REPUBLIC OF INDONESIA

THE ACADEMIC DEVELOPMENT OF THE GRADUATE PROGRAM AT THE FACULTY OF AGRICULTURAL ENGINEERING AND TECHNOLOGY, INSTITUT PERTANIAN BOGOR

DETAILED DESIGN REPORT ON MODEL INFRASTRUCTURE IMPROVEMENT WORKS

APPENDIX C
TECHNICAL DATA

APRIL, 1990

JAPAN INTERNATIONAL COOPERATION AGENCY

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Appendix C. Technical Data

1. Climate
2. Hydrology
3. Soil Mechanics
4. Irrigation & Drainage
5. Bill of Quantities
6. Labour Cost and Material Cost
7. Unit Price
8. General Plan of the Agro-civil Engineering Tests and Farm Machinery Tests Fields
9. Measurement Plot
10. Pump Station at the Cihideung River
11. Workshop / Workstation

Appendix C1 Climate

1. General

The project site is located at the outskirts of Bogor city which is about 60 km south of Jakarta.

It is laid on the alluvial fan developed from the northern slope of the Salak volcanic mountain (EL. 2,211 m).

Its geographical position is 6°34'S, 106°43' E and the elevation is about 200 m above see level.

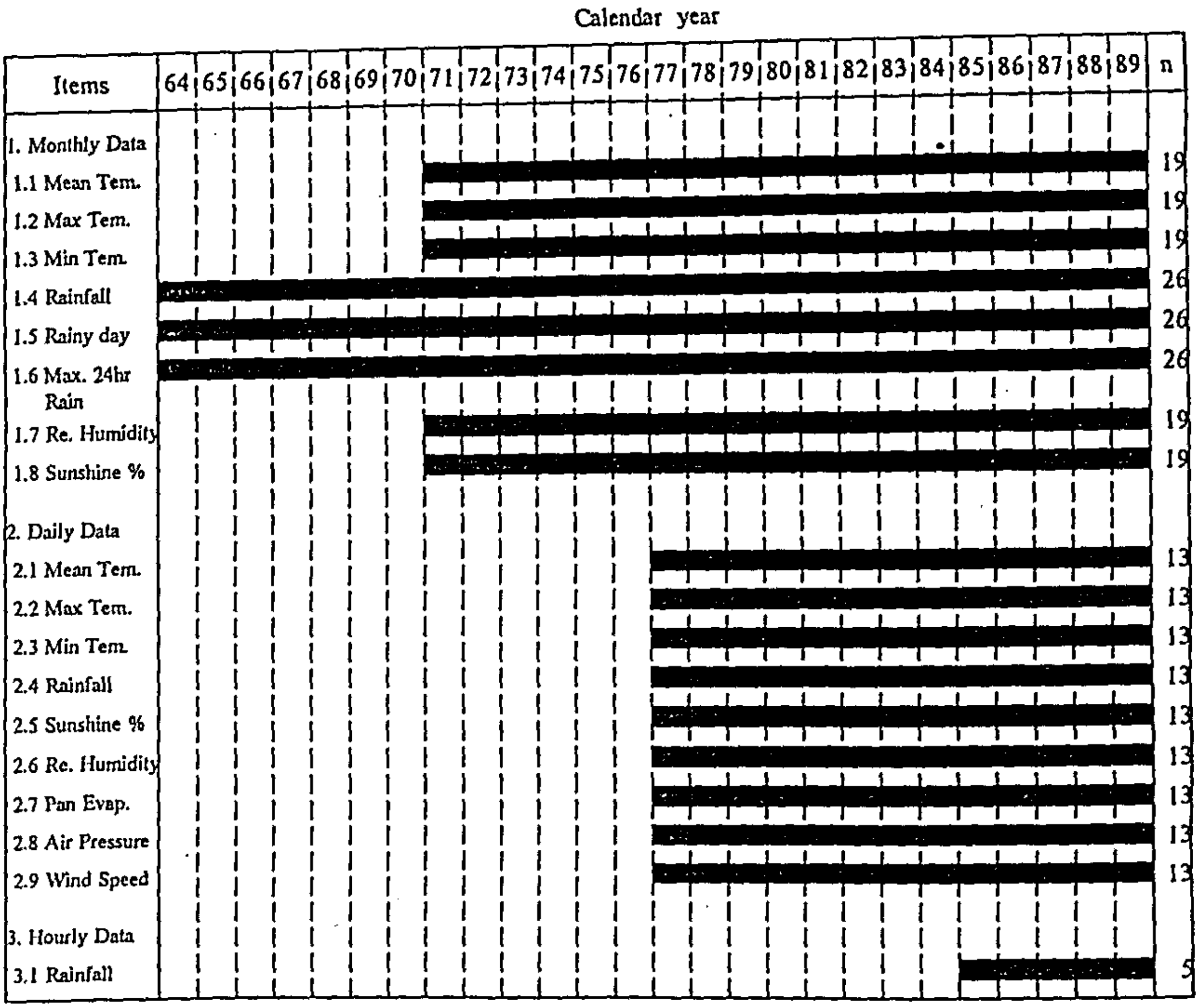
The climate belongs to the tropical monsoonal pattern. The Salak volcanic mountain, along with other mountains to the east, influences the rainfall distribution in the vicinity of Bogor city.

The Darmaga rainfall observation station was established in January, 1964 by the Meteorology and Geophysics Board of the Government (BMG) and in 1976 it is reorganized as the 1st class Climatological Station Darmaga Bogor (CSDB) with installation of additional climate measurement instrument. Since then, the climate observation is operating by the said BMO. The main office is located at Jalan Raya Darmaga 6.5 km, but its observation station is placed on the cleared land between the swamp (Rawadjaha) and the rubber forest in the north-east about 2.5 km of the project site. It can be accessed through Jalan Sindangbarang from Jalan Raya Sindang Barang or through village road from the Darmaga Campus IPB. Its geographic position is announced to be 6°30'S, 106°45'E, EL. 250 m, however, it can be read as 6°33'S, 106°45'E, EL. 190 m from the topographic map with scale of 1/50,000.

The area of the CSDB is 250 m^2 with 50 m length and 50 m width. The observing meteorological elements are air temperature, humidity, air pressure, sunshine, radiation, evaporation, wind speed and soil temperature.

2. Collected Data

The valuable observation records have been collected during the field survey period for the study as follows :



3. Evaluation, Tabulation and Analysis

All the collected data have been evaluated, tabulated and analyzed as shown in the following tables and a figure.

Table C1-1 Monthly Mean temperature at the Climatological Station of Darmaga Bogor (CSDB)

C1-2 Monthly Mean Maximum Temperature at the Climatological Station of Darmaga Bogor (CSDB)

C1-3 Monthly Mean Minimum Temperature at the Climatological Station of Darmaga Bogor (CSDB)

C1-4 Monthly Maximum Temperature at the Climatological Station of Darmaga Bogor (CSDB)

C1-5 Monthly Minimum Temperature at the Climatological Station of Darmaga Bogor (CSDB)

C1-6 Monthly Mean Relative Humidity (%) at the Climatological Station of Darmaga Bogor (CSDB)

C1-7 Monthly Mean and Maximum of Pan Evaporation at the Climatological Station of Darmaga Bogor (CSDB)

C1-8 Monthly Mean of Sunshine Percentage between 8:00 and 16:00 at the Climatological Station of Darmaga Bogor (CSDB)

C1-9 Monthly Mean of Radiation Intensity (Kcal/cm^2/day) at the Climatological Station of Darmaga Bogor (CSDB)

C1-10 Monthly Total Rainfall at the Climatological Station of Darmaga Bogor (CSDB)

C1-11 Number of Rainy Days at the CSDB

C1-12 The Highest 24 hours Rainfall in the Month at the CSDB

C1-13 Probability Calculation on the Highest Rainfall Data at the CSDB by Gumble Method, Data Period 26 years from 1964 to 1989

(1) January	(7) July	(13) Annual Maximum
(2) February	(8) August	
(3) March	(9) September	
(4) April	(10) October	
(5) May	(11) November	
(6) June	(12) December	

C1-14 The Highest Rainfall (mm) for the Short Duration in the Month and Annual at the CSDB

No. 1 1985, 1986
No. 2 1987, 1988
No. 3 1989

C1-15 Calculation of Probability of Exceedance on the Data of the Short Duration Rainfall Intensity (mm/hr)

No. 1 5 minutes, 10 minutes and 15 minutes
No. 2 30 minutes,45 minutes and 60 minutes
No. 3 2 hours, 3 hours and 6 hours
No. 4 12 hours and 24 hours

C1-16 The Longest Dry Consecutive Days During one year at the CSDB

Table C1-1 Monthly Mean Temperature At The Climatological Station of Darmaga Bogor (CSDB)

Latitude : 06°30'S Longitude : 106°45'E Altitude : 250m.

YEAR	Temperature in degree centigrade (°C)											
	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
1977	24.5	24.6	24.7	25.6	25.7	24.9	25.0	25.0	25.2	26.7	25.8	25.3
1978	24.7	25.1	25.3	25.3	25.7	25.2	24.8	25.1	25.3	25.1	25.6	24.9
1979	25.0	25.0	25.3	25.5	25.7	25.3	24.9	25.3	25.6	25.8	25.8	25.1
1980	24.7	24.8	24.8	25.6	26.0	26.2	25.3	24.8	25.8	25.4	25.5	24.9
1981	24.1	24.8	25.5	24.9	25.8	25.6	25.1	25.3	25.8	26.1	25.6	25.6
1982	24.1	24.8	25.1	25.3	25.9	25.4	25.0	24.9	25.6	26.0	26.1	25.8
1983	25.3	25.6	25.9	26.2	26.0	26.1	25.5	25.8	26.2	25.8	25.4	25.3
1984	24.7	24.6	24.9	25.3	24.9	25.3	25.0	25.0	24.7	25.8	25.5	24.9
1985	24.9	25.5	25.6	25.7	25.9	25.4	24.7	25.3	25.5	25.5	25.8	25.6
1986	24.7	24.6	24.8	25.7	26.2	25.7	25.1	25.0	25.1	25.8	25.0	25.7
1987	24.9	24.6	25.5	26.1	25.7	26.9	25.7	25.7	26.4	26.6	26.2	25.5
1988	25.7	25.4	25.5	26.3	26.1	25.4	25.7	25.6	26.1	26.0	25.8	24.7
1989	25.3	24.4	25.0	25.8	26.4	26.8	25.2	25.7	25.6	25.7	25.9	25.4
Mean	24.8	24.9	25.2	25.6	25.8	25.7	25.2	25.3	25.6	25.9	25.7	25.3

Table C1-2 Monthly Mean Maximum Temperature At The Climatological Station of Darmaga Bogor (CSDB)

Latitude : 06°30'S Longitude : 106°45'E Altitude : 250m.

YEAR	Temperature in degree centigrade (°C)											
	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
1977	30.3	29.8	30.7	32.4	32.3	31.0	32.3	32.6	32.2	34.5	32.8	31.6
1978	30.3	31.1	31.5	32.3	32.2	31.7	30.7	30.0	30.8	31.2	31.6	29.6
1979	29.3	31.0	30.5	31.2	31.5	30.8	31.2	31.5	31.9	32.3	31.2	29.8
1980	28.5	29.7	31.3	31.6	31.6	31.7	31.4	31.0	31.7	31.6	31.4	29.8
1981	27.7	29.6	30.7	31.3	31.3	31.3	30.4	30.8	31.8	32.0	30.4	29.9
1982	27.8	29.6	30.7	30.6	31.4	30.9	31.1	31.8	33.5	33.2	32.9	31.3
1983	29.6	30.9	31.2	31.7	31.2	32.1	31.5	32.5	33.0	31.9	30.4	30.4
1984	28.7	28.9	29.9	30.5	30.7	31.0	30.7	30.9	30.4	31.5	31.1	29.4
1985	29.5	30.5	30.9	30.7	31.3	30.6	29.9	31.3	31.3	31.2	31.1	30.8
1986	28.2	29.7	30.0	31.2	31.8	31.3	30.9	30.8	30.7	31.2	30.6	30.9
1987	28.4	28.7	31.0	31.3	31.4	31.3	31.5	32.6	33.0	32.8	31.9	29.7
1988	30.2	30.3	30.6	31.6	31.3	30.9	31.6	31.5	32.8	31.6	30.8	29.0
1989	29.7	28.0	30.1	31.4	30.8	30.7	31.3	31.5	31.7	31.7	30.8	29.8
Mean	29.1	29.8	30.7	31.4	31.4	31.2	31.1	31.4	31.9	32.0	31.3	30.2

Table C1-3 Monthly Mean Minimum Temperature At The Climatological Station of Darmaga Bogor (CSDB)

Latitude : 06°30'S Longitude : 106°45'E Altitude : 250m.

YEAR	Temperature in degree centigrade (°C)											
	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
1977	21.2	21.6	21.5	22.1	22.2	21.5	20.6	21.0	20.3	21.2	21.6	21.7
1978	21.8	21.8	21.8	21.7	22.1	21.8	21.1	21.1	21.2	21.2	21.2	21.9
1979	21.9	22.0	22.2	22.2	21.7	21.3	20.1	20.1	21.1	21.4	22.2	21.7
1980	22.2	21.7	21.1	22.1	22.1	21.4	21.2	20.6	21.7	21.2	21.6	21.7
1981	21.2	21.2	21.8	21.9	25.8	21.7	21.5	21.6	21.7	21.8	21.8	21.7
1982	21.5	21.5	21.7	22.2	21.8	21.4	20.4	19.5	19.8	20.8	21.6	22.2
1983	22.3	22.3	22.6	22.6	22.7	21.1	20.9	20.8	21.1	21.6	21.9	21.2
1984	21.7	21.7	21.7	21.9	21.6	20.9	25.0	21.0	21.1	21.7	21.8	21.3
1985	21.7	21.8	21.8	22.5	22.6	21.8	21.1	20.2	21.3	21.6	21.7	21.5
1986	22.1	21.5	22.0	22.6	22.4	22.1	20.9	20.8	21.5	22.1	22.0	22.3
1987	22.5	21.9	22.4	22.8	22.1	22.4	21.4	20.7	21.6	22.1	21.7	22.4
1988	22.7	22.2	22.7	22.3	22.8	21.6	21.4	21.5	21.4	22.2	21.4	21.4
1989	22.3	21.9	21.7	22.1	22.4	22.3	21.2	21.5	21.4	21.8	22.1	22.2
Mean	21.9	21.8	21.9	22.2	22.5	21.6	21.3	20.8	21.2	21.6	21.7	21.8

Table C1-4 Monthly Maximum Temperature At The Climatological Station of Darmaga Bogor (CSDB)

Latitude : 06°30'S Longitude : 106°45'E Altitude : 250m.

YEAR	Temperature in degree centigrade (°C)											
	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
1977	33.8	31.8	33.2	33.8	33.3	32.7	33.9	34.0	34.8	35.9	34.4	33.4
1978	32.9	33.3	33.8	33.2	33.2	32.9	32.8	32.0	32.9	32.8	33.7	31.7
1979	33.0	31.8	33.2	33.2	32.8	33.5	33.8	32.6	33.6	33.8	32.6	32.5
1980	31.0	32.8	33.2	32.9	33.2	32.7	32.6	33.0	33.7	33.6	32.8	31.4
1981	31.3	32.0	33.6	32.5	32.4	32.2	32.0	32.3	33.0	33.8	32.9	33.8
1982	30.4	32.6	33.1	31.6	32.2	32.6	32.4	33.4	34.8	35.6	34.7	33.1
1983	33.2	33.0	32.9	33.4	32.3	33.4	33.4	34.3	34.4	33.2	32.3	32.5
1984	31.6	31.0	31.8	32.0	31.8	32.2	32.0	32.0	32.6	33.7	33.4	32.4
1985	32.0	32.3	33.0	32.8	32.9	32.0	32.3	32.6	32.6	33.0	32.9	33.9
1986	31.5	31.1	31.8	32.7	33.2	32.8	32.7	32.7	32.6	32.4	32.4	33.1
1987	30.9	31.8	32.5	32.5	33.0	32.7	32.8	33.7	35.2	34.4	34.4	32.8
1988	33.2	32.6	32.1	32.9	32.2	32.4	33.0	33.9	34.4	34.5	32.7	32.6
1989	31.0	30.3	32.7	33.6	32.5	31.9	32.4	33.0	33.6	33.6	32.9	32.5
Mean	32.0	32.0	32.8	32.9	32.7	32.6	32.8	33.0	33.7	33.9	33.2	32.7

Table C1-5 Monthly Minimum Temperature At The Climatological Station of Darmaga Bogor (CSDB)

Latitude : 06°30'S Longitude : 106°45'E Altitude : 250m.

YEAR	Temperature in degree centigrade (°C)											
	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
1977	19.3	20.5	20.4	20.8	19.7	18.5	18.9	18.5	17.0	20.0	20.4	20.2
1978	20.5	20.8	20.2	20.2	21.0	20.2	19.6	20.2	20.1	20.1	16.5	20.5
1979	20.7	21.0	20.8	21.0	18.4	18.6	14.2	19.0	13.6	18.4	21.0	18.3
1980	21.0	19.4	17.6	20.6	21.0	19.7	19.1	18.4	19.0	19.9	20.4	20.2
1981	19.6	20.0	19.6	20.3	19.6	20.0	20.0	19.7	20.2	18.6	19.5	20.5
1982	20.0	20.0	19.6	21.1	19.6	19.8	18.2	17.7	16.3	18.2	19.9	21.0
1983	20.9	21.0	20.8	21.0	21.4	19.4	18.5	18.0	19.3	20.5	20.6	17.8
1984	20.7	20.2	20.4	20.8	20.2	17.6	19.5	18.2	19.4	20.2	19.2	19.0
1985	19.9	20.2	19.5	21.3	21.2	19.6	20.0	18.3	19.4	19.8	20.3	19.8
1986	21.2	20.0	20.6	20.9	20.7	20.5	17.2	17.8	20.0	20.7	20.4	20.9
1987	21.5	20.5	21.0	21.4	19.8	20.6	19.9	18.6	19.2	20.6	21.2	21.2
1988	20.0	19.1	21.4	20.6	21.8	18.7	19.4	20.3	19.9	20.1	21.4	19.6
1989	21.0	20.6	19.6	21.0	21.4	21.0	19.8	19.5	19.0	20.4	20.1	20.1
Mean	20.5	20.3	20.1	20.8	20.4	19.6	18.8	18.8	18.6	19.8	20.1	19.9

Table C1-6 Monthly Mean Relative Humidity (%) at the Climatological Station of Darmaga Bogor (CSDB)

Latitude : 06°30'S Longitude : 106°45'E Altitude : 250m.

YEAR	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Average
1971	90	92	90	88	88	87	84	82	82	86	86	89	87
1972	92	88	89	86	88	81	78	-	71	74	-	-	83
1973	91	91	90	90	92	88	86	87	87	87	86	89	87
1974	92	89	89	87	88	86	86	86	87	88	88	86	88
1975	88	88	84	87	85	82	85	82	89	85	85	84	85
1976	89	82	85	82	78	75	71	75	72	78	83	82	79
1977	90	86	90	87	86	88	79	81	77	75	84	86	84
1978	89	87	89	87	87	86	85	84	84	86	82	88	86
1979	88	88	88	87	84	83	81	85	82	82	85	88	85
1980	90	87	87	81	85	81	84	82	83	87	85	88	85
1981	90	88	87	86	86	85	85	82	83	81	84	85	85
1982	92	88	88	90	85	85	82	77	75	78	83	87	84
1983	90	88	88	87	88	84	81	79	92	86	88	86	86
1984	89	89	89	90	90	83	85	86	86	84	87	87	87
1985	89	86	85	88	86	86	86	82	83	85	85	85	86
1986	91	88	89	87	84	89	82	81	84	85	88	87	86
1987	90	91	88	87	87	85	82	77	77	81	84	87	85
1988	87	87	88	85	88	85	80	82	77	83	85	88	85
1989	88	88	87	83	88	84	83	81	82	83	85	89	85
Mean	90	88	88	87	86	84	82	82	82	83	85	87	

Table C1-7 Monthly Mean and Maximum of Pan Evaporation (mm/day) at the Climatological Station of Dramaga Bogor (CSDB)

Latitude : 06°30'S Longitude : 106°45'E Altitude : 250m.

No. 1

YEAR		Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual Mean, Max
1977	Mean	2.22	1.94	1.69	2.75	3.06	2.24	3.20	3.63	3.68	4.23	3.33	2.81	2.90
	σ	1.08	0.89	0.99	1.00	0.85	0.80	0.44	0.55	1.29	0.78	0.99	0.90	
	Max	4.1	3.5	3.9	4.3	4.5	4.3	3.9	4.1	6.6	5.9	4.9	5.3	6.6
1978	Mean	2.34	3.20	2.76	3.26	2.92	2.49	2.76	2.86	3.30	3.70	4.45	3.30	2.86
	σ	1.40	1.30	1.18	1.32	0.86	0.87	0.84	1.26	0.85	1.21	1.60	1.65	
	Max	6.0	5.7	5.9	6.8	4.9	3.9	4.2	6.5	4.6	5.4	6.4	6.0	6.8
1979	Mean	2.92	3.12	2.97	3.08	3.02	2.66	3.06	3.03	3.24	3.57	2.53	2.32	2.96
	σ	1.22	0.99	1.13	0.90	0.73	0.89	0.76	0.94	0.87	0.88	0.63	0.97	
	Max	5.8	5.8	5.0	4.6	4.6	4.8	4.4	5.3	5.4	4.7	3.4	3.9	5.8
1980	Mean	1.75	2.34	2.87	2.25	2.62	2.91	2.98	2.92	3.20	3.13	3.06	2.31	2.70
	σ	1.00	1.23	1.26	0.59	0.89	1.09	0.64	1.16	0.94	0.97	0.92	1.02	
	Max	4.7	5.5	5.4	3.6	3.9	6.8	4.2	5.2	5.0	5.1	5.2	4.6	6.8
1981	Mean	1.69	2.71	2.99	3.02	2.75	2.72	2.79	2.68	2.84	3.16	2.87	2.86	2.76
	σ	0.70	1.03	0.88	0.87	0.89	0.79	0.85	0.78	0.89	1.12	0.84	1.14	
	Max	3.2	4.8	4.7	4.6	4.5	4.8	4.6	4.3	4.3	5.3	4.3	6.0	6.0
1982	Mean	1.67	2.76	2.87	2.63	2.73	2.40	2.70	3.09	3.85	3.74	3.21	2.63	2.86
	σ	0.77	1.01	0.82	0.80	0.73	0.63	0.49	0.88	0.56	0.87	0.80	0.97	
	Max	3.4	5.1	5.3	4.3	3.7	3.6	3.7	4.9	4.9	6.0	4.2	4.9	6.0
1983	Mean	2.49	2.94	3.12	3.26	3.00	3.40	3.40	4.05	4.67	3.64	3.09	3.67	3.39
	σ	0.93	0.86	1.28	0.89	0.83	0.69	0.98	0.55	0.60	1.07	0.87	1.09	
	Max	5.2	5.2	5.8	5.1	4.8	4.2	4.7	5.3	6.3	5.6	5.5	6.4	6.4

Table C1-7 Monthly Mean and Maximum of Pan Evaporation (mm/day) at the Climatological Station of Dramaga Bogor (CSDB)

Latitude : 06°30'S Longitude : 106°45'E Altitude : 250m. No. 2

YEAR		Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual Mean, Max
1984	Mean	2.72	2.84	2.95	3.10	2.83	3.16	3.26	3.70	3.25	3.86	3.37	3.02	3.17
	σ	1.12	0.88	1.03	0.73	0.82	0.63	0.76	0.82	0.77	0.87	0.99	1.24	
	Max	5.1	4.3	4.7	5.6	5.6	4.1	4.8	5.4	4.9	5.4	5.2	5.9	5.9
1985	Mean	3.01	3.44	3.72	3.25	3.19	2.81	2.70	3.79	4.11	3.60	3.78	3.86	3.43
	σ	1.10	0.98	1.02	0.89	0.72	0.79	0.72	0.66	0.60	0.89	1.17	1.27	
	Max	5.0	4.5	5.5	5.4	5.0	4.0	3.6	5.2	5.3	5.1	5.8	6.6	6.6
1986	Mean	2.52	3.24	2.93	3.35	3.78	3.28	3.41	3.65	3.50	4.11	3.51	3.80	3.42
	σ	0.72	1.05	0.87	0.75	0.50	0.65	0.57	0.93	1.12	0.99	1.17	0.94	
	Max	4.2	4.6	4.4	4.4	4.7	4.3	4.4	6.1	5.7	5.9	5.4	5.5	6.1
1987	Mean	2.28	2.78	3.63	3.47	4.10	3.69	4.02	4.99	5.37	5.10	4.65	3.39	3.96
	σ	0.93	1.09	1.07	0.91	0.94	0.74	0.59	0.62	0.79	0.81	0.78	0.15	
	Max	4.2	4.7	4.7	5.9	5.7	5.5	4.9	7.2	6.6	6.7	6.1	6.1	7.2
1988	Mean	3.45	4.27	3.75	4.34	3.77	3.40	3.96	4.12	4.89	4.49	3.87	3.36	3.97
	σ	1.20	1.95	1.03	1.46	1.01	0.98	0.53	1.04	0.71	1.21	1.02	1.19	
	Max	6.2	7.9	5.9	7.4	6.3	4.7	5.0	6.3	6.6	6.2	6.2	5.2	7.4
1989	Mean	3.56	2.56	3.89	4.17	3.47	3.58	3.89	4.39	4.29	4.36	4.13	3.28	3.8
	σ	1.25	1.03	1.35	1.17	0.84	0.85	0.88	0.80	0.81	1.18	1.24	1.28	
	Max	5.5	4.6	7.3	6.8	5.2	6.5	6.8	5.9	6.1	6.4	6.3	5.8	7.3
No.		13	13	13	13	13	13	13	13	13	13	13	13	
Mean		2.51	2.93	3.09	3.23	3.17	2.98	3.24	3.61	3.86	3.90	3.53	3.12	3.26
Std. Dev.		0.59	0.54	0.55	0.54	0.45	0.45	0.46	0.65	0.73	0.53	0.60	0.50	

Table C1-8 Monthly Mean of Sunshine Percentage between 8:00 and 16:00 at the Climatological Station of Dramaga Bogor (CSDB)

Latitude : 06°30'S Longitude : 106°45'E Altitude : 250m.

YEAR	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Average
1971	29	23	33	76	73	72	81	90	73	43	38	40	56
1972	26	45	38	77	70	89	91	-	88	83	-	-	67
1973	29	48	39	64	61	67	73	80	60	63	48	37	56
1974	19	35	52	71	71	77	78	71	70	57	37	43	57
1975	47	30	41	62	75	77	76	83	67	50	57	34	58
1976	12	53	38	61	79	85	92	88	79	67	51	51	63
1977	34	18	39	68	81	60	87	89	81	83	66	48	63
1978	35	47	50	69	62	52	65	72	65	65	63	37	57
1979	30	42	38	60	63	70	79	83	72	75	51	43	59
1980	18	37	61	62	78	86	80	77	69	58	57	25	59
1981	15	42	65	70	69	74	67	76	62	66	36	37	57
1982	20	44	52	61	78	70	87	91	88	93	78	48	68
1983	42	56	57	62	61	86	89	87	85	63	42	55	65
1984	27	31	49	62	63	83	75	77	44	52	58	32	54
1985	50	48	56	51	70	67	69	87	80	62	60	52	63
1986	18	46	43	63	78	73	79	65	50	65	55	63	58
1987	19	34	67	67	80	71	90	90	79	80	61	28	64
1988	41	48	41	68	64	71	76	72	82	54	44	40	58
1989	47	18	53	67	65	66	76	77	77	59	55	55	60
Mean	29	39	48	65	71	73	79	81	72	65	53	40	

Table C1-9 Monthly Mean of Radiation Intensity (Kcal/cm2/day) at the Climatological Station of Dramaga Bogor (CSDB)

Latitude : 06°30'S Longitude : 106°45'E Altitude : 250m.

YEAR	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Average	σ
1977	199.1	174.6	199.6	276.6	-	-	295.2	319.4	294.3	299.8	-	-	257.3	52.9
1978	237.3	269.4	264.5	292.2	272.7	227.2	275.9	262.7	268.9	271.1	258.4	218.3	259.9	20.6
1979	225.7	269.2	247.4	244.7	258.4	264.7	278.6	292.6	264.6	271.9	245.5	204.9	255.7	22.9
1980	189.5	226.3	274.1	237.4	234.3	245.7	230.5	225.5	161.6	173.0	182.5	134.1	209.5	39.0
1981	102.3	168.3	179.5	196.6	188.7	199.5	192.4	206.7	203.1	220.2	190.8	173.2	185.1	28.5
1982	110.5	192.1	216.5	227.2	231.6	210.7	234.1	245.2	246.9	228.1	178.8	151.8	206.1	39.5
1983	139.3	155.9	147.3	162.3	134.4	194.3	195.5	233.0	231.6	188.8	150.5	166.3	174.9	32.2
1984	118.8	133.5	137.8	142.5	138.2	168.3	153.4	169.6	148.0	169.1	132.4	251.4	155.3	32.9
1985	299.4	304.3	309.1	323.8	294.0	283.0	286.9	351.1	347.9	333.5	277.7	289.6	308.4	24.1
1986	202.9	258.5	264.0	274.3	309.1	289.1	294.9	287.1	285.5	296.8	238.7	271.2	272.7	27.9
1987	200.2	256.7	289.8	244.8	290.4	273.6	311.6	340.9	286.0	269.4	302.5	206.5	272.7	39.3
1988	268.6	249.2	247.8	308.1	300.7	296.2	300.0	281.9	361.4	322.0	268.7	259.2	288.7	31.7
1989	276.2	218.1	310.6	-	295.4	-	396.7	298.3	313.6	324.9	280.0	263.7	297.8	43.9
n	13	13	13	12	12	11	13	13	13	13	12	12		
Mean	197.7	221.2	237.5	244.2	245.7	241.1	265.1	270.3	262.6	259.1	225.5	215.9		
σ	62.2	50.2	55.1	53.5	59.3	41.6	60.8	51.1	64.4	55.6	53.8	49.3		
Max.	299.4	304.3	310.6	323.8	309.1	296.2	396.7	351.1	361.4	333.5	302.5	289.6		

Table C1-10 Monthly Total Rainfall At The Climatological Station of Darmaga Bogor (CSDB)

Latitude : 06°30'S Longitude : 106°45'E Altitude : 250m.

YEAR	Rainfall in millimeter (mm)												Annual	Jun. to Nov.
	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.		Total
1964	457	305	321	417	202	143	86	257	348	286	208	343	3,373	1,328
1965	620	420	139	421	224	302	195	158	109	214	266	337	3,405	1,244
1966	211	301	270	389	118	61	80	39	37	353	135	181	2,175	705
1967	231	403	452	520	309	34	174	68	191	247	361	305	3,295	1,075
1968	259	272	482	214	103	295	225	183	449	263	255	245	3,245	1,670
1969	397	285	440	618	334	166	218	87	341	284	467	97	3,734	1,563
1970	328	445	303	343	281	185	238	279	376	159	272	187	3,396	1,509
1971	320	517	414	360	312	293	270	439	290	344	238	206	4,003	1,874
1972	527	293	344	272	330	48	69	129	20	172	392	313	2,909	830
1973	514	479	438	744	539	288	96	398	497	386	289	380	5,048	1,954
1974	402	306	413	336	337	250	368	327	552	493	169	257	4,210	2,159
1975	243	376	227	361	532	325	248	466	583	163	458	270	4,252	2,243
1976	781	181	242	202	345	113	73	244	160	241	382	305	3,269	1,213
1977	602	467	545	532	365	352	84	135	248	228	495	285	4,338	1,542
1978	384	229	628	332	303	320	309	414	412	553	474	313	4,671	2,482
1979	541	293	334	354	227	223	261	161	384	438	373	327	3,916	1,840
1980	386	368	308	476	338	272	223	226	348	413	518	454	4,330	2,000
1981	476	240	421	335	263	383	551	194	366	246	157	436	4,068	1,897
1982	477	240	214	580	396	164	247	71	90	241	501	430	3,651	1,314
1983	328	241	256	296	224	140	263	93	178	654	300	253	3,226	1,628
1984	382	235	551	508	420	190	259	455	317	328	252	185	4,082	1,801
1985	375	354	231	337	321	156	514	285	298	241	279	273	3,664	1,773
1986	311	436	526	233	241	281	232	264	387	252	543	528	4,234	1,959
1987	295	282	404	290	460	218	235	103	50	413	436	231	3,417	1,455
1988	434	380	344	445	371	148	89	200	80	240	151	307	3,189	908
1989	464	507	281	150	554	333	147	230	255	367	346	444	4,078	1,678
Mean	413	341	366	387	325	219	221	227	283	316	335	304	3,738	1,602
σ	131	93	119	135	112	96	120	125	156	120	122	97	598	431
Max.	781	517	628	744	554	383	551	455	497	654	543	528	5,048	2,482
Min.	211	181	139	150	103	61	69	39	20	159	135	97	2,175	705

Table C1-11 Number of Rainy Days at the CSDB

YEAR	The number of rainy days												TOTAL
	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	
1964	19	20	21	24	18	12	12	20	17	17	20	21	221
1965	30	26	20	18	16	19	10	6	9	9	17	24	204
1966	21	25	23	18	18	9	7	9	12	26	22	22	212
1967	23	24	22	24	12	3	11	5	8	16	24	25	197
1968	25	22	23	24	17	19	16	16	21	23	19	19	244
1969	17	21	17	28	11	12	11	7	19	12	22	14	191
1970	26	23	25	18	20	17	9	10	16	12	24	21	221
1971	18	23	23	8	18	19	12	11	14	23	18	17	214
1972	24	21	29	18	21	3	3	11	2	10	25	25	192
1973	26	25	28	22	25	15	14	20	17	18	17	23	250
1974	25	24	22	22	19	15	13	22	19	25	17	22	245
1975	26	25	27	26	24	9	16	19	23	22	20	20	257
1976	30	20	24	20	13	9	6	12	11	21	23	22	181
1977	29	25	29	23	23	18	9	11	12	9	23	24	235
1978	26	22	26	19	21	20	15	22	20	22	17	22	252
1979	20	20	24	20	22	11	7	16	16	18	26	21	221
1980	28	21	23	21	14	12	16	14	22	23	28	25	247
1981	29	21	25	22	20	16	19	20	19	18	21	20	259
1982	29	21	22	23	18	16	12	5	10	13	21	24	214
1983	21	22	18	20	22	11	12	7	14	24	24	21	216
1984	26	26	24	25	22	12	17	19	24	23	23	22	263
1985	25	24	24	23	22	21	16	14	19	17	18	15	238
1986	30	24	26	21	13	17	14	14	24	23	26	26	258
1987	31	26	24	19	22	16	12	4	9	16	21	23	223
1988	28	24	25	15	24	14	4	14	15	19	20	19	221
1989	25	24	19	16	24	14	14	9	11	19	16	25	216
Mean	25.3	23.0	23.6	20.7	19.2	13.8	11.8	13.0	15.5	18.4	21.2	21.6	226.6
σ	3.9	2.0	3.0	4.0	4.0	4.6	4.0	5.5	5.4	5.0	3.2	3.0	22.8
Max	31	26	29	25	25	21	17	22	24	26	26	26	259
Min	17	20	17	8	11	3	6	4	2	9	17	14	181

Table C1-12 The Highest 24 hours Rainfall in the Month at the CSDB

(unit : mm)

