.8	2.1	3.0	4.4
1988	4.2	3.3	9.1	9.7	8.1	1.9	3.7	3.5	2.8	2.2	4.2	5.1	6.3	4.7	5.9	4.0	6.5	3.4	3.1	1.6	1.3	0.1	1.3	3.3	4.1
1989	6.1	2.6	2.4	6.7	9.5	8.8	7.1	4.5	5.0	3.4	3.9	3.5	4.9	5.9	3.5	1.5	4.1	5.8	3.7	2.0	0.6	0.7	1.8	4.9	4.3
1990	3.5	4.2	4.5	3.2	5.5	8.8	2.7	2.5	4.8	4.4	4.0	4.8	5.1	2.9	7.4	5.2	5.3	6.0	5.0	2.4	1.9	0.8	2.5	5.1	4.3
1991	4.4	3.2	2.0	7.9	8.2	8.2	5.2	5.6	4.8	6.0	5.5	6.0	6.8	7.4	8.2	7.5	7.6	6.3	5.0	2.6	1.3	0.4	2.4	3.0	5.2
1992	5.7	5.8	2.9	6.0	5.7	1.8	1.0	5.8	2.0	3.3	3.4	6.0	6.8	7.4	7.4	5.9	3.2	6.0	1.7	1.2	0.8	0.7	1.0	3.8	4.0
1993	2.3	6.6	2.3	11.1	11.1	7.8	2.6	2.6	1.1	4.7	3.9	3.5	6.8	5.9	1.5	5.5	4.4	4.9	4.4	2.6	1.7	0.4	2.1	3.2	4.3
Mean	3.9	4.5	4.8	6.3	4.9	6.7	4.6	4.4	3.4	3.9	3.1	4.3	5.0	5.6	5.8	6.0	5.5	4.5	3.5	2.2	1.2	0.5	2.1	3.5	4.2
Min.	1.4	2.2	1.3	1.9	0.5	1.8	0.0	0.9	0.4	1.1	0.4	1.1	1.5	2.7	0.9	1.5	1.4	0.6	0.3	0.5	0.2	0.1	1.0	1.4	3.4
Max.	6.4	9.1	12.2	13.9	11.1	10.4	9.8	7.4	6.0	6.0	5.5	6.0	6.8	7.4	8.2	7.5	7.6	6.3	5.0	3.2	1.9	0.9	2.9	5.4	5.2

Table 18 IRRIGATION WATER REQUIREMENT FOR CIDURIAN-RANCASUMUR AREA (2/2)

Scenario C (unit : cu.m/s)