YEAR	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
1964	100	92	49	71	42	44	19	44	87	50	41	49
1965	80	58	32	70	105	43	47	75	70	62	51	112
1966	63	81	40	99	39	37	26	26	15	46	27	23
1967	29	51	59	80	91	33	60	6	74	65	94	52
1968	78	52	103	59	21	47	54	101	77	85	58	37
1969	66	18	71	98	99	87	70	38	91	57	77	25
1970	52	59	39	59	55	57	58	117	116	33	38	30
1971	92	98	86	98	98	61	103	132	89	68	39	35
1972	85	88	57	70	59	28	11	22	20	72	17	44
1973	113	69	51	104	70	63	54	71	96	64	79	87
1974	68	41	85	71	69	59	148	81	61	80	25	38
1975	36	54	33	88	78	177	44	84	86	30	67	48
1976	84	43	50	36	181	72	41	96	29	35	63	58
1977	80	77	60	84	60	80	28	36	69	74	49	80
1978	47	41	80	70	27	69	149	53	108	109	65	53
1979	106	63	79	71	60	110	137	26	119	77	82	40
1980	41	115	50	66	70	76	61	45	119	129	77	144
1981	52	58	111	70	44	83	146	72	57	47	31	128
1982	56	68	55	97	89	78	82	31	48	63	85	111
1983	74	43	69	82	44	57	81	34	55	90	64	56
1984	73	32	106	93	79	88	57	114	88	83	59	33
1985	73	105	64	74	63	36	103	88	59	84	76	60
1986	40	105	104	53	72	110	105	71	87	48	80	82
1987	42	33	66	76	88	63	69	50	11	81	83	31
1988	89	67	61	83	77	64	73	63	17	53	34	59
1989	75	240	54	41	122	92	51	64	70	83	50	104

Table C1-13

Probability Calculation of the Highest Daily Rainfall Data at the CSDB by Gumble Method (Data period 26 years 1964-1989)

(1) January

(2) February

(3) March

(4) April

(5) May

(6) June

(7) July

(8) August

(9) September

(10) October

(11) November

(12) December

(13) Annual Maximum

(1) Probability Calculation of Maximum Daily Rainfall in January at the Climatological Station of Darmaga Bogor (CSDB).by Gumble Method (Data period : 1964 - 1989)

```
GUMBLE MAX. DISTRIBUTION

DATA N=26.
D(1)=   100.0
D(2)=    80.0
D(3)=    63.0
D(4)=    29.0
D(5)=    78.0
D(6)=    66.0
D(7)=    52.0
D(8)=    92.0
D(9)=    85.0
D(10)=  113.0
D(11)=   68.0
D(12)=   36.0
D(13)=   84.0
D(14)=   80.0
D(15)=   47.0
D(16)=  106.0
D(17)=   41.0
D(18)=   52.0
D(19)=   56.0
D(20)=   74.0
D(21)=   73.0
D(22)=   73.0
D(23)=   40.0
D(24)=   42.0
D(25)=   89.0
D(26)=   75.0

RANKING
I=1.  X=113.
I=2.  X=106.
I=3.  X=100.
I=4.  X=92.
I=5.  X=89.
I=6.  X=85.
I=7.  X=84.
I=8.  X=80.
I=9.  X=80.
I=10.  X=78.
I=11.  X=75.
I=12.  X=74.
I=13.  X=73.
I=14.  X=73.
I=15.  X=68.
I=16.  X=66.
I=17.  X=63.
I=18.  X=56.
I=19.  X=52.
I=20.  X=52.
I=21.  X=47.
I=22.  X=42.
I=23.  X=41.
I=24.  X=40.
I=25.  X=36.
I=26.  X=29.
```

```
CALCULATION
SUM X= 1794.
SUM X^2= 136198.
SUM X^3= 11118768.

MEAN X= 69.
MEAN X^2= 5238.384615
MEAN X^3= 427644.9231
SUM DEV SQU. S=12412.
VARIANCE S/N=477.38
UNBIASED VARI. =S/(N-1)=
496.48
VARIATION COEF.=SX/MEAN
X=0.32
STANDARD DEV. SX=√(S/N)=
21.85
STA. DEV. EST. USX=√(S/(
N-1))=22.28
SKEWNESS COEF. CS!=0.03
UNBIASED S.C. CS1=0.03

 PROBABLE EXTREAM VALUE(
XT), RETURN PERIOD(T),
FREQUENCY FUNCTION:

XT=XM+K*SX, K=(YT-YM)/SY
, XM=MEAN X, YT=-LN(LN(T
/(T-1)))
SO THAT XT=XM-(YM*SX/SY)
+(SX/SY)*YT

 CAL. VALUE:
XM=69.  SX=22.28  YM=0.5
321  SY=1.0961

 ESTIMATE EQUATION:
XT=58.18+20.33YT

T=2. XT=65.6
T=4. XT=83.5
T=5. XT=88.7
T=10. XT=103.9
T=20. XT=118.6
T=25. XT=123.2
T=50. XT=137.5
T=100. XT=151.7
T=200. XT=165.8
T=1000. XT=198.5
```

```
CONFIDENCE INTERVAL

T=5.
 C.L.=95%  LMT=+-14.5
 C.L.=90%  LMT=+-12.2
 C.L.=80%  LMT=+-9.5
 C.L.=68%  LMT=+-7.4
T=10.
 C.L.=95%  LMT=+-20.1
 C.L.=90%  LMT=+-16.8
 C.L.=80%  LMT=+-13.1
 C.L.=68%  LMT=+-10.2
T=20.
 C.L.=95%  LMT=+-25.7
 C.L.=90%  LMT=+-21.5
 C.L.=80%  LMT=+-16.8
 C.L.=68%  LMT=+-13.1
T=25.
 C.L.=95%  LMT=+-27.5
 C.L.=90%  LMT=+-23.
 C.L.=80%  LMT=+-18.
 C.L.=68%  LMT=+-14.
T=50.
 C.L.=95%  LMT=+-33.1
 C.L.=90%  LMT=+-27.7
 C.L.=80%  LMT=+-21.6
 C.L.=68%  LMT=+-16.9
T=100.
 C.L.=95%  LMT=+-38.7
 C.L.=90%  LMT=+-32.5
 C.L.=80%  LMT=+-25.3
 C.L.=68%  LMT=+-19.7
T=200.
 C.L.=95%  LMT=+-44.3
 C.L.=90%  LMT=+-37.2
 C.L.=80%  LMT=+-29.
 C.L.=68%  LMT=+-22.6
T=1000.
 C.L.=95%  LMT=+-57.3
 C.L.=90%  LMT=+-48.1
 C.L.=80%  LMT=+-37.5
 C.L.=68%  LMT=+-29.3
```

NOTE
1. XT : Magnitude of the event reached or exceeded on an average once in T years
2. T : Return period
3. C. L. : Confidence level
4. LMT : Conficence limit

(2) Probability Calculation of Maximum Daily Rainfall in February at the Climatological Station of Darmaga Bogor (CSDB).by Gumble Method (Data period : 1964 - 1989)

```
GUMBLE MAX. DISTRIBUTION

DATA N=26.
D(1)=    92.0
D(2)=    58.0
D(3)=    81.0
D(4)=    51.0
D(5)=    52.0
D(6)=    18.0
D(7)=    59.0
D(8)=    98.0
D(9)=    88.0
D(10)=   69.0
D(11)=   41.0
D(12)=   54.0
D(13)=   43.0
D(14)=   77.0
D(15)=   41.0
D(16)=   63.0
D(17)=  115.0
D(18)=   58.0
D(19)=   68.0
D(20)=   43.0
D(21)=   32.0
D(22)=  105.0
D(23)=  105.0
D(24)=   33.0
D(25)=   67.0
D(26)=  240.0

RANKING
I=1.  X=240.
I=2.  X=115.
I=3.  X=105.
I=4.  X=105.
I=5.  X=98.
I=6.  X=92.
I=7.  X=88.
I=8.  X=81.
I=9.  X=77.
I=10.  X=69.
I=11.  X=68.
I=12.  X=67.
I=13.  X=63.
I=14.  X=59.
I=15.  X=58.
I=16.  X=58.
I=17.  X=54.
I=18.  X=52.
I=19.  X=51.
I=20.  X=43.
I=21.  X=43.
I=22.  X=41.
I=23.  X=41.
I=24.  X=33.
I=25.  X=32.
I=26.  X=18.
```

```
CALCULATION
SUM X= 1851.
SUM X^2= 176947.
SUM X^3= 23640921.

MEAN X= 71.19230769
MEAN X^2= 6805.653846
MEAN X^3= 909266.1923
SUM DEV SQU. S=45170.038
46
VARIANCE S/N=1737.31
UNBIASED VARI. =S/(N-1)=
1806.8
VARIATION COEF.=SX/MEAN
X=0.59
STANDARD DEV. SX=√(S/N)=
41.68
STA. DEV. EST. USX=√(S/(
N-1))=42.51
SKEWNESS COEF. CS!=2.45
UNBIASED S.C. CS1=2.402

 PROBABLE EXTREAM VALUE(
XT), RETURN PERIOD(T),
FREQUENCY FUNCTION:

XT=XM+K*SX, K=(YT-YM)/SY
, XM=MEAN X, YT=-LN(LN(T
/(T-1)))
SO THAT XT=XM-(YM*SX/SY)
+(SX/SY)*YT

 CAL. VALUE:
XM=71.19230769  SX=42.51
  YM=0.5321  SY=1.0961

 ESTIMATE EQUATION:
XT=50.56+38.78YT

T=2. XT=64.8
T=4. XT=98.9
T=5. XT=108.7
T=10. XT=137.8
T=20. XT=165.7
T=25. XT=174.6
T=50. XT=201.9
T=100. XT=229.
T=200. XT=255.9
T=1000. XT=318.4
```

```
CONFIDENCE INTERVAL

T=5.
 C.L.=95%  LMT=+-27.7
 C.L.=90%  LMT=+-23.2
 C.L.=80%  LMT=+-18.1
 C.L.=68%  LMT=+-14.1
T=10.
 C.L.=95%  LMT=+-38.3
 C.L.=90%  LMT=+-32.1
 C.L.=80%  LMT=+-25.
 C.L.=68%  LMT=+-19.5
T=20.
 C.L.=95%  LMT=+-49.
 C.L.=90%  LMT=+-41.1
 C.L.=80%  LMT=+-32.
 C.L.=68%  LMT=+-25.
T=25.
 C.L.=95%  LMT=+-52.4
 C.L.=90%  LMT=+-44.
 C.L.=80%  LMT=+-34.3
 C.L.=68%  LMT=+-26.7
T=50.
 C.L.=95%  LMT=+-63.1
 C.L.=90%  LMT=+-52.9
 C.L.=80%  LMT=+-41.3
 C.L.=68%  LMT=+-32.2
T=100.
 C.L.=95%  LMT=+-73.8
 C.L.=90%  LMT=+-61.9
 C.L.=80%  LMT=+-48.3
 C.L.=68%  LMT=+-37.6
T=200.
 C.L.=95%  LMT=+-84.5
 C.L.=90%  LMT=+-70.9
 C.L.=80%  LMT=+-55.3
 C.L.=68%  LMT=+-43.1
T=1000.
 C.L.=95%  LMT=+-109.4
 C.L.=90%  LMT=+-91.8
 C.L.=80%  LMT=+-71.6
 C.L.=68%  LMT=+-55.8
```

NOTE
1. XT : Magnitude of the event reached or exceeded on an average once in T years
2. T : Return period
3. C. L. : Confidence level
4. LMT : Conficence limit

(3) Probability Calculation of Maximum Daily Rainfall in March at the Climatological Station of Darmaga Bogor (CSDB).by Gumble Method (Data period : 1964 - 1989)

```
GUMBLE

DATA N=      26.0
D(1)=     49.0
D(2)=     32.0
D(3)=     40.0
D(4)=     59.0
D(5)=    103.0
D(6)=     71.0
D(7)=     39.0
D(8)=     86.0
D(9)=     57.0
D(10)=    51.0
D(11)=    85.0
D(12)=    33.0
D(13)=    50.0
D(14)=    60.0
D(15)=    80.0
D(16)=    79.0
D(17)=    50.0
D(18)=   111.0
D(19)=    55.0
D(20)=    69.0
D(21)=   106.0
D(22)=    64.0
D(23)=   104.0
D(24)=    66.0
D(25)=    61.0
D(26)=    54.0

RANKING
I=1.  X=111.
I=2.  X=106.
I=3.  X=104.
I=4.  X=103.
I=5.  X=86.
I=6.  X=85.
I=7.  X=80.
I=8.  X=79.
I=9.  X=71.
I=10.  X=69.
I=11.  X=66.
I=12.  X=64.
I=13.  X=61.
I=14.  X=60.
I=15.  X=59.
I=16.  X=57.
I=17.  X=55.
I=18.  X=54.
I=19.  X=51.
I=20.  X=50.
I=21.  X=50.
I=22.  X=49.
I=23.  X=40.
I=24.  X=39.
I=25.  X=33.
I=26.  X=32.
```

```
CALCULATION
SUM X= 1714.
SUM X^2= 125726.
SUM X^3= 10117234.

MEAN X= 65.92307692
MEAN X^2= 4835.615385
MEAN X^3= 389124.3846
SUM DEV SQU. S=12733.846
15
VARIANCE S/N=489.76
UNBIASED VARI. =S/(N-1)=
509.35
VARIATION COEF.=SX/MEAN
X=0.34
STANDARD DEV. SX=√(S/N)=
22.13
STA. DEV. EST. USX=√(S/(
N-1))=22.57
SKEWNESS COEF. CS!=0.533
UNBIASED S.C. CS1=0.522

 PROBABLE EXTREAM VALUE(
XT), RETURN PERIOD(T),
FREQUENCY FUNCTION:

XT=XM+K*SX, K=(YT-YM)/SY
, XM=MEAN X, YT=-LN(LN(T
/(T-1)))
SO THAT XT=XM-(YM*SX/SY)
+(SX/SY)*YT

 CAL. VALUE:
XM=65.92307692  SX=22.57
  YM=0.5321  SY=1.0961

 ESTIMATE EQUATION:
XT=54.97+20.59YT

T=2. XT=62.5
T=4. XT=80.6
T=5. XT=85.9
T=10. XT=101.3
T=20. XT=116.1
T=25. XT=120.8
T=50. XT=135.3
T=100. XT=149.7
T=200. XT=164.
T=1000. XT=197.2
```

```
CONFIDENCE INTERVAL

T=5.
 C.L.=95%  LMT=+-14.7
 C.L.=90%  LMT=+-12.3
 C.L.=80%  LMT=+-9.6
 C.L.=68%  LMT=+-7.5
T=10.
 C.L.=95%  LMT=+-20.3
 C.L.=90%  LMT=+-17.1
 C.L.=80%  LMT=+-13.3
 C.L.=68%  LMT=+-10.4
T=20.
 C.L.=95%  LMT=+-26.
 C.L.=90%  LMT=+-21.8
 C.L.=80%  LMT=+-17.
 C.L.=68%  LMT=+-13.3
T=25.
 C.L.=95%  LMT=+-27.8
 C.L.=90%  LMT=+-23.3
 C.L.=80%  LMT=+-18.2
 C.L.=68%  LMT=+-14.2
T=50.
 C.L.=95%  LMT=+-33.5
 C.L.=90%  LMT=+-28.1
 C.L.=80%  LMT=+-21.9
 C.L.=68%  LMT=+-17.1
T=100.
 C.L.=95%  LMT=+-39.2
 C.L.=90%  LMT=+-32.9
 C.L.=80%  LMT=+-25.6
 C.L.=68%  LMT=+-20.
T=200.
 C.L.=95%  LMT=+-44.9
 C.L.=90%  LMT=+-37.6
 C.L.=80%  LMT=+-29.3
 C.L.=68%  LMT=+-22.9
T=1000.
 C.L.=95%  LMT=+-58.1
 C.L.=90%  LMT=+-48.8
 C.L.=80%  LMT=+-38.
 C.L.=68%  LMT=+-29.6
```

NOTE 1. XT : Magnitude of the event reached or exceeded on an average once in T years
2. T : Return period
3. C. L. : Confidence level
4. LMT : Conficence limit

(4) Probability Calculation of Maximum Daily Rainfall in April at the Climatological Station of Darmaga Bogor (CSDB).by Gumble Method (Data period : 1964 - 1989)

```
GUMBLE MAX. DISTRIBUTION

DATA N=26.
D(1)=    71.0
D(2)=    70.0
D(3)=    99.0
D(4)=    80.0
D(5)=    59.0
D(6)=    98.0
D(7)=    59.0
D(8)=    98.0
D(9)=    70.0
D(10)=  104.0
D(11)=   71.0
D(12)=   88.0
D(13)=   36.0
D(14)=   84.0
D(15)=   70.0
D(16)=   71.0
D(17)=   66.0
D(18)=   70.0
D(19)=   70.0
D(20)=   82.0
D(21)=   93.0
D(22)=   74.0
D(23)=   53.0
D(24)=   76.0
D(25)=   83.0
D(26)=   41.0

RANKING
I=1.  X=104.
I=2.  X=99.
I=3.  X=98.
I=4.  X=98.
I=5.  X=93.
I=6.  X=88.
I=7.  X=84.
I=8.  X=83.
I=9.  X=82.
I=10.  X=80.
I=11.  X=76.
I=12.  X=74.
I=13.  X=71.
I=14.  X=71.
I=15.  X=71.
I=16.  X=70.
I=17.  X=70.
I=18.  X=70.
I=19.  X=70.
I=20.  X=70.
I=21.  X=66.
I=22.  X=59.
I=23.  X=59.
I=24.  X=53.
I=25.  X=41.
I=26.  X=36.
```

```
CALCULATION
SUM X= 1936.
SUM X^2= 151266.
SUM X^3= 12286876.

MEAN X= 74.46153846
MEAN X^2= 5817.923077
MEAN X^3= 472572.1538
SUM DEV SQU. S=7108.4615
39
VARIANCE S/N=273.4
UNBIASED VARI. =S/(N-1)=
284.34
VARIATION COEF.=SX/MEAN
X=0.22
STANDARD DEV. SX=√(S/N)=
16.53
STA. DEV. EST. USX=√(S/(
N-1))=16.86
SKEWNESS COEF. CS!=-0.3
UNBIASED S.C. CS1=-0.294

 PROBABLE EXTREAM VALUE(
XT), RETURN PERIOD(T),
FREQUENCY FUNCTION:

XT=XM+K*SX, K=(YT-YM)/SY
, XM=MEAN X, YT=-LN(LN(T
/(T-1)))
SO THAT XT=XM-(YM*SX/SY)
+(SX/SY)*YT

 CAL. VALUE:
XM=74.46153846  SX=16.86
  YM=0.5321  SY=1.0961

 ESTIMATE EQUATION:
XT=66.28+15.38YT

T=2. XT=71.9
T=4. XT=85.4
T=5. XT=89.3
T=10. XT=100.9
T=20. XT=112.
T=25. XT=115.5
T=50. XT=126.3
T=100. XT=137.
T=200. XT=147.7
T=1000. XT=172.5
```

```
CONFIDENCE INTERVAL

T=5.
 C.L.=95%  LMT=+-11.
 C.L.=90%  LMT=+-9.2
 C.L.=80%  LMT=+-7.2
 C.L.=68%  LMT=+-5.6
T=10.
 C.L.=95%  LMT=+-15.2
 C.L.=90%  LMT=+-12.7
 C.L.=80%  LMT=+-9.9
 C.L.=68%  LMT=+-7.7
T=20.
 C.L.=95%  LMT=+-19.4
 C.L.=90%  LMT=+-16.3
 C.L.=80%  LMT=+-12.7
 C.L.=68%  LMT=+-9.9
T=25.
 C.L.=95%  LMT=+-20.8
 C.L.=90%  LMT=+-17.4
 C.L.=80%  LMT=+-13.6
 C.L.=68%  LMT=+-10.6
T=50.
 C.L.=95%  LMT=+-25.
 C.L.=90%  LMT=+-21.
 C.L.=80%  LMT=+-16.4
 C.L.=68%  LMT=+-12.8
T=100.
 C.L.=95%  LMT=+-29.3
 C.L.=90%  LMT=+-24.6
 C.L.=80%  LMT=+-19.1
 C.L.=68%  LMT=+-14.9
T=200.
 C.L.=95%  LMT=+-33.5
 C.L.=90%  LMT=+-28.1
 C.L.=80%  LMT=+-21.9
 C.L.=68%  LMT=+-17.1
T=1000.
 C.L.=95%  LMT=+-43.4
 C.L.=90%  LMT=+-36.4
 C.L.=80%  LMT=+-28.4
 C.L.=68%  LMT=+-22.1
```

NOTE
1. XT : Magnitude of the event reached or exceeded on an average once in T years
2. T : Return period
3. C. L. : Confidence level
4. LMT : Conficence limit

(5) Probability Calculation of Maximum Daily Rainfall in <u>May</u> at the Climatological Station of Darmaga Bogor (CSDB).by Gumble Method (Data period : 1964 - 1989)

```
GUMBLE MAX. DISTRIBUTION

DATA N=26.
D(1)=    42.0
D(2)=   105.0
D(3)=    39.0
D(4)=    91.0
D(5)=    21.0
D(6)=    99.0
D(7)=    55.0
D(8)=    98.0
D(9)=    59.0
D(10)=   70.0
D(11)=   69.0
D(12)=   78.0
D(13)=   81.0
D(14)=   60.0
D(15)=   27.0
D(16)=   60.0
D(17)=   70.0
D(18)=   44.0
D(19)=   89.0
D(20)=   44.0
D(21)=   79.0
D(22)=   63.0
D(23)=   72.0
D(24)=   88.0
D(25)=   77.0
D(26)=  122.0

RANKING
I=1.  X=181.
I=2.  X=122.
I=3.  X=105.
I=4.  X=99.
I=5.  X=98.
I=6.  X=91.
I=7.  X=89.
I=8.  X=88.
I=9.  X=79.
I=10.  X=78.
I=11.  X=77.
I=12.  X=72.
I=13.  X=70.
I=14.  X=70.
I=15.  X=69.
I=16.  X=63.
I=17.  X=60.
I=18.  X=60.
I=19.  X=59.
I=20.  X=55.
I=21.  X=44.
I=22.  X=44.
I=23.  X=42.
I=24.  X=39.
I=25.  X=27.
I=26.  X=21.

CALCULATION
SUM X= 1902.
SUM X^2= 166022.
SUM X^3= 17153118.

MEAN X= 73.15384615
MEAN X^2= 6385.461538
MEAN X^3= 659735.3077
SUM DEV SQU. S=26883.384
62
VARIANCE S/N=1033.98
UNBIASED VARI. =S/(N-1)=
1075.34
VARIATION COEF.=SX/MEAN
X=0.44
STANDARD DEV. SX=√(S/N)=
32.16
STA. DEV. EST. USX=√(S/(
N-1))=32.79
SKEWNESS COEF. CS!=1.243
UNBIASED S.C. CS1=1.219


CONFIDENCE INTERVAL

 PROBABLE EXTREAM VALUE(
XT), RETURN PERIOD(T),
FREQUENCY FUNCTION:

XT=XM+K*SX, K=(YT-YM)/SY
, XM=MEAN X, YT=-LN(LN(T
/(T-1)))
SO THAT XT=XM-(YM*SX/SY)
+(SX/SY)*YT

 CAL. VALUE:
XM=73.15384615  SX=32.79
  YM=0.5321  SY=1.0961

 ESTIMATE EQUATION:
XT=57.24+29.92YT

T=2. XT=68.2
T=4. XT=94.5
T=5. XT=102.1
T=10. XT=124.6
T=20. XT=146.1
T=25. XT=152.9
T=50. XT=174.
T=100. XT=194.9
T=200. XT=215.7
T=1000. XT=263.9

CONFIDENCE INTERVAL

T=5.
 C.L.=95%  LMT=+-21.3
 C.L.=90%  LMT=+-17.9
 C.L.=80%  LMT=+-14.
 C.L.=68%  LMT=+-10.9
T=10.
 C.L.=95%  LMT=+-29.5
 C.L.=90%  LMT=+-24.8
 C.L.=80%  LMT=+-19.3
 C.L.=68%  LMT=+-15.1
T=20.
 C.L.=95%  LMT=+-37.8
 C.L.=90%  LMT=+-31.7
 C.L.=80%  LMT=+-24.7
 C.L.=68%  LMT=+-19.3
T=25.
 C.L.=95%  LMT=+-40.4
 C.L.=90%  LMT=+-33.9
 C.L.=80%  LMT=+-26.4
 C.L.=68%  LMT=+-20.6
T=50.
 C.L.=95%  LMT=+-48.7
 C.L.=90%  LMT=+-40.8
 C.L.=80%  LMT=+-31.8
 C.L.=68%  LMT=+-24.8
T=100.
 C.L.=95%  LMT=+-56.9
 C.L.=90%  LMT=+-47.8
 C.L.=80%  LMT=+-37.2
 C.L.=68%  LMT=+-29.
T=200.
 C.L.=95%  LMT=+-65.2
 C.L.=90%  LMT=+-54.7
 C.L.=80%  LMT=+-42.6
 C.L.=68%  LMT=+-33.2
T=1000.
 C.L.=95%  LMT=+-84.4
 C.L.=90%  LMT=+-70.8
 C.L.=80%  LMT=+-55.2
 C.L.=68%  LMT=+-43.1
```

NOTE 1. XT : Magnitude of the event reached or exceeded on an average once in T years
2. T : Return period
3. C. L. : Confidence level
4. LMT : Conficence limit

(6) Probability Calculation of Maximum Daily Rainfall in June at the Climatological Station of Darmaga Bogor (CSDB).by Gumble Method (Data period : 1964 - 1989)

```
GUMBLE MAX. DISTRIBUTION

DATA N=26.
D(1)=    44.0
D(2)=    43.0
D(3)=    37.0
D(4)=    33.0
D(5)=    47.0
D(6)=    87.0
D(7)=    57.0
D(8)=    61.0
D(9)=    28.0
D(10)=   63.0
D(11)=   59.0
D(12)=  177.0
D(13)=   72.0
D(14)=   80.0
D(15)=   69.0
D(16)=  110.0
D(17)=   76.0
D(18)=   83.0
D(19)=   78.0
D(20)=   57.0
D(21)=   88.0
D(22)=   36.0
D(23)=  110.0
D(24)=   63.0
D(25)=   64.0
D(26)=   92.0

RANKING
I=1.  X=177.
I=2.  X=110.
I=3.  X=110.
I=4.  X=92.
I=5.  X=88.
I=6.  X=87.
I=7.  X=83.
I=8.  X=80.
I=9.  X=78.
I=10.  X=76.
I=11.  X=72.
I=12.  X=69.
I=13.  X=64.
I=14.  X=63.
I=15.  X=63.
I=16.  X=61.
I=17.  X=59.
I=18.  X=57.
I=19.  X=57.
I=20.  X=47.
I=21.  X=44.
I=22.  X=43.
I=23.  X=37.
I=24.  X=36.
I=25.  X=33.
I=26.  X=28.
```

```
CALCULATION
SUM X= 1814.
SUM X^2= 150666.
SUM X^3= 15013664.

MEAN X= 69.76923077
MEAN X^2= 5794.846154
MEAN X^3= 577448.6154
SUM DEV SQU. S=24104.615
39
VARIANCE S/N=927.1
UNBIASED VARI. =S/(N-1)=
964.18
VARIATION COEF.=SX/MEAN
X=0.44
STANDARD DEV. SX=√(S/N)=
30.45
STA. DEV. EST. USX=√(S/(
N-1))=31.05
SKEWNESS COEF. CS!=1.551
UNBIASED S.C. CS1=1.521

 PROBABLE EXTREAM VALUE(
XT), RETURN PERIOD(T),
FREQUENCY FUNCTION:

XT=XM+K*SX, K=(YT-YM)/SY
, XM=MEAN X, YT=-LN(LN(T
/(T-1)))
SO THAT XT=XM-(YM*SX/SY)
+(SX/SY)*YT

 CAL. VALUE:
XM=69.76923077  SX=31.05
  YM=0.5321  SY=1.0961

 ESTIMATE EQUATION:
XT=54.7+28.33YT

T=2. XT=65.1
T=4. XT=90.
T=5. XT=97.2
T=10. XT=118.5
T=20. XT=138.8
T=25. XT=145.3
T=50. XT=165.2
T=100. XT=185.
T=200. XT=204.7
T=1000. XT=250.4
```

```
CONFIDENCE INTERVAL

T=5.
 C.L.=95%  LMT=+-20.2
 C.L.=90%  LMT=+-17.
 C.L.=80%  LMT=+-13.2
 C.L.=68%  LMT=+-10.3
T=10.
 C.L.=95%  LMT=+-28.
 C.L.=90%  LMT=+-23.5
 C.L.=80%  LMT=+-18.3
 C.L.=68%  LMT=+-14.3
T=20.
 C.L.=95%  LMT=+-35.8
 C.L.=90%  LMT=+-30.
 C.L.=80%  LMT=+-23.4
 C.L.=68%  LMT=+-18.2
T=25.
 C.L.=95%  LMT=+-38.3
 C.L.=90%  LMT=+-32.1
 C.L.=80%  LMT=+-25.
 C.L.=68%  LMT=+-19.5
T=50.
 C.L.=95%  LMT=+-46.1
 C.L.=90%  LMT=+-38.7
 C.L.=80%  LMT=+-30.1
 C.L.=68%  LMT=+-23.5
T=100.
 C.L.=95%  LMT=+-53.9
 C.L.=90%  LMT=+-45.2
 C.L.=80%  LMT=+-35.2
 C.L.=68%  LMT=+-27.5
T=200.
 C.L.=95%  LMT=+-61.7
 C.L.=90%  LMT=+-51.8
 C.L.=80%  LMT=+-40.4
 C.L.=68%  LMT=+-31.5
T=1000.
 C.L.=95%  LMT=+-79.9
 C.L.=90%  LMT=+-67.1
 C.L.=80%  LMT=+-52.3
 C.L.=68%  LMT=+-40.8
```

NOTE
1. XT : Magnitude of the event reached or exceeded on an average once in T years
2. T : Return period
3. C. L. : Confidence level
4. LMT : Conficence limit

(7) Probability Calculation of Maximum Daily Rainfall in July at the Climatological Station of Darmaga Bogor (CSDB).by Gumble Method (Data period : 1964 - 1989)

```
GUMBLE MAX. DISTRIBUTION

DATA N=26.
D(1)=    19.
D(2)=    47.0
D(3)=    26.0
D(4)=    60.0
D(5)=    54.0
D(6)=    70.0
D(7)=    58.0
D(8)=   103.0
D(9)=    11.0
D(10)=   54.0
D(11)=  148.0
D(12)=   44.0
D(13)=   41.0
D(14)=   28.0
D(15)=  149.0
D(16)=  137.0
D(17)=   61.0
D(18)=  146.0
D(19)=   82.0
D(20)=   81.0
D(21)=   57.0
D(22)=  103.0
D(23)=  105.0
D(24)=   69.0
D(25)=   73.0
D(26)=   51.0

RANKING
I=1.  X=149.
I=2.  X=148.
I=3.  X=146.
I=4.  X=137.
I=5.  X=105.
I=6.  X=103.
I=7.  X=103.
I=8.  X=82.
I=9.  X=81.
I=10.  X=73.
I=11.  X=70.
I=12.  X=69.
I=13.  X=61.
I=14.  X=60.
I=15.  X=58.
I=16.  X=57.
I=17.  X=54.
I=18.  X=54.
I=19.  X=51.
I=20.  X=47.
I=21.  X=44.
I=22.  X=41.
I=23.  X=28.
I=24.  X=26.
I=25.  X=19.
I=26.  X=11.

CALCULATION
SUM X= 1877.
SUM X^2= 174843.
SUM X^3= 19296155.

MEAN X= 72.19230769
MEAN X^2= 6724.730769
MEAN X^3= 742159.8077
SUM DEV SQU. S=39338.038
46
VARIANCE S/N=1513.
UNBIASED VARI. =S/(N-1)=
1573.52
VARIATION COEF.=SX/MEAN
X=0.54
STANDARD DEV. SX=√(S/N)=
38.9
STA. DEV. EST. USX=√(S/(
N-1))=39.67
SKEWNESS COEF. CS!=0.65
UNBIASED S.C. CS1=0.637

 PROBABLE EXTREAM VALUE(
XT), RETURN PERIOD(T),
FREQUENCY FUNCTION:

XT=XM+K*SX, K=(YT-YM)/SY
, XM=MEAN X, YT=-LN(LN(T
/(T-1)))
SO THAT XT=XM-(YM*SX/SY)
+(SX/SY)*YT

 CAL. VALUE:
XM=72.19230769  SX=39.67
  YM=0.5321  SY=1.0961

 ESTIMATE EQUATION:
XT=52.93+36.19YT

T=2. XT=66.2
T=4. XT=98.
T=5. XT=107.2
T=10. XT=134.4
T=20. XT=160.4
T=25. XT=168.7
T=50. XT=194.1
T=100. XT=219.4
T=200. XT=244.6
T=1000. XT=302.9

CONFIDENCE INTERVAL

T=5.
 C.L.=95%  LMT=+-25.8
 C.L.=90%  LMT=+-21.7
 C.L.=80%  LMT=+-16.9
 C.L.=68%  LMT=+-13.2
T=10.
 C.L.=95%  LMT=+-35.7
 C.L.=90%  LMT=+-30.
 C.L.=80%  LMT=+-23.4
 C.L.=68%  LMT=+-18.2
T=20.
 C.L.=95%  LMT=+-45.7
 C.L.=90%  LMT=+-38.3
 C.L.=80%  LMT=+-29.9
 C.L.=68%  LMT=+-23.3
T=25.
 C.L.=95%  LMT=+-48.9
 C.L.=90%  LMT=+-41.
 C.L.=80%  LMT=+-32.
 C.L.=68%  LMT=+-24.9
T=50.
 C.L.=95%  LMT=+-58.9
 C.L.=90%  LMT=+-49.4
 C.L.=80%  LMT=+-38.5
 C.L.=68%  LMT=+-30.
T=100.
 C.L.=95%  LMT=+-68.8
 C.L.=90%  LMT=+-57.8
 C.L.=80%  LMT=+-45.
 C.L.=68%  LMT=+-35.1
T=200.
 C.L.=95%  LMT=+-78.8
 C.L.=90%  LMT=+-66.2
 C.L.=80%  LMT=+-51.6
 C.L.=68%  LMT=+-40.2
T=1000.
 C.L.=95%  LMT=+-102.1
 C.L.=90%  LMT=+-85.7
 C.L.=80%  LMT=+-66.8
 C.L.=68%  LMT=+-52.1
```

NOTE
1. XT : Magnitude of the event reached or exceeded on an average once in T years
2. T : Return period
3. C. L. : Confidence level
4. LMT : Conficence limit

(8) Probability Calculation of Maximum Daily Rainfall in August at the Climatological Station of Darmaga Bogor (CSDB).by Gumble Method (Data period : 1964 - 1989)

```
GUMBLE MAX. DISTRIBUTION

DATA N=26.
D(1)=    44.0
D(2)=    75.0
D(3)=    26.0
D(4)=     6.0
D(5)=   101.0
D(6)=    38.0
D(7)=   117.0
D(8)=   132.0
D(9)=    22.0
D(10)=   71.0
D(11)=   81.0
D(12)=   84.0
D(13)=   96.0
D(14)=   36.0
D(15)=   53.0
D(16)=   26.0
D(17)=   45.0
D(18)=   72.0
D(19)=   31.0
D(20)=   34.0
D(21)=  114.0
D(22)=   88.0
D(23)=   71.0
D(24)=   50.0
D(25)=   63.0
D(26)=   64.0

RANKING
I=1.  X=132.
I=2.  X=117.
I=3.  X=114.
I=4.  X=101.
I=5.  X=96.
I=6.  X=88.
I=7.  X=84.
I=8.  X=81.
I=9.  X=75.
I=10.  X=72.
I=11.  X=71.
I=12.  X=71.
I=13.  X=64.
I=14.  X=63.
I=15.  X=53.
I=16.  X=50.
I=17.  X=45.
I=18.  X=44.
I=19.  X=38.
I=20.  X=36.
I=21.  X=34.
I=22.  X=31.
I=23.  X=26.
I=24.  X=26.
I=25.  X=22.
I=26.  X=6.

CALCULATION
SUM X= 1640.
SUM X^2= 129842.
SUM X^3= 11793740.

MEAN X= 63.07692308
MEAN X^2= 4993.923077
MEAN X^3= 453605.3846
SUM DEV SQU. S=26395.846
15
VARIANCE S/N=1015.22
UNBIASED VARI. =S/(N-1)=
1055.83
VARIATION COEF.=SX/MEAN
X=0.51
STANDARD DEV. SX=√(S/N)=
31.86
STA. DEV. EST. USX=√(S/(
N-1))=32.49
SKEWNESS COEF. CS!=0.326
UNBIASED S.C. CS1=0.319

 PROBABLE EXTREAM VALUE(
XT), RETURN PERIOD(T),
FREQUENCY FUNCTION:

XT=XM+K*SX, K=(YT-YM)/SY
, XM=MEAN X, YT=-LN(LN(T
/(T-1)))
SO THAT XT=XM-(YM*SX/SY)
+(SX/SY)*YT

 CAL. VALUE:
XM=63.07692308  SX=32.49
  YM=0.5321  SY=1.0961

 ESTIMATE EQUATION:
XT=47.3+29.64YT

T=2. XT=58.2
T=4. XT=84.2
T=5. XT=91.8
T=10. XT=114.
T=20. XT=135.3
T=25. XT=142.1
T=50. XT=163.
T=100. XT=183.6
T=200. XT=204.3
T=1000. XT=252.

CONFIDENCE INTERVAL

T=5.
 C.L.=95%  LMT=+-21.1
 C.L.=90%  LMT=+-17.7
 C.L.=80%  LMT=+-13.8
 C.L.=68%  LMT=+-10.8
T=10.
 C.L.=95%  LMT=+-29.3
 C.L.=90%  LMT=+-24.6
 C.L.=80%  LMT=+-19.1
 C.L.=68%  LMT=+-14.9
T=20.
 C.L.=95%  LMT=+-37.4
 C.L.=90%  LMT=+-31.4
 C.L.=80%  LMT=+-24.5
 C.L.=68%  LMT=+-19.1
T=25.
 C.L.=95%  LMT=+-40.
 C.L.=90%  LMT=+-33.6
 C.L.=80%  LMT=+-26.2
 C.L.=68%  LMT=+-20.4
T=50.
 C.L.=95%  LMT=+-48.2
 C.L.=90%  LMT=+-40.5
 C.L.=80%  LMT=+-31.5
 C.L.=68%  LMT=+-24.6
T=100.
 C.L.=95%  LMT=+-56.4
 C.L.=90%  LMT=+-47.3
 C.L.=80%  LMT=+-36.9
 C.L.=68%  LMT=+-28.8
T=200.
 C.L.=95%  LMT=+-64.6
 C.L.=90%  LMT=+-54.2
 C.L.=80%  LMT=+-42.2
 C.L.=68%  LMT=+-32.9
T=1000.
 C.L.=95%  LMT=+-83.6
 C.L.=90%  LMT=+-70.2
 C.L.=80%  LMT=+-54.7
 C.L.=68%  LMT=+-42.7
```

NOTE
1. XT : Magnitude of the event reached or exceeded on an average once in T years
2. T : Return period
3. C. L. : Confidence level
4. LMT : Conficence limit

(9) Probability Calculation of Maximum Daily Rainfall in <u>September</u> at the Climatological Station of Darmaga Bogor (CSDB).by Gumble Method (Data period : 1964 - 1989)

9A GUMBLE MAX. DISTRIBUTION

```
DATA N=26.
D(1)=    87.0
D(2)=    70.0
D(3)=    15.0
D(4)=    74.0
D(5)=    77.0
D(6)=    91.0
D(7)=   116.0
D(8)=    89.0
D(9)=    20.0
D(10)=   96.0
D(11)=   61.0
D(12)=   86.0
D(13)=   29.0
D(14)=   69.0
D(15)=  108.0
D(16)=  119.0
D(17)=  119.0
D(18)=   57.0
D(19)=   48.0
D(20)=   55.0
D(21)=   88.0
D(22)=   59.0
D(23)=   87.0
D(24)=   11.0
D(25)=   17.0
D(26)=   70.0

RANKING
I=1.  X=119.
I=2.  X=119.
I=3.  X=116.
I=4.  X=108.
I=5.  X=96.
I=6.  X=91.
I=7.  X=89.
I=8.  X=88.
I=9.  X=87.
I=10.  X=87.
I=11.  X=86.
I=12.  X=77.
I=13.  X=74.
I=14.  X=70.
I=15.  X=70.
I=16.  X=69.
I=17.  X=61.
I=18.  X=59.
I=19.  X=57.
I=20.  X=55.
I=21.  X=48.
I=22.  X=29.
I=23.  X=20.
I=24.  X=17.
I=25.  X=15.
I=26.  X=11.
```

```
CALCULATION
SUM X= 1818.
SUM X^2= 152760.
SUM X^3= 13981530.

MEAN X= 69.92307692
MEAN X^2= 5875.384615
MEAN X^3= 537751.1538
SUM DEV SQU. S=25639.846
15
VARIANCE S/N=986.15
UNBIASED VARI. =S/(N-1)=
1025.59
VARIATION COEF.=SX/MEAN
X=0.45
STANDARD DEV. SX=√(S/N)=
31.4
STA. DEV. EST. USX=√(S/(
N-1))=32.02
SKEWNESS COEF. CS!=-0.35
5
UNBIASED S.C. CS1=-0.348

 PROBABLE EXTREAM VALUE(
XT), RETURN PERIOD(T),
FREQUENCY FUNCTION:

XT=XM+K*SX, K=(YT-YM)/SY
, XM=MEAN X, YT=-LN(LN(T
/(T-1)))
SO THAT XT=XM-(YM*SX/SY)
+(SX/SY)*YT

 CAL. VALUE:
XM=69.92307692  SX=32.02
  YM=0.5321  SY=1.0961

 ESTIMATE EQUATION:
XT=54.38+29.21YT

T=2. XT=65.1
T=4. XT=90.8
T=5. XT=98.2
T=10. XT=120.1
T=20. XT=141.1
T=25. XT=147.8
T=50. XT=168.4
T=100. XT=188.8
T=200. XT=209.1
T=1000. XT=256.1
```

```
CONFIDENCE INTERVAL

T=5.
 C.L.=95%  LMT=+-20.8
 C.L.=90%  LMT=+-17.5
 C.L.=80%  LMT=+-13.6
 C.L.=68%  LMT=+-10.6
T=10.
 C.L.=95%  LMT=+-28.8
 C.L.=90%  LMT=+-24.2
 C.L.=80%  LMT=+-18.9
 C.L.=68%  LMT=+-14.7
T=20.
 C.L.=95%  LMT=+-36.9
 C.L.=90%  LMT=+-31.
 C.L.=80%  LMT=+-24.1
 C.L.=68%  LMT=+-18.8
T=25.
 C.L.=95%  LMT=+-39.5
 C.L.=90%  LMT=+-33.1
 C.L.=80%  LMT=+-25.8
 C.L.=68%  LMT=+-20.1
T=50.
 C.L.=95%  LMT=+-47.5
 C.L.=90%  LMT=+-39.9
 C.L.=80%  LMT=+-31.1
 C.L.=68%  LMT=+-24.2
T=100.
 C.L.=95%  LMT=+-55.6
 C.L.=90%  LMT=+-46.6
 C.L.=80%  LMT=+-36.3
 C.L.=68%  LMT=+-28.4
T=200.
 C.L.=95%  LMT=+-63.6
 C.L.=90%  LMT=+-53.4
 C.L.=80%  LMT=+-41.6
 C.L.=68%  LMT=+-32.5
T=1000.
 C.L.=95%  LMT=+-82.4
 C.L.=90%  LMT=+-69.2
 C.L.=80%  LMT=+-53.9
 C.L.=68%  LMT=+-42.1
```

NOTE
1. XT : Magnitude of the event reached or exceeded on an average once in T years
2. T : Return period
3. C. L. : Confidence level
4. LMT : Conficence limit

(10) Probability Calculation of Maximum Daily Rainfall in October at the Climatological Station of Darmaga Bogor (CSDB).by Gumble Method (Data period : 1964 - 1989)

```
GUMBLE MAX. DIS.  :UTION

DATA N=26.
D(1)=    50.0
D(2)=    62.0
D(3)=    46.0
D(4)=    65.0
D(5)=    35.0
D(6)=    57.0
D(7)=    33.0
D(8)=    68.0
D(9)=    72.0
D(10)=   64.0
D(11)=   80.0
D(12)=   30.0
D(13)=   35.0
D(14)=   74.0
D(15)=  109.0
D(16)=   77.0
D(17)=  129.0
D(18)=   47.0
D(19)=   63.0
D(20)=   90.0
D(21)=   85.0
D(22)=   84.0
D(23)=   48.0
D(24)=   81.0
D(25)=   53.0
D(26)=   83.0

RANKING
I=1.  X=129.
I=2.  X=109.
I=3.  X=90.
I=4.  X=85.
I=5.  X=84.
I=6.  X=83.
I=7.  X=83.
I=8.  X=81.
I=9.  X=80.
I=10. X=77.
I=11. X=74.
I=12. X=72.
I=13. X=68.
I=14. X=65.
I=15. X=64.
I=16. X=63.
I=17. X=62.
I=18. X=57.
I=19. X=53.
I=20. X=50.
I=21. X=48.
I=22. X=47.
I=23. X=46.
I=24. X=35.
I=25. X=33.
I=26. X=30.

CALCULATION
SUM X= 1768.
SUM X^2= 133390.
SUM X^3= 11015776.

MEAN X= 68.
MEAN X^2= 5130.384615
MEAN X^3= 423683.6923
SUM DEV SQU. S=13166.
VARIANCE S/N=506.38
UNBIASED VARI. =S/(N-1)=
526.64
VARIATION COEF.=SX/MEAN
X=0.33
STANDARD DEV. SX=Г(S/N)=
22.5
STA. DEV. EST. USX=Г(S/(
N-1))=22.95
SKEWNESS COEF. CS!=0.522
UNBIASED S.C. CS1=0.512

PROBABLE EXTREAM VALUE(
XT), RETURN PERIOD(T),
FREQUENCY FUNCTION:

XT=XM+K*SX, K=(YT-YM)/SY
, XM=MEAN X, YT=-LN(LN(T
/(T-1)))
SO THAT XT=XM-(YM*SX/SY)
+(SX/SY)*YT

CAL. VALUE:
XM=68.  SX=22.95  YM=0.5
321  SY=1.0961

ESTIMATE EQUATION:
XT=56.86+20.94YT

T=2. XT=64.5
T=4. XT=82.9
T=5. XT=88.3
T=10. XT=104.
T=20. XT=119.1
T=25. XT=123.8
T=50. XT=138.6
T=100. XT=153.2
T=200. XT=167.8
T=1000. XT=201.5

CONFIDENCE INTERVAL

T=5.
 C.L.=95%  LMT=+-14.9
 C.L.=90%  LMT=+-12.5
 C.L.=80%  LMT=+-9.8
 C.L.=68%  LMT=+-7.6
T=10.
 C.L.=95%  LMT=+-20.7
 C.L.=90%  LMT=+-17.3
 C.L.=80%  LMT=+-13.5
 C.L.=68%  LMT=+-10.5
T=20.
 C.L.=95%  LMT=+-26.4
 C.L.=90%  LMT=+-22.2
 C.L.=80%  LMT=+-17.3
 C.L.=68%  LMT=+-13.5
T=25.
 C.L.=95%  LMT=+-28.3
 C.L.=90%  LMT=+-23.7
 C.L.=80%  LMT=+-18.5
 C.L.=68%  LMT=+-14.4
T=50.
 C.L.=95%  LMT=+-34.1
 C.L.=90%  LMT=+-28.6
 C.L.=80%  LMT=+-22.3
 C.L.=68%  LMT=+-17.4
T=100.
 C.L.=95%  LMT=+-39.8
 C.L.=90%  LMT=+-33.4
 C.L.=80%  LMT=+-26.1
 C.L.=68%  LMT=+-20.3
T=200.
 C.L.=95%  LMT=+-45.6
 C.L.=90%  LMT=+-38.3
 C.L.=80%  LMT=+-29.8
 C.L.=68%  LMT=+-23.3
T=1000.
 C.L.=95%  LMT=+-59.1
 C.L.=90%  LMT=+-49.6
 C.L.=80%  LMT=+-38.6
 C.L.=68%  LMT=+-30.1
```

NOTE 1. XT : Magnitude of the event reached or exceeded on an average once in T years
2. T : Return period
3. C. L. : Confidence level
4. LMT : Conficence limit

(11) Probability Calculation of Maximum Daily Rainfall in <u>November</u> at the Climatological Station of Darmaga Bogor (CSDB).by Gumble Method (Data period : 1964 - 1989)

```
GUMBLE MAX. DISTRIBUTION

DATA N=26.
D(1)=    41.0
D(2)=    51.0
D(3)=    27.0
D(4)=    94.0
D(5)=    58.0
D(6)=    77.0
D(7)=    38.0
D(8)=    39.0
D(9)=    17.0
D(10)=   79.0
D(11)=   25.0
D(12)=   67.0
D(13)=   63.0
D(14)=   49.0
D(15)=   65.0
D(16)=   82.0
D(17)=   77.0
D(18)=   31.0
D(19)=   85.0
D(20)=   64.0
D(21)=   59.0
D(22)=   76.0
D(23)=   80.0
D(24)=   83.0
D(25)=   34.0
D(26)=   50.0

RANKING
I=1.  X=94.
I=2.  X=85.
I=3.  X=83.
I=4.  X=82.
I=5.  X=80.
I=6.  X=79.
I=7.  X=77.
I=8.  X=77.
I=9.  X=76.
I=10.  X=67.
I=11.  X=65.
I=12.  X=64.
I=13.  X=63.
I=14.  X=59.
I=15.  X=58.
I=16.  X=51.
I=17.  X=50.
I=18.  X=49.
I=19.  X=41.
I=20.  X=39.
I=21.  X=38.
I=22.  X=34.
I=23.  X=31.
I=24.  X=27.
I=25.  X=25.
I=26.  X=17.
```

```
CALCULATION
SUM X= 1511.
SUM X^2= 99481.
SUM X^3= 7080743.

MEAN X= 58.11538462
MEAN X^2= 3826.192308
MEAN X^3= 272336.2692
SUM DEV SQU. S=11668.653
85
VARIANCE S/N=448.79
UNBIASED VARI. =S/(N-1)=
466.75
VARIATION COEF.=SX/MEAN
X=0.36
STANDARD DEV. SX=√(S/N)=
21.18
STA. DEV. EST. USX=√(S/(
N-1))=21.6
SKEWNESS COEF. CS!=-0.23
UNBIASED S.C. CS1=-0.226

 PROBABLE EXTREAM VALUE(
XT), RETURN PERIOD(T),
FREQUENCY FUNCTION:

XT=XM+K*SX, K=(YT-YM)/SY
, XM=MEAN X, YT=-LN(LN(T
/(T-1)))
SO THAT XT=XM-(YM*SX/SY)
+(SX/SY)*YT

 CAL. VALUE:
XM=58.11538462  SX=21.6
 YM=0.5321  SY=1.0961

 ESTIMATE EQUATION:
XT=47.63+19.71YT

T=2. XT=54.9
T=4. XT=72.2
T=5. XT=77.2
T=10. XT=92.
T=20. XT=106.2
T=25. XT=110.7
T=50. XT=124.5
T=100. XT=138.3
T=200. XT=152.
T=1000. XT=183.8
```

```
CONFIDENCE INTERVAL

T=5.
 C.L.=95%  LMT=+-14.1
 C.L.=90%  LMT=+-11.8
 C.L.=80%  LMT=+-9.2
 C.L.=68%  LMT=+-7.2
T=10.
 C.L.=95%  LMT=+-19.5
 C.L.=90%  LMT=+-16.3
 C.L.=80%  LMT=+-12.7
 C.L.=68%  LMT=+-9.9
T=20.
 C.L.=95%  LMT=+-24.9
 C.L.=90%  LMT=+-20.9
 C.L.=80%  LMT=+-16.3
 C.L.=68%  LMT=+-12.7
T=25.
 C.L.=95%  LMT=+-26.6
 C.L.=90%  LMT=+-22.3
 C.L.=80%  LMT=+-17.4
 C.L.=68%  LMT=+-13.6
T=50.
 C.L.=95%  LMT=+-32.1
 C.L.=90%  LMT=+-26.9
 C.L.=80%  LMT=+-21.
 C.L.=68%  LMT=+-16.4
T=100.
 C.L.=95%  LMT=+-37.5
 C.L.=90%  LMT=+-31.5
 C.L.=80%  LMT=+-24.5
 C.L.=68%  LMT=+-19.1
T=200.
 C.L.=95%  LMT=+-42.9
 C.L.=90%  LMT=+-36.
 C.L.=80%  LMT=+-28.1
 C.L.=68%  LMT=+-21.9
T=1000.
 C.L.=95%  LMT=+-55.6
 C.L.=90%  LMT=+-46.7
 C.L.=80%  LMT=+-36.4
 C.L.=68%  LMT=+-28.4
```

NOTE
1. XT : Magnitude of the event reached or exceeded on an average once in T years
2. T : Return period
3. C. L. : Confidence level
4. LMT : Conficence limit

(12) Probability Calculation of Maximum Daily Rainfall in <u>December</u> at the Climatological Station of Darmaga Bogor (CSDB).by Gumble Method (Data period : 1964 - 1989)

```
GUMBLE MAX. DISTRIBUTION

DATA N=26.
D(1)=    49.0
D(2)=   112.0
D(3)=    23.0
D(4)=    52.0
D(5)=    37.0
D(6)=    25.0
D(7)=    30.0
D(8)=    35.0
D(9)=    44.0
D(10)=   87.0
D(11)=   38.0
D(12)=   48.0
D(13)=   58.0
D(14)=   80.0
D(15)=   53.0
D(16)=   40.0
D(17)=  144.0
D(18)=  128.0
D(19)=  111.0
D(20)=   [illegible]
D(21)=   33.0
D(22)=   59.0
D(23)=   82.0
D(24)=   31.0
D(25)=   59.0
D(26)=  104.0

RANKING
I=1.  X=144.
I=2.  X=128.
I=3.  X=112.
I=4.  X=111.
I=5.  X=104.
I=6.  X=87.
I=7.  X=82.
I=8.  X=80.
I=9.  X=60.
I=10.  X=59.
I=11.  X=58.
I=12.  X=56.
I=13.  X=53.
I=14.  X=52.
I=15.  X=49.
I=16.  X=48.
I=17.  X=44.
I=18.  X=40.
I=19.  X=38.
I=20.  X=37.
I=21.  X=35.
I=22.  X=33.
I=23.  X=31.
I=24.  X=30.
I=25.  X=25.
I=26.  X=23.
```

```
CALCULATION
SUM X= 1619.
SUM X^2= 128971.
SUM X^3= 12430367.

MEAN X= 62.26923077
MEAN X^2= 4960.423077
MEAN X^3= 478091.0385
SUM DEV SQU. S=28157.115
39
VARIANCE S/N=1082.97
UNBIASED VARI. =S/(N-1)=
1126.28
VARIATION COEF.=SX/MEAN
X=0.53
STANDARD DEV. SX=√(S/N)=
32.91
STA. DEV. EST. USX=√(S/(
N-1))=33.56
SKEWNESS COEF. CS!=0.964
UNBIASED S.C. CS1=0.945

 PROBABLE EXTREAM VALUE(
XT), RETURN PERIOD(T),
FREQUENCY FUNCTION:

XT=XM+K*SX, K=(YT-YM)/SY
, XM=MEAN X, YT=-LN(LN(T
/(T-1)))
SO THAT XT=XM-(YM*SX/SY)
+(SX/SY)*YT

 CAL. VALUE:
XM=62.26923077  SX=33.56
  YM=0.5321  SY=1.0961

 ESTIMATE EQUATION:
XT=45.98+30.62YT

T=2. XT=57.2
T=4. XT=84.1
T=5. XT=91.9
T=10. XT=114.9
T=20. XT=136.9
T=25. XT=143.9
T=50. XT=165.5
T=100. XT=186.8
T=200. XT=208.1
T=1000. XT=257.5
```

```
CONFIDENCE INTERVAL

T=5.
 C.L.=95%  LMT=+-21.8
 C.L.=90%  LMT=+-18.3
 C.L.=80%  LMT=+-14.3
 C.L.=68%  LMT=+-11.1
T=10.
 C.L.=95%  LMT=+-30.2
 C.L.=90%  LMT=+-25.4
 C.L.=80%  LMT=+-19.8
 C.L.=68%  LMT=+-15.4
T=20.
 C.L.=95%  LMT=+-38.7
 C.L.=90%  LMT=+-32.4
 C.L.=80%  LMT=+-25.3
 C.L.=68%  LMT=+-19.7
T=25.
 C.L.=95%  LMT=+-41.4
 C.L.=90%  LMT=+-34.7
 C.L.=80%  LMT=+-27.1
 C.L.=68%  LMT=+-21.1
T=50.
 C.L.=95%  LMT=+-49.8
 C.L.=90%  LMT=+-41.8
 C.L.=80%  LMT=+-32.6
 C.L.=68%  LMT=+-25.4
T=100.
 C.L.=95%  LMT=+-58.2
 C.L.=90%  LMT=+-48.9
 C.L.=80%  LMT=+-38.1
 C.L.=68%  LMT=+-29.7
T=200.
 C.L.=95%  LMT=+-66.7
 C.L.=90%  LMT=+-56.
 C.L.=80%  LMT=+-43.6
 C.L.=68%  LMT=+-34.
T=1000.
 C.L.=95%  LMT=+-86.4
 C.L.=90%  LMT=+-72.5
 C.L.=80%  LMT=+-56.5
 C.L.=68%  LMT=+-44.1
```

NOTE
1. XT : Magnitude of the event reached or exceeded on an average once in T years
2. T : Return period
3. C. L. : Confidence level
4. LMT : Conficence. limit

(13) Probability Calculation of Annual Maximum Daily Rainfall at the Climatological Station of Darmaga Bogor (CSDB).by Gumble Method (Data period : 1964 - 1989)

```
GUMBLE MAX. DISTRIBUTION

DATA N=26.
D(1)=   100.0
D(2)=   112.0
D(3)=    99.0
D(4)=    94.0
D(5)=   103.0
D(6)=    99.0
D(7)=   117.0
D(8)=   132.0
D(9)=    88.0
D(10)=  113.0
D(11)=  148.0
D(12)=  177.0
D(13)=  181.0
D(14)=   84.0
D(15)=  149.0
D(16)=  137.0
D(17)=  144.0
D(18)=  146.0
D(19)=  111.0
D(20)=   90.0
D(21)=  114.0
D(22)=  105.0
D(23)=  110.0
D(24)=   88.0
D(25)=   89.0
D(26)=  240.0

RANKING
I=1.  X=240.
I=2.  X=181.
I=3.  X=177.
I=4.  X=149.
I=5.  X=148.
I=6.  X=146.
I=7.  X=144.
I=8.  X=137.
I=9.  X=132.
I=10.  X=117.
I=11.  X=114.
I=12.  X=113.
I=13.  X=112.
I=14.  X=111.
I=15.  X=110.
I=16.  X=105.
I=17.  X=103.
I=18.  X=100.
I=19.  X=99.
I=20.  X=99.
I=21.  X=94.
I=22.  X=90.
I=23.  X=89.
I=24.  X=88.
I=25.  X=88.
I=26.  X=84.
```

```
CALCULATION
SUM X= 3170.
SUM X^2= 419096.
SUM X^3= 60858920.

MEAN X= 121.9230769
MEAN X^2= 16119.07692
MEAN X^3= 2340727.692
SUM DEV SQU. S=32599.846
15
VARIANCE S/N=1253.84
UNBIASED VARI. =S/(N-1)=
1303.99
VARIATION COEF.=SX/MEAN
X=0.29
STANDARD DEV. SX=√(S/N)=
35.41
STA. DEV. EST. USX=√(S/(
N-1))=36.11
SKEWNESS COEF. CS!=1.57
UNBIASED S.C. CS1=1.539

 PROBABLE EXTREAM VALUE(
XT), RETURN PERIOD(T),
FREQUENCY FUNCTION:

XT=XM+K*SX, K=(YT-YM)/SY
, XM=MEAN X, YT=-LN(LN(T
/(T-1)))
SO THAT XT=XM-(YM*SX/SY)
+(SX/SY)*YT

 CAL. VALUE:
XM=121.9230769  SX=36.11
  YM=0.5321  SY=1.0961

 ESTIMATE EQUATION:
XT=104.39+32.94YT

T=2. XT=116.5
T=4. XT=145.4
T=5. XT=153.8
T=10. XT=178.5
T=20. XT=202.2
T=25. XT=209.7
T=50. XT=232.9
T=100. XT=255.9
T=200. XT=278.8
T=1000. XT=331.9
```

```
CONFIDENCE INTERVAL

T=5.
 C.L.=95%  LMT=+-23.5
 C.L.=90%  LMT=+-19.7
 C.L.=80%  LMT=+-15.4
 C.L.=68%  LMT=+-12.
T=10.
 C.L.=95%  LMT=+-32.5
 C.L.=90%  LMT=+-27.3
 C.L.=80%  LMT=+-21.3
 C.L.=68%  LMT=+-16.6
T=20.
 C.L.=95%  LMT=+-41.6
 C.L.=90%  LMT=+-34.9
 C.L.=80%  LMT=+-27.2
 C.L.=68%  LMT=+-21.2
T=25.
 C.L.=95%  LMT=+-44.5
 C.L.=90%  LMT=+-37.4
 C.L.=80%  LMT=+-29.1
 C.L.=68%  LMT=+-22.7
T=50.
 C.L.=95%  LMT=+-53.5
 C.L.=90%  LMT=+-45.
 C.L.=80%  LMT=+-35.
 C.L.=68%  LMT=+-27.3
T=100.
 C.L.=95%  LMT=+-62.7
 C.L.=90%  LMT=+-52.6
 C.L.=80%  LMT=+-41.
 C.L.=68%  LMT=+-32.
T=200.
 C.L.=95%  LMT=+-71.8
 C.L.=90%  LMT=+-60.2
 C.L.=80%  LMT=+-46.9
 C.L.=68%  LMT=+-36.6
T=1000.
 C.L.=95%  LMT=+-92.9
 C.L.=90%  LMT=+-78.
 C.L.=80%  LMT=+-60.8
 C.L.=68%  LMT=+-47.4
```

NOTE
1. XT : Magnitude of the event reached or exceeded on an average once in T years
2. T : Return period
3. C. L. : Confidence level
4. LMT : Conficence limit

Table C1-14

The Highest Rainfall (mm) for the Short Duration in the Month and Annual at the CSDB

No. 1	1985, 1986
No. 2	1987, 1988
No. 3	1989

The Highest Rainfall for the Short Duration in the Month and Annual at the CSDB.

No. 1

Month	Minutes						Hours				
	5	10	15	30	45	60	2	3	6	12	24
A. Records											
1985											
Jan.	14.7	29.4	39.2	58.8	62.0	73.1	73.1	73.4	73.4	73.4	73.4
Feb.	10.2	20.4	25.5	39.9	55.7	63.6	74.8	83.2	101.5	105.0	105.0
Mar.	10.0	18.0	20.0	36.0	47.0	50.0	60.5	63.5	64.0	64.0	64.0
Apr.	9.9	19.9	29.8	49.7	62.4	62.8	63.8	63.9	64.0	64.0	64.0
May	9.9	19.8	29.7	44.6	55.6	60.4	62.1	62.5	62.9	62.9	62.9
Jun.	9.0	10.0	16.0	27.8	28.7	30.0	33.5	34.1	34.4	35.9	35.9
Jul.	20.0	30.0	45.0	60.0	72.0	85.0	90.0	94.0	102.7	102.7	102.7
Aug.	20.2	25.3	35.4	60.6	75.8	84.3	87.7	87.7	87.7	87.7	86.8
Sep.	10.4	13.0	17.0	28.0	35.3	42.5	43.2	43.7	58.5	58.7	58.7
Oct.	10.0	16.0	20.0	40.0	54.0	60.0	78.9	83.5	84.0	84.0	84.0
Nov.	10.0	15.0	20.0	36.0	45.5	48.4	48.4	48.4	76.7	76.7	76.7
Dec.	10.0	19.0	23.0	34.0	38.0	40.0	60.5	60.5	60.5	60.5	60.5
Annual Max											
mm	20.2	30.0	45.0	60.6	75.8	85.0	90.0	94.0	102.7	105.0	105.0
mm/hr	242.4	180.0	180.0	121.2	101.1	85.0	45.0	31.3	17.1	8.8	4.4
1986											
Jan.	7.5	13.0	20.0	34.0	38.0	39.9	39.9	39.9	39.9	40.5	41.0
Feb.	20.0	30.0	40.0	60.0	68.0	82.5	98.0	102.5	104.7	104.7	104.7
Mar.	10.0	20.0	24.0	38.0	54.0	64.0	80.0	96.0	104.2	104.2	104.2
Apr.	10.0	20.0	23.0	40.0	54.0	54.9	55.3	55.4	55.4	55.4	55.4
May	20.0	30.0	40.0	50.0	66.0	71.4	71.4	71.4	71.4	71.4	71.4
Jun.	10.0	20.0	30.0	60.0	65.0	68.8	80.0	90.0	112.5	113.8	113.8
Jul.	10.0	20.0	30.0	50.0	55.0	70.0	104.5	104.8	104.8	104.8	104.8
Aug.	20.0	30.0	35.0	50.0	58.0	62.0	66.4	66.4	67.0	70.4	70.4
Sep.	20.0	30.0	37.0	49.0	52.0	70.0	72.5	72.5	80.6	88.8	88.8
Oct.	10.0	18.0	26.0	35.9	36.3	40.0	44.8	46.4	47.4	47.4	47.4
Nov.	15.0	20.0	30.0	40.0	58.0	62.5	74.5	78.0	78.4	78.4	78.4
Dec.	15.0	25.0	35.0	60.0	62.0	76.0	80.5	80.5	80.5	80.5	80.5
Annual Max											
mm	20.0	30.0	40.0	60.0	68.0	82.5	104.5	104.8	112.5	113.8	113.8
mm/hr	240.0	180.0	160.0	120.0	90.7	82.5	52.3	34.9	18.8	9.5	4.7

The Highest Rainfall for the Short Duration in the Month and Annual at the CSDB.

No. 2

Month	Minutes						Hours				
	5	10	15	30	45	60	2	3	6	12	24
1987											
Jan.	10.0	17.0	20.0	32.0	39.0	37.0	40.0	42.5	43.4	43.4	43.4
Feb.	7.0	9.8	10.0	20.0	30.5	30.0	30.9	32.5	32.5	32.5	67.4
Mar.	10.0	18.7	18.9	25.0	33.0	37.0	60.0	64.5	67.4	67.4	67.4
Apr.	17.0	20.0	25.0	33.0	36.0	50.0	61.0	72.5	76.8	76.8	76.8
May	15.0	25.0	39.0	43.0	64.0	67.0	85.0	87.9	87.9	87.9	87.9
Jun.	14.0	20.0	25.0	34.0	46.0	52.0	59.0	59.0	64.0	64.0	64.0
Jul.	10.0	20.0	27.0	40.0	60.0	63.5	68.5	69.5	70.2	70.2	70.2
Aug.	10.0	20.0	30.0	40.0	48.0	50.0	50.3	50.3	50.3	50.3	50.3
Sep.	5.5	9.5	10.0	10.1	10.2	10.3	11.3	11.3	11.3	11.3	11.3
Oct.	10.0	20.0	23.0	42.0	54.0	60.0	72.3	72.3	83.0	83.0	83.0
Nov.	16.0	20.0	26.0	37.0	45.5	55.0	75.5	77.0	77.0	82.5	82.5
Dec.	7.3	9.5	12.7	15.5	17.5	27.1	29.2	29.2	29.2	29.8	29.8
Annual Max											
mm	17.0	25.0	39.0	43.0	64.0	67.0	85.0	87.9	87.9	87.9	87.9
mm/hr	204.0	150.0	156.0	86.0	85.3	67.0	42.5	29.3	14.7	7.3	3.7
1988											
Jan.	10.0	20.0	26.0	40.0	56.0	71.0	74.0	74.0	74.0	90.0	90.0
Feb.	10.0	20.0	27.0	40.0	50.0	66.0	67.0	67.0	67.0	67.0	67.0
Mar.	10.0	15.0	20.0	31.0	33.5	34.0	50.0	53.0	58.8	59.0	59.0
Apr.	15.0	20.0	30.0	50.0	65.6	70.5	75.0	75.6	86.7	86.7	86.7
May	9.6	16.8	19.8	34.8	39.1	40.3	52.4	55.6	80.2	80.2	80.2
Jun.	9.5	16.5	21.0	28.6	30.0	33.8	34.0	34.4	64.3	64.3	64.3
Jul.	9.8	19.6	31.5	41.3	46.1	48.7	52.5	61.8	69.8	70.0	70.0
Aug.	8.5	10.2	20.1	35.5	36.6	36.9	37.0	37.0	60.5	63.1	63.1
Sep.	6.5	8.7	9.6	13.0	14.9	15.8	15.9	15.9	16.7	16.7	16.7
Oct.	8.0	10.2	12.2	20.4	25.4	26.5	43.8	47.3	51.3	52.1	52.1
Nov.	6.0	10.0	14.7	20.2	30.2	31.7	33.5	33.9	33.9	33.9	33.9
Dec.	10.0	20.0	20.4	33.2	38.0	40.6	40.6	40.6	46.5	49.0	49.0
Annual Max											
mm	15.0	20.0	31.5	50.0	56.0	71.0	74.0	74.0	86.7	86.7	86.7
mm/hr	180.0	120.0	126.0	100.0	74.7	71.0	37.0	24.7	14.5	7.2	3.6

The Highest Rainfall for the Short Duration in the Month and Annual at the CSDB.

No. 3

Month	Minutes						Hours				
	5	10	15	30	45	60	2	3	6	12	24
1989											
Jan.	8.0	10.2	19.4	31.4	48.6	58.9	69.0	75.0	75.2	75.2	75.2
Feb.	10.1	17.1	22.9	36.7	40.2	43.9	67.5	87.4	127.4	226.3	233.1
Mar.	10.2	20.1	23.9	32.3	33.8	35.4	52.4	54.7	54.7	54.7	54.8
Apr.	18.6	21.8	22.8	29.3	32.1	33.9	38.3	40.1	40.7	40.8	40.8
May	10.0	20.0	25.5	47.3	60.0	71.7	78.2	82.8	122.6	123.6	133.6
Jun.	9.0	12.3	18.0	28.0	41.0	63.0	77.0	91.1	92.7	92.7	92.7
Jul.	11.0	19.0	25.0	42.0	48.3	50.2	50.6	50.7	50.7	50.7	50.7
Aug.	10.0	15.0	24.8	41.0	49.7	52.1	53.7	56.3	60.0	62.7	62.7
Sep.	14.0	24.0	34.0	53.0	54.1	54.1	70.3	70.3	70.3	70.3	70.3
Oct.	16.0	30.0	40.0	44.5	54.0	57.0	59.0	61.5	61.5	61.7	61.7
Nov.	11.2	21.2	25.0	31.3	40.0	41.3	61.0	73.5	83.4	83.4	83.4
Dec.	20.0	26.0	31.0	54.0	75.0	82.0	91.1	94.1	103.5	103.5	103.5
Annual Max											
mm	18.6	30.0	40.0	54.0	75.0	82.0	91.1	94.1	127.4	226.3	233.1
mm/hr	223.2	180.0	160.0	108.0	100.0	82.0	45.6	31.4	21.2	18.9	9.7

B. Maximum of Records (1985 - 1988)

mm	20.2	30.0	40.0	60.0	75.0	82.5	104.5	104.8	127.4	226.3	233.1
mm/hr	242.2	180.0	160.0	120.0	100.0	82.5	52.3	34.9	21.2	18.9	9.7

Table C1-15

Calculation of Probability of Exceedance on the Data
of the Short Duration Rainfall Intensity (mm/hr)
Data Period 5 years

No. 1 5 minutes, 10 minutes, 15 minutes

No. 2 30 minutes, 45 minutes, 60 minutes

No. 3 2 hours, 3 hours, 6 hours

No. 4 12 hours, 24 hours

Probability Calculation of Rainfall Intensity for the short duration at the CSDB (unit: mm/hr) : No. 1

IWAI METHOD 5 min.