Year	Jan.		Feb.		Mar.		Apr.		May		June		July		Aug.		Sept.		Oct.		Nov.		Dec.		Annual
	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	Mean
1970	4.2	2.1	2.1	5.0	3.4	5.4	0.0	5.3	1.4	2.1	1.7	3.4	2.3	6.4	6.0	6.6	5.7	3.5	5.6	2.0	1.8	1.5	2.0	2.0	3.4
1971	2.3	4.7	2.9	3.5	0.4	7.4	0.0	6.4	2.8	1.0	1.8	2.9	6.7	6.6	6.9	4.7	5.3	4.6	5.5	0.5	2.7	0.6	1.4	3.3	3.5
1972	2.3	4.7	5.6	3.8	0.8	5.6	6.6	5.0	0.3	4.5	5.4	5.9	6.7	6.6	7.1	6.6	0.9	6.5	5.6	5.1	3.7	0.1	3.2	2.5	4.4
1973	3.8	2.3	1.0	8.5	3.5	2.7	7.1	2.0	2.2	2.6	2.0	1.4	6.1	5.0	4.1	4.6	5.4	1.5	3.3	4.8	3.5	0.3	2.7	3.5	3.5
1974	1.1	7.4	1.5	6.6	1.1	8.0	3.0	4.2	2.2	2.7	3.9	1.3	4.6	6.5	5.5	3.5	3.8	4.2	1.3	3.5	0.3	1.6	1.8	4.1	3.5
1975	3.4	2.8	1.7	6.1	7.8	4.3	8.1	2.8	2.8	2.7	3.9	5.8	6.7	6.6	6.7	4.3	5.7	4.3	2.2	2.4	1.5	0.9	2.6	2.4	4.1
1976	2.9	3.2	4.6	5.1	2.8	4.9	8.1	1.9	1.1	5.4	2.6	5.9	3.5	5.3	4.2	5.6	6.0	6.1	4.2	4.9	1.8	0.5	2.7	4.8	4.1
1977	3.4	2.6	4.9	1.5	1.0	5.3	4.3	3.3	2.5	3.7	1.1	4.2	1.7	6.6	6.4	5.4	5.4	5.7	5.6	5.1	3.0	2.5	3.2	1.1	3.7
1978	5.3	2.9	5.1	2.6	3.3	4.3	8.9	3.3	2.2	3.1	2.5	2.6	2.3	3.6	3.3	1.6	6.7	1.9	2.6	1.8	2.0	2.3	1.6	2.7	3.3
1979	2.9	3.2	10.1	2.7	0.5	8.8	1.9	4.0	2.7	4.4	3.9	5.2	6.7	3.0	5.2	5.0	4.7	3.4	2.4	5.1	1.6	0.7	1.0	2.9	3.8
1980	3.0	3.0	4.4	2.2	3.6	3.3	2.1	3.2	3.7	3.1	4.1	1.5	3.7	3.7	0.9	6.6	5.0	5.7	4.8	0.9	0.6	1.6	2.7	1.4	3.1
1981	3.0	3.0	3.2	3.0	0.5	6.8	5.1	4.9	5.4	1.7	1.1	2.7	2.1	5.3	7.1	6.6	3.1	3.4	0.3	3.2	0.4	1.3	1.6	2.4	3.2
1982	2.9	3.2	1.2	11.8	3.8	9.1	2.7	5.9	3.7	5.2	1.4	5.7	5.0	2.5	1.1	6.6	6.7	4.0	3.6	3.3	1.5	1.5	3.4	3.9	4.2
1983	4.2	2.9	5.6	4.2	8.4	2.2	4.2	0.7	4.4	3.2	1.0	5.9	2.2	4.5	7.1	6.6	6.7	6.5	4.5	1.0	3.7	1.5	2.1	3.6	4.0
1984	1.9	4.8	3.5	4.9	1.8	6.1	6.9	1.2	4.0	5.4	2.5	5.9	5.8	4.6	2.9	6.1	2.7	5.5	2.3	4.5	1.4	0.6	1.7	2.3	3.7
1985	2.7	5.8	4.4	3.8	2.5	7.6	3.6	3.0	4.9	3.1	4.7	1.0	5.4	4.6	4.5	6.6	4.9	4.8	3.4	4.0	1.8	1.6	2.9	2.0	3.9
1986	4.7	1.7	6.0	9.1	6.0	6.9	4.9	4.3	1.2	4.1	3.0	4.8	4.8	3.9	6.2	5.9	2.3	3.8	4.8	3.5	1.1	1.1	1.6	2.7	4.1
1987	1.6	5.3	6.0	2.3	5.4	7.8	0.0	5.7	5.2	3.5	0.8	5.9	4.0	5.2	7.1	6.6	6.7	0.8	4.6	4.3	3.0	1.8	2.2	2.4	4.1
1988	3.4	2.6	7.4	7.9	6.9	1.5	3.2	2.8	2.3	2.0	4.1	5.0	6.1	4.4	5.3	3.5	5.8	3.3	3.3	1.9	2.5	0.1	1.1	2.8	3.7
1989	5.2	2.0	1.9	5.5	8.0	7.7	6.3	3.6	4.4	3.0	3.7	3.4	4.7	5.4	3.1	1.3	3.6	5.9	3.9	2.6	0.5	1.8	1.5	4.3	3.9
1990	2.8	3.3	3.6	2.6	4.4	7.7	3.2	2.6	4.1	3.9	3.8	4.7	5.0	2.7	6.5	4.5	4.7	6.2	5.6	3.3	3.7	2.0	2.7	4.5	4.1
1991	3.6	2.5	1.5	6.5	6.8	7.0	4.4	4.6	4.2	5.6	5.4	5.9	6.7	6.6	7.1	6.6	6.7	6.5	5.6	3.8	2.1	0.6	2.7	2.3	4.8
1992	4.7	4.6	2.3	4.9	4.9	1.5	0.8	4.9	1.6	2.9	3.1	5.9	6.7	6.6	6.5	5.1	2.8	6.2	1.8	1.7	1.0	1.5	0.8	3.3	3.6
1993	1.8	5.2	1.8	9.2	9.6	6.7	2.3	2.2	0.9	4.2	3.7	3.4	6.7	5.3	1.5	4.8	3.8	4.8	4.8	3.7	3.0	0.6	2.1	2.6	3.9
Mean	3.2	3.6	3.8	5.1	4.1	5.8	4.1	3.7	2.9	3.5	3.0	4.2	4.8	5.1	5.1	5.2	4.8	4.5	3.8	3.2	2.0	1.2	2.1	2.9	3.8
Min.	1.1	1.7	1.0	1.5	0.4	1.5	0.0	0.7	0.3	1.0	0.8	1.0	1.7	2.5	0.9	1.3	0.9	0.8	0.3	0.5	0.3	0.1	0.8	1.1	3.1
Max.	5.3	7.4	10.1	11.8	9.6	9.1	8.9	6.4	5.4	5.6	5.4	5.9	6.7	6.6	7.1	6.6	6.7	6.5	5.6	5.1	3.7	2.5	3.4	4.8	4.8

Table 19 PARAMETER ASSUMPTION ON IRRIGATION WATER REQUIREMENT

Parameter	Method/Source
Evapotranspiration	Penman method using climatic data at Serang
Effective Rainfall	by multiplying proportion by monthly probable rainfall, EFFECTIVE RAINFALL, No.25 by FAO For paddy = 84% ~ 62%, Max. = 175 mm/month For palawija = 72% ~ 63%, Max. = 100 mm/month
Percolation	Paddy Land = 2 mm/day
Water Requirement of Land Preparation	The land preparation period = 30 days Water Requirement = 250 mm Van de Goor and Zijlstra's formula $IR = M e^k / (e^k - 1)$ Where ; IR : Irrigation requirement at field level (mm/day) M : Water requirements to compensate for evaporation and percolation of the fields already saturated (mm/day) $M = Eo + p$ Eo is open water evaporation taken at 1.1 • ETo during land preparation (mm/day). $K = MT/S$ T : land preparation period (days) S : presaturation requirements
Water Layer Replacement	50 mm at about 1 month and 2 months after transplanting.
Consumptive Use	The consumptive use is calculated by the follwoing formula: $Etc = kc \times Eto$ Etc : crop evapotranspiration (mm/day) Eto : reference crop evapotranspiration (mm/day) kc : crop coefficient
Crop Coefficients **)	Standard of Ministry of Public Works
Irrigation Efficiency	65 % both for Paddy and Palawija based on Cisadane-Cimanuk Integrated Water Resources Study, which is used in JWRMS.