DATA N=5.
D(1)=242.4
D(2)=240.
D(3)=204.
D(4)=180.
D(5)=223.2
RANKING & PLOTTING POSIT
ION

P. OF EXCEEDANCE

RANK (J)	DATA (X)	WEIBULL J/(N+1)	PLOT% F=1-P
1.	242.4	16.7	83.3
2.	240.	33.3	66.7
3.	223.2	50.	50.
4.	204.	66.7	33.3
5.	180.	83.3	16.7

CALCULATION
SUM X= 1089.6
MEAN X= 217.92
SUM OF DEVIATION SQUARE
S=2746.368
VARIANCE S/N=549.27
S/(N-1)=686.592
SD/(MEAN X)=0.108
SD=√(S/N)=23.437
USD=√(S/(N-1))=26.203
SKEWNESS CFT. CS!=-0.491
6
UNBIASED S.C. CS1=-0.439
7

MEAN LOG(XI)=2.335668144
XG=216.6

CAL. OF B-VALUE
1. T=242.4 S=180.
B(1.)=-304.0333333

MEAN B=-304.03

USED B=0.
X0=216.6
LOG(X0+B)=2.33567
1/A=0.07643 SX=0.04825

IWAI FORMULA
LOG(Y+(0.))=2.33567
+0.07643*KSI(YR)

PROBABILITY	IWAI
Y(2)	216.6
Y(3)	228.5
Y(4)	235.6
Y(5)	240.5
Y(10)	254.1
Y(20)	265.8
Y(25)	269.3
Y(50)	279.7
Y(100)	289.3

IWAI METHOD 10 min.

DATA N=5.
D(1)=180.
D(2)=180.
D(3)=150.
D(4)=120.
D(5)=180.
RANKING & PLOTTING POSIT
ION

P. OF EXCEEDANCE

RANK (J)	DATA (X)	WEIBULL J/(N+1)	PLOT% F=1-P
1.	180.	16.7	83.3
2.	180.	33.3	66.7
3.	180.	50.	50.
4.	150.	66.7	33.3
5.	120.	83.3	16.7

CALCULATION
SUM X= 810.
MEAN X= 162.
SUM OF DEVIATION SQUARE
S=2880.
VARIANCE S/N=576.
S/(N-1)=720.
SD/(MEAN X)=0.148
SD=√(S/N)=24.
USD=√(S/(N-1))=26.833
SKEWNESS CFT. CS!=-0.843
8
UNBIASED S.C. CS1=-0.754
7

MEAN LOG(XI)=2.204218004
XG=160.04

CAL. OF B-VALUE
1. T=180. S=120.
B(1.)=-199.8407171

MEAN B=-199.84

USED B=0.
X0=160.04
LOG(X0+B)=2.20422
1/A=0.1101 SX=0.06957

IWAI FORMULA
LOG(Y+(0.))=2.20422
+0.1101*KSI(YR)

PROBABILITY	IWAI
Y(2)	160.
Y(3)	172.9
Y(4)	180.6
Y(5)	186.1
Y(10)	201.4
Y(20)	214.9
Y(25)	219.
Y(50)	231.3
Y(100)	242.8

IWAI METHOD 15 min.

DATA N=5.
D(1)=180.
D(2)=160.
D(3)=156.
D(4)=126.
D(5)=160.
RANKING & PLOTTING POSIT
ION

P. OF EXCEEDANCE

RANK (J)	DATA (X)	WEIBULL J/(N+1)	PLOT% F=1-P
1.	180.	16.7	83.3
2.	160.	33.3	66.7
3.	160.	50.	50.
4.	156.	66.7	33.3
5.	126.	83.3	16.7

CALCULATION
SUM X= 782.
MEAN X= 156.4
SUM OF DEVIATION SQUARE
S=1507.2
VARIANCE S/N=301.44
S/(N-1)=376.8
SD/(MEAN X)=0.111
SD=√(S/N)=17.362
USD=√(S/(N-1))=19.411
SKEWNESS CFT. CS!=-0.567
8
UNBIASED S.C. CS1=-0.507
8

MEAN LOG(XI)=2.191401522
XG=155.38

CAL. OF B-VALUE
1. T=180. S=126.
B(1.)=-307.3412605

MEAN B=-307.34

USED B=0.
X0=155.38
LOG(X0+B)=2.1914
1/A=0.07966 SX=0.05045

IWAI FORMULA
LOG(Y+(0.))=2.1914
+0.07966*KSI(YR)

PROBABILITY	IWAI
Y(2)	155.4
Y(3)	164.3
Y(4)	169.6
Y(5)	173.3
Y(10)	183.5
Y(20)	192.3
Y(25)	195.
Y(50)	202.8
Y(100)	210.1

Probability Calculation of Rainfall Intensity for the short duration at the CSDB (unit: mm/hr) : No. 2

IWAI METHOD 30 min.

DATA N=5.
D(1)=121.2
D(2)=120.
D(3)=86.
D(4)=100.
D(5)=108.
RANKING & PLOTTING POSIT
ION

P. OF EXCEEDANCE

RANK	DATA	WEIBULL	PLOT%
(J)	(X)	J/(N+1)	F=1-P
1.	121.2	16.7	83.3
2.	120.	33.3	66.7
3.	108.	50.	50.
4.	100.	66.7	33.3
5.	86.	83.3	16.7

CALCULATION
SUM X= 535.2
MEAN X= 107.04
SUM OF DEVIATION SQUARE
S=861.632
VARIANCE S/N=172.33
S/(N-1)=215.408
SD/(MEAN X)=0.123
SD=√(S/N)=13.127
USD=√(S/(N-1))=14.677
SKEWNESS CFT. CS!=-0.410
8
UNBIASED S.C. CS1=-0.367
4

MEAN LOG(XI)=2.026121214
XG=106.2

CAL. OF B-VALUE
1. T=121.2 S=86.
B(1.)=-164.4692308

MEAN B=-164.47

USED B=0.
X0=106.2
LOG(X0+B)=2.02612
1/A=0.08729 SX=0.05525

IWAI FORMULA
LOG(Y+(0.))=2.02612
+0.08729*KSI(YR)

PROBABILITY	IWAI
Y(2)	106.2
Y(3)	112.9
Y(4)	116.9
Y(5)	119.7
Y(10)	127.4
Y(20)	134.2
Y(25)	136.2
Y(50)	142.2
Y(100)	147.8

IWAI METHOD 45 min.

DATA N=5.
D(1)=101.1
D(2)=90.7
D(3)=85.3
D(4)=74.7
D(5)=100.
RANKING & PLOTTING POSIT
ION

P. OF EXCEEDANCE

RANK	DATA	WEIBULL	PLOT%
(J)	(X)	J/(N+1)	F=1-P
1.	101.1	16.7	83.3
2.	100.	33.3	66.7
3.	90.7	50.	50.
4.	85.3	66.7	33.3
5.	74.7	83.3	16.7

CALCULATION
SUM X= 451.8
MEAN X= 90.36
SUM OF DEVIATION SQUARE
S=479.232
VARIANCE S/N=95.85
S/(N-1)=119.808
SD/(MEAN X)=0.108
SD=√(S/N)=9.79
USD=√(S/(N-1))=10.946
SKEWNESS CFT. CS!=-0.391
2
UNBIASED S.C. CS1=-0.349
9

MEAN LOG(XI)=1.953325615
XG=89.81

CAL. OF B-VALUE
1. T=101.1 S=74.7
B(1.)=-134.4675654

MEAN B=-134.47

USED B=0.
X0=89.81
LOG(X0+B)=1.95333
1/A=0.07663 SX=0.04829

IWAI FORMULA
LOG(Y+(0.))=1.95333
+0.07663*KSI(YR)

PROBABILITY	IWAI
Y(2)	89.8
Y(3)	94.8
Y(4)	97.7
Y(5)	99.8
Y(10)	105.4
Y(20)	110.3
Y(25)	111.7
Y(50)	116.
Y(100)	120.1

IWAI METHOD 60 min.

DATA N=5.
D(1)=85.
D(2)=82.5
D(3)=67.
D(4)=71.
D(5)=82.
RANKING & PLOTTING POSIT
ION

P. OF EXCEEDANCE

RANK	DATA	WEIBULL	PLOT%
(J)	(X)	J/(N+1)	F=1-P
1.	85.	16.7	83.3
2.	82.5	33.3	66.7
3.	82.	50.	50.
4.	71.	66.7	33.3
5.	67.	83.3	16.7

CALCULATION
SUM X= 387.5
MEAN X= 77.5
SUM OF DEVIATION SQUARE
S=254.
VARIANCE S/N=50.8
S/(N-1)=63.5
SD/(MEAN X)=0.092
SD=√(S/N)=7.127
USD=√(S/(N-1))=7.969
SKEWNESS CFT. CS!=-0.438
8
UNBIASED S.C. CS1=-0.392
5

MEAN LOG(XI)=1.887403976
XG=77.16

CAL. OF B-VALUE
1. T=85. S=67.
B(1.)=-111.4937931

MEAN B=-111.49

USED B=0.
X0=77.16
LOG(X0+B)=1.8874
1/A=0.06471 SX=0.04111

IWAI FORMULA
LOG(Y+(0.))=1.8874
+0.06471*KSI(YR)

PROBABILITY	IWAI
Y(2)	77.2
Y(3)	80.7
Y(4)	82.8
Y(5)	84.3
Y(10)	88.3
Y(20)	91.8
Y(25)	92.8
Y(50)	95.8
Y(100)	98.6

Probability Calculation of Rainfall Intensity for the short duration at the CSDB (unit: mm/hr) : No. 3

IWAI METHOD 2 hours

```
DATA N=5.
D(1)=45.
D(2)=52.3
D(3)=42.5
D(4)=37.
D(5)=45.6
RANKING & PLOTTING POSIT
ION

P. OF EXCEEDANCE
RANK DATA WEIBULL PLOT%
(J)  (X)  J/(N+1) F=1-P
1.  52.3   16.7    83.3
2.  45.6   33.3    66.7
3.  45.    50.     50.
4.  42.5   66.7    33.3
5.  37.    83.3    16.7

   CALCULATION
SUM X= 222.4
MEAN X= 44.48
SUM OF DEVIATION SQUARE
  S=122.548
VARIANCE S/N=24.51
S/(N-1)=30.637
SD/(MEAN X)=0.111
SD=√(S/N)=4.951
USD=√(S/(N-1))=5.535
SKEWNESS CFT. CS!=0.0881
UNBIASED S.C. CS1=0.0788

MEAN LOG(XI)=1.64545394
XG=44.2

CAL. OF B-VALUE
1.  T=52.3  S=37.
  B(1.)=20.6

 MEAN B=20.6

USED B=20.6
X0=44.29
LOG(X0+B)=1.81219
1/A=0.05234  SX=0.03301

  IWAI FORMULA
LOG(Y+(20.6))=1.81219
    +0.05234*KSI(YR)

PROBABILITY IWAI
   Y(2)          44.3
   Y(3)          46.7
   Y(4)          48.1
   Y(5)          49.1
  Y(10)          51.8
  Y(20)          54.1
  Y(25)          54.7
  Y(50)          56.7
 Y(100)          58.5
```

IWAI METHOD 3 hours

```
DATA N=5.
D(1)=31.3
D(2)=34.9
D(3)=29.3
D(4)=24.7
D(5)=31.4
RANKING & PLOTTING POSIT
ION

P. OF EXCEEDANCE
RANK DATA WEIBULL PLOT%
(J)  (X)  J/(N+1) F=1-P
1.  34.9   16.7    83.3
2.  31.4   33.3    66.7
3.  31.3   50.     50.
4.  29.3   66.7    33.3
5.  24.7   83.3    16.7

   CALCULATION
SUM X= 151.6
MEAN X= 30.32
SUM OF DEVIATION SQUARE
  S=55.728
VARIANCE S/N=11.15
S/(N-1)=13.932
SD/(MEAN X)=0.11
SD=√(S/N)=3.339
USD=√(S/(N-1))=3.733
SKEWNESS CFT. CS!=-0.431
4
UNBIASED S.C. CS1=-0.385
8

MEAN LOG(XI)=1.478972797
XG=30.13

CAL. OF B-VALUE
1.  T=34.9  S=24.7
  B(1.)=-69.37409091

 MEAN B=-69.37

USED B=0.
X0=30.13
LOG(X0+B)=1.47897
1/A=0.07831  SX=0.04961

  IWAI FORMULA
LOG(Y+(0.))=1.47897
    +0.07831*KSI(YR)

PROBABILITY IWAI
   Y(2)          30.1
   Y(3)          31.8
   Y(4)          32.8
   Y(5)          33.5
  Y(10)          35.5
  Y(20)          37.2
  Y(25)          37.7
  Y(50)          39.1
 Y(100)          40.5
```

IWAI METHOD 6 hours

```
DATA N=5.
D(1)=14.7
D(2)=14.5
D(3)=17.1
D(4)=18.8
D(5)=21.6
RANKING & PLOTTING POSIT
ION

P. OF EXCEEDANCE
RANK DATA WEIBULL PLOT%
(J)  (X)  J/(N+1) F=1-P
1.  21.6   16.7    83.3
2.  18.8   33.3    66.7
3.  17.1   50.     50.
4.  14.7   66.7    33.3
5.  14.5   83.3    16.7

   CALCULATION
SUM X= 86.7
MEAN X= 17.34
SUM OF DEVIATION SQUARE
  S=35.372
VARIANCE S/N=7.07
S/(N-1)=8.843
SD/(MEAN X)=0.153
SD=√(S/N)=2.66
USD=√(S/(N-1))=2.974
SKEWNESS CFT. CS1=0.4155
UNBIASED S.C. CS1=0.3716

MEAN LOG(XI)=1.234058609
XG=17.14

CAL. OF B-VALUE
1.  T=21.6  S=14.5
  B(1.)=-10.67054945

 MEAN B=-10.67

USED B=0.
X0=17.14
LOG(X0+B)=1.23406
1/A=0.10351  SX=0.06544

  IWAI FORMULA
LOG(Y+(0.))=1.23406
    +0.10351*KSI(YR)

PROBABILITY IWAI
   Y(2)          17.1
   Y(3)          18.4
   Y(4)          19.2
   Y(5)          19.8
  Y(10)          21.3
  Y(20)          22.6
  Y(25)          23.
  Y(50)          24.2
 Y(100)          25.4
```

Probability Calculation of Rainfall Intensity for the short duration at the CSDB (unit: mm/hr) : No. 4

IWAI METHOD 12 hours

DATA N=5.
D(1)=7.3
D(2)=7.2
D(3)=8.8
D(4)=9.5
D(5)=18.9
RANKING & PLOTTING POSIT
ION

P. OF EXCEEDANCE

RANK (J)	DATA (X)	WEIBULL J/(N+1)	PLOT% F=1-P
1.	18.9	16.7	83.3
2.	9.5	33.3	66.7
3.	8.8	50.	50.
4.	7.3	66.7	33.3
5.	7.2	83.3	16.7

CALCULATION
SUM X= 51.7
MEAN X= 10.34
SUM OF DEVIATION SQUARE
S=95.452
VARIANCE S/N=19.09
S/(N-1)=23.863
SD/(MEAN X)=0.423
SD=√(S/N)=4.369
USD=√(S/(N-1))=4.885
SKEWNESS CFT. CS!=1.3524
UNBIASED S.C. CS1=1.2096

MEAN LOG(XI)=9.838646874
E-01
XG=9.64

CAL. OF B-VALUE
1. T=18.9 S=7.2
B(1.)=-6.327038123

MEAN B=-6.33

USED B=0.
X0=9.64
LOG(X0+B)=0.98386
1/A=0.24263 SX=0.15349

IWAI FORMULA
LOG(Y+(0.))=0.98386
+0.24263*KSI(YR)

PROBABILITY	IWAI
Y(2)	9.6
Y(3)	11.4
Y(4)	12.6
Y(5)	13.4
Y(10)	16.
Y(20)	18.5
Y(25)	19.2
Y(50)	21.7
Y(100)	24.2

IWAI METHOD 24 hours

DATA N=5.
D(1)=3.7
D(2)=3.6
D(3)=4.4
D(4)=4.7
D(5)=9.7
RANKING & PLOTTING POSIT
ION

P. OF EXCEEDANCE

RANK (J)	DATA (X)	WEIBULL J/(N+1)	PLOT% F=1-P
1.	9.7	16.7	83.3
2.	4.7	33.3	66.7
3.	4.4	50.	50.
4.	3.7	66.7	33.3
5.	3.6	83.3	16.7

CALCULATION
SUM X= 26.1
MEAN X= 5.22
SUM OF DEVIATION SQUARE
S=25.948
VARIANCE S/N=5.19
S/(N-1)=6.487
SD/(MEAN X)=0.436
SD=√(S/N)=2.278
USD=√(S/(N-1))=2.547
SKEWNESS CFT. CS!=1.3782
UNBIASED S.C. CS1=1.2327

MEAN LOG(XI)=6.853652986
E-01
XG=4.85

CAL. OF B-VALUE
1. T=9.7 S=3.6
B(1.)=-3.165972222

MEAN B=-3.17

USED B=0.
X0=4.85
LOG(X0+B)=0.68537
1/A=0.24816 SX=0.15693

IWAI FORMULA
LOG(Y+(0.))=0.68537
+0.24816*KSI(YR)

PROBABILITY	IWAI
Y(2)	4.8
Y(3)	5.8
Y(4)	6.4
Y(5)	6.8
Y(10)	8.1
Y(20)	9.4
Y(25)	9.8
Y(50)	11.1
Y(100)	12.4

Table C1 - 16 The Longest Dry Consecutive Days During One Year at The CSDB

GUMBLE MAX. DISTRIBUTION

DATA N=13.

D(1)=	23.0	1977
D(2)=	10.0	1978
D(3)=	19.0	1979
D(4)=	15.0	1980
D(5)=	15.0	1981
D(6)=	34.0	1982
D(7)=	20.0	1983
D(8)=	18.0	1984
D(9)=	9.0	1985
D(10)=	10.0	1986
D(11)=	25.0	1987
D(12)=	17.0	1989
D(13)=	21.0	1988

RANKING
I=1. X=34.
I=2. X=25.
I=3. X=23.
I=4. X=21.
I=5. X=20.
I=6. X=19.
I=7. X=18.
I=8. X=17.
I=9. X=15.
I=10. X=15.
I=11. X=10.
I=12. X=10.
I=13. X=9.

CALCULATION
SUM X= 236.
SUM X^2= 4856.
SUM X^3= 111440.

MEAN X= 18.15384615
MEAN X^2= 373.5384615
MEAN X^3= 8572.307692
SUM DEV SQU. S=571.69230
77
VARIANCE S/N=43.98
UNBIASED VARI. =S/(N-1)=
47.64
VARIATION COEF.=SX/MEAN
X=0.37
STANDARD DEV. SX=√(S/N)=
6.63
STA. DEV. EST. USX=√(S/(
N-1))=6.9
SKEWNESS COEF. CS!=0.667
UNBIASED S.C. CS1=0.641

PROBABLE EXTREAM VALUE(
XT), RETURN PERIOD(T),
FREQUENCY FUNCTION:

XT=XM+K*SX, XM=MEAN X,
K=(YT-YN)/SY, YT=-LN(LN(
T/(T-1)))
YT=REDUCED VARIATE, YN=R
EDUCED MEAN

XT=XM-(YN*SX/SY)+(SX/SY)
*YT

CAL. VALUE:
XM=18.15384615 SX=6.9
YN=0.507 SY=0.9971

ESTIMATE EQUATION:
XT=14.65+6.92YT

T=2. XT=17.2
T=4. XT=23.3
T=5. XT=25.
T=10. XT=30.2
T=20. XT=35.2
T=25. XT=36.8
T=50. XT=41.7
T=100. XT=46.5
T=200. XT=51.3
T=1000. XT=62.4

T=11. XT=30.9
T=12. XT=31.5
T=13. XT=32.1
T=14. XT=32.7
T=15. XT=33.2
T=16. XT=33.6
T=17. XT=34.
T=18. XT=34.5
T=19. XT=34.8
T=20. XT=35.2

Table C-17

Calculation of Probability of Exceedance
on the Data of Monthly Mean Pan Evaporation
at the C S D B.

No.1 January, February and March
No.2 April, May and June
No.3 July, August and September
No.4 October, November and December

Calculation of Probability of Exceedance

Monthly Mean Pan Evaporation : No. 1 January,February and March

Jan

```
IWAI METHOD

DATA N=13.
D(1)=2.22
D(2)=2.34
D(3)=2.92
D(4)=1.75
D(5)=1.69
D(6)=1.67
D(7)=2.49
D(8)=2.72
D(9)=3.01
D(10)=2.52
D(11)=2.28
D(12)=3.45
D(13)=3.56

P. OF EXCEEDANCE
RANK DATA WEIBULL PLOT%
(J)  (X)  J/(N+1) F=1-P
1.  3.56   7.1   92.9
2.  3.45   14.3   85.7
3.  3.01   21.4   78.6
4.  2.92   28.6   71.4
5.  2.72   35.7   64.3
6.  2.52   42.9   57.1
7.  2.49   50.   50.
8.  2.34   57.1   42.9
9.  2.28   64.3   35.7
10.  2.22   71.4   28.6
11.  1.75   78.6   21.4
12.  1.69   85.7   14.3
13.  1.67   92.9   7.1

   CALCULATION
SUM X= 32.62
MEAN X= 2.509230769
SUM OF DEVIATION SQUARE
  S=4.570292308
VARIANCE S/N=0.35
S/(N-1)=3.808576923E-01
SD/(MEAN X)=0.236
SD=√(S/N)=0.593
USD=√(S/(N-1))=0.617
SKEWNESS CFT. CS!=0.213
UNBIASED S.C. CS1=0.2046

MEAN LOG(XI)=3.871178565
E-01
XG=2.44

CAL. OF B-VALUE
1.  T=3.56  S=1.67
  B(1.)=0.024

 MEAN B=0.02

USED B=0.02
X0=2.44
LOG(X0+B)=0.39077
1/A=0.15293  SX=0.10389

  IWAI FORMULA
LOG(Y+(0.02))=0.39077
    +0.15293*KSI(YR)

PROBABILITY IWAI
   Y(2)               2.4
   Y(3)               2.7
   Y(4)               2.9
   Y(5)               3.
  Y(10)               3.4
  Y(20)               3.7
  Y(25)               3.8
  Y(50)               4.1
 Y(100)               4.4
```

Feb

```
IWAI METHOD

DATA N=13.
D(1)=1.94
D(2)=3.2
D(3)=3.12
D(4)=2.34
D(5)=2.71
D(6)=2.76
D(7)=2.94
D(8)=2.84
D(9)=3.44
D(10)=3.24
D(11)=2.78
D(12)=4.27
D(13)=2.56
RANKING & PLOTTING POSIT
ION

P. OF EXCEEDANCE
RANK DATA WEIBULL PLOT%
(J)  (X)  J/(N+1) F=1-P
1.  4.27   7.1   92.9
2.  3.44   14.3   85.7
3.  3.24   21.4   78.6
4.  3.2   28.6   71.4
5.  3.12   35.7   64.3
6.  2.94   42.9   57.1
7.  2.84   50.   50.
8.  2.78   57.1   42.9
9.  2.76   64.3   35.7
10.  2.71   71.4   28.6
11.  2.56   78.6   21.4
12.  2.34   85.7   14.3
13.  1.94   92.9   7.1

   CALCULATION
SUM X= 38.14
MEAN X= 2.933846154
SUM OF DEVIATION SQUARE
  S=3.833707693
VARIANCE S/N=0.29
S/(N-1)=3.194756411E-01
SD/(MEAN X)=0.185
SD=√(S/N)=0.543
USD=√(S/(N-1))=0.565
SKEWNESS CFT. CS!=0.6269
UNBIASED S.C. CS1=0.6023

MEAN LOG(XI)=0.460129407
XG=2.88

CAL. OF B-VALUE
1.  T=4.27  S=1.94
  B(1.)=2.355555556E-02

 MEAN B=0.02

USED B=0.02
X0=2.89
LOG(X0+B)=0.46318
1/A=0.11658  SX=0.0792

  IWAI FORMULA
LOG(Y+(0.02))=0.46318
    +0.11658*KSI(YR)

PROBABILITY IWAI
   Y(2)               2.9
   Y(3)               3.1
   Y(4)               3.3
   Y(5)               3.4
  Y(10)               3.7
  Y(20)               3.9
  Y(25)               4.
  Y(50)               4.3
 Y(100)               4.5
```

Mar

```
IWAI METHOD

DATA N=13.
D(1)=1.69
D(2)=2.76
D(3)=2.97
D(4)=2.87
D(5)=2.99
D(6)=2.87
D(7)=3.12
D(8)=2.95
D(9)=3.72
D(10)=2.93
D(11)=3.63
D(12)=3.75
D(13)=3.89
RANKING & PLOTTING POSIT
ION

P. OF EXCEEDANCE
RANK DATA WEIBULL PLOT%
(J)  (X)  J/(N+1) F=1-P
1.  3.89   7.1   92.9
2.  3.75   14.3   85.7
3.  3.72   21.4   78.6
4.  3.63   28.6   71.4
5.  3.12   35.7   64.3
6.  2.99   42.9   57.1
7.  2.97   50.   50.
8.  2.95   57.1   42.9
9.  2.93   64.3   35.7
10.  2.87   71.4   28.6
11.  2.87   78.6   21.4
12.  2.76   85.7   14.3
13.  1.69   92.9   7.1

   CALCULATION
SUM X= 40.14
MEAN X= 3.087692308
SUM OF DEVIATION SQUARE
  S=4.00023077
VARIANCE S/N=0.31
S/(N-1)=3.333525642E-01
SD/(MEAN X)=0.18
SD=√(S/N)=0.555
USD=√(S/(N-1))=0.577
SKEWNESS CFT. CS!=-0.709
2
UNBIASED S.C. CS1=-0.691
4

MEAN LOG(XI)=4.814047602
E-01
XG=3.03

CAL. OF B-VALUE
1.  T=3.89  S=1.69
  B(1.)=-5.430833333

 MEAN B=-5.43

USED B=0.
X0=3.03
LOG(X0+B)=0.4814
1/A=0.13045  SX=0.08865

  IWAI FORMULA
LOG(Y+(0.))=0.4814
    +0.13045*KSI(YR)

PROBABILITY IWAI
   Y(2)               3.
   Y(3)               3.3
   Y(4)               3.5
   Y(5)               3.6
  Y(10)               4.
  Y(20)               4.3
  Y(25)               4.4
  Y(50)               4.7
 Y(100)               5.
```

Calculation of Probability of Exceedance

Monthly Mean Pan Evaporation : No.2 April, May and June

IWAI METHOD Apr

DATA N=13.
D(1)=2.75
D(2)=3.26
D(3)=3.08
D(4)=2.25
D(5)=3.02
D(6)=2.63
D(7)=3.26
D(8)=3.1
D(9)=3.25
D(10)=3.35
D(11)=3.47
D(12)=4.34
D(13)=4.17
RANKING & PLOTTING POSIT
ION

P. OF EXCEEDANCE

RANK (J)	DATA (X)	WEIBULL J/(N+1)	PLOT% F=1-P
1.	4.34	7.1	92.9
2.	4.17	14.3	85.7
3.	3.47	21.4	78.6
4.	3.35	28.6	71.4
5.	3.26	35.7	64.3
6.	3.26	42.9	57.1
7.	3.25	50.	50.
8.	3.1	57.1	42.9
9.	3.08	64.3	35.7
10.	3.02	71.4	28.6
11.	2.75	78.6	21.4
12.	2.63	85.7	14.3
13.	2.25	92.9	7.1

CALCULATION
SUM X= 41.93
MEAN X= 3.225384615
SUM OF DEVIATION SQUARE
S=3.823923077
VARIANCE S/N=0.29
S/(N-1)=3.186602564E-01
SD/(MEAN X)=0.168
SD=√(S/N)=0.542
USD=√(S/(N-1))=0.565
SKEWNESS CFT. CS!=0.4755
UNBIASED S.C. CS1=0.4568

MEAN LOG(XI)=5.025160724
E-01
XG=3.18

CAL. OF B-VALUE
1. T=4.34 S=2.25
B(1.)=1.510434783

MEAN B=1.51

USED B=1.51
X0=3.19
LOG(X0+B)=0.67256
1/A=0.07238 SX=0.04911

IWAI FORMULA
LOG(Y+(1.51))=0.67256
+0.07238*KSI(YR)

PROBABILITY IWAI	
Y(2)	3.2
Y(3)	3.4
Y(4)	3.6
Y(5)	3.7
Y(10)	4.
Y(20)	4.2
Y(25)	4.3
Y(50)	4.5
Y(100)	4.7

IWAI METHOD May

DATA N=13.
D(1)=3.06
D(2)=2.92
D(3)=3.02
D(4)=2.62
D(5)=2.75
D(6)=2.73
D(7)=3.
D(8)=2.83
D(9)=3.19
D(10)=3.78
D(11)=4.1
D(12)=3.77
D(13)=3.47

RANKING & PLOTTING POSIT
ION

P. OF EXCEEDANCE

RANK (J)	DATA (X)	WEIBULL J/(N+1)	PLOT% F=1-P
1.	4.1	7.1	92.9
2.	3.78	14.3	85.7
3.	3.77	21.4	78.6
4.	3.47	28.6	71.4
5.	3.19	35.7	64.3
6.	3.06	42.9	57.1
7.	3.02	50.	50.
8.	3.	57.1	42.9
9.	2.92	64.3	35.7
10.	2.83	71.4	28.6
11.	2.75	78.6	21.4
12.	2.73	85.7	14.3
13.	2.62	92.9	7.1

CALCULATION
SUM X= 41.24
MEAN X= 3.172307692
SUM OF DEVIATION SQUARE
S=2.60143077
VARIANCE S/N=0.2
S/(N-1)=2.167858975E-01
SD/(MEAN X)=0.141
SD=√(S/N)=0.447
USD=√(S/(N-1))=0.466
SKEWNESS CFT. CS!=0.746
UNBIASED S.C. CS1=0.7167

MEAN LOG(XI)=4.972732852
E-01
XG=3.14

CAL. OF B-VALUE
1. T=4.1 S=2.62
B(1.)=-2.005454545

MEAN B=-2.01

USED B=-2.01
X0=3.09
LOG(X0+B)=0.03506
1/A=0.23579 SX=0.16019

IWAI FORMULA
LOG(Y+(-2.01))=0.03506
+0.23579*KSI(YR)

PROBABILITY IWAI	
Y(2)	3.1
Y(3)	3.3
Y(4)	3.4
Y(5)	3.5
Y(10)	3.8
Y(20)	4.
Y(25)	4.1
Y(50)	4.4
Y(100)	4.7

Jun.

IWAI METHOD

DATA N=13.
D(1)=2.24
D(2)=2.49
D(3)=2.66
D(4)=2.91
D(5)=2.72
D(6)=2.4
D(7)=3.4
D(8)=3.16
D(9)=2.81
D(10)=3.28
D(11)=3.69
D(12)=3.4
D(13)=3.58
RANKING & PLOTTING POSIT
ION

P. OF EXCEEDANCE

RANK (J)	DATA (X)	WEIBULL J/(N+1)	PLOT% F=1-P
1.	3.69	7.1	92.9
2.	3.58	14.3	85.7
3.	3.4	21.4	78.6
4.	3.4	28.6	71.4
5.	3.28	35.7	64.3
6.	3.16	42.9	57.1
7.	2.91	50.	50.
8.	2.81	57.1	42.9
9.	2.72	64.3	35.7
10.	2.66	71.4	28.6
11.	2.49	78.6	21.4
12.	2.4	85.7	14.3
13.	2.24	92.9	7.1

CALCULATION
SUM X= 38.74
MEAN X= 2.98
SUM OF DEVIATION SQUARE
S=2.6672
VARIANCE S/N=0.21
S/(N-1)=2.222666667E-01
SD/(MEAN X)=0.152
SD=√(S/N)=0.453
USD=√(S/(N-1))=0.471
SKEWNESS CFT. CS!=-0.015
4
UNBIASED S.C. CS1=-0.014
8

MEAN LOG(XI)=4.690874316
E-01
XG=2.95

CAL. OF B-VALUE
1. T=3.69 S=2.24
B(1.)=14.56333333

MEAN B=14.56

USED B=14.56
X0=2.97
LOG(X0+B)=1.24388
1/A=0.01652 SX=0.01173

IWAI FORMULA
LOG(Y+(14.56))=1.24388
+0.01652*KSI(YR)

PROBABILITY IWAI	
Y(2)	3.
Y(3)	3.2
Y(4)	3.3
Y(5)	3.4
Y(10)	3.6
Y(20)	3.8
Y(25)	3.8
Y(50)	4.
Y(100)	4.1

Calculation of Probability of Exceedance

Monthly Mean Pan Evaporation : No. 3 July,August and September

```
IWAI METHOD

DATA N=13.
D(1)=3.2
D(2)=2.76
D(3)=3.06
D(4)=2.98
D(5)=2.79
D(6)=2.7
D(7)=3.4
D(8)=3.26
D(9)=2.7
D(10)=3.41
D(11)=4.02
D(12)=3.96
D(13)=3.89
RANKING & PLOTTING POSIT
ION

P. OF EXCEEDANCE
RANK DATA WEIBULL PLOT%
(J)  (X)  J/(N+1) F=1-P
1.  4.02   7.1   92.9
2.  3.96   14.3   85.7
3.  3.89   21.4   78.6
4.  3.41   28.6   71.4
5.  3.4   35.7   64.3
6.  3.26   42.9   57.1
7.  3.2   50.   50.
8.  3.06   57.1   42.9
9.  2.98   64.3   35.7
10.  2.79   71.4   28.6
11.  2.76   78.6   21.4
12.  2.7   85.7   14.3
13.  2.7   92.9   7.1

   CALCULATION
SUM X= 42.13
MEAN X= 3.240769231
SUM OF DEVIATION SQUARE
  S=2.721892308
VARIANCE S/N=0.21
S/(N-1)=0.226824359
SD/(MEAN X)=0.141
SD=√(S/N)=0.458
USD=√(S/(N-1))=0.476
SKEWNESS CFT. CS!=0.4684
UNBIASED S.C. CS1=0.4501

MEAN LOG(XI)=5.064346321
E-01
XG=3.21

CAL. OF B-VALUE
1.  T=4.02  S=2.7
  B(1.)=-1.833

 MEAN B=-1.83

USED B=0.
X0=3.21
LOG(X0+B)=0.50643
1/A=0.08847  SX=0.06015

  IWAI FORMULA
LOG(Y+(0.))=0.50643
    +0.08847*KSI(YR)

PROBABILITY IWAI
   Y(2)              3.2
   Y(3)              3.4
   Y(4)              3.5
   Y(5)              3.6
  Y(10)              3.9
  Y(20)              4.1
  Y(25)              4.1
  Y(50)              4.3
 Y(100)              4.5
```

```
IWAI METHOD

DATA N=13.
D(1)=3.63
D(2)=2.86
D(3)=3.03
D(4)=2.92
D(5)=2.68
D(6)=3.09
D(7)=4.05
D(8)=3.7
D(9)=3.79
D(10)=3.65
D(11)=4.99
D(12)=4.12
D(13)=4.39
RANKING & PLOTTING POSIT
ION

P. OF EXCEEDANCE
RANK DATA WEIBULL PLOT%
(J)  (X)  J/(N+1) F=1-P
1.  4.99   7.1   92.9
2.  4.39   14.3   85.7
3.  4.12   21.4   78.6
4.  4.05   28.6   71.4
5.  3.79   35.7   64.3
6.  3.7   42.9   57.1
7.  3.65   50.   50.
8.  3.63   57.1   42.9
9.  3.09   64.3   35.7
10.  3.03   71.4   28.6
11.  2.92   78.6   21.4
12.  2.86   85.7   14.3
13.  2.68   92.9   7.1

   CALCULATION
SUM X= 46.9
MEAN X= 3.607692308
SUM OF DEVIATION SQUARE
  S=5.51923077
VARIANCE S/N=0.42
S/(N-1)=4.599358975E-01
SD/(MEAN X)=0.181
SD=√(S/N)=0.652
USD=√(S/(N-1))=0.678
SKEWNESS CFT. CS!=0.4093
UNBIASED S.C. CS1=0.3933

MEAN LOG(XI)=5.502494242
E-01
XG=3.55

CAL. OF B-VALUE
1.  T=4.99  S=2.68
  B(1.)=-1.352105263

 MEAN B=-1.35

USED B=-1.35
X0=3.51
LOG(X0+B)=0.33543
1/A=0.18634  SX=0.12658

  IWAI FORMULA
LOG(Y+(-1.35))=0.33543
    +0.18634*KSI(YR)

PROBABILITY IWAI
   Y(2)              3.5
   Y(3)              3.8
   Y(4)              4.
   Y(5)              4.1
  Y(10)              4.5
  Y(20)              4.9
  Y(25)              5.
  Y(50)              5.4
 Y(100)              5.7
```

```
IWAI METHOD

DATA N=13.
D(1)=3.68
D(2)=3.3
D(3)=3.24
D(4)=3.2
D(5)=2.84
D(6)=3.85
D(7)=4.67
D(8)=3.25
D(9)=4.11
D(10)=3.5
D(11)=5.37
D(12)=4.89
D(13)=4.29
RANKING & PLOTTING POSIT
ION

P. OF EXCEEDANCE
RANK DATA WEIBULL PLOT%
(J)  (X)  J/(N+1) F=1-P
1.  5.37   7.1   92.9
2.  4.89   14.3   85.7
3.  4.67   21.4   78.6
4.  4.29   28.6   71.4
5.  4.11   35.7   64.3
6.  3.85   42.9   57.1
7.  3.68   50.   50.
8.  3.5   57.1   42.9
9.  3.3   64.3   35.7
10.  3.25   71.4   28.6
11.  3.24   78.6   21.4
12.  3.2   85.7   14.3
13.  2.84   92.9   7.1

   CALCULATION
SUM X= 50.19
MEAN X= 3.860769231
SUM OF DEVIATION SQUARE
  S=6.952692308
VARIANCE S/N=0.53
S/(N-1)=5.793910257E-01
SD/(MEAN X)=0.189
SD=√(S/N)=0.731
USD=√(S/(N-1))=0.761
SKEWNESS CFT. CS!=0.6113
UNBIASED S.C. CS1=0.5873

MEAN LOG(XI)=5.792066432
E-01
XG=3.79

CAL. OF B-VALUE
1.  T=5.37  S=2.84
  B(1.)=-1.407460317

 MEAN B=-1.41

USED B=-1.41
X0=3.76
LOG(X0+B)=0.37067
1/A=0.18606  SX=0.12641

  IWAI FORMULA
LOG(Y+(-1.41))=0.37067
    +0.18606*KSI(YR)

PROBABILITY IWAI
   Y(2)              3.8
   Y(3)              4.1
   Y(4)              4.3
   Y(5)              4.4
  Y(10)              4.9
  Y(20)              5.3
  Y(25)              5.4
  Y(50)              5.8
 Y(100)              6.2
```

Calculation of Probability of Exceedance

Monthly Mean Pan Evaporation : No.4 October, November and December

IWAI METHOD (Oct.)

DATA N=13.
D(1)=4.23
D(2)=3.7
D(3)=3.57
D(4)=3.13
D(5)=3.16
D(6)=3.74
D(7)=3.64
D(8)=3.86
D(9)=3.6
D(10)=4.11
D(11)=5.1
D(12)=4.49
D(13)=4.36
RANKING & PLOTTING POSIT
ION

P. OF EXCEEDANCE

RANK (J)	DATA (X)	WEIBULL J/(N+1)	PLOT% F=1-P
1.	5.1	7.1	92.9
2.	4.49	14.3	85.7
3.	4.36	21.4	78.6
4.	4.23	28.6	71.4
5.	4.11	35.7	64.3
6.	3.86	42.9	57.1
7.	3.74	50.	50.
8.	3.7	57.1	42.9
9.	3.64	64.3	35.7
10.	3.6	71.4	28.6
11.	3.57	78.6	21.4
12.	3.16	85.7	14.3
13.	3.13	92.9	7.1

CALCULATION
SUM X= 50.69
MEAN X= 3.899230769
SUM OF DEVIATION SQUARE
S=3.626892308
VARIANCE S/N=0.28
S/(N-1)=3.022410257E-01
SD/(MEAN X)=0.135
SD=√(S/N)=0.528
USD=√(S/(N-1))=0.55
SKEWNESS CFT. CS!=0.5904
UNBIASED S.C. CS1=0.5673

MEAN LOG(XI)=5.871114883
E-01
XG=3.86

CAL. OF B-VALUE
1. T=5.1 S=3.13
B(1.)=-2.085098039

MEAN B=-2.09

USED B=-2.09
X0=3.82
LOG(X0+B)=0.23914
1/A=0.18676 SX=0.12688

IWAI FORMULA
LOG(Y+(-2.09))=0.23914
+0.18676*KSI(YR)

PROBABILITY IWAI

Y(2)	3.8
Y(3)	4.1
Y(4)	4.2
Y(5)	4.3
Y(10)	4.7
Y(20)	4.9
Y(25)	5.
Y(50)	5.3
Y(100)	5.6

IWAI METHOD (Nov.)

DATA N=13.
D(1)=3.33
D(2)=4.45
D(3)=2.53
D(4)=3.06
D(5)=2.87
D(6)=3.21
D(7)=3.09
D(8)=3.37
D(9)=3.78
D(10)=3.51
D(11)=4.65
D(12)=3.87
D(13)=4.13
RANKING & PLOTTING POSIT
ION

P. OF EXCEEDANCE

RANK (J)	DATA (X)	WEIBULL J/(N+1)	PLOT% F=1-P
1.	4.65	7.1	92.9
2.	4.45	14.3	85.7
3.	4.13	21.4	78.6
4.	3.87	28.6	71.4
5.	3.78	35.7	64.3
6.	3.51	42.9	57.1
7.	3.37	50.	50.
8.	3.33	57.1	42.9
9.	3.21	64.3	35.7
10.	3.09	71.4	28.6
11.	3.06	78.6	21.4
12.	2.87	85.7	14.3
13.	2.53	92.9	7.1

CALCULATION
SUM X= 45.85
MEAN X= 3.526923077
SUM OF DEVIATION SQUARE
S=4.657276924
VARIANCE S/N=0.36
S/(N-1)=3.881064103E-01
SD/(MEAN X)=0.17
SD=√(S/N)=0.599
USD=√(S/(N-1))=0.623
SKEWNESS CFT. CS!=0.3494
UNBIASED S.C. CS1=0.3357

MEAN LOG(XI)=5.411949528
E-01
XG=3.48

CAL. OF B-VALUE
1. T=4.65 S=2.53
B(1.)=1.572272727

MEAN B=1.57

USED B=1.57
X0=3.49
LOG(X0+B)=0.70435
1/A=0.07442 SX=0.05057

IWAI FORMULA
LOG(Y+(1.57))=0.70435
+0.07442*KSI(YR)

PROBABILITY IWAI

Y(2)	3.5
Y(3)	3.8
Y(4)	3.9
Y(5)	4.
Y(10)	4.3
Y(20)	4.6
Y(25)	4.7
Y(50)	4.9
Y(100)	5.1

IWAI METHOD (Dec.)

DATA N=13.
D(1)=2.81
D(2)=3.3
D(3)=2.32
D(4)=2.31
D(5)=2.86
D(6)=2.63
D(7)=3.67
D(8)=3.02
D(9)=3.86
D(10)=3.8
D(11)=3.39
D(12)=3.36
D(13)=3.28
RANKING & PLOTTING POSIT
ION

P. OF EXCEEDANCE

RANK (J)	DATA (X)	WEIBULL J/(N+1)	PLOT% F=1-P
1.	3.86	7.1	92.9
2.	3.8	14.3	85.7
3.	3.67	21.4	78.6
4.	3.39	28.6	71.4
5.	3.36	35.7	64.3
6.	3.3	42.9	57.1
7.	3.28	50.	50.
8.	3.02	57.1	42.9
9.	2.86	64.3	35.7
10.	2.81	71.4	28.6
11.	2.63	78.6	21.4
12.	2.32	85.7	14.3
13.	2.31	92.9	7.1

CALCULATION
SUM X= 40.61
MEAN X= 3.123846154
SUM OF DEVIATION SQUARE
S=3.210707693
VARIANCE S/N=0.25
S/(N-1)=2.675589744E-01
SD/(MEAN X)=0.159
SD=√(S/N)=0.497
USD=√(S/(N-1))=0.517
SKEWNESS CFT. CS!=-0.198
7
UNBIASED S.C. CS1=-0.190
9

MEAN LOG(XI)=4.889306718
E-01
XG=3.08

CAL. OF B-VALUE
1. T=3.86 S=2.31
B(1.)=56.98

MEAN B=56.98

USED B=56.98
X0=3.12
LOG(X0+B)=1.77889
1/A=0.00529 SX=0.00192

IWAI FORMULA
LOG(Y+(56.98))=1.77889
+0.00529*KSI(YR)

PROBABILITY IWAI

Y(2)	3.1
Y(3)	3.3
Y(4)	3.5
Y(5)	3.6
Y(10)	3.8
Y(20)	4.
Y(25)	4.
Y(50)	4.2
Y(100)	4.3

Table C1-18

Estimated Possible Working Hours of Outdoor Works for Construction and Farming Practice

No. 1 1985

No. 2 1986

No. 3 1987

No. 4 1988

No. 5 1989

No. 6 Recapitulation of Estimated Possible Working Hours and their Percentage to the Scheduled Construction Working Hours

No. 1 Estimated Possible Working Hours

Scheduled Daily Construction Working Hours : 10 hrs from 7:00 up to 17:00
If rainfall is equal to or in excess of 0.25 mm per hour, outdoor works will be deferred.

Year : 1985

Month / Date	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Remarks
1	10	10	9	8	10	10	10	10	7	10	10	10	
2	10	10	8	10	9	10	8	8	10	9	10	10	
3	9	10	9	9	10	9	8	10	10	10	7	10	
4	10	10	8	10	10	10	10	10	10	10	8	9	
5	9	10	8	10	9	9	10	10	10	10	7	7	
Sub-Total	48	50	42	47	48	48	46	48	47	49	42	46	
6	9	9	10	10	10	10	10	10	10	10	10	8	
7	7	9	9	10	10	9	10	7	10	10	9	10	
8	8	8	9	10	9	9	10	10	9	10	10	10	
9	8	7	9	8	9	10	9	10	6	10	10	10	
10	10	9	10	7	10	9	10	10	10	8	9	10	
Sub-Total	42	42	47	45	48	47	49	47	45	48	48	48	
11	9	8	10	10	10	10	8	10	10	10	9	10	
12	5	8	10	10	7	9	10	10	10	10	10	10	
13	10	10	9	10	8	10	10	10	9	10	10	10	
14	10	10	10	8	8	10	7	10	10	7	10	10	
15	5	10	10	10	10	10	10	10	10	10	10	10	
Sub-Total	39	46	49	48	43	49	45	50	49	47	49	50	
16	9	9	10	9	10	10	10	10	10	9	10	8	
17	10	10	8	9	10	10	9	10	9	7	10	10	
18	10	8	10	9	10	10	10	9	10	10	10	10	
19	8	10	10	9	10	10	10	10	10	7	7	10	
20	10	9	8	10	10	9	8	10	10	10	10	9	
Sub-Total	47	46	46	46	50	49	47	49	49	43	47	47	
21	8	10	10	10	10	10	7	10	10	10	10	8	
22	8	6	10	7	10	10	10	10	10	10	10	10	
23	10	8	10	10	9	10	10	10	10	10	10	7	
24	10	10	10	10	10	10	10	9	9	10	9	10	
25	10	10	8	9	10	8	9	8	10	10	10	10	
Sub-Total	46	44	48	46	49	48	46	47	49	50	49	45	
26	9	10	8	7	7	10	10	10	7	8	7	10	
27	10	6	10	9	9	10	8	10	10	10	10	9	
28	10	7	10	10	5	9	8	10	8	4	8	7	
29	10	-	10	10	10	9	10	10	10	10	10	10	
30	9	-	10	10	10	10	10	10	10	7	9	10	
31	10	-	7	-	10	-	10	10	-	10	-	10	
Sub-Total	58	23	55	46	51	48	56	60	45	49	44	56	
Grand Total	280	251	287	278	289	289	289	301	284	286	279	292	

No. 2 Estimated Possible Working Hours

Scheduled Daily Construction Working Hours : 10 hrs from 7:00 up to 17:00
If rainfall is equal to or in excess of 0.25 mm per hour, outdoor works will be deferred.

Year : 1986

Month / Date	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Remarks
1	10	8	7	5	10	9	10	10	10	10	9	10	
2	8	10	8	10	10	10	10	9	10	10	9	10	
3	10	10	8	10	10	10	10	10	9	8	9	10	
4	8	10	9	9	10	10	10	7	9	10	10	10	
5	10	8	9	9	10	8	10	10	10	7	6	10	
Sub-Total	46	46	41	43	50	47	50	46	48	45	43	50	
6	7	9	7	7	10	10	10	8	10	10	6	10	
7	7	10	6	10	10	10	10	10	9	10	9	10	
8	5	9	10	10	10	9	9	9	10	10	6	10	
9	10	10	10	8	9	10	10	10	9	10	9	10	
10	10	7	9	9	10	8	10	10	10	9	8	8	
Sub-Total	39	45	42	44	49	47	49	47	48	49	38	48	
11	9	8	8	7	10	8	10	10	9	10	8	10	
12	7	7	10	8	8	10	10	10	10	8	7	8	
13	6	10	10	9	10	10	10	9	10	9	10	10	
14	10	9	8	9	9	10	10	10	10	10	8	10	
15	8	10	6	9	9	7	10	10	9	10	10	8	
Sub-Total	40	44	42	42	46	45	50	49	48	47	43	46	
16	10	7	10	10	10	9	10	10	6	10	10	8	
17	8	10	7	10	10	10	10	10	10	10	9	5	
18	8	10	10	10	10	8	10	10	10	10	10	10	
19	7	10	9	8	10	10	10	10	10	10	9	8	
20	7	10	9	10	10	10	10	10	10	10	7	10	
Sub-Total	40	47	45	48	50	47	50	50	46	50	45	41	
21	7	10	8	8	10	10	10	10	10	10	8	9	
22	6	10	7	10	10	10	8	10	10	10	10	10	
23	8	10	7	10	10	10	10	10	7	10	9	10	
24	7	NA	10	10	10	10	10	9	10	10	10	10	
25	9	NA	10	10	10	10	10	9	9	10	10	8	
Sub-Total	37	-	42	48	50	50	48	48	46	50	47	47	
26	6	NA	10	10	10	10	10	10	8	6	10	8	
27	9	NA	10	10	10	10	8	10	10	4	7	10	
28	10	NA	8	10	10	10	10	10	10	6	8	7	
29	10	-	10	9	10	10	8	10	10	8	7	8	
30	10	-	8	10	9	10	10	10	10	8	10	7	
31	8	-	10	-	9	-	10	10	-	10	-	9	
Sub-Total	53	-	56	49	58	50	56	60	48	42	42	42	
Grand Total	255	-	268	274	303	286	303	300	284	283	258	274	

No. 3 Estimated Possible Working Hours

Scheduled Daily Construction Working Hours : 10 hrs from 7:00 up to 17:00
If rainfall is equal to or in excess of 0.25 mm per hour, outdoor works will be deferred.

Year : 1987

Month / Date	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Remarks
1	9	10	10	10	8	9	10	10	10	9	10	10	
2	9	7	9	7	10	10	10	9	10	9	9	9	
3	5	10	6	10	10	10	10	10	9	10	8	8	
4	7	8	10	10	10	10	10	10	10	10	9	9	
5	7	9	9	10	8	8	10	10	9	10	10	9	
Sub-Total	37	44	44	47	46	47	50	49	48	48	46	45	
6	10	9	9	9	8	7	10	10	10	10	10	5	
7	9	7	10	10	10	8	10	10	10	10	8	6	
8	9	8	10	8	10	9	10	10	10	10	8	7	
9	9	4	10	7	10	10	8	10	10	10	8	8	
10	10	6	9	9	8	10	10	10	10	10	10	8	
Sub-Total	47	34	48	43	46	44	48	50	50	50	44	34	
11	10	7	10	10	7	10	10	10	10	10	10	6	
12	10	9	10	6	10	10	10	10	10	8	10	10	
13	10	10	10	9	9	10	10	10	10	10	9	10	
14	4	9	10	9	9	10	10	10	10	10	7	10	
15	7	10	9	8	8	10	10	10	10	10	7	8	
Sub-Total	41	45	49	42	43	50	50	50	50	48	43	44	
16	8	8	10	8	10	10	10	10	9	10	8	10	
17	10	8	9	10	8	10	10	10	10	9	9	10	
18	7	6	7	10	8	10	10	10	10	10	10	8	
19	8	10	9	10	10	10	10	10	10	9	9	9	
20	9	9	8	10	10	10	10	10	10	10	10	8	
Sub-Total	42	43	43	48	46	50	50	50	49	48	46	45	
21	10	10	8	10	10	10	10	9	10	9	10	10	
22	7	7	9	10	10	10	10	10	10	10	8	10	
23	10	7	9	10	10	10	10	10	10	10	10	9	
24	7	8	8	9	10	10	10	10	10	10	10	4	
25	9	10	10	10	10	9	10	10	10	10	10	10	
Sub-Total	43	42	44	49	50	49	50	49	50	49	48	43	
26	9	7	10	10	9	10	10	10	10	10	10	10	
27	5	7	9	10	10	10	10	10	8	10	10	10	
28	10	10	6	10	9	8	10	9	10	9	10	10	
29	10	-	7	10	10	9	10	10	10	10	10	8	
30	8	-	8	10	8	10	10	10	9	9	8	10	
31	9	-	10	-	10	-	10	10	-	10	-	10	
Sub-Total	51	24	50	50	56	47	60	59	47	58	48	58	
Grand Total	261	232	278	279	287	287	308	307	294	301	275	269	

No. 4 Estimated Possible Working Hours

Scheduled Daily Construction Working Hours : 10 hrs from 7:00 up to 17:00
If rainfall is equal to or in excess of 0.25 mm per hour, outdoor works will be deferred.

Year : 1988

Month / Date	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Remarks
1	10	10	9	8	10	10	10	10	9	10	7	9	
2	10	6	10	7	10	10	10	10	10	9	8	10	
3	9	10	10	8	7	9	10	10	10	10	10	7	
4	10	9	8	10	8	10	8	10	10	9	8	9	
5	10	6	8	10	10	10	10	8	10	10	9	10	
Sub-Total	49	41	45	43	45	49	48	48	49	48	42	45	
6	10	3	9	10	10	10	10	9	10	10	10	10	
7	7	10	10	8	10	10	10	10	10	10	8	9	
8	10	10	10	10	10	7	10	10	9	10	9	9	
9	9	10	10	10	10	10	10	10	10	9	10	6	
10	10	10	7	10	10	10	10	10	10	10	10	10	
Sub-Total	46	43	46	48	50	47	50	49	49	49	47	44	
11	10	10	10	10	10	9	10	10	10	7	8	8	
12	10	8	9	8	10	10	10	10	9	10	9	8	
13	10	7	10	10	6	10	10	10	10	10	7	6	
14	9	9	10	10	8	10	10	10	9	10	9	8	
15	6	8	8	10	6	10	10	9	10	9	10	7	
Sub-Total	45	42	47	48	40	49	50	49	48	46	43	37	
16	10	7	9	10	10	10	6	10	10	10	10	9	
17	8	8	10	10	8	10	10	10	9	8	10	4	
18	8	10	9	10	10	10	10	10	10	8	10	4	
19	8	8	10	10	8	8	10	10	10	8	10	4	
20	9	9	10	10	10	10	10	10	10	9	10	4	
Sub-Total	43	42	48	50	46	48	46	50	49	43	50	25	
21	9	10	6	9	10	10	10	9	10	10	10	6	
22	10	10	7	10	10	10	10	10	9	10	10	10	
23	9	10	7	10	10	10	9	10	10	5	9	10	
24	10	8	10	10	10	10	10	10	10	10	9	10	
25	7	10	8	10	10	10	10	10	9	10	10	10	
Sub-Total	45	48	38	49	50	50	49	49	48	45	48	46	
26	8	9	6	10	9	10	10	10	9	10	6	10	
27	7	10	10	10	10	10	10	10	8	10	9	8	
28	10	10	8	10	10	10	10	10	9	10	9	10	
29	10	10	6	7	9	10	10	10	9	6	9	10	
30	9	-	4	8	10	10	10	10	10	10	10	8	
31	10	-	10	-	10	-	10	10	-	10	-	10	
Sub-Total	54	39	44	45	58	50	60	60	45	56	43	56	
Grand Total	282	255	268	283	289	293	303	305	288	287	273	253	

No. 5 Estimated Possible Working Hours

Scheduled Daily Construction Working Hours : 10 hrs from 7:00 up to 17:00
If rainfall is equal to or in excess of 0.25 mm per hour, outdoor works will be deferred.

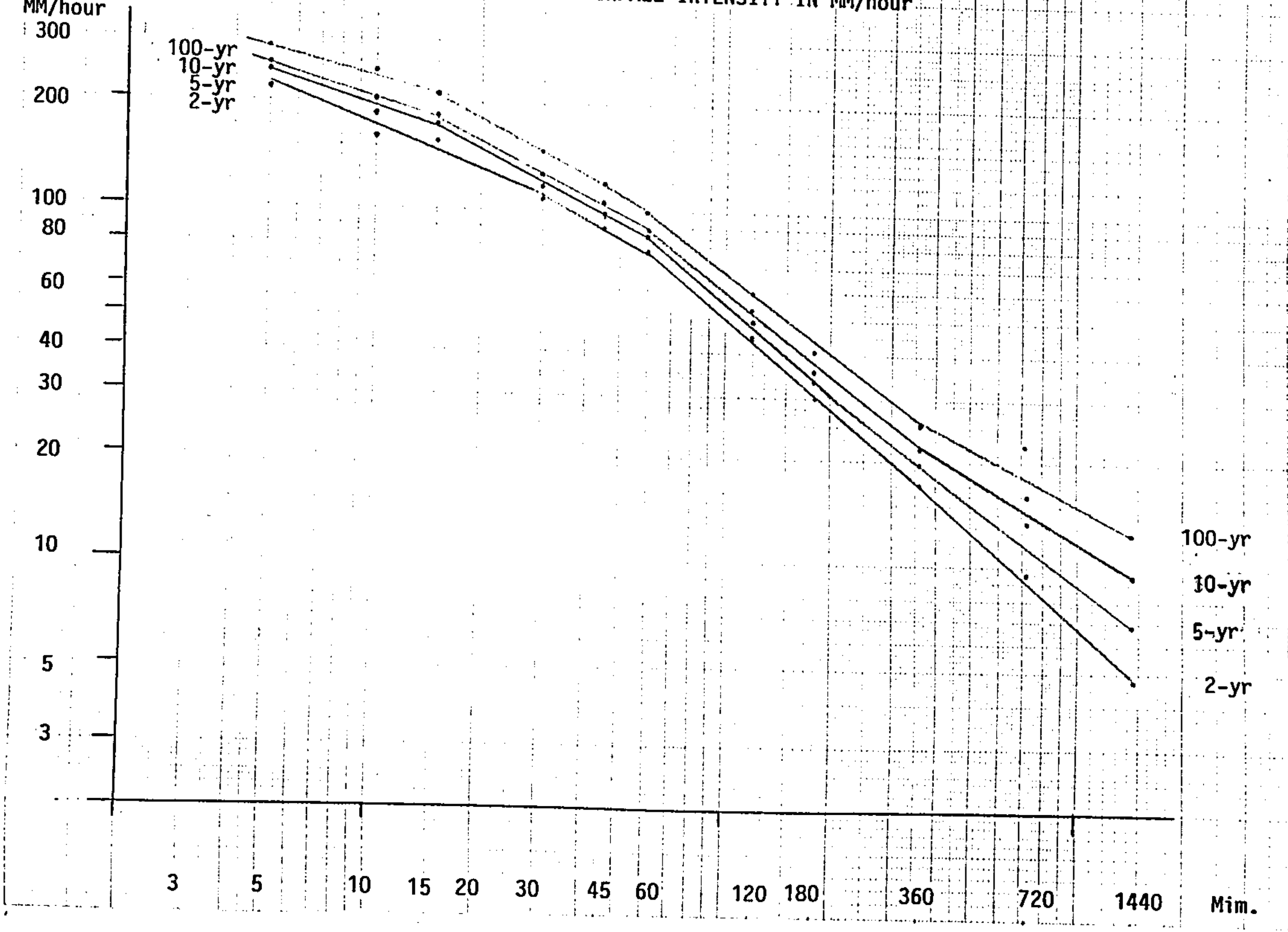
Year : 1989

Month / Date	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Remarks
1	9	10	10	7	10	10	10	10	10	10	6	10	
2	10	8	8	10	10	9	10	10	9	10	8	7	
3	10	9	10	10	9	10	10	10	10	10	6	9	
4	10	3	10	9	8	8	10	10	10	8	8	10	
5	10	6	10	8	9	10	8	10	10	10	10	10	
Sub-Total	49	36	48	44	46	47	48	50	49	48	38	46	
6	10	6	9	9	9	10	10	10	9	10	10	7	
7	10	5	10	6	10	10	10	9	10	10	10	10	
8	9	8	10	10	8	10	10	10	10	9	6	9	
9	10	10	8	7	10	10	7	10	10	9	9	7	
10	8	10	5	10	8	10	10	10	10	10	8	8	
Sub-Total	47	39	42	42	45	50	47	49	49	48	43	41	
11	8	9	7	9	10	10	10	10	10	10	10	10	
12	10	8	10	8	10	10	10	10	10	10	10	5	
13	9	4	10	10	8	10	10	10	10	10	10	10	
14	8	10	10	9	10	10	10	10	9	10	10	9	
15	9	10	10	9	9	10	10	10	10	10	9	8	
Sub-Total	44	41	47	45	47	50	50	50	49	50	49	42	
16	10	5	9	10	9	10	10	10	10	5	9	9	
17	8	10	10	10	10	10	10	10	9	10	10	10	
18	7	10	9	9	10	10	10	10	10	10	9	9	
19	8	7	10	10	10	10	10	10	10	9	10	10	
20	7	5	10	10	9	10	10	10	10	8	10	10	
Sub-Total	40	37	48	49	48	50	50	50	49	42	48	48	
21	8	10	8	10	8	10	10	10	9	9	10	10	
22	8	10	9	10	8	10	10	10	8	8	6	10	
23	9	9	8	10	10	10	10	10	9	9	10	10	
24	10	10	9	10	10	9	9	10	9	10	10	9	
25	8	10	10	9	10	8	10	9	10	7	10	10	
Sub-Total	43	49	44	49	46	47	49	49	45	43	46	49	
26	9	9	10	10	10	10	9	7	10	10	9	10	
27	10	10	10	9	10	10	10	10	10	10	9	8	
28	7	10	10	10	10	10	9	10	10	10	10	8	
29	9	-	9	9	10	10	10	10	10	8	9	9	
30	10	-	8	10	10	10	10	7	9	10	10	8	
31	10	-	10	-	8	-	10	10	-	9	-	9	
Sub-Total	55	29	57	48	58	50	58	54	49	57	47	52	
Grand Total	278	231	286	277	290	294	302	302	290	288	271	278	

No. 6 Recapitulation of Estimated Possible Working Hours and their Percentage to the Scheduled Construction Working Hours

Year	Month Decade		Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Remarks
1985	1	Hrs	90	92	89	92	96	95	95	95	92	97	90	94	
		%	dittos												
	2	Hrs	86	92	95	94	93	98	92	99	98	90	96	97	
		%	dittos												
	3	Hrs	104	67	103	92	100	96	102	107	94	99	93	101	
		%	95	84	94	92	91	96	93	97	94	90	93	92	
	T	Hrs	280	251	287	278	289	289	289	301	284	286	279	292	
		%	90	90	93	93	93	96	93	97	95	92	93	94	
1986	1	Hrs	85	91	83	87	99	94	99	93	96	94	81	98	
		%	dittos												
	2	Hrs	80	91	87	90	96	92	100	99	94	97	88	87	
		%	dittos												
	3	Hrs	90	NA	98	97	108	100	104	108	94	92	89	89	
		%	82	-	89	97	98	100	95	98	94	84	89	81	
	T	Hrs	255	-	268	274	303	286	303	300	284	283	258	274	
		%	82		86	91	98	95	98	97	95	91	86	88	
1987	1	Hrs	84	78	92	90	92	91	98	99	98	98	90	89	
		%	dittos												
	2	Hrs	83	88	92	90	89	100	100	100	99	96	89	89	
		%	dittos												
	3	Hrs	94	66	94	99	106	96	110	108	97	107	96	101	
		%	85	83	85	99	96	96	100	98	97	97	96	92	
	T	Hrs	261	232	278	279	287	287	308	307	294	301	275	269	
		%	84	83	90	90	93	96	99	99	98	97	92	87	
1988	1	Hrs	95	84	91	91	95	96	98	97	98	97	99	99	
		%	dittos												
	2	Hrs	88	86	95	98	86	97	96	99	97	89	93	62	
		%	dittos												
	3	Hrs	99	87	82	94	108	100	99	109	93	101	91	102	
		%	90	97	74	94	98	100	90	99	93	92	91	93	
	T	Hrs	282	255	268	283	289	293	303	305	288	287	273	253	
		%	91	88	86	94	93	98	98	98	96	93	91	82	
1989	1	Hrs	96	75	90	86	91	97	95	99	98	96	81	87	
		%	dittos												
	2	Hrs	84	78	95	94	95	100	100	100	98	92	97	90	
		%	dittos												
	3	Hrs	98	78	101	97	104	97	107	103	94	100	93	101	
		%	89	98	92	97	95	97	97	94	94	91	93	92	
	T	Hrs	278	231	286	277	290	294	302	302	290	288	271	278	
		%	90	83	92	92	94	98	97	97	97	93	90	90	

Fig C1 - 1 CURVES OF PROBABLE RAINFALL INTENSITY IN MM/hour



No.8

Appendix C2 Hydrology

1. General

The water source of the Cihideung River is available at the Project site. It, therefore, is necessary to study on availability of drought discharge in the dry season and on recurrence of flood, river capacity of flood passing in relations to flood water level and discharge of the Cihideung River.

During the field survey, efforts have been made for collection of hydrological data of the Cihideung River at the water source section of Bogor Branch Office, West Java Provincial Public Works. Irrigation intake water records at the Cihideung weir were collected for only 1988 and 1989. Also, river surveying for plan, profile and cross section of about 400 m distance of the Cihideung River at the Project site was carried out by the survey team. The results were studied subsequently for flood discharge estimate as well as location of future pump station.

2. River System of the Cihideung River

The color topographic maps with scale of 1/50,000 (old print) and the black and white copies of topographic maps with the same scale have been used for study of the catchment area.

The Cihideung River Originates the Salak mountains, accurately in the Peak (EL. 2,180 m) which locates on the connected ridge between the Salak mountain (EL. 2,211 m) and the Sumbu mountain (EL. 1,916 m). It flows down toward north in collecting drained water from its tributaries developed on the northern slope of the Salak mountains and reaches to the Project site after run about 18 km. The catchment area is 35 km^2 showing nearly a long elliptic shape on the map.

The Project site and catchment area of the Cihideung River is attached as Fig. C2-1 and the river system is illustrated in Fig. C2-2. As seen from Fig. C2-2, there are nine (9) tributaries, and the catchment areas are estimated at 35 km^2, 16 km^2, 15 km^2 and 13 km^2 at the sites of the pump station, the Cihideung weir, the Cianyar weir and the Cisunar weir, respectively.

River profile in the Catchment area has been prepared as shown in Fig. C2-3.

3. River Surveying Results of the Cihideung River at the Project Site

During the field survey period, the river route surveying for plan, profile and cross section was carried out for about 400 m distance of the Cihideung River.

The plan, profile and typical cross sections are given in Drawing C2-1 to -3.

The typical flow section is estimated as follows :

1.	Bottom width at EL. 209.0 m	:	5.8 m
2.	Width at EL. 211.6 m of the crest of Cihideung Supply Weir	:	22 m
3.	Width at EL. 213.6 m	:	34 m
4.	Side Slope	:	3 to 1
5.	River bed slope (average)	:	-0.00725
6.	Damming up height at the Cihideung Supply Weir (EL. 211.6 m - EL. 209 m)	:	2.6 m
7.	Distance between Cihideung Supply Weir and pump station	:	255 m
8.	Roughness coefficient of Manning Formula	:	0.020

Utilizing the above survey results, river capacity on flood passing in relation to water level and discharge has been calculated and shown in a curve as given in Fig. C2-4.

4. Recapitulation of Records for Irrigation Intake Water at the Cihideung River

The Water Resource Division, Bogor Branch Office of the West Java Provincial Public Works (SBDPUJB) is the responsible agency for water use of the Cihideung River.

Irrigation intake water and spilled water at the Cihideung Weir site is being record by the gate master at every morning and evening.

In order to know the status of river discharge, daily records from February, 1988 to December, 1989 have been collected with kind cooperation of the above SPBPU.

All the data were evaluated and arranged in a form of mean flow during pentad period as attached in Table C2-1.

Table C 2-1 Pentad Mean Irrigation Intake Flow and Spilled Flow at the Cihideung Irrigation Weir (Catchment Area = 16 km ^{2})

(Unit : lit/sec)

		1988				1989			
		Intake	Spill	Total	Note	Intake	Spill	Total	Note
J	1	No Data Available				440	528	968	
	2					428	152	580	
	3					423	472	895	
	4					432	104	536	
	5					452	546	998	
	6					485	0	485	
	M					443	300	743	
F	1	315	378	693		322	191	513	
	2	329	178	507		324	262	586	
	3	319	214	533		311	369	680	
	4	317	0	317		308	202	510	
	5	355	116	471		274	0	274	
	6	354	985	1,339		214	205	419	
	M	332	312	644		292	205	497	
M	1	223	1,024	1,247		306	0	306	
	2	276	3,034	3,310		313	0	313	
	3	270	2,596	2,866		318	0	318	
	4	255	1,402	1,657		314	0	314	
	5	264	920	1,184		319	104	423	
	6	271	1,587	1,858		319	1,434	1,753	
	M	260	1,761	2,021		315	256	571	
A	1	266	325	591		313	943	1,256	
	2	265	960	1,225		313	281	594	
	3	267	1,044	1,311		301	0	301	
	4	259	342	601		307	864	1,171	
	5	257	274	531		300	90	390	
	6	254	0	254		289	0	289	
	M	261	491	752		304	363	667	
M	1	263	576	839		300	779	1,079	
	2	241	474	715		309	868	1,177	
	3	236	461	697		295	866	1,161	
	4	269	435	704		317	967	1,284	
	5	264	90	354		306	860	1,166	
	6	261	128	389		321	1,357	1,678	
	M	256	361	617		308	950	1,258	
J	1	251	0	251		329	1,051	1,380	
	2	260	628	888		324	638	962	
	3	253	156	409		336	0	336	
	4	230	0	230		270	0	270	
	5	207	0	207		282	0	282	
	6	198	0	198		288	0	288	
	M	233	131	364		305	281	586	
J	1	189	0	189		296	384	680	
	2	195	634	829		305	393	698	
	3	179	0	179		300	275	575	
	4	176	0	176		294	90	384	
	5	163	0	163		305	435	740	
	6	198	0	198		302	0	302	
	M	183	106	183		300	263	563	
A	1	No Data Available				251	0	251	
	2					275	0	275	
	3					252	0	252	
	4					270	0	270	
	5					252	202	457	
	6					260	164	424	
	M					260	61	321	
S	1	239	0	239		249	0	249	
	2	240	0	240		263	0	263	
	3	232	0	232		247	0	247	
	4	239	0	239		251	0	251	
	5	243	0	243		241	0	241	
	6	266	0	266		264	0	264	
	M	243	0	243		253	0	253	
O	1	265	1,165	1,430		230	366	596	
	2	261	1,328	1,589		233	188	421	
	3	257	2,611	2,868		244	1,548	1,792	
	4	273	1,178	1,451		240	3,860	4,100	
	5	279	1,370	1,649		240	2,732	2,972	
	6	247	563	810		242	3,140	3,382	
	M	264	1,369	1,633		238	1,972	2,210	
N	1	284	435	719		375	8,080	8,455	
	2	245	0	245		298	388	686	
	3	245	0	245		361	3,336	3,697	
	4	287	594	881		363	6,256	6,619	
	5	287	563	850		305	224	529	
	6	258	0	258		304	0	304	
	M	268	265	533		334	3,047	3,381	
D	1	267	176	443		359	11,447	11,806	
	2	259	90	349		442	1,728	2,170	
	3	288	269	557		414	0	414	
	4	291	370	661		347	1,249	1,596	
	5	253	0	253		401	458	859	
	6	258	0	258		360	6,244	6,604	
	M	269	151	420		387	3,521	3,908	

Note
1. Source : Seksi BOGOR DPU. Java Barat. (SBDPUJB)
2. Flow is estimated on the basis of overflow depth read at morning and evening.
3. M means the average in the month.