Table 20 HALF-MONTHLY RAINFALL AT STATION 23C

(unit : mm)

Year	Jan.		Feb.		Mar.		Apr.		May		June		July		Aug.		Sept.		Oct.		Nov.		Dec.		Annual Amount
	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	(mm)
1970	166	372	388	225	125	78	214	53	151	134	124	66	96	3	22	0	22	65	0	88	71	48	237	369	3,117
1971	153	108	250	205	375	70	205	22	103	183	123	88	0	0	4	40	30	40	3	164	44	98	109	77	2,494
1972	153	107	80	112	204	85	36	44	195	35	0	0	0	0	0	0	13	0	0	0	13	166	29	109	1,381
1973	122	228	361	77	139	146	29	116	110	99	163	196	13	35	62	44	32	132	57	9	17	120	44	59	2,410
1974	217	33	242	92	177	29	102	67	112	96	43	135	42	2	33	71	65	52	131	51	165	60	81	36	2,134
1975	113	164	220	96	48	84	13	93	84	84	37	3	0	0	9	49	21	47	107	95	87	87	58	119	1,718
1976	210	245	100	94	143	93	13	116	131	4	76	0	67	28	59	21	14	9	34	4	102	146	44	10	1,763
1977	225	340	261	405	270	125	80	87	87	48	160	45	12	0	15	25	27	16	0	0	30	0	40	231	2,529
1978	39	134	95	130	135	105	0	80	102	72	91	87	110	78	107	155	0	110	95	120	60	10	125	125	2,165
1979	300	352	0	110	220	15	143	83	80	29	38	15	0	80	38	35	46	71	78	0	106	132	191	132	2,294
1980	249	311	228	309	136	131	140	105	56	66	35	123	65	69	145	0	36	17	20	135	124	50	85	264	2,899
1981	212	264	202	185	237	60	60	47	15	120	195	115	105	30	0	0	85	75	225	90	225	120	145	157	2,969
1982	248	292	195	0	100	7	104	28	52	9	129	5	38	96	14	0	0	52	51	49	79	52	18	41	1,659
1983	80	155	79	97	41	126	152	275	39	63	149	0	107	50	0	0	0	0	30	127	10	46	70	56	1,752
1984	181	106	135	108	155	66	35	144	45	5	7	0	19	43	86	10	89	22	84	16	126	150	170	209	2,011
1985	119	64	110	111	128	33	102	104	26	65	21	158	26	44	51	0	39	36	55	30	67	41	43	143	1,616
1986	90	266	63	29	71	42	65	60	137	40	64	24	40	61	18	15	109	66	20	42	113	85	122	120	1,762
1987	196	92	79	139	77	27	224	41	20	52	14	0	55	30	0	0	0	20	25	21	29	30	88	139	1,398
1988	113	173	42	45	71	153	112	109	113	131	32	18	12	49	38	71	21	73	63	97	75	194	347	261	2,413
1989	52	191	327	167	42	29	42	75	38	71	45	57	40	26	113	168	67	12	44	69	130	40	95	29	1,969
1990	292	325	168	173	93	30	9	9	43	40	40	25	37	92	12	45	43	6	0	46	9	24	43	22	1,626
1991	152	250	360	142	58	39	74	54	41	0	0	0	0	0	0	0	0	0	0	32	71	112	54	125	1,564
1992	52	89	311	204	178	264	172	60	136	90	57	0	0	0	12	32	86	6	186	191	103	50	236	121	2,636
1993	180	92	175	34	22	43	188	181	151	38	45	57	0	27	134	45	63	36	20	37	33	96	82	112	1,891
Min.	39	33	0	0	22	7	0	9	15	0	0	0	0	0	0	0	0	0	0	0	9	0	18	10	1,381
Max.	300	372	388	405	375	264	224	275	195	183	195	196	110	96	145	168	109	132	225	191	225	194	347	369	3,117
Mean	163	198	186	137	135	78	96	86	86	66	70	51	37	35	41	34	38	40	55	63	79	82	107	128	2,090

Table 21 HALF-MONTHLY MEAN DISCHARGE AT DAMSITES (1/2)

(1) Karian dam

(unit:cu.m/s)