5. Available River Water at the Project Site

As seen from Table C2-1, the spilled flow at the Cihideung weir is high in the rainy season but very small or zero in both dry season and in no rain pentad in rainy season.

While the water shortage of the irrigation experimental farm, IPB concentrates in the dry season, much water release from the Cihideung Weir can be unexpected.

So, run-off from the tributaries : Cimoboran, Cirandi, Cibeurem, Cikiruk, Cipakar and Cisasah becomes to the reliable water source for the Project. Such remaining part of the catchment area in downstream of the Cihideung Weir is 19 km^2 in total at the pump station site under consideration.

The run-off in the drought period available for the Project is estimated as follows :

1.	The lowest run-off at the Cihideung Weir, 5th pentad July, 1988 (CA = 16 km^2)	:	163 lit/sec
2.	Specific run-off of the above	:	10 lit/sec/km^2
3.	Estimated lowest run-off from the remaining catchment (CA = 19 km^2, safety factor 0.7)	:	133 lit/sec
4.	Irrigation water requirements for the Cihideung irrigation system from the Cihideung Supply Weir (IA = 64 ha, Unit W. R. = 1.8 lit/sec/ha)	:	115 lit/sec
5.	Available water source at the Pump Station Site (Item 3 - Item 4)	:	18 lit/sec

From the above, it is concluded that river discharge available for the Project is 18 lit/sec during the drought period.

6. Estimate of Flood Discharge of the Cihideung River

The catchment area of the Chihideung River is estimated at 35 km^2 at pump station site under consideration read on the Topographic Map with the scale of 1:50,000.

Also, the following features of the catchment area are found :

- the highest elevation EL 2,000 m
- the lowest elevation EL 190 m
- the longest river length L = 17.8 km
- the average river slope I = 910/16,000 = 0.0569

The Chihideung River system and profile have been illustrated as shown in Fig and Fig .

The Der Weduwen flood formula has been applied for this area as follows :

$$Qn = \alpha \cdot \beta \cdot qn \cdot A$$

in which,

$$\alpha = 1 - \frac{4.1}{\beta \cdot qu + 7}$$

$$\beta = \frac{120 + (\frac{t+1}{t+9})\, A}{120 + A}$$

$$qu = \frac{Rn}{240} \cdot \frac{67.65}{t + 1.45}$$

$$t = 0.25 \cdot L \cdot Q^{-0.125} \cdot I^{-0.25}$$

and where,

Qn or Q	=	N - Yr flood discharge in m^3/sec
Rn	=	N - Yr design rainfall in mm/day
α or F	=	run-off coefficient
β or B	=	areal reduction coefficient for the catchment rainfall
qu or Qu	=	heavy rainfall given in m^3/sec per km^2
A	=	catchment area in km^2 upto 100 km^2
t	=	duration of heavy rainfall in hours
L	=	river length in km
I	=	average gradient of river or terrain, for determination the upstream 10 % of the length is excluded. Height difference and length are taken from a point 0.1 L from the upstream catchment boundary.

Using the above figures of the Catchment, the relationship between Rn and QN have been calculated with the try and error method by assuming QN as follows.

Calculated Flood Qn by Der Weduwen Formula

RN = 5	RN = 10	RN = 20	RN = 30	RN = 50
T = 8.406	T = 7.606	T = 6.859	T = 6.441	T = 5.932
F = 0.425	F = 0.437	F = 0.461	F = 0.484	F = 0.528
B = 0.896	B = 0.891	B = 0.886	B = 0.883	B = 0.879
QU = 0.143	QU = 0.311	QU = 0.678	QU = 1.072	QU = 1.909
QN = 1.9	QN = 4.2	QN = 9.7	QN = 16	QN = 31

RN = 60	RN = 70	RN = 80	RN = 90	RN = 100
T = 5.755	T = 5.608	T = 5.483	T = 5.374	T = 5.278
F = 0.547	F = 0.566	F = 0.583	F = 0.6	F = 0.615
B = 0.878	B = 0.876	B = 0.875	B = 0.874	B = 0.873
QU = 2.347	QU = 2.796	QU = 3.253	QU = 3.717	QU = 4.189
QN = 39.5	QN = 48.5	QN = 58.2	QN = 68.3	QN = 78.8

RN = 200	RN = 300	RN = 400
T = 4.691	T = 4.386	T = 4.188
F = 0.726	F = 0.79	F = 0.831
B = 0.868	B = 0.865	B = 0.863
QU = 9.18	QU = 14.489	QU = 19.999
QN = 202.5	QN = 346.6	QN = 502

Based on the above calculation, curve of the relationship between Rn and QN for flood discharge of the Cihideung River has been shown in Fig. C2-5.

By applying the Der Weduwen flood formula with parameters of probable daily rainfall (mm/day) for annual and every monthly maximum rainfall, flood discharges of the Cihideung River have been estimated as shown in Table C2-2.

Table C2-2 Calculated Probable Flood Discharge

Return Period	Items	Unit	Annual	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
2-Yr	Rn	mm/day	116.5	65.6	64.8	62.5	71.9	68.2	65.1	66.2	58.2	65.1	64.5	54.9	57.2
	Qn	m^3/s	97.1	44.5	48.3	41.7	50.3	46.9	44.0	45.0	37.9	44.0	43.5	35.1	37.0
4-Yr	Rn	mm/day	145.4	83.5	98.9	80.6	85.4	94.5	90.0	98.0	84.2	90.8	82.9	72.2	84.1
	Qn	m^3/s	131.5	61.6	77.6	58.7	63.6	73.0	68.3	76.7	62.3	69.1	61.0	50.6	62.2
5-Yr	Rn	mm/day	153.8	88.7	108.7	85.9	89.3	102.1	97.2	107.2	91.8	98.2	88.3	77.2	91.9
	Qn	m^3/s	141.9	66.9	88.3	64.1	67.5	81.1	75.8	86.7	70.1	76.9	66.5	55.4	70.2
10-Yr	Rn	mm/day	178.5	103.9	137.8	101.3	100.9	124.6	118.5	134.4	114.0	120.1	104.0	92.0	114.9
	Qn	m^3/s	173.7	83.0	122.2	80.2	79.8	106.5	99.4	118.1	94.3	101.2	83.2	70.3	95.3
20-Yr	Rn	mm/day	202.2	118.6	165.7	116.1	112.0	146.1	138.8	160.4	135.3	141.1	119.1	106.2	136.9
	Qn	m^3/s	205.5	99.5	157.0	96.7	92.0	132.3	123.4	150.3	119.2	126.2	100.1	85.6	121.1
50-Yr	Rn	mm/day	232.9	137.5	201.9	135.3	126.3	174.0	165.2	194.1	163.0	168.4	138.6	124.5	165.5
	Qn	m^3/s	248.3	121.8	205.1	119.2	108.5	167.8	156.4	194.5	153.6	160.5	123.1	106.3	156.8
100-Yr	Rn	mm/day	255.9	151.7	229.0	149.7	137.0	194.9	185.0	219.4	183.6	188.8	153.2	138.3	186.8
	Qn	m^3/s	281.3	139.3	242.8	136.8	121.2	195.6	182.3	229.3	180.5	187.4	141.2	122.8	184.7

7. Design Flood and Design Floor Elevation of the Pump Station under Consideration

As seen from Table C2-2, 100-Yr flood is 255.9 m^3/sec and 229.0 m^3/sec for annual data and February data, respectively. Thus, the design flood for the pump station is decided to be 260 m^3/sec. Accordingly, design high water level is found to be EL 214.6 m so that the design floor elevation of the pump station is determined to be EL. 215.0 m in adding 0.4 m allowance to the designed high water level.

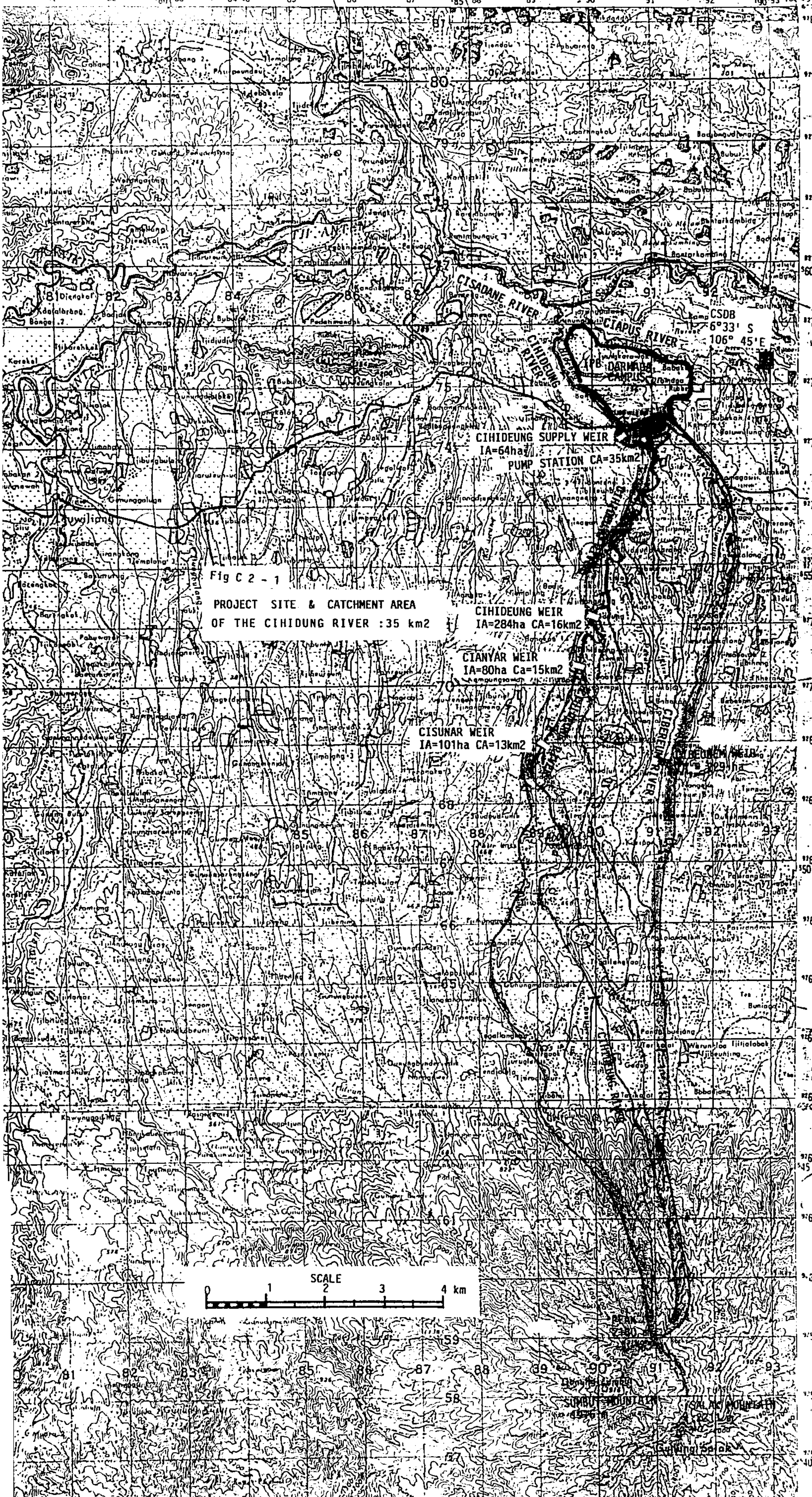


Fig C 2 - 1

PROJECT SITE & CATCHMENT AREA OF THE CIHIDUNG RIVER :35 km2

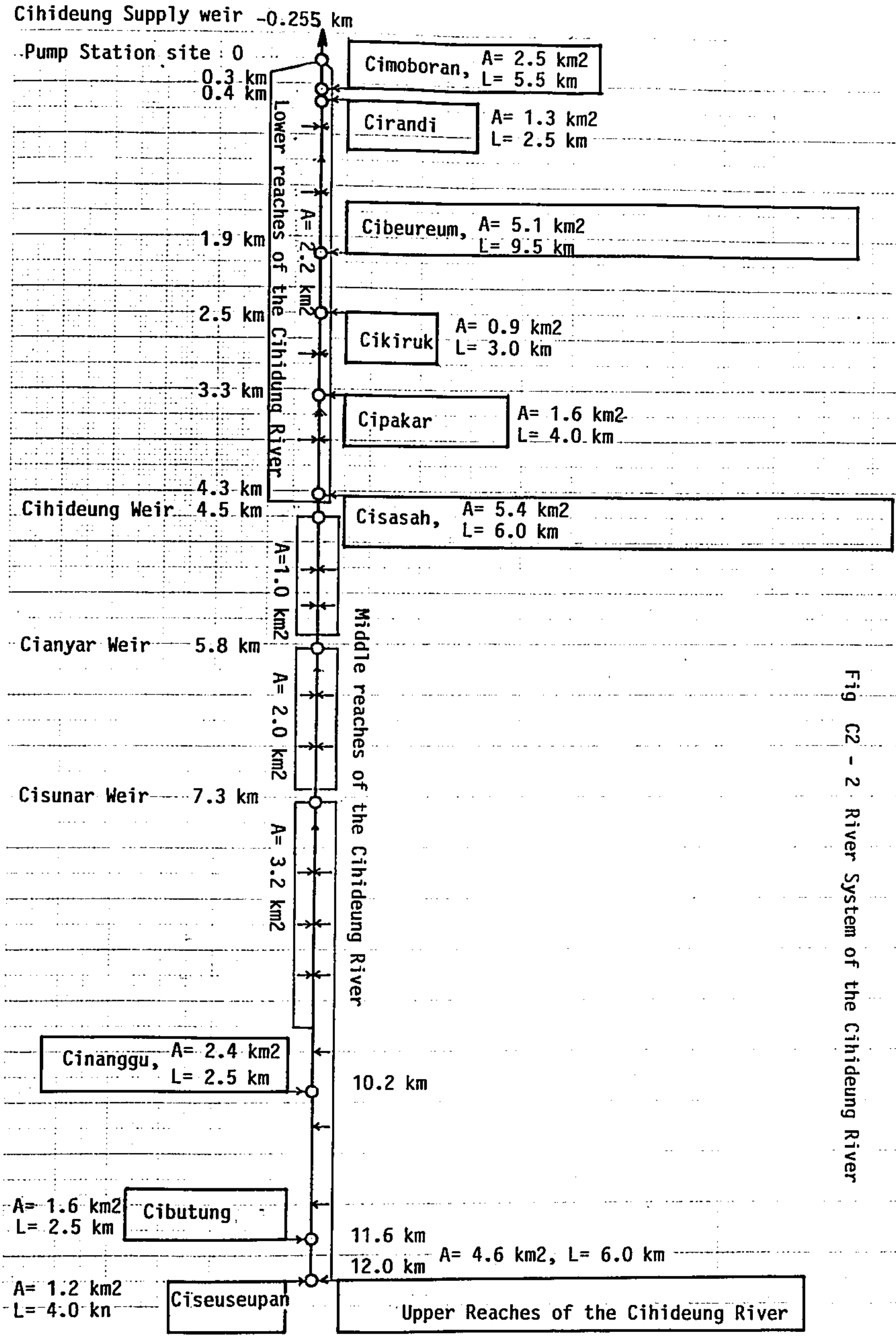
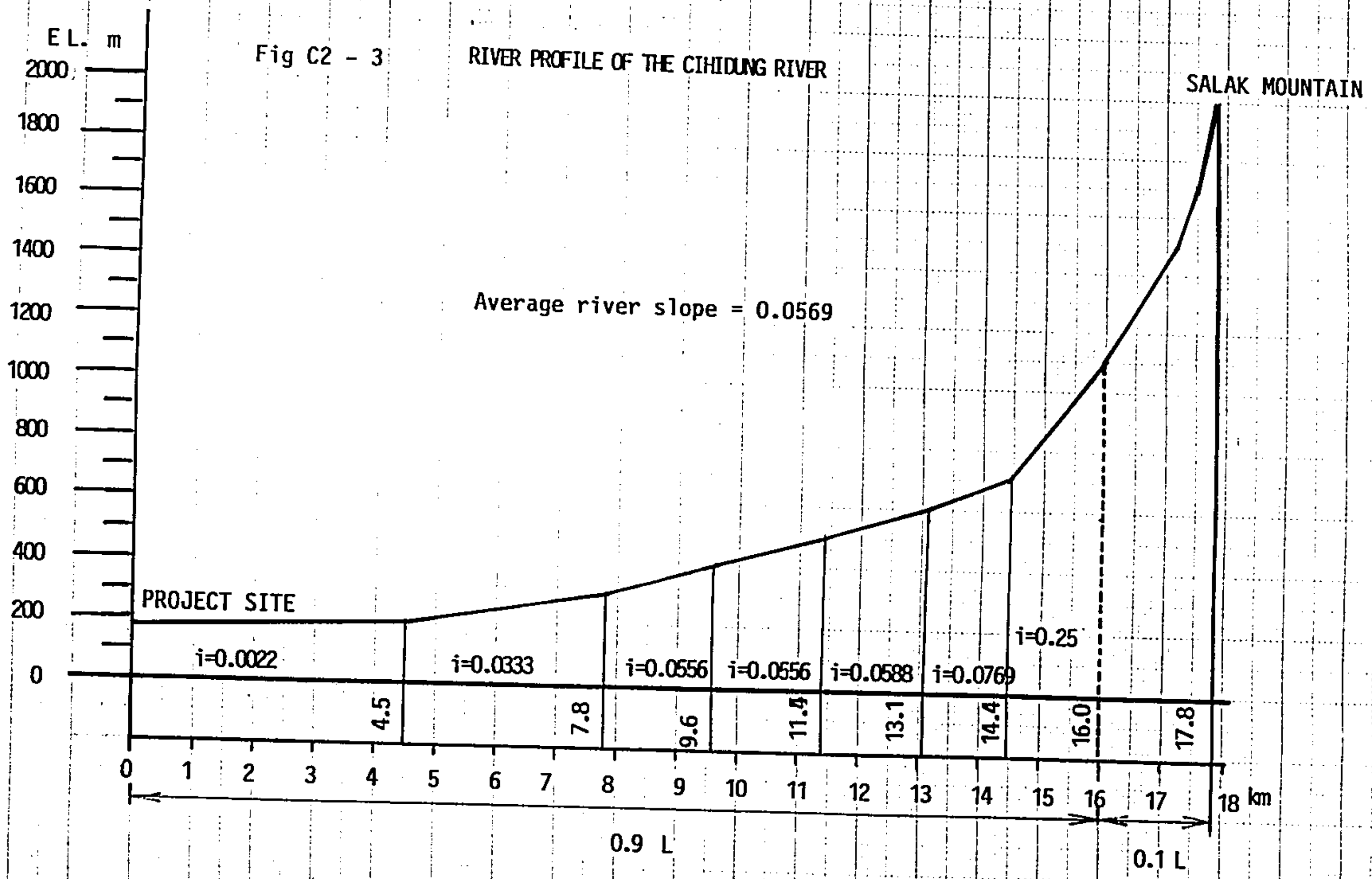


Fig C2 - 2 River System of the Cihideung River

Fig C2 - 3 RIVER PROFILE OF THE CIHIDUNG RIVER



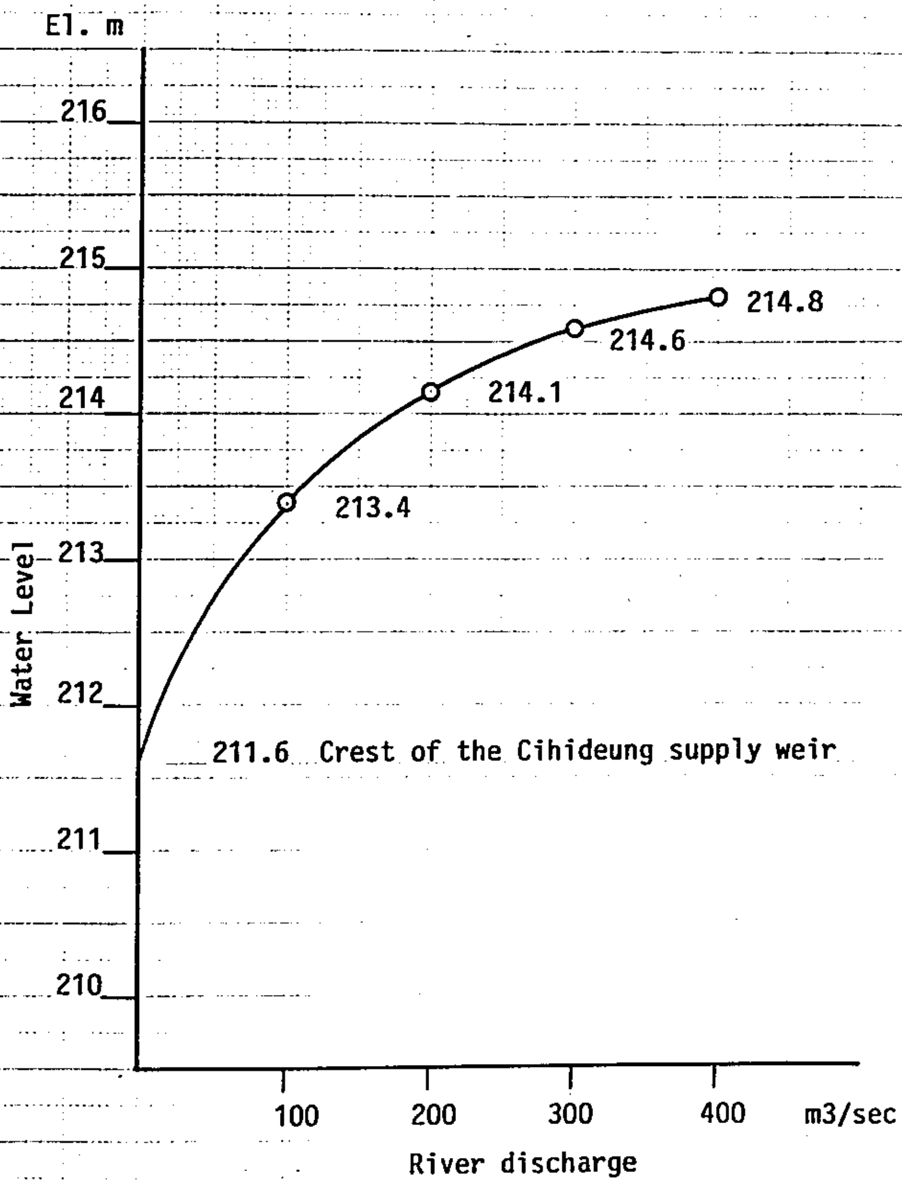


Fig C2 - 4 Discharge Curve of the Cihideung River at Pump Station Site under consideration

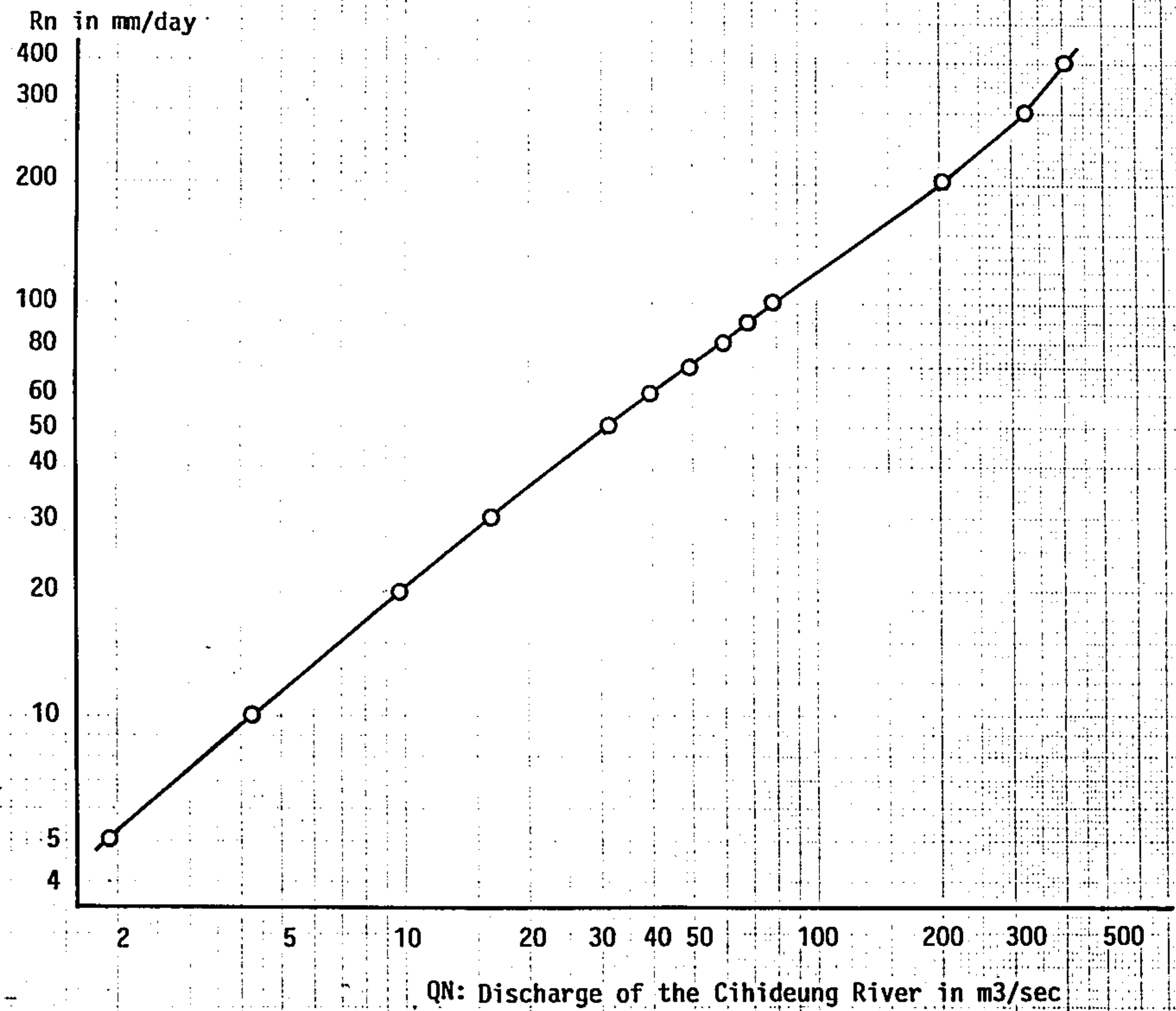
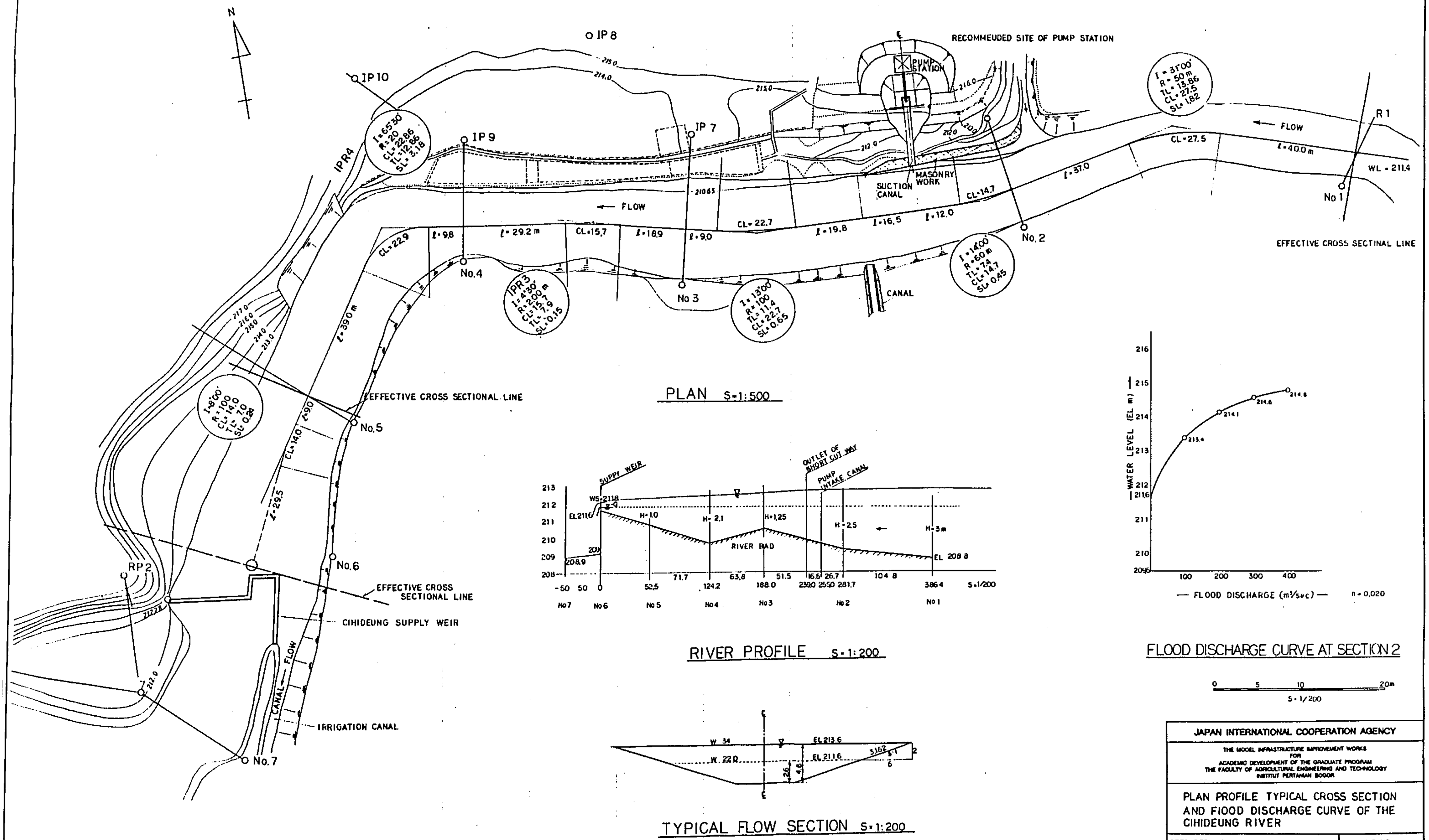


Fig C2-5 Curve of the Relationship between Rn and QN



PLAN S=1:500

RIVER PROFILE S=1:200

FLOOD DISCHARGE CURVE AT SECTION 2

TYPICAL FLOW SECTION S=1:200

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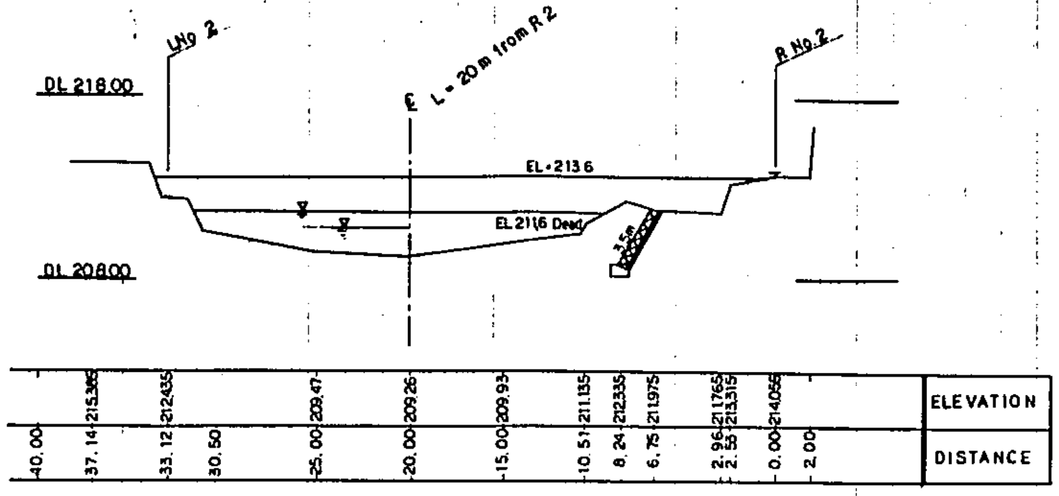
PLAN PROFILE TYPICAL CROSS SECTION AND FIOOD DISCHARGE CURVE OF THE CIHIDEUNG RIVER

PREPARED BY	DRAWING NO.
CHECKED BY	C2-1



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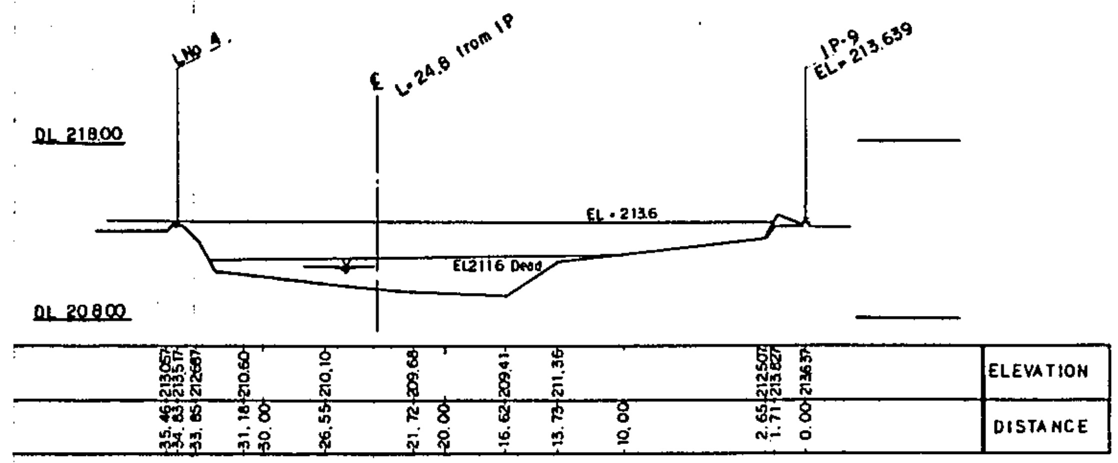

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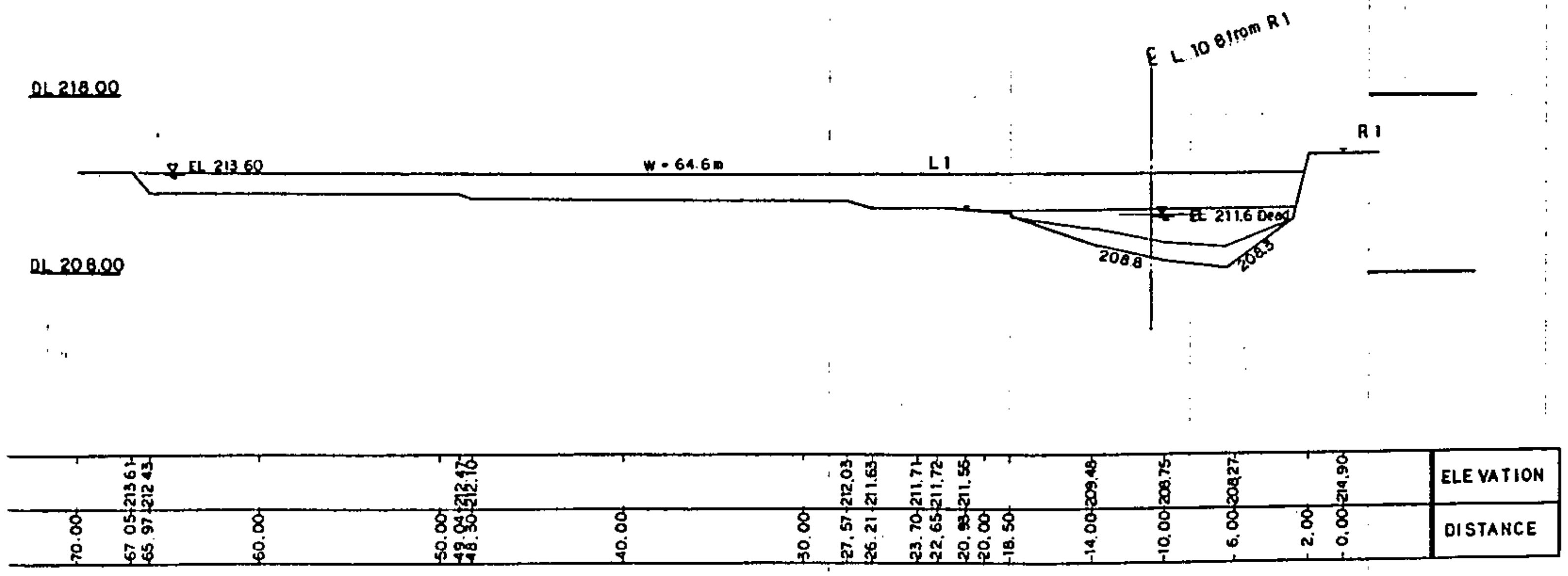
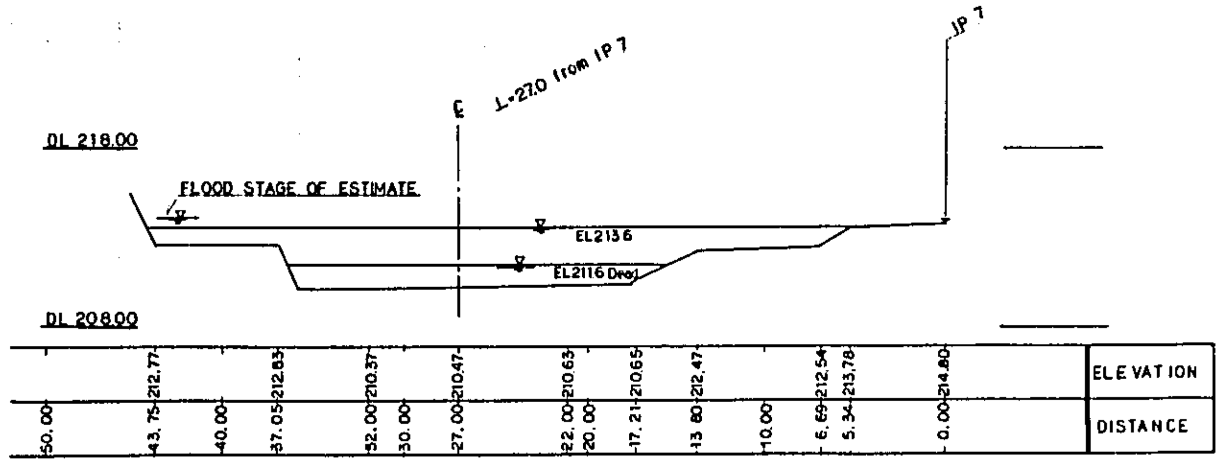


No.1 SECTION S=1:200



No.3 SECTION S=1:200

0 5 10 20m
S 1/200

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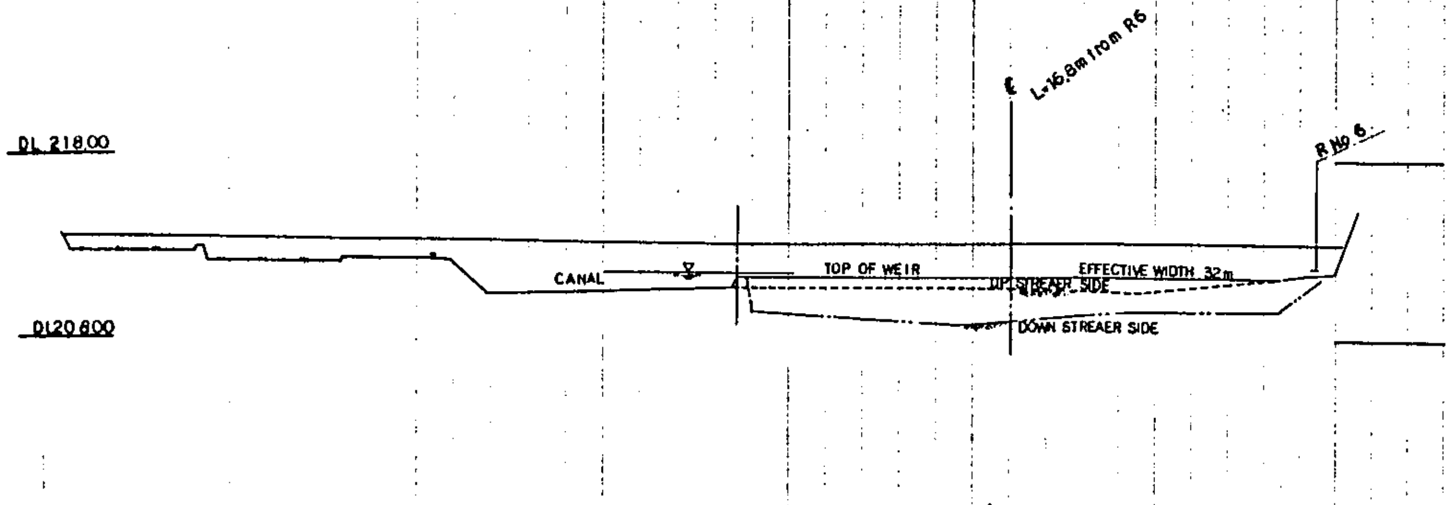
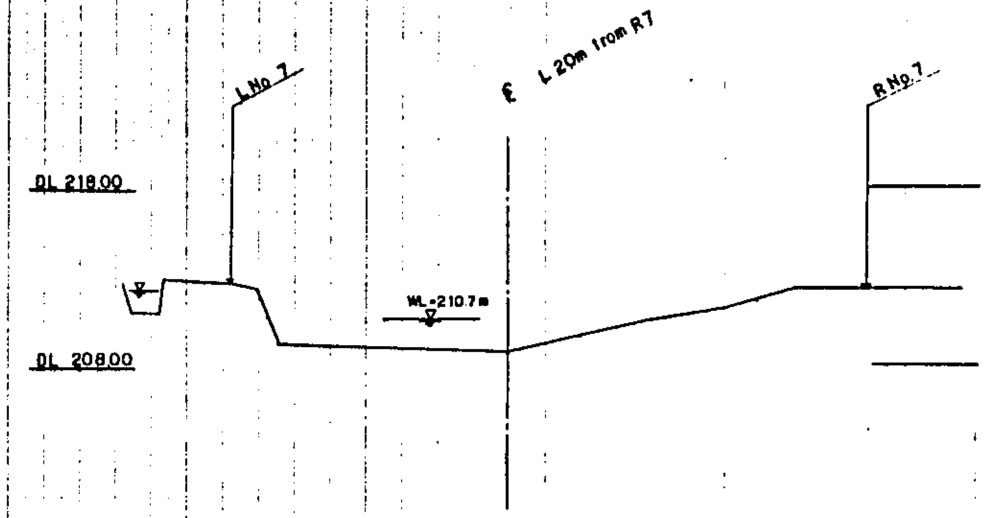
CROSS SECTION OF THE CIHIDEUNG RIVER (1/2)

PREPARED BY	DRAWING NO. C2-2
CHECKED BY	



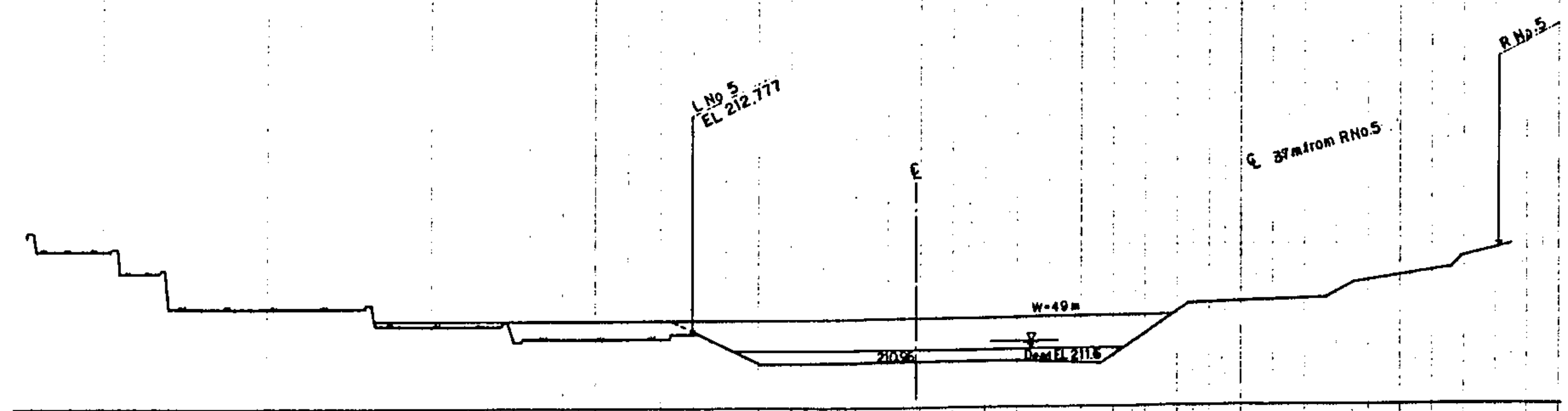
DISTANCE	ELEVATION
70.00	
67.14	212.94
61.33	212.97
60.46	213.14
53.06	212.41
50.00	
48.41	212.627
	210.69
40.00	210.71
	210.98
30.00	209.72
20.00	211.04
10.00	209.73 (210.73)
	209.78
0.00	212.277

No.6 SECTION S=1:200



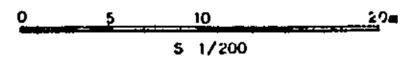
DISTANCE	ELEVATION
50.00	
40.23	210.91
39.10	212.91
35.41	212.88
34.05	212.50
32.88	209.24
30.00	209.10
20.00	2089
11.90	210.85
10.00	
7.80	211.45
5.00	212.05
4.00	
0.00	212.65

No.7 SECTION S=1:200



DISTANCE	ELEVATION
90.50	217.257
85.88	217.747
85.54	217.897
82.94	216.352
82.53	216.567
70.36	214.212
69.98	214.387
69.33	213.077
61.04	212.077
60.00	
59.12	212.427
51.39	212.757
50.39	212.777
45.00	
40.00	210.74
35.00	210.96
30.00	210.84
25.00	210.67
20.00	212.405
19.53	
10.83	214.697
10.00	
9.16	215.687
2.85	216.657
2.42	217.277
0.00	218.107

No.5 SECTION S=1:200



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CROSS SECTION OF THE CIHIDEUNG RIVER (2/2)

PREPARED BY
CHECKED BY
DRAWING NO. C2-3

Appendix C3 Soil Mechanics

1. General

During the field survey, one test pit with dimensions of 1.5 m width, 1.5 m length and 1.0 m depth was digged at the south west part of the coconut trees growing area.

Two soil samples were taken from 0.5 m (No. 1) and 1.0 m (No. 2) depth and tested the soil mechanic characteristics at the Soil Laboratory of Soil Physics and Mechanics, Faculty of Agricultural Technology, IPB Darmaga Campus.

The tested items were :

(1) mechanical analysis including measurement of soil moisture ratio, hydrometer test and grading by sieve
(2) plastic limit and liquid limit

The test was carried out by Messers M. Azron D., Asep. S., Erizal who are counterparts of JICA Expert Dr. Seiji Sudo.

2. Result

The test results have been arranged in Table C3-1 and Fig. C3-1 and Fig. C3-2.

As seen from the data, the soil has been classified as volcanic cohesive soil with high liquid limit (VH2).

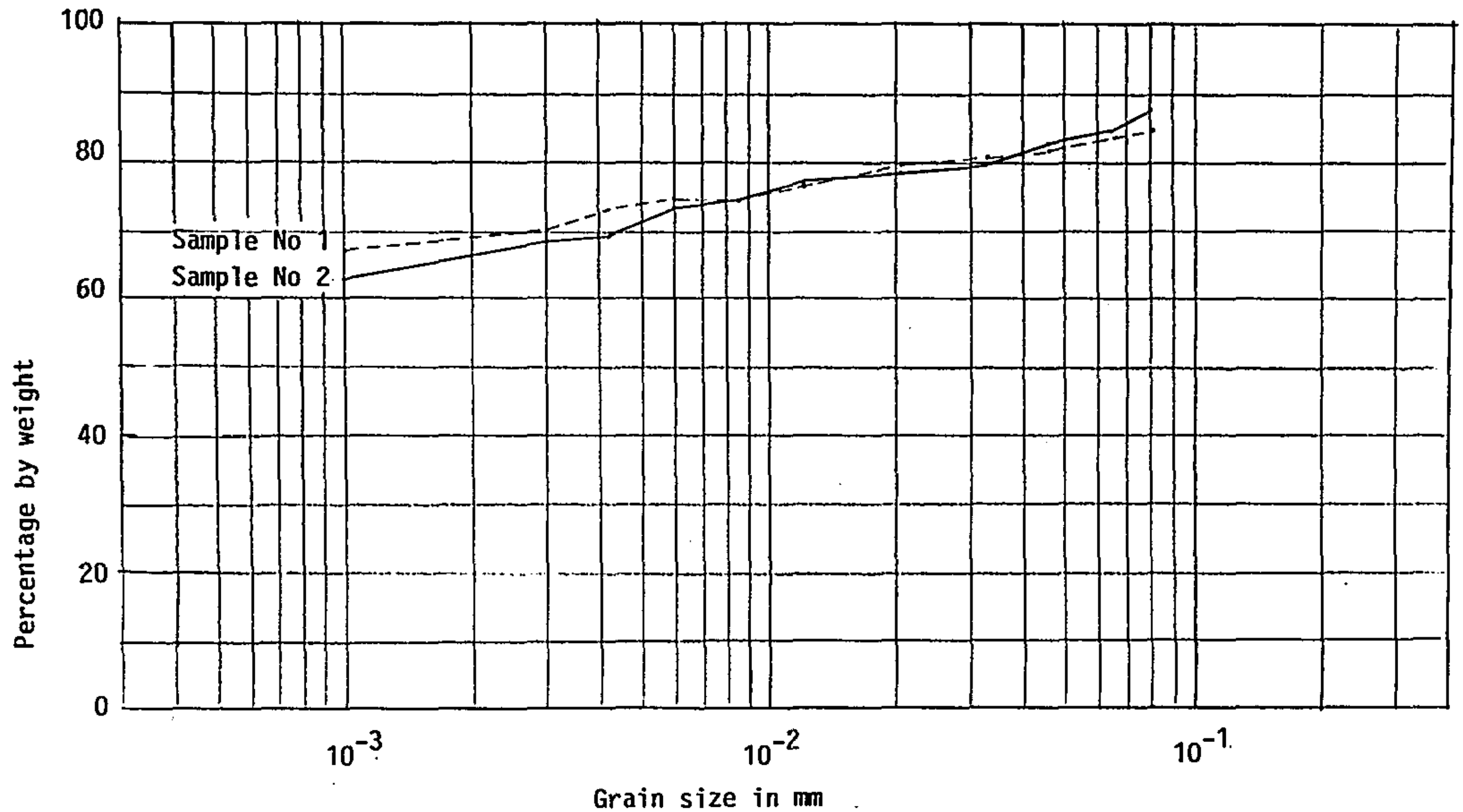
Table C3-1 Results of soil Physical Characteristics Determinations

Location : Leuwikopo, IPB Darmaga Campus Bogor

Characteristics	Sample No. 1	2
1. Natural water content, Wn (by weight, %)	59.70	62.34
2. Atterberg limit :		
Air dried soil :		
- Plastic limit, Wp (%)	60.92	63.54
- Liquid limit, Wl (%)	84.10	85.80
- Plasticity index, IP (%)	23.18	22.26
Fresh soil :		
- Plastic limit, Wp (%)	59.67	63.52
- Liquid limit, Wl (%)	85.70	91.00
- Plasticity index, IP (%)	26.03	27.48
Plasticity Chart : Volcanic cohesive soil (VH2)		
3. Specific gravity, Gs	2.64	2.70
4. Texture (JSF Grading) :		
- Plastic limit, Wp (%)	73.80	71.10
- Liquid limit, Wl (%)	10.30	15.60
- Plasticity index, IP (%)	15.90	13.30
Triangle coordinates : fine soil, F		
5. Data sheets : enclosed		

Fig C3 - 1 Grain size accumulation curve

	clay	silt	sand
Sample No 1	73.80	10.30	15.00
Sample No 2	71.10	15.60	13.30



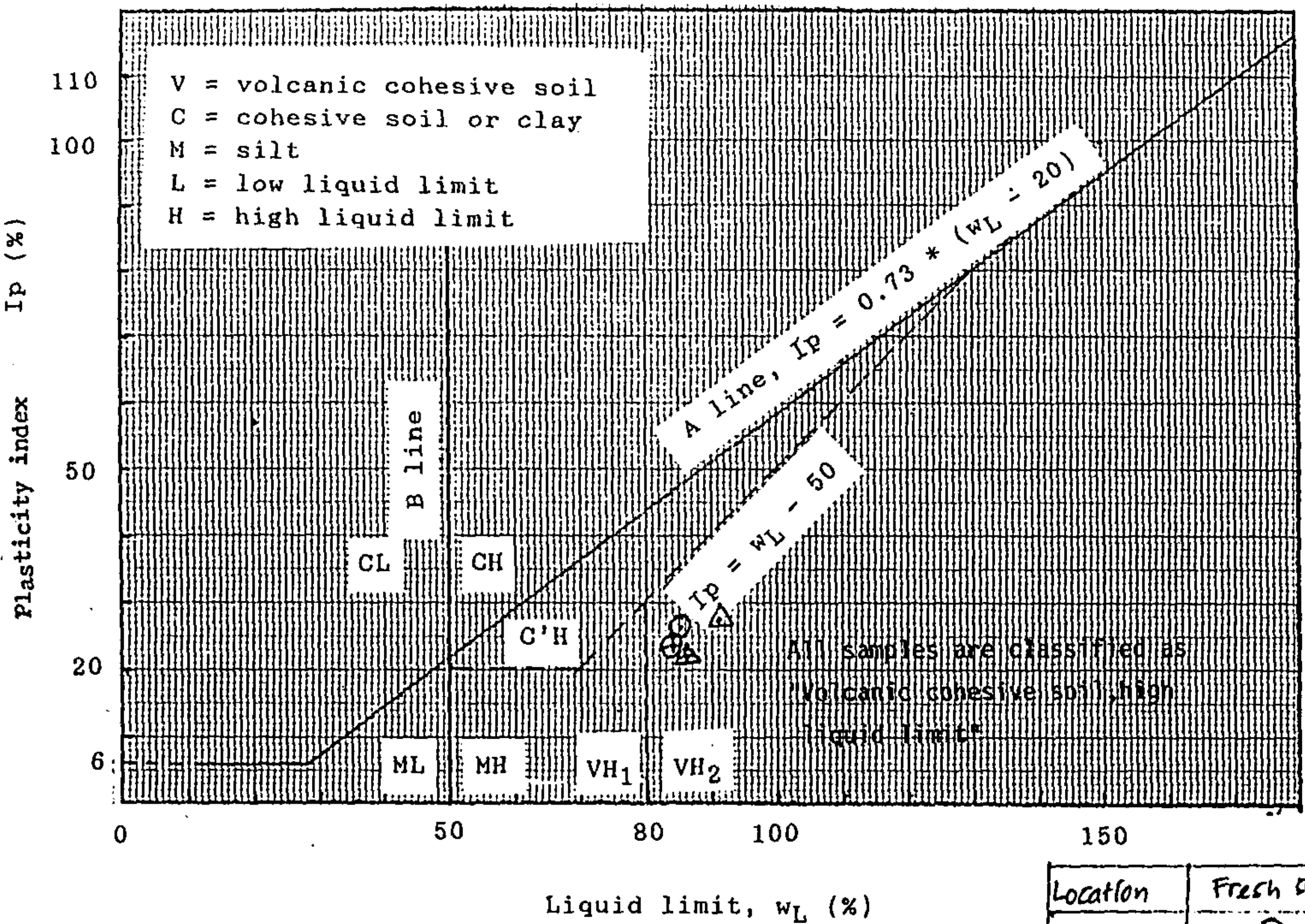


Fig C3 - 2 plasticity chart

Location	Fresh soil	Airdry soil
1	⊙	⊕
2	◬	⨹

Appendix C4 Irrigation & Drainage

1. Determination of the basic years for planning and design of irrigation facilities

Probability analyses have been made on the dry season rainfall of 4 months : July, August, September, October and annual rainfall obtained data at the Climatological Station Darmaga Bogor (CSDB), by the Iwai method as shown in Tables C4-1 to 3, respectively. As the results, the years of 1988 and 1977 have been decided as the basic years for irrigation planning and design.

It has been found that the year of 1988 is regarded as the dry year having the probability of non-exceedance with 5 years return period for annual rainfall but with 10 years return period for dry season rainfall, while the year of 1977 as the wet year having the probability of exceedance with 5 years return period for annual rainfall but having the probability of non-exceedance with 6 years return period for dry season rainfall.

Moreover, the longest dry consecutive days during one year have been calculated with the negligence of a light rain less than 5 mm/day based on the daily rainfall data of 13 years from 1977 through 1989 obtained at the CSDB and arranged as follows :

The Longest Dry Consecutive Days during One Year at the CSDB

Year	Days	Period	Remarks
1977	23	3 to 25 July	Basic year
1978	10	15 to 24 July	
1979	19	6 to 25 May	
1980	15	19 August to 2 September	
1981	15	5 to 19 August	
1982	34	15 August to 17 September	Maximum
1983	20	23 July to 11 August	
1984	18	16 June to 3 July	
1985	9	8 to 20 December	Minimum
1986	10	15 to 24 August	
1987	25	3 to 27 August	
1988	21	22 August to 11 September	Basic year
1989	17	15 April to 1 May	
Mean	18.1		
σ	6.6		

The probability of non-exceedance for the above data is also analyzed with the Gamble method. It was found that the years of 1977 and 1988 correspond to the return period of 4 years and 3 years, respectively.

From the above, it was concluded that the decided basic years are adequate to use for irrigation planning and design of this project.

2. Calculation of crop water requirements

Crop water requirements of upland crops and paddy were estimated by applying FAO : Pan Evaporation Method : Irrigation & Drainage paper No.24 to the evaluated data of the observation records at the CSDB. Most of the data are shown in Appendix C1 Climate.

2.1 Reference crop evapotranspiration

Probability of non-exceedance on the data of monthly mean pan evaporation has been analyzed with the application of the Iwai method. The results are as follows :

(unit : mm/day)

	Return Period			Return Period	
	5-yr	10-yr		5-yr	10-yr
January	3.0	3.4	July	3.6	3.9
February	3.4	3.7	August	4.1	4.5
March	3.6	4.0	September	4.4	4.9
April	3.7	4.0	October	4.3	4.7
May	3.5	3.8	November	4.0	4.3
June	3.4	3.6	December	3.6	3.8

Reference crop evapotranspiration ETo has been estimated using the data of monthly mean temperature, wind velocity, relative humidity and the pan evaporation with 10 years return period.

The Class A evaporation pan has been placed in the dry surface area at the windward side distance of about 25 m at the CSDB, therefore the pan factor (Kp) to be used in the calculation was decided to be 0.79 throughout one year.

The estimated reference crop evaporation ETo are shown on Table C4-4.

2.2 Cropping plan on irrigation experiment fields

With consideration to the natural climate of Bogor area, cropping plans were studied for upland experiment fields of 5,500 m^2 and paddy experiment fields of 3,150 m^2, respectively.

Two kinds of cropping have been chosen for this study. The former consists of 3 times upland cropping on upland fields and 3 times paddy cropping on paddy fields in one year as Case A, and the later is comprised of 3 times upland cropping on upland fields and 2 times paddy cropping in the rainy season and 1 time upland cropping in the dry season on paddy field as Case B.

From the tendency of rainfall distribution, it was found that the start of paddy cropping will be at the beginning of November, so, this has been taken into the both cases.

Paddy variety is assumed to be the improved varieties such as Cisadane, Knung Aceh, of which the growing periods are 130 - 140 days.

Corn of 133 days, fruit vegetable of 133 days (such as cucumber, eggplant, melons, tomatoes and peppers) and soybeans of 92 days are chosen for upland cropping on upland fields.

Also, soybeans of 92 days are selected as the dry season crop on the paddy field.

2.3 Crop coefficients (Kc)

The crop growing season has been divided into four stages, those are, (1) initial stage, (2) crop development stage, (3) mid-season stage and (4) late season stage. In referring Fig. 7, Table 21 & 22 in the said FAO : I & D Papers

No.24, the following crop coefficients have been applied to the calculation of crop water requirements :

	Corn (133)		Fruit, Vegetable (133)		Soybeans (92)		Paddy (102)	
(1) Initial stage	0.5	(20)	0.5	(31)	0.5	(15)	1.1	(25)
(2) Crop development stage	0.75	(41)	0.78	(41)	0.75	(16)	1.1	(26)
(3) Mid-season stage	1.05	(41)	1.05	(40)	1.0	(30)	1.05	(25)
(4) Late-season stage	1.0-0.55	(31)	0.93-0.6	(21)	0.9-0.45	(31)	0.95	(26)

Note : 1. Parentheses ( ) show the growing days for each stage of crops.
2. Paddy is given the figures after transplanting.

2.4 Crop water requirements

The calculation of crop water requirements has been tabulated for the above two Cases as shown in Table C4-5 and C4-6.

In the calculation, percolation of the paddy field is assumed to be 2 mm/day throughout one year. Also, the necessary water for land preparation and paddling practice before transplanting of seedling is assumed to be 250 mm during 10 days or 5 days. Seedling age may be 20 to 25 days olds.

3. Calculation of water balance

In order to check the status of water balance after construction of irrigation and drainage facilities and to find the adequacy of the designed farm pond capacity (1,000 m^3) and the necessity of supplemental pumping irrigation water supply from the Cihidung river, the calculation of water balance has been made for every pentad period throughout one year by dividing two cases : Case A & B and two basic years : 1988 & 1977, as shown in Table C4-7 to 10.

After deduction of effective rainfall, crop requirements of upland and paddy crops : Column (5) & (6) in the Tables have been calculated for every pentad period throughout one year of 1988 & 1977 with the following assumptions :

(1) If daily rainfall is less than 5 mm, the effective rainfall for crops is regarded as zero.

(2) If daily rainfall is more than 5 mm and less than the estimated crop water requirements, the difference is to be irrigated.

(3) If daily rainfall is equal to or more than the estimated crop water requirements, irrigation is not required.

Irrigation requirements of upland field : Column (9) in the Tables were calculated for 5,500 m^2 including the tracter test field by multiplying the above crop requirements and by dividing 60 % of irrigation efficiency and 95 % of conveyance efficiency.

Irrigation requirements of paddy field : Column (10) in the Tables were calculated for 3,150 m^2 of paddy field including lysimeter are by multiplying the above crop requirements and by dividing 95 % of conveyance efficiency.

The catchment area of the farmpond has been designed to be 24,100 m^2 in total on the topographic survey drawing, which includes 5,400 m^2 of the tractor test road, 5,700 m^2 of the tractor test field, 7,700 m^2 of the irrigation experiment field (paddy), the lysimeter area and the farm pond, and 5,300 m^2 of the irrigation experiment field (upland crops). However the effective catchment area of the farm pond has been estimated to be 21,000 m^2 nearly equal to 90 % of the designed area, with the safety side consideration.

Rainfall on the catchment area will be drained to the designed drainage canal and led to the farm pond.

The run-off to the pond in each pentad period is estimated from the daily rainfall records in 1988 and 1977 with the following assumptions :

1. Total rainfall in the pentad (5-day as normal, 6-day is the last pentad of the month having 31 days, 3-or 4-day is the last pentad of February) is considered as the source of run-off to the farm pond.

2. If the pentad rainfall is less than the Product of 3 mm/day multiplying the number of the days in the pentad, the run-off to the pond is regarded as zero.

3. If the pentad rainfall is more than the above Product, the run-off to the pond is calculated as 60 % to the amount over the Product.

The calculation of water balance have been made in the following manner:

1. Calculate the Water Volume: the carried over pond volume (Column 12) from the previous pentad plus the run-off (Column 8) minus the irrigation requirements (Column 11) in the pentad,

2. If Water Volume is less than 1,000 m^3 of the pond capacity, the Water Volume will be stored in the farm pond,

3. If Water Volume is more than 1,000 m^3, the exceed water volume will be spilled out, and

4. If Water Volume becomes minus, the water shortage will be filled by the Cihidung pump.

The maximum water shortage was found to be 486 m^3 in the 1st pentad July, 1988 (Case B, Table C4-8). Based on this figure, the required pump capacity at the Cihidung river may be with the assumption of 9 hr pump operation in one day:

$$\text{Req. Capacity} = \frac{486\ m^3}{5\ \text{day} \times 9\ \text{hr}} = 10.8\ m^3/\text{hr} = 0.18\ m^3/\text{min.} = 3\ \text{lit/sec.}$$

The following table is the recapitulation of water balance calculation.

		Case A		Case B	
		1977	1988	1977	1988
1. Rainfall	mm	4,338	3,189	4,338	3,189
2. Crop Water Requirements.					
upland	mm	664	707	664	707
paddy	mm	1,456	1,853	950	1,275
3. Run-off to Pond					
	mm	2,065	1,390	2,065	1,390
	m^3	43,365	29,190	43,365	29,190
4. Irrigation Water Requirements.					
upland	m^3	6,412	6,831	6,412	6,831
paddy	m^3	4,820	6,133	3,147	4,222
Total		11,232	12,964	9,559	11,053
5. Water Shortage	m^3	1,421	2,395	415	1,187
6. Spillout Water	m^3	32,686	18,080	33,353	18,783
7. Pump Operation	hr	133	224	38	112
8. Number of Full Storage of Pond		10	10	11	9
9. Full storage of Pond					
No. of pentad		36	31	39	34
Percentage in the year		50	43	54	47

Table C4 - 1 Calculation of Probability of Non Exceedance on Dry Season Rainfall at the CSDB , for 4 months period : July,August,September,October

IWAI METHOD

DATA N=26.

D(1)=977. 1964
D(2)=676. 1965
D(3)=509. 1966
D(4)=680. 1967
D(5)=1120. 1968
D(6)=930. 1969
D(7)=1052. 1970
D(8)=1343. 1971
D(9)=390. 1972
D(10)=1377. 1973
D(11)=1740. 1974
D(12)=1460. 1975
D(13)=718. 1976
D(14)=695. 1977
D(15)=1688. 1978
D(16)=1244. 1979
D(17)=1210. 1980
D(18)=1357. 1981
D(19)=649. 1982
D(20)=1188. 1983
D(21)=1359. 1984
D(22)=1338. 1985
D(23)=1135. 1986
D(24)=801. 1987
D(25)=609. 1988
D(26)=999. 1989

RANKING & PLOTTING POSITION

P. OF NON-EXCEEDANCE

RANK (I)	DATA (X)	WEIBULL I/(N+1)	PLOT% P=1-F
1.	390.	3.7	96.3
2.	509.	7.4	92.6
3.	609.	11.1	88.9
4.	649.	14.8	85.2
5.	676.	18.5	81.5
6.	680.	22.2	77.8
7.	695.	25.9	74.1
8.	718.	29.6	70.4
9.	801.	33.3	66.7
10.	930.	37.	63.
11.	977.	40.7	59.3
12.	999.	44.4	55.6
13.	1052.	48.1	51.9
14.	1120.	51.9	48.1
15.	1135.	55.6	44.4
16.	1188.	59.3	40.7
17.	1210.	63.	37.
18.	1244.	66.7	33.3
19.	1338.	70.4	29.6
20.	1343.	74.1	25.9
21.	1357.	77.8	22.2
22.	1359.	81.5	18.5
23.	1377.	85.2	14.8
24.	1460.	88.9	11.1
25.	1688.	92.6	7.4
26.	1740.	96.3	3.7

CALCULATION
SUM X= 27244.
MEAN X= 1047.846154
SUM OF DEVIATION SQUARE
S=3291903.385
VARIANCE S/N=126611.67
S/(N-1)=131676.1354
SD/(MEAN X)=0.34
SD=√(S/N)=355.825
USD=√(S/(N-1))=362.872
SKEWNESS CFT. CS!=0.0322
UNBIASED S.C. CS1=0.0316

MEAN LOG(XI)=2.991806788
XG=981.31

CAL. OF B-VALUE
1. T=1740. S=390.
B(1.)=1698.944415
2. T=1688. S=509.
B(2.)=442.7737695
3. T=1460. S=609.
B(3.)=694.0150038

MEAN B=945.24

USED B=945.24
X0=1015.38
LOG(X0+B)=3.29239
1/A=0.11456 δX=0.07957

IWAI FORMULA
LOG(Y+(945.24))=3.29239
-0.11456*KSI

PROBABILITY IWAI

Y(2)	1015.4
Y(3)	864.
Y(4)	783.6
Y(5)	730.3
Y(6)	690.9
Y(7)	661.4
Y(8)	636.8
Y(9)	616.
Y(10)	598.5
Y(11)	583.1
Y(12)	569.5
Y(13)	557.4
Y(15)	536.6
Y(16)	527.5
Y(17)	519.1
Y(18)	511.4
Y(19)	504.1
Y(20)	497.4
Y(22)	485.1
Y(24)	474.1
Y(26)	464.4
Y(28)	455.4
Y(30)	447.4
Y(25)	469.1
Y(50)	391.5
Y(100)	325.2
Y(200)	267.4
Y(300)	236.8
Y(400)	216.2
Y(500)	201.