Year	Jan.		Feb.		Mar.		Apr.		May		Jun.		Jul.		Aug.		Sep.		Oct.		Nov.		Dec.		Annual
	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	Mean
1970	16.1	19.7	66.5	28.9	47.0	55.7	32.1	75.8	36.2	35.5	34.1	32.2	16.3	27.3	7.3	8.2	7.9	17.8	12.5	11.9	13.5	42.0	27.9	72.3	31.0
1971	34.6	51.6	86.7	38.6	52.3	29.4	23.8	20.7	15.1	15.0	15.5	15.0	22.3	7.7	12.6	24.8	14.8	9.8	12.2	42.0	40.1	18.7	21.4	22.5	27.0
1972	76.4	51.1	39.4	27.9	59.7	32.2	14.2	25.1	26.4	24.1	6.6	5.2	4.0	2.7	4.1	6.0	1.6	1.4	0.8	3.6	7.7	9.0	13.7	16.5	19.1
1973	41.6	39.6	26.5	27.6	26.8	39.4	40.8	43.5	63.5	29.6	37.8	13.9	12.5	11.2	15.6	15.4	24.7	36.1	20.2	32.5	19.9	29.3	25.6	37.8	29.6
1974	80.3	14.2	34.4	35.3	44.9	24.0	29.7	26.4	34.2	28.1	12.0	16.3	21.1	11.2	20.8	23.5	50.2	39.6	29.5	17.7	13.7	25.3	29.9	13.6	28.2
1975	26.6	23.6	40.9	38.0	24.6	27.0	14.7	12.3	11.5	22.5	13.8	6.9	8.6	21.2	25.8	18.6	34.5	31.5	15.3	21.0	39.8	22.1	50.3	46.8	24.9
1976	53.4	79.4	27.9	21.2	37.7	25.4	15.4	30.9	21.0	7.9	13.1	5.3	7.0	4.4	4.9	6.9	3.6	3.7	16.1	5.7	13.5	23.6	14.3	10.4	18.9
1977	19.3	47.5	28.1	25.8	47.1	29.4	39.6	30.9	39.8	25.5	19.7	16.9	9.0	5.6	3.7	3.9	2.8	4.8	4.3	4.4	8.2	5.4	9.5	13.1	18.5
1978	19.7	67.9	23.7	19.6	37.0	31.0	18.1	23.7	22.2	14.3	16.6	17.9	14.2	15.6	17.3	23.2	15.7	20.3	11.8	25.3	28.8	17.3	18.1	19.7	22.5
1979	24.4	39.9	35.8	37.9	33.8	25.5	45.3	35.0	17.9	13.2	14.4	5.5	12.6	9.3	6.9	6.1	7.4	8.6	9.1	7.1	22.5	24.6	15.0	24.2	20.1
1980	49.7	60.7	33.3	25.0	19.3	16.0	30.8	25.1	29.3	19.5	11.9	11.1	10.3	13.7	31.0	15.1	22.2	25.3	18.5	17.1	21.4	24.5	21.6	43.9	24.8
1981	48.9	55.7	34.1	37.1	25.7	40.7	20.1	35.5	29.2	34.8	35.4	38.0	12.6	43.0	17.3	20.4	28.8	19.3	23.1	29.8	33.0	46.3	19.6	45.3	32.2
1982	70.4	57.9	24.8	17.4	15.6	6.7	20.0	21.1	19.6	9.8	6.3	6.2	2.9	5.2	2.8	1.6	1.0	1.9	1.9	5.7	23.2	18.2	15.2	36.4	16.3
1983	24.6	19.8	13.2	19.2	15.1	11.6	14.3	8.8	14.0	19.4	12.0	3.7	3.3	7.7	3.0	2.1	2.5	4.1	4.4	12.5	19.0	32.2	16.5	21.2	12.7
1984	38.2	20.1	25.2	34.3	48.6	20.2	17.6	52.7	45.3	21.8	13.8	8.0	18.4	19.6	15.7	24.6	33.7	24.3	23.1	12.0	11.4	12.4	11.6	12.6	23.6
1985	21.5	14.7	51.0	20.5	63.3	6.7	11.1	25.2	20.0	16.8	6.4	6.4	7.8	17.9	11.8	8.3	20.7	12.0	9.2	15.2	28.0	11.0	49.5	12.9	19.5
1986	24.6	76.7	36.4	21.3	30.6	29.7	31.3	42.8	29.0	17.4	36.0	14.7	5.0	6.4	5.9	6.6	10.4	4.9	9.6	14.9	10.2	21.2	46.1	24.1	23.2
1987	25.0	33.1	41.2	33.9	27.4	26.5	32.3	33.4	40.8	22.6	45.0	19.1	25.5	14.2	14.5	13.9	9.6	8.8	9.2	9.2	12.4	12.6	16.8	12.6	22.5
1988	29.0	44.1	50.7	38.7	41.3	67.0	67.3	36.8	21.4	23.4	14.2	4.8	8.6	12.0	11.2	10.7	11.4	11.1	8.8	14.6	14.7	17.2	26.7	33.1	25.8
1989	14.7	22.4	37.2	95.7	30.9	13.4	13.8	12.1	22.7	19.3	13.7	9.4	10.8	8.5	12.6	13.3	18.8	12.4	12.1	14.3	18.5	14.5	21.2	27.9	20.4
1990	81.5	106.9	27.0	21.3	35.2	27.4	20.9	20.3	22.1	19.3	22.4	13.4	23.6	32.5	27.1	22.5	23.8	35.9	21.1	23.1	22.4	15.3	6.4	20.2	28.8
1991	7.6	12.2	43.0	44.3	11.0	25.7	19.7	4.4	6.0	2.9	2.5	3.7	3.3	2.9	2.5	2.3	4.8	3.2	6.3	7.9	6.5	8.5	13.4	14.4	10.8
1992	20.9	18.1	29.2	14.4	11.5	27.8	16.1	36.4	24.3	16.9	13.2	11.3	6.3	9.1	8.0	11.4	10.6	8.8	30.9	19.4	31.3	23.6	21.6	11.7	18.0
1993	32.3	59.2	51.0	29.9	23.2	24.5	22.1	44.4	55.6	30.3	28.0	26.5	14.7	14.1	7.9	65.9	45.2	26.8	16.3	37.4	24.5	32.7	23.4	45.4	32.6
Mean	36.7	43.2	37.8	31.4	33.7	27.6	25.5	30.1	27.8	20.4	18.5	13.0	11.7	13.5	12.1	14.8	16.9	15.5	13.6	16.8	20.2	21.1	22.3	26.6	23.0
Min	7.6	12.2	13.2	14.4	11.0	6.7	11.1	4.4	6.0	2.9	2.5	3.7	2.9	2.7	2.5	1.6	1.0	1.4	0.8	3.6	6.5	5.4	6.4	10.4	10.8
Max	81.5	106.9	86.7	95.7	63.3	67.0	67.3	75.8	63.5	35.5	45.0	38.0	25.5	43.0	31.0	65.9	50.2	39.6	30.9	42.0	40.1	46.3	50.3	72.3	32.6

(2) Pasir Kopo dam

(unit:cu.m/s)

Year	Jan.		Feb.		Mar.		Apr.		May		Jun.		Jul.		Aug.		Sep.		Oct.		Nov.		Dec.		Annual
	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	Mean
1970	8.5	10.4	35.2	15.3	24.9	29.5	17.0	40.1	19.2	18.8	18.0	17.0	8.6	14.5	3.9	4.3	4.2	9.4	6.6	6.3	7.1	22.3	14.8	38.3	16.4
1971	18.3	27.3	45.9	20.4	27.7	15.6	12.6	10.9	8.0	7.9	8.2	8.0	11.8	4.1	6.7	13.1	7.8	5.2	6.5	22.2	21.2	9.9	11.3	11.9	14.3
1972	40.4	27.0	20.8	14.8	31.6	17.1	7.5	13.3	14.0	12.8	3.5	2.8	2.1	1.4	2.2	3.2	0.9	0.7	0.4	1.9	4.1	4.7	7.3	8.7	10.1
1973	22.0	21.0	14.0	14.6	14.2	20.9	21.6	23.0	33.6	15.7	20.0	7.3	6.6	5.9	8.2	8.2	13.1	19.1	10.7	17.2	10.5	15.5	13.6	20.0	15.7
1974	42.5	7.5	18.2	18.7	23.8	12.7	15.7	14.0	18.1	14.9	6.4	8.6	11.2	5.9	11.0	12.4	26.6	21.0	15.6	9.4	7.3	13.4	15.8	7.2	14.9
1975	14.1	12.5	21.6	20.1	13.0	14.3	7.8	6.5	6.1	11.9	7.3	3.6	4.6	11.2	13.7	9.8	18.2	16.7	8.1	11.1	21.1	11.7	26.6	24.8	13.2
1976	28.3	42.0	14.8	11.2	19.9	13.4	8.1	16.4	11.1	4.2	6.9	2.8	3.7	2.4	2.6	3.7	1.9	1.9	8.5	3.0	7.2	12.5	7.6	5.5	10.0
1977	10.2	25.2	14.9	13.7	24.9	15.6	21.0	16.4	21.1	13.5	10.4	8.9	4.8	3.0	2.0	2.1	1.5	2.5	2.3	2.3	4.4	2.9	5.0	6.9	9.8
1978	10.4	35.9	12.5	10.4	19.6	16.4	9.6	12.6	11.7	7.6	8.8	9.5	7.5	8.2	9.2	12.3	8.3	10.7	6.3	13.4	15.2	9.2	9.6	10.4	11.9
1979	12.9	21.1	18.9	20.1	17.9	13.5	24.0	18.5	9.5	7.0	7.6	2.9	6.7	4.9	3.7	3.2	3.9	4.5	4.8	3.8	11.9	13.0	7.9	12.8	10.6
1980	26.3	32.1	17.6	13.2	10.2	8.5	16.3	13.3	15.5	10.3	6.3	5.9	5.5	7.3	16.4	8.0	11.7	13.4	9.8	9.1	11.3	13.0	11.4	23.2	13.2
1981	25.9	29.5	18.0	19.6	13.6	21.5	10.6	18.8	15.4	18.4	18.7	20.1	6.7	22.7	9.1	10.8	15.2	10.2	12.2	15.8	17.5	24.5	10.4	24.0	17.1
1982	37.3	30.6	13.1	9.2	8.3	3.6	10.6	11.2	10.4	5.2	3.4	3.3	1.6	2.7	1.5	0.9	0.5	1.0	1.0	3.0	12.3	9.6	8.0	19.3	8.7
1983	13.0	10.5	7.0	10.2	8.0	6.1	7.6	4.7	7.4	10.3	6.4	2.0	1.7	4.1	1.6	1.1	1.3	2.2	2.3	6.6	10.0	17.0	8.7	11.2	6.7
1984	20.2	10.6	13.3	18.2	25.7	10.7	9.3	27.9	24.0	11.5	7.3	4.3	9.8	10.4	8.3	13.0	17.9	12.9	12.2	6.4	6.0	6.6	6.1	6.6	12.5
1985	11.4	7.8	27.0	10.9	33.5	3.5	5.9	13.4	10.6	8.9	3.4	3.4	4.1	9.5	6.2	4.4	10.9	6.4	4.9	8.0	14.8	5.8	26.2	6.8	10.3
1986	13.0	40.6	19.3	11.3	16.2	15.7	16.6	22.6	15.4	9.2	19.1	7.8	2.7	3.4	3.1	3.5	5.5	2.6	5.1	7.9	5.4	11.2	24.4	12.8	12.3
1987	13.2	17.5	21.8	17.9	14.5	14.0	17.1	17.7	21.6	12.0	23.8	10.1	13.5	7.5	7.7	7.4	5.1	4.7	4.9	4.9	6.6	6.7	8.9	6.7	11.9
1988	15.3	23.4	26.9	20.5	21.9	35.5	35.6	19.5	11.4	12.4	7.5	2.6	4.6	6.4	5.9	5.7	6.0	5.9	4.7	7.7	7.8	9.1	14.1	17.5	13.7
1989	7.8	11.8	19.7	50.6	16.4	7.1	7.3	6.4	12.0	10.2	7.2	5.0	5.7	4.5	6.7	7.1	10.0	6.6	6.4	7.5	9.8	7.7	11.2	14.8	10.8
1990	43.1	56.6	14.3	11.3	18.6	14.5	11.1	10.7	11.7	10.2	11.9	7.1	12.5	17.2	14.4	11.9	12.6	19.0	11.2	12.2	11.9	8.1	3.4	10.7	15.3
1991	4.0	6.5	22.8	23.5	5.8	13.6	10.5	2.3	3.2	1.5	1.3	1.9	1.7	1.5	1.3	1.2	2.6	1.7	3.3	4.2	3.4	4.5	7.1	7.6	5.7
1992	11.0	9.6	15.4	7.6	6.1	14.7	8.5	19.3	12.9	9.0	7.0	6.0	3.3	4.8	4.3	6.0	5.6	4.6	16.4	10.3	16.6	12.5	11.4	6.2	9.5
1993	17.1	31.3	27.0	15.8	12.3	13.0	11.7	23.5	29.4	16.0	14.8	14.1	7.8	7.5	4.2	34.9	23.9	14.2	8.7	19.8	13.0	17.3	12.4	24.0	17.2
Mean	19.4	22.8	20.0	16.6	17.9	14.6	13.5	16.0	14.7	10.8	9.8	6.9	6.2	7.1	6.4	7.8	9.0	8.2	7.2	8.9	10.7	11.2	11.8	14.1	12.2
Min	4.0	6.5	7.0	7.6	5.8	3.5	5.9	2.3	3.2	1.5	1.3	1.9	1.6	1.4	1.3	0.9	0.5	0.7	0.4	1.9	3.4	2.9	3.4	5.5	5.7
Max	43.1	56.6	45.9	50.6	33.5	35.5	35.6	40.1	33.6	18.8	23.8	20.1	13.5	22.7	16.4	34.9	26.6	21.0	16.4	22.2	21.2	24.5	26.6	38.3	17.2

Table 22 HALF-MONTHLY MEAN DISCHARGE AT DAMSITES (2/2)

(3) Cilawang dam

(unit:cu.m/s)

Year	Jan.		Feb.		Mar.		Apr.		May		Jun.		Jul.		Aug.		Sep.		Oct.		Nov.		Dec.		Annual
	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	Mean
1970	4.7	9.0	15.0	6.8	7.5	6.3	8.2	4.5	15.9	8.6	6.9	4.8	1.4	3.2	1.4	2.9	5.0	6.3	2.2	2.3	7.0	10.7	2.3	6.3	6.2
1971	5.5	7.5	21.2	8.0	7.3	7.7	8.4	9.2	5.2	4.9	5.9	5.3	6.0	2.3	3.7	5.0	2.2	1.7	3.0	13.0	4.2	4.4	6.1	5.7	6.4
1972	15.6	22.1	12.8	6.3	18.6	10.4	6.3	10.4	10.8	9.3	4.6	1.3	0.7	0.7	3.0	1.8	0.5	0.4	0.4	2.0	3.2	4.4	6.1	9.6	6.7
1973	10.1	7.2	17.2	11.6	9.7	9.2	14.6	16.7	10.3	10.3	8.2	6.2	4.3	5.1	4.3	6.5	11.4	13.9	7.5	9.4	7.3	5.0	6.8	7.5	9.2
1974	24.9	5.8	9.7	10.1	9.6	4.8	8.8	9.2	13.0	8.7	4.1	6.3	5.5	4.0	7.8	6.3	18.8	15.3	8.6	6.7	7.5	5.1	3.3	3.6	8.6
1975	4.2	10.8	9.7	10.4	7.3	5.2	9.9	10.2	13.1	10.3	6.4	2.0	2.8	6.2	10.6	5.2	10.3	9.7	7.4	5.8	8.7	4.9	4.6	4.5	7.5
1976	17.4	33.0	10.7	7.0	12.9	5.0	6.8	8.6	9.7	2.2	4.6	2.1	1.6	1.0	2.5	2.8	2.3	1.5	9.4	3.0	5.4	8.3	3.2	3.9	6.9
1977	8.0	18.1	8.6	9.2	11.7	8.6	14.6	11.5	19.9	8.2	8.7	4.9	4.2	5.4	4.4	1.4	1.3	3.3	1.3	3.3	6.9	2.3	4.3	11.1	7.6
1978	9.8	13.0	5.3	3.7	15.3	5.2	4.4	8.1	4.4	3.3	2.6	5.4	3.4	4.4	3.2	6.1	8.8	7.2	5.3	7.8	7.1	4.0	4.5	6.6	6.2
1979	5.9	13.7	8.8	5.9	9.1	7.4	10.7	8.5	4.9	5.2	7.0	2.5	6.9	3.8	6.4	2.6	2.5	4.5	6.6	4.9	19.3	9.9	4.3	6.9	7.0
1980	12.9	15.7	8.0	11.1	7.1	5.1	7.2	7.5	11.5	9.3	3.9	3.6	3.4	4.5	10.2	4.9	10.6	5.6	4.8	7.3	8.0	9.0	6.5	7.6	7.7
1981	10.1	16.9	7.4	6.6	9.8	11.8	8.4	13.4	9.6	11.4	11.6	12.5	4.2	14.1	5.7	6.7	9.4	6.3	7.6	9.8	5.0	6.5	1.7	19.2	9.4
1982	15.1	15.1	5.2	3.2	2.5	2.0	6.1	8.1	7.0	6.4	3.7	2.1	1.3	2.1	1.0	0.6	0.3	0.5	1.3	1.3	3.8	5.2	1.8	5.2	4.2
1983	5.7	5.5	7.8	5.8	6.0	5.8	8.9	4.4	7.6	6.9	4.4	1.8	2.5	2.8	2.5	0.9	1.6	3.2	2.3	8.0	12.3	4.3	3.1	5.3	5.0
1984	12.2	5.4	7.8	8.5	10.0	6.9	6.0	13.3	13.5	6.8	7.9	2.2	3.4	5.0	5.3	4.9	10.0	6.8	4.2	2.8	7.3	7.0	6.5	3.8	7.0
1985	7.1	6.5	14.1	4.9	8.6	2.5	4.5	4.7	7.2	7.5	4.6	2.7	4.3	7.1	4.7	4.4	7.1	4.0	3.6	3.6	8.8	3.4	5.4	3.2	5.6
1986	8.7	13.9	8.8	3.3	9.5	8.4	14.3	8.2	12.4	5.8	5.7	3.7	2.8	3.7	5.0	2.6	3.0	7.6	2.9	2.9	6.6	5.0	11.2	6.6	6.8
1987	7.8	8.7	8.1	5.0	12.3	8.5	10.5	6.0	9.1	4.2	5.8	2.9	4.5	2.3	1.5	0.6	1.0	0.9	1.3	1.4	2.9	1.8	2.9	2.4	4.7
1988	2.5	5.4	9.0	3.5	10.8	9.4	7.7	8.1	10.5	7.4	3.1	1.2	1.3	1.6	3.4	1.0	2.1	3.7	2.5	3.0	2.9	1.4	1.4	4.4	4.5
1989	6.7	8.5	13.6	12.3	3.6	2.6	4.0	2.2	9.0	7.0	4.2	2.1	1.7	1.5	1.4	3.5	4.1	1.8	1.4	2.5	3.5	1.2	2.9	4.5	4.4
1990	8.9	14.3	5.3	10.0	4.7	4.8	4.7	3.7	8.1	6.1	4.5	2.7	2.4	4.4	7.3	3.9	8.0	3.9	3.7	4.0	4.5	3.1	3.9	6.0	5.5
1991	6.2	6.1	10.4	11.2	6.7	8.5	9.5	3.9	5.8	1.8	1.1	1.0	0.8	0.8	1.2	0.4	0.5	0.4	0.3	1.6	2.7	2.7	4.3	5.2	3.9
1992	4.0	4.0	5.8	3.6	2.6	9.8	3.9	4.8	8.3	2.0	4.7	2.5	3.3	2.7	2.2	2.6	4.8	2.9	10.5	6.0	7.2	8.6	11.7	5.4	5.2
1993	9.2	12.8	16.2	7.0	7.5	7.6	5.8	9.4	10.7	11.1	8.1	10.9	4.6	4.8	3.6	13.0	11.7	7.8	7.5	8.8	6.3	13.4	10.3	17.3	9.4
Mean	9.3	11.6	10.3	7.3	8.8	6.8	8.1	8.1	9.9	6.9	5.5	3.9	3.2	3.9	4.3	3.8	5.7	5.0	4.4	5.1	6.6	5.5	5.0	6.7	6.5
Min	2.5	4.0	5.2	3.2	2.5	2.0	3.9	2.2	4.4	1.8	1.1	1.0	0.7	0.7	1.0	0.4	0.3	0.4	0.3	1.3	2.7	1.2	1.4	2.4	3.9
Max	24.9	33.0	21.2	12.3	18.6	11.8	14.6	16.7	19.9	11.4	11.6	12.5	6.9	14.1	10.6	13.0	18.8	15.3	10.5	13.0	19.3	13.4	11.7	19.2	9.4

(4) Tanjung dam

(unit:cu.m/s)

Year	Jan.		Feb.		Mar.		Apr.		May		Jun.		Jul.		Aug.		Sep.		Oct.		Nov.		Dec.		Annual
	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	Mean
1970	14.6	28.0	46.5	21.1	23.3	19.6	25.4	14.1	49.3	26.8	21.6	15.0	4.2	10.0	4.5	9.0	15.4	19.5	7.0	7.3	21.7	33.1	7.2	19.6	19.3
1971	17.0	23.4	66.0	24.8	22.6	24.1	26.0	28.6	16.2	15.3	18.4	16.4	18.8	7.2	11.4	15.5	6.8	5.3	9.5	40.5	13.1	13.5	18.9	17.8	19.9
1972	48.4	68.8	39.6	19.7	57.7	32.4	19.7	32.3	33.5	28.8	14.2	4.2	2.3	2.1	9.4	5.5	1.6	1.4	1.4	6.3	10.0	13.6	19.1	29.7	20.9
1973	31.5	22.4	53.4	36.1	30.2	28.6	45.5	52.1	31.9	32.0	25.6	19.4	13.5	15.8	13.4	20.1	35.5	43.1	23.4	29.2	22.8	15.6	21.3	23.2	28.6
1974	77.4	18.2	30.2	31.4	29.9	15.0	27.3	28.7	40.6	27.1	12.7	19.6	17.0	12.6	24.1	19.7	58.6	47.5	26.8	20.9	23.2	15.8	10.2	11.3	26.9
1975	13.2	33.6	30.2	32.4	22.6	16.1	30.7	31.6	40.7	31.9	20.0	6.1	8.7	19.3	33.0	16.3	32.1	30.2	22.9	18.0	27.2	15.3	14.4	13.9	23.4
1976	54.1	102.7	33.2	21.7	40.0	15.6	21.2	26.8	30.1	7.0	14.4	6.4	5.1	3.1	7.7	8.7	7.2	4.5	29.1	9.4	16.7	26.0	10.1	12.2	21.4
1977	24.8	56.3	26.7	28.5	36.4	26.8	45.5	35.6	62.0	25.4	27.1	15.3	12.9	16.7	13.6	4.4	4.0	10.3	4.0	10.3	21.3	7.2	13.4	34.4	23.5
1978	30.5	40.4	16.3	11.5	47.6	16.1	13.6	25.2	13.6	10.4	8.2	16.9	10.7	13.8	9.9	18.9	27.4	22.5	16.6	24.2	22.1	12.5	14.0	20.7	19.3
1979	18.3	42.4	27.4	18.4	28.4	22.9	33.2	26.4	15.1	16.1	21.6	7.8	21.4	11.9	19.9	8.0	7.8	13.9	20.5	15.2	60.0	30.6	13.3	21.6	21.8
1980	40.1	48.8	25.0	34.5	22.0	15.9	22.5	23.4	35.7	29.1	12.1	11.3	10.5	14.0	31.5	15.3	33.0	17.4	14.9	22.7	24.8	27.9	20.1	23.5	24.0
1981	31.4	52.5	23.0	20.6	30.6	36.7	26.2	41.7	29.7	35.4	36.0	38.7	12.8	43.7	17.6	20.8	29.3	19.6	23.5	30.3	15.4	20.1	5.1	59.6	29.2
1982	47.0	47.0	16.1	10.0	7.9	6.2	18.8	25.2	21.9	20.0	11.5	6.5	4.2	6.6	3.2	1.8	0.9	1.5	4.1	4.1	11.7	16.2	5.5	16.2	13.1
1983	17.8	17.1	24.2	18.1	18.7	18.2	27.8	13.7	23.8	21.5	13.7	5.5	7.9	8.7	7.7	2.7	4.9	9.9	7.1	25.0	38.2	13.3	9.8	16.4	15.5
1984	37.9	16.7	24.1	26.3	31.1	21.4	18.8	41.3	41.9	21.0	24.6	6.8	10.5	15.6	16.4	15.1	31.0	21.0	13.0	8.8	22.7	21.6	20.3	11.9	21.7
1985	22.0	20.3	44.0	15.4	26.7	7.8	13.8	14.5	22.5	23.2	14.4	8.4	13.5	22.2	14.5	13.5	22.1	12.5	11.3	11.1	27.5	10.5	16.7	9.9	17.4
1986	27.0	43.4	27.3	10.3	29.7	26.2	44.5	25.5	38.6	18.0	17.6	11.6	8.7	11.6	15.6	8.1	9.4	23.5	9.1	8.9	20.4	15.6	34.9	20.5	21.1
1987	24.2	26.9	25.2	15.6	38.2	26.4	32.5	18.6	28.2	13.1	17.9	8.9	14.0	7.2	4.6	1.8	3.1	2.7	4.0	4.4	9.0	5.6	9.1	7.5	14.5
1988	7.9	16.9	28.0	10.9	33.5	29.1	23.9	25.1	32.7	23.1	9.5	3.9	4.2	5.0	10.4	3.1	6.4	11.6	7.7	9.4	9.0	4.5	4.5	13.8	13.9
1989	20.9	26.3	42.2	38.3	11.1	8.1	12.6	6.7	28.1	21.7	12.9	6.4	5.2	4.6	4.2	10.9	12.7	5.4	4.5	7.7	11.0	3.8	8.9	14.0	13.7
1990	27.6	44.4	16.4	30.9	14.7	15.0	14.7	11.5	25.1	19.0	14.0	8.4	7.6	13.7	22.7	12.2	24.9	12.3	11.6	12.6	14.0	9.6	12.3	18.5	17.2
1991	19.3	19.0	32.2	34.9	21.0	26.3	29.7	12.0	18.2	5.6	3.3	3.2	2.6	2.6	3.6	1.1	1.7	1.2	0.9	5.0	8.3	8.4	13.4	16.1	12.1
1992	12.6	12.4	18.1	11.2	7.9	30.5	12.0	14.8	25.8	6.1	14.5	7.8	10.2	8.3	6.8	8.1	15.0	9.0	32.6	18.7	22.5	26.7	36.2	16.9	16.0
1993	28.6	39.7	50.4	21.6	23.4	23.8	18.0	29.2	33.3	34.6	25.1	33.9	14.4	14.9	11.2	40.5	36.5	24.4	23.2	27.3	19.5	41.6	31.9	53.9	29.2
Mean	28.9	36.2	31.9	22.7	27.3	21.2	25.2	25.2	30.8	21.3	17.1	12.0	10.0	12.1	13.2	11.7	17.8	15.4	13.7	15.7	20.5	17.0	15.4	21.0	20.1
Min	7.9	12.4	16.1	10.0	7.9	6.2	12.0	6.7	13.6	5.6	3.3	3.2	2.3	2.1	3.2	1.1	0.9	1.2	0.9	4.1	8.3	3.8	4.5	7.5	12.1
Max	77.4	102.7	66.0	38.3	57.7	36.7	45.5	52.1	62.0	35.4	36.0	38.7	21.4	43.7	33.0	40.5	58.6	47.5	32.6	40.5	60.0	41.6	36.2	59.6	29.2

FIGURES

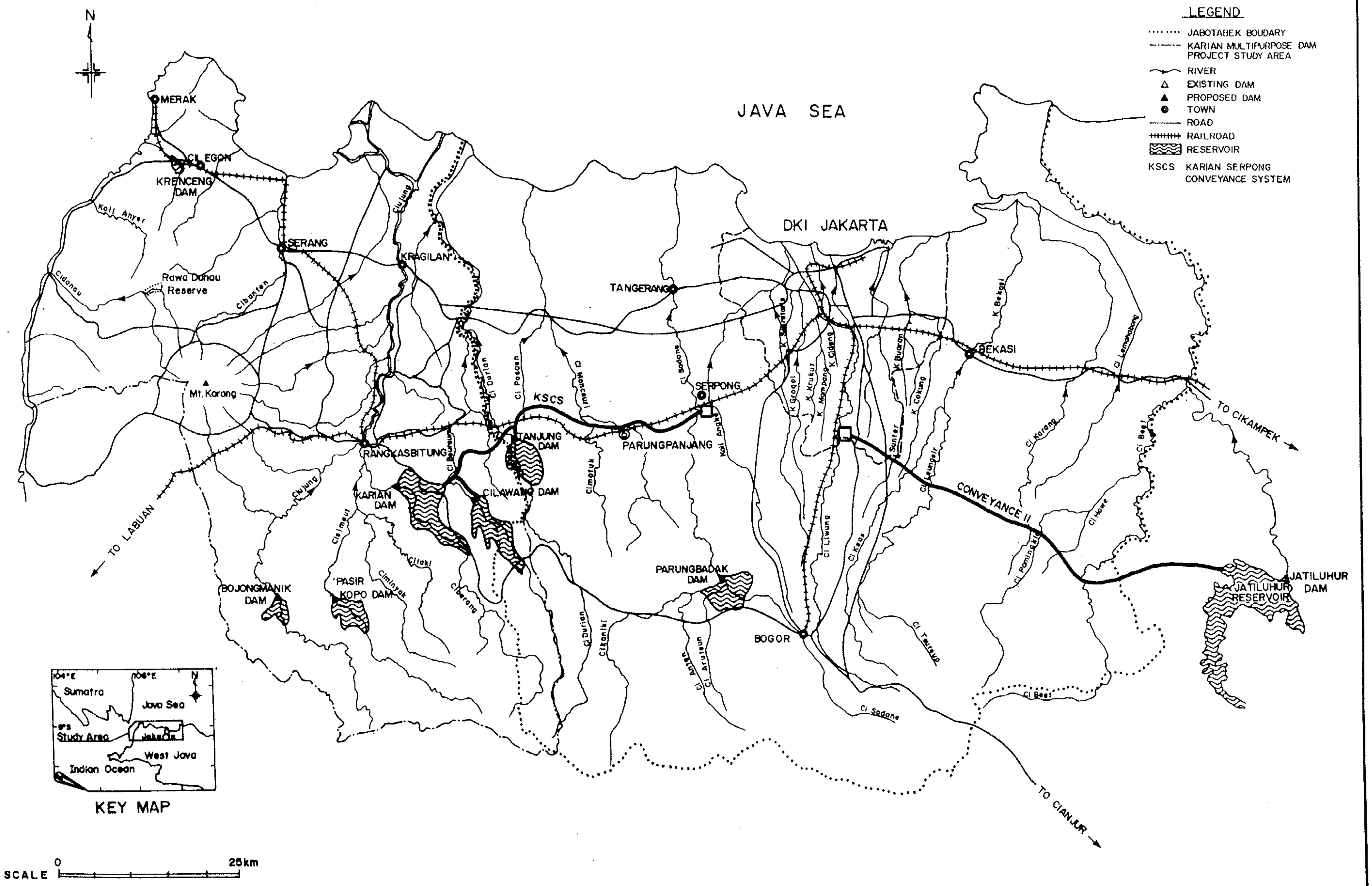


Figure 1 MAJOR RIVER SYSTEM IN THE STUDY AREA