1977 Return period T= 6

1988 Return period T=10

Table C4 - 2 Calculation of Probability of Non-Exceedance on Annual Rainfall at the CSDB

```
IWAI METHOD

DATA N=26.
D(1)=3373.      1964
D(2)=3405.
D(3)=2175.
D(4)=3295.
D(5)=3245.
D(6)=3734.
D(7)=3396.
D(8)=4003.
D(9)=2909.
D(10)=5048.
D(11)=4210.
D(12)=4252.
D(13)=3269.
D(14)=4338.
D(15)=4671.
D(16)=3916.
D(17)=4330.
D(18)=4068.
D(19)=3651.
D(20)=3226.
D(21)=4082.
D(22)=3664.
D(23)=4234.
D(24)=3417.
D(25)=3189.
D(26)=4078.      1989
RANKING & PLOTTING POSIT
ION

P. OF NON-EXCEEDANCE
RANK DATA WEIBULL PLOT%
(I) (X) 1/(N+1) P=1-F
1.  2175.   3.7   96.3
2.  2909.   7.4   92.6
3.  3189.   11.1  88.9
4.  3226.   14.8  85.2
5.  3245.   18.5  81.5
6.  3269.   22.2  77.8
7.  3295.   25.9  74.1
8.  3373.   29.6  70.4
9.  3396.   33.3  66.7
10.  3405.   37.   63.
11.  3417.   40.7  59.3
12.  3651.   44.4  55.6
13.  3664.   48.1  51.9
14.  3734.   51.9  48.1
15.  3916.   55.6  44.4
16.  4003.   59.3  40.7
17.  4068.   63.   37.
18.  4078.   66.7  33.3
19.  4082.   70.4  29.6
20.  4210.   74.1  25.9
21.  4234.   77.8  22.2
22.  4252.   81.5  18.5
23.  4330.   85.2  14.8
24.  4338.   88.9  11.1
25.  4671.   92.6  7.4
26.  5048.   96.3  3.7

   CALCULATION
SUM X= 97178.
MEAN X= 3737.615385
SUM OF DEVIATION SQUARE
  S=9304984.154
VARIANCE S/N=357884.01
S/(N-1)=372199.3662
SD/(MEAN X)=0.16
SD=√(S/N)=598.234
USD=√(S/(N-1))=610.081
SKEWNESS CFT. CS!=-0.208
3
UNBIASED S.C. CS1=-0.204
3

MEAN LOG(XI)=3.56662142
XG=3686.56

CAL. OF B-VALUE
1.  T=5048.  S=2175.
  B(1.)=-17394.91496
2.  T=4671.  S=2909.
  B(2.)=13.46497293
3.  T=4338.  S=3189.
  B(3.)=-1580.175243

 MEAN B=-6320.54

USED B=0.
X0=3686.56
LOG(X0+B)=3.56662
1/A=0.10629  SX=0.07377

  IWAI FORMULA
LOG(Y+(0.))=3.56662
   -0.10629*KSI

PROBABILITY IWAI
   Y(2)          3686.5
   Y(3)          3421.7
   Y(4)          3280.4
   Y(5)          3186.9
  Y(10)          2953.2
  Y(20)          2773.4
  Y(25)          2722.9
  Y(50)          2584.
 Y(100)          2464.8
```

Table C4 - 3 Calculation of Probability of Exceedance on Annual Rainfall at the CSDB

RANKING & PLOTTING POSIT
ION

P. OF EXCEEDANCE

RANK (J)	DATA (X)	WEIBULL J/(N+1)	PLOT% F=1-P
1.	5048.	3.7	96.3
2.	4671.	7.4	92.6
3.	4338.	11.1	88.9
4.	4330.	14.8	85.2
5.	4252.	18.5	81.5
6.	4234.	22.2	77.8
7.	4210.	25.9	74.1
8.	4082.	29.6	70.4
9.	4078.	33.3	66.7
10.	4068.	37.	63.
11.	4003.	40.7	59.3
12.	3916.	44.4	55.6
13.	3734.	48.1	51.9
14.	3664.	51.9	48.1
15.	3651.	55.6	44.4
16.	3417.	59.3	40.7
17.	3405.	63.	37.
18.	3396.	66.7	33.3
19.	3373.	70.4	29.6
20.	3295.	74.1	25.9
21.	3269.	77.8	22.2
22.	3245.	81.5	18.5
23.	3226.	85.2	14.8
24.	3189.	88.9	11.1
25.	2909.	92.6	7.4
26.	2175.	96.3	3.7

CALCULATION
SUM X= 97178.
MEAN X= 3737.615385
SUM OF DEVIATION SQUARE
S=9304984.154
VARIANCE S/N=357884.01
S/(N-1)=372199.3662
SD/(MEAN X)=0.16
SD=√(S/N)=598.234
USD=√(S/(N-1))=610.081
SKEWNESS CFT. CS!=-0.208
3
UNBIASED S.C. CS1=-0.204
3

MEAN LOG(XI)=3.56662142
XG=3686.56

CAL. OF B-VALUE
1. T=5048. S=2175.
B(1.)=-17394.91496
2. T=4671. S=2909.
B(2.)=13.46497293
3. T=4338. S=3189.
B(3.)=-1580.175243

MEAN B=-6320.54

USED B=0.
X0=3686.56
LOG(X0+B)=3.56662
1/A=0.10629 SX=0.07377

IWAI FORMULA
LOG(Y+(0.))=3.56662
+0.10629*KSI(YR)

PROBABILITY IWAI	
Y(2)	3686.5
Y(3)	3971.9
Y(4)	4143.
Y(5)	4264.5
Y(10)	4601.9
Y(20)	4900.4
Y(25)	4991.2
Y(50)	5259.6
Y(100)	5514.

Table C4-4 Estimated Reference Crop Evapotranspiration : ETo by applying FAO : Pan Evaporation Method

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Remarks
1. Monthly Mean Temp. (°C)	24.8	24.9	25.2	25.6	25.8	25.7	25.2	25.3	25.6	25.9	25.7	25.3	1977-1989
2. Wind Velocity													
a. 0.5 m height (km/day)	1.71	2.09	2.15	1.75	1.67	1.55	1.85	1.79	1.93	1.93	1.96	2.10	1972-1989
b. Corrected at 2 m height (km/day)	55	68	70	57	54	50	60	58	63	63	64	68	Factor 1.35
3. R. H. mean (%)	90	88	88	87	86	84	82	82	82	83	85	87	1971-1989
4. Pan Factor (Kp)	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	FAO Case B-D=25 m RH > 70 % Kp = 0.79
5. Pan Evaporation (mm/day)	3.4	3.7	4.0	4.0	3.8	3.6	3.9	4.5	4.9	4.7	4.3	3.8	T = 10 Yr n = 13
6. ETo (mm/day)	2.7	2.9	3.2	3.2	3.0	2.8	3.1	3.6	3.9	3.7	3.4	3.0	

Table C4-5 Estimated Crop Water Requirements of the Experimental Farm by applying FAO : Pan Evaporation Method (Case A)

Upland Field : 3 cropping, Paddy Field : 3 cropping

No. 1

Month	Pentad	ETo mm/day	Upland Field Growing day	Upland Field Kc	Upland Field CWR mm/day	Paddy Field Growing day	Paddy Field Kc	Paddy Field CWR mm/day	P mm/day	Total mm/day
			Corn			1st paddy				
Nov.	1	3.4	5	0.5	1.7	-	-	-	-	25
	2	3.4	10	0.5	1.7	-	-	-	-	25
	3	3.4	15	0.5	1.7	5	1.1	3.7	2	5.7
	4	3.4	20	0.5	1.7	10	1.1	3.7	2	5.7
	5	3.4	25	0.75	2.6	15	1.1	3.7	2	5.7
	6	3.4	30	0.75	2.6	20	1.1	3.7	2	5.7
Dec.	1	3.0	35	0.75	2.3	25	1.1	3.3	2	5.7
	2	3.0	40	0.75	2.3	30	1.1	3.3	2	5.7
	3	3.0	45	0.75	2.3	35	1.1	3.3	2	5.7
	4	3.0	50	0.75	2.3	40	1.1	3.3	2	5.7
	5	3.0	55	0.75	2.3	45	1.1	3.3	2	5.7
	6	3.0	61	0.75	2.3	51	1.1	3.3	2	5.7
Jan.	1	2.7	66	1.05	2.8	56	1.05	2.8	2	4.8
	2	2.7	71	1.05	2.8	61	1.05	2.8	2	4.8
	3	2.7	76	1.05	2.8	66	1.05	2.8	2	4.8
	4	2.7	81	1.05	2.8	71	1.05	2.8	2	4.8
	5	2.7	86	1.05	2.8	76	1.05	2.8	2	4.8
	6	2.7	92	1.05	2.8	82	0.95	2.6	2	4.6

Month	Pentad	ETo mm/day	Upland Field Growing day	Upland Field Kc	Upland Field CWR mm/day	Paddy Field Growing day	Paddy Field Kc	Paddy Field CWR mm/day	P mm/day	Total mm/day
Feb.	1	2.9	97	1.05	3.0	87	0.95	2.8	2	4.8
	2	2.9	102	1.05	3.0	92	0.95	2.8	2	4.8
	3	2.9	105	1.00	2.9	97	0.95	2.8	2	4.8
	4	2.9	110	1.00	2.9	102	0.95	2.8	2	4.8
	5	2.9	115	0.9	2.6	107	-		-	0
	6	2.9	118	0.8	2.3	110	-		-	0
Mar.	1	3.2	123	0.7	2.2	115	-		-	0
	2	3.2	128	0.6	1.9	-	2nd paddy			50
	3	3.2	133	0.55	1.8	5	1.1	3.5	2	5.5
	4	3.2	Fruit	Vegetable		10	1.1	3.5	2	5.5
	5	3.2	5	0.5	1.6	15	1.1	3.5	2	5.5
	6	3.2	11	0.5	1.6	21	1.1	3.5	2	5.5
Apr.	1	3.2	16	0.5	1.6	26	1.1	3.5	2	5.5
	2	3.2	21	0.5	1.6	31	1.1	3.5	2	5.5
	3	3.2	26	0.5	1.6	36	1.1	3.5	2	5.5
	4	3.2	31	0.5	1.6	41	1.1	3.5	2	5.5
	5	3.2	36	0.78	2.5	46	1.1	3.5	2	5.5
	6	3.2	41	0.78	2.5	51	1.1	3.5	2	5.5

Table C4-5 Estimated Crop Water Requirements of the Experimental Farm by applying FAO :
Pan Evaporation Method (Case A)

Upland Field : 3 cropping, Paddy Field : 3 cropping

No. 2

Month	Pentad	ETo mm/day	Upland Field Growing day	Upland Field Kc	Upland Field CWR mm/day	Paddy Field Growing day	Paddy Field Kc	Paddy Field CWR mm/day	P mm/day	Total mm/day
May	1	3.0	46	0.78	2.3	56	1.05	3.2	2	5.2
	2	3.0	51	0.78	2.3	61	1.05	3.2	2	5.2
	3	3.0	56	0.78	2.3	66	1.05	3.2	2	5.2
	4	3.0	61	0.78	2.3	71	1.05	3.2	2	5.2
	5	3.0	66	0.78	2.3	76	1.05	3.2	2	5.2
	6	3.0	72	0.78	2.3	82	0.95	3.2	2	5.2
Jun.	1	2.8	77	1.05	2.9	87	0.95	2.7	2	4.7
	2	2.8	82	1.05	2.9	92	0.95	2.7	2	4.7
	3	2.8	87	1.05	2.9	97	0.95	2.7	2	4.7
	4	2.8	92	1.05	2.9	102	-	-	-	0
	5	2.8	97	1.05	2.9	107	-	-	-	0
	6	2.8	102	1.05	2.9	112	-	-	-	0
Jul.	1	3.1	107	1.05	3.3	-	3rd paddy		-	50
	2	3.1	112	1.05	3.3	5	1.1	3.4	2	5.4
	3	3.1	117	0.93	2.9	10	1.1	3.4	2	5.4
	4	3.1	122	0.82	2.5	15	1.1	3.4	2	5.4
	5	3.1	127	0.7	2.2	20	1.1	3.4	2	5.4
	6	3.1	133	0.6	1.9	26	1.1	3.4	2	5.4
			Soybeans							
Aug.	1	3.6	5	0.5	1.8	31	1.1	4.0	2	6.0
	2	3.6	10	0.5	1.8	36	1.1	4.0	2	6.0
	3	3.6	15	0.5	1.8	41	1.1	4.0	2	6.0
	4	3.6	20	0.75	2.7	46	1.1	4.0	2	6.0
	5	3.6	25	0.75	2.7	51	1.1	4.0	2	6.0
	6	3.6	31	0.75	2.7	57	1.05	4.0	2	6.0
Sep.	1	3.9	36	1.0	3.9	62	1.05	4.1	2	6.1
	2	3.9	41	1.0	3.9	67	1.05	4.1	2	6.1
	3	3.9	46	1.0	3.9	72	1.05	4.1	2	6.1
	4	3.9	51	1.0	3.9	77	1.05	4.1	2	6.1
	5	3.9	56	1.0	3.9	82	0.95	3.7	2	5.7
	6	3.9	61	1.0	3.9	87	0.95	3.7	2	5.7
Oct.	1	3.7	66	0.9	3.3	92	0.95	3.5	2	5.5
	2	3.7	71	0.8	3.0	97	0.95	3.5	2	5.5
	3	3.7	76	0.7	2.6	102	-	-	-	0
	4	3.7	81	0.6	2.2	107	-	-	-	0
	5	3.7	86	0.5	1.9	112	-	-	-	0
	6	3.7	92	0.45	1.7					

1. ETo : Estimated reference crop evapotranspiration by Pan Evaporation Method with Return Period of 10 years.
2. Growing day : Days after planted at the end of the Pentad, as for Paddy the day after transplanting (Seedling 25 days old).
3. Kc : Assumed value in reference to FAO Irrigation and Drainage Paper No.24.
4. CWR : Crop water requirements = ETo times Kc.
5. Fruit Vegetable : Total growing days of vegetable are as follows : Cucumber 130 days, Egg plant 130 days, Melons 120 days, Tomato 135 days, Peppers 125 days

Table C4-6 Estimated Crop Water Requirements of the Experimental Farm by applying FAO :
Pan Evaporation Method (Case B)

No. 1

			Upland Field			Paddy Field				
Month	Pentad	ETo mm/day	Growing day	Kc	CWR mm/day	Growing day	Kc	CWR mm/day	P mm/day	Total mm/day
			Corn							
Nov.	1	3.4	5	0.5	1.7	-	-	-	-	25
	2	3.4	10	0.5	1.7	-	-	-	-	25
	3	3.4	15	0.5	1.7	5	1.1	3.7	2	5.7
	4	3.4	20	0.5	1.7	10	1.1	3.7	2	5.7
	5	3.4	25	0.75	2.6	15	1.1	3.7	2	5.7
	6	3.4	30	0.75	2.6	20	1.1	3.7	2	5.7
Dec.	1	3.0	35	0.75	2.3	25	1.1	3.3	2	5.7
	2	3.0	40	0.75	2.3	30	1.1	3.3	2	5.7
	3	3.0	45	0.75	2.3	35	1.1	3.3	2	5.7
	4	3.0	50	0.75	2.3	40	1.1	3.3	2	5.7
	5	3.0	55	0.75	2.3	45	1.1	3.3	2	5.7
	6	3.0	61	0.75	2.3	51	1.1	3.3	2	5.7
Jan.	1	2.7	66	1.05	2.8	56	1.05	2.8	2	4.8
	2	2.7	71	1.05	2.8	61	1.05	2.8	2	4.8
	3	2.7	76	1.05	2.8	66	1.05	2.8	2	4.8
	4	2.7	81	1.05	2.8	71	1.05	2.8	2	4.8
	5	2.7	86	1.05	2.8	76	1.05	2.8	2	4.8
	6	2.7	92	1.05	2.8	82	0.95	2.6	2	4.8

			Upland Field			Paddy Field				
Month	Pentad	ETo mm/day	Growing day	Kc	CWR mm/day	Growing day	Kc	CWR mm/day	P mm/day	Total mm/day
Feb.	1	2.9	97	1.05	3.0	87	0.95	2.8	2	4.8
	2	2.9	102	1.05	3.0	92	0.95	2.8	2	4.8
	3	2.9	105	1.00	2.9	97	0.95	2.8	2	4.8
	4	2.9	110	1.00	2.9	102	0.95	2.8	2	4.8
	5	2.9	115	0.9	2.6	107	-	-	-	-
	6	2.9	118	0.8	2.3	110	-	-	-	-
Mar.	1	3.2	123	0.7	2.2	115	-	-	-	-
	2	3.2	128	0.6	1.9					
	3	3.2	133	0.55	1.8	-	-	-	-	25
	4	3.2	Fruit	Vegetable		-	-	-	-	25
	5	3.2	5	0.5	1.6	5	1.1	3.5	2	5.5
	6	3.2	11	0.5	1.6	11	1.1	3.5	2	5.5
Apr.	1	3.2	16	0.5	1.6	16	1.1	3.5	2	5.5
	2	3.2	21	0.5	1.6	21	1.1	3.5	2	5.5
	3	3.2	26	0.5	1.6	26	1.1	3.5	2	5.5
	4	3.2	31	0.5	1.6	31	1.1	3.5	2	5.5
	5	3.2	36	0.78	2.5	36	1.1	3.5	2	5.5
	6	3.2	41	0.78	2.5	41	1.1	3.5	2	5.5

Table C4-6 Estimated Crop Water Requirements of the Experimental Farm by applying FAO : Pan Evaporation Method (Case B)

No. 2

Month	Pentad	ETo mm/day	Upland Field Growing day	Upland Field Kc	Upland Field CWR mm/day	Paddy Field Growing day	Paddy Field Kc	Paddy Field CWR mm/day	P mm/day	Total mm/day
May	1	3.0	46	0.78	2.3	46	1.1	3.3	2	5.3
	2	3.0	51	0.78	2.3	51	1.1	3.3	2	5.3
	3	3.0	56	0.78	2.3	56	1.05	3.2	2	5.2
	4	3.0	61	0.78	2.3	61	1.05	3.2	2	5.2
	5	3.0	66	0.78	2.3	66	1.05	3.2	2	5.2
	6	3.0	72	0.78	2.3	72	1.05	3.2	2	5.2
Jun.	1	2.8	77	1.05	2.9	77	1.05	2.9	2	4.9
	2	2.8	82	1.05	2.9	82	0.95	2.7	2	4.7
	3	2.8	87	1.05	2.9	87	0.95	2.7	2	4.7
	4	2.8	92	1.05	2.9	92	0.95	2.7	2	4.7
	5	2.8	97	1.05	2.9	97	0.95	2.7	2	4.7
	6	2.8	102	1.05	2.9	102	0.95	2.7	2	4.7
Jul.	1	3.1	107	1.05	3.3	107	-	-	-	-
	2	3.1	112	1.05	3.3	110	-	-	-	-
	3	3.1	117	0.93	2.9	115	-	-	-	-
	4	3.1	122	0.82	2.5					
	5	3.1	127	0.7	2.2					
	6	3.1	133	0.6	1.9					
			Soybeans			Soybeans				
Aug.	1	3.6	5	0.5	1.8	5	0.5	1.8	-	1.8
	2	3.6	10	0.5	1.8	10	0.5	1.8	-	1.8
	3	3.6	15	0.5	1.8	15	0.5	1.8	-	1.8
	4	3.6	20	0.75	2.7	20	0.75	2.7	-	2.7
	5	3.6	25	0.75	2.7	25	0.75	2.7	-	2.7
	6	3.6	31	0.75	2.7	31	0.75	2.7	-	2.7
Sep.	1	3.9	36	1.0	3.9	36	1.0	3.9	-	3.9
	2	3.9	41	1.0	3.9	41	1.0	3.9	-	3.9
	3	3.9	46	1.0	3.9	46	1.0	3.9	-	3.9
	4	3.9	51	1.0	3.9	51	1.0	3.9	-	3.9
	5	3.9	56	1.0	3.9	56	1.0	3.9	-	3.9
	6	3.9	61	1.0	3.9	61	1.0	3.9	-	3.9
Oct.	1	3.7	66	0.9	3.3	66	0.9	3.3	-	3.3
	2	3.7	71	0.8	3.0	71	0.8	3.0	-	3.0
	3	3.7	76	0.7	2.6	76	0.7	2.6	-	2.6
	4	3.7	81	0.6	2.2	81	0.6	2.2	-	2.2
	5	3.7	86	0.5	1.9	86	0.5	1.9	-	1.9
	6	3.7	92	0.45	1.7	92	0.45	1.7	-	1.7

1. ETo : Estimated reference crop evapotranspiration by Pan Evaporation Method with Return Period of 10 years.
2. Growing day : Days after planted at the end of the Pentad, as for Paddy the day after transplanting (Seedling 25 days old).
3. Kc : Assumed value in reference to FAO Irrigation and Drainage Paper No.24.
4. CWR : Crop water requirements = ETo times Kc.
5. Fruit Vegetable : Total growing days of vegetable are as follows : Cucumber 130 days, Egg plant 130 days, Melons 120 days, Tomato 135 days, Peppers 125 days

Table C4-7

Calculation of Water Balance in the Wet year of 1977
which is corresponding to 5 years Return Period
in the Probability of Exceedance for Data of Annual Rainfall at the CSDB. (Case A)

No. 1

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Year	Month	Pentad	Rainfall	Crop Req.		Run-off to Pond		Irrigation Req.			Balance				
				Upland	Paddy	Ro	Volume	Upland	Paddy	Total	Pond volume	Shortage	Spill out	Pump Ope.	Remarks
			mm	mm	mm	mm	m^3	m^3	m^3	m^3	m^3	m^3	m^3	hr	Rmax(mm/day)
1977	Jan.	5	42	6	10	16	336	58	33	91	245		0		
		5	89	6	10	44	924	58	33	91	1,000		78		
		5	18	12	20	2	42	116	66	182	860		0		
		5	182	0	0	100	2,100	0	0	0	1,000		1,960		54
		5	102	6	10	52	1,092	58	33	91	1,000		1,001		60
		6	169	6	10	91	1,911	58	33	91	1,000		1,820		80
	Sub-total		602	36	60	305	6,405	348	198	546			4,859		
	Feb.	5	133	6	10	71	1,491	58	33	91	1,000		1,400		55
		5	133	3	5	71	1,491	29	17	46	1,000		1,445		65
		5	128	6	10	68	1,428	58	33	91	1,000		1,337		77
		5	12	12	20	0	0	116	66	182	818		0		
		5	46	6	0	19	399	58	0	58	1,000		159		19
		3	15	3	0	0	0	29	0	29	971		0		
	Sub-total		467	36	45	229	4,809	348	149	497			4,341		
	Mar.	5	63	6	0	29	609	58	0	58	1,000		522		44
		5	78	4	176	38	798	39	583	622	1,000		176		54
		5	99	0	0	50	1,050	0	0	0	1,000		1,050		35
		5	64	0	0	29	609	0	0	0	1,000		609		22
		5	105	2	6	54	1,134	19	20	39	1,000		1,095		53
		6	136	2	6	71	1,491	19	20	39	1,000		1,452		60
	Sub-total		545	14	188	271	5,691	135	623	758			4,904		

Table C4-7

Calculation of Water Balance in the Wet year of 1977 which is corresponding to 5 years Return Period in the Probability of Exceedance for Data of Annual Rainfall at the CSDB. (Case A)

No. 2

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Year	Month	Pentad	Rainfall	Crop Req.		Run-off to Pond		Irrigation Req.			Balance				
				Upland	Paddy	Ro	Volume	Upland	Paddy	Total	Pond volume	Shortage	Spill out	Pump Ope.	Remarks
			mm	mm	mm	mm	m^3	m^3	m^3	m^3	m^3	m^3	m^3	hr	Rmax(mm/day)
1977	Apr.	5	44	8	24	17	357	77	79	156	1,000		201		37
		5	77	4	12	37	777	39	40	79	1,000		698		33
		5	74	2	6	35	735	19	20	39	1,000		696		29
		5	162	6	18	88	1,848	58	60	118	1,000		1,730		84
		5	93	6	12	47	987	58	40	98	1,000		889		37
		5	82	9	18	40	840	87	60	147	1,000		693		39
Sub-total			532	35	90	264	5,544	338	299	637			4,907		
	May	5	50	6	12	21	441	58	40	98	1,000		343		24
		5	117	3	6	61	1,281	29	20	49	1,000		1,232		48
		5	87	3	6	43	903	29	20	49	1,000		854		36
		5	22	9	18	4	84	87	60	147	937		0		
		5	77	9	18	37	777	87	60	147	1,000		567		60
		6	12	18	24	0	0	174	79	253	747		0		
Sub-total			365	48	84	166	3,486	464	279	743			2,996		
	Jun.	5	91	6	10	46	966	58	33	91	1,000		622		56
		5	153	6	10	83	1,743	58	33	91	1,000		1,652		73
		5	94	9	15	47	987	87	50	137	1,000		850		80
		5	9	15	0	0	0	145	0	145	855		0		
		5	5	15	0	0	0	145	0	145	710		0		
		5	0	15	0	0	0	145	0	145	565		0		
Sub-total			352	66	35	176	3,696	638	116	754			3,124		

Table C4-7

Calculation of Water Balance in the Wet year of 1977
which is corresponding to 5 years Return Period
in the Probability of Exceedance for Data of Annual Rainfall at the CSDB. (Case A)

No. 3

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Year	Month	Pentad	Rainfall	Crop Req.		Run-off to Pond		Irrigation Req.			Balance				
				Upland	Paddy	Ro	Volume	Upland	Paddy	Total	Pond volume	Shortage	Spill out	Pump Ope.	Remarks
			mm	mm	mm	mm	m3	m3	m3	m3	m3	m3	m3	hr	Rmax(mm/day)
1977	Jul.	5	6	16	244	0	0	154	808	962	0	397		37	
		5	0	20	30	0	0	193	99	292	0	292		27	
		5	0	15	30	0	0	145	99	244	0	244		23	
		5	7	15	30	0	0	145	99	244	0	244		23	
		5	0	15	30	0	0	145	99	244	0	244		23	
		6	71	6	18	32	672	58	60	118	554				
Sub-total			84	87	382	32	672	840	1,264	2,104		1,421		133	
	Aug.	5	3	10	30	0	0	97	99	196	358				
		5	36	8	24	13	273	77	79	156	475				
		5	41	6	18	16	336	58	60	118	693				
		5	1	15	30	0	0	145	99	244	449				
		5	9	12	24	0	0	116	79	195	254				
		6	45	12	24	18	378	116	79	195	437				
Sub-total			135	63	150	47	987	609	495	1,104					
	Sep.	5	53	16	28	23	483	154	93	247	673				
		5	0	20	35	0	0	193	116	309	364				49
		5	66	12	21	31	651	116	70	186	829				
		5	128	8	14	68	1,428	77	46	123	1,000				35
		5	1	20	30	0	0	193	99	292	708		1,134		69
		5	0	20	30	0	0	193	99	292	416				
Sub-total			248	96	158	122	2,562	920	523	1,449			1,134		

Table C4-7

Calculation of Water Balance in the Wet year of 1977
which is corresponding to 5 years Return Period
in the Probability of Exceedance for Data of Annual Rainfall at the CSDB. (Case A)

No. 4

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Year	Month	Pentad	Rainfall	Crop Req.		Run-off to Pond		Irrigation Req.			Balance				
				Upland	Paddy	Ro	Volume	Upland	Paddy	Total	Pond volume	Shortage	Spill out	Pump Ope.	Remarks
			mm	mm	mm	mm	m^3	m^3	m^3	m^3	m^3	m^3	m^3	hr	Rmax(mm/day)
1977	Oct.	5	11	16	24	0	0	154	79	233	183				
		5	45	16	24	18	378	154	79	233	328				
		5	3	20	0	0	0	193	0	193	135				
		5	8	12	0	0	0	116	0	116	19				
		5	74	16	0	35	735	154	0	154	600				
		6	87	16	0	41	861	154	0	154	1,000		307		45
	Sub-total		228	96	48	94	1,974	925	158	1,083			307		
	Nov.	5	140	2	30	75	1,575	19	99	118	1,000		1,457		82
		5	214	0	0	119	2,499	0	0	0	1,000		2,499		48
		5	26	4	18	7	147	39	60	99	1,000		48		15
		5	13	6	18	0	0	58	60	118	882		0		
		5	35	12	24	12	252	116	79	195	939		0		
		5	67	6	12	31	651	58	40	98	1,000		492		47
	Sub-total		495	30	102	244	5,124	290	338	628			4,496		
	Dec.	5	20	12	24	3	63	116	79	195	868		0		
		5	99	9	18	50	1,050	87	60	147	1,000		771		80
		5	42	9	18	16	336	87	60	147	1,000		189		25
		5	46	6	12	19	399	58	40	98	1,000		301		30
		5	55	9	18	24	504	87	60	147	1,000		357		40
		6	23	12	24	3	63	116	79	195	868		0		
	Sub-total		285	57	114	115	2,415	551	378	929			1,618		
	Total		4,338	664	1,456	2,065	43,365	6,412	4,820	11,232		1,421	32,686	133	

Table C4-8

Calculation of Water Balance in the Dry year of 1988
which is corresponding to 5 years Return Period
in the Probability of Non Exceedance for Data of Annual Rainfall at the CSDB. (Case A)

No. 1

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Year	Month	Pentad	Rainfall	Crop Req.		Run-off to Pond		Irrigation Req.			Balance				
				Upland	Paddy	Ro	Volume	Upland	Paddy	Total	Pond volume	Shortage	Spill out	Pump Ope.	Remarks
			mm	mm	mm	mm	m^3	m^3	m^3	m^3	m^3	m^3	m^3	hr	Rmax(mm/day)
1988	Jan.	5	95	9	15	48	1,008	87	50	137	871		0		73
		5	10	15	20	0	0	145	66	211	660		0		
		5	55	9	15	24	504	87	50	137	1,000		27		45
		5	158	3	5	86	1,806	29	17	46	1,000		1,760		89
		5	47	6	10	19	399	58	33	91	1,000		308		23
		6	69	6	10	32	672	58	33	91	1,000		581		37
	Sub-total		434	48	75	209	4,389	464	249	713			2,676		
	Feb.	5	43	9	15	17	357	87	50	137	1,000		220		29
		5	31	9	15	10	210	87	50	137	1,000		73		15
		5	22	12	20	4	84	116	66	182	902		0		
		5	68	6	10	32	672	58	33	91	1,000		483		28
		5	65	9	0	30	630	87	0	87	1,000		543		43
		4	151	3	0	83	1,743	29	0	29	1,000		1,714		67
	Sub-total		380	48	60	176	3,696	464	199	663			3,033		
	Mar.	5	63	9	0	29	609	87	0	87	1,000		522		45
		5	69	6	250	32	672	58	828	886	786		0		41
		5	89	4	12	44	924	39	40	79	1,000		631		61
		5	15	0	24	0	0	0	79	79	921		0		
		5	62	4	12	28	588	39	40	79	1,000		430		32
		6	46	6	18	17	357	58	60	118	1,000		239		18
	Sub-total		344	29	316	150	3,150	281	1,047	1,328			1,822		

Table C4-8

Calculation of Water Balance in the Dry year of 1988
which is corresponding to 5 years Return Period
in the Probability of Non Exceedance for Data of Annual Rainfall at the CSDB. (Case A)

No. 2

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Year	Month	Pentad	Rainfall	Crop Req.		Run-off to Pond		Irrigation Req.			Balance				
				Upland	Paddy	Ro	Volume	Upland	Paddy	Total	Pond volume	Shortage	Spill out	Pump Ope.	Remarks
			mm	mm	mm	mm	m^3	m^3	m^3	m^3	m^3	m^3	m^3	hr	Rmax(mm/day)
1988	Apr.	5	30	6	18	9	189	58	60	118	1,000		71		17
		5	73	4	12	35	735	39	40	79	1,000		656		37
		5	123	6	18	65	1,365	58	60	118	1,000		1,247		78
		5	92	6	18	46	966	58	60	118	1,000		848		75
		5	35	12	24	12	252	116	79	195	1,000		57		35
		5	92	9	18	46	966	87	60	147	1,000		819		83
	Sub-total		445	43	108	213	4,473	416	359	775			3,698		
	May	5	77	6	12	37	777	58	40	98	1,000		679		37
		5	66	9	18	31	651	87	60	147	1,000		504		55
		5	124	3	6	65	1,365	29	20	49	1,000		1,316		77
		5	47	6	12	19	399	58	40	98	1,000		301		33
		5	21	12	24	4	84	116	79	195	889		0		
		6	36	12	24	11	231	116	79	195	925		0		
	Sub-total		371	48	96	167	3,507	464	318	782			2,800		
	Jun.	5	66	12	20	31	651	116	66	182	1,000		394		64
		5	51	6	10	22	462	58	33	91	1,000		371		27
		5	21	12	20	4	84	116	66	182	902		0		
		5	3	15	0	0	0	145	0	145	757		0		
		5	7	12	0	0	0	116	0	116	641		0		
		5	0	15	0	0	0	145	0	145	496		0		
	Sub-total		148	72	50	57	1,197	696	165	861			765		

Table C4-8

Calculation of Water Balance in the Dry year of 1988
which is corresponding to 5 years Return Period
in the Probability of Non Exceedance for Data of Annual Rainfall at the CSDB. (Case A)

No. 3

(1) Year	(2) Month	(3) Pentad	(4) Rainfall	(5) Crop Req.	(6)	(7) Run-off to Pond	(8)	(9) Irrigation Req.	(10)	(11)	(12) Balance	(13)	(14)	(15)	(16)
				Upland	Paddy	Ro	Volume	Upland	Paddy	Total	Pond volume	Shortage	Spill out	Pump Ope.	Remarks
			mm	mm	mm	mm	m^3	m^3	m^3	m^3	m^3	m^3	m^3	hr	Rmax(mm/day)
1988	Jul.	5	6	16	250	0	0	154	828	982	0	486		45	
		5	7	16	30	0	0	154	99	253	0	253		24	
		5	0	15	30	0	0	145	99	244	0	244		23	
		5	73	12	30	35	735	116	99	215	520				
		5	3	15	30	0	0	145	99	244	276				
		6	0	12	36	0	0	116	119	235	41				
Sub-total			89	86	406	35	735	830	1,343	2,173		983		92	
	Aug.	5	42	6	18	16	336	58	60	118	259				
		5	64	8	24	29	609	77	79	156	712				
		5	69	6	18	32	672	58	60	118	1,000		266		41
		5	0	15	30	0	0	145	99	244	756				
		5	25	12	24	6	126	116	79	195	687				
		6	0	18	36	0	0	174	119	293	394				
Sub-total			200	65	150	83	1,743	628	496	1,124			266		
	Sep.	5	3	20	35	0	0	193	116	309	85			0	
		5	1	20	35	0	0	193	116	309	0	224		21	
		5	26	12	22	7	147	116	73	189	0	42		4	
		5	15	16	28	0	0	154	93	247	0	247		23	
		5	17	16	24	1	21	154	79	233	0	212		20	
		5	18	16	24	2	42	154	79	233	0	191		18	
Sub-total			80	100	168	10	210	964	556	1,520		916		86	

Table C4-8

Calculation of Water Balance in the Dry year of 1988 which is corresponding to 5 years Return Period in the Probability of Non Exceedance for Data of Annual Rainfall at the CSDB. (Case A)

No. 4

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Year	Month	Pentad	Rainfall	Crop Req.		Run-off to Pond		Irrigation Req.			Balance				
				Upland	Paddy	Ro	Volume	Upland	Paddy	Total	Pond volume	Shortage	Spill out	Pump Ope.	Remarks
			mm	mm	mm	mm	m^3	m^3	m^3	m^3	m^3	m^3	m^3	hr	Rmax(mm/day)
1988	Oct.	5	4	20	24	0	0	193	79	272	0	272		25	
		5	5	15	24	0	0	145	79	224	0	224		21	
		5	73	6	0	35	735	58	0	58	677				
		5	83	6	0	41	861	58	0	58	1,000		480		53
		5	9	8	0	0	0	77	0	77	923				
		6	66	8	0	29	609	77	0	77	1,000		455		36
Sub-total			240	63	48	105	2,205	608	158	766		496	935	46	
	Nov.	5	51	4	75	22	462	39	248	287	1,000		175		21
		5	43	6	91	17	357	58	301	359	998		0		
		5	21	4	12	4	84	39	40	79	1,000		3		
		5	1	10	30	0	0	97	99	196	804				
		5	18	12	24	2	42	116	79	195	651				
		5	17	12	24	1	21	116	79	195	477				
Sub-total			151	48	256	46	966	465	846	1,311			178		
	Dec.	5	41	9	18	16	336	87	60	147	666				
		5	44	12	24	17	357	116	79	195	828				
		5	99	3	6	50	1,050	29	20	49	1,000		829		45
		5	109	6	12	56	1,176	58	40	98	1,000		1,078		59
		5	5	12	30	0	0	116	99	215	785				
		6	9	15	30	0	0	145	99	244	541				
Sub-total			307	57	120	139	2,919	551	397	948			1,907		
Total			3,189	707	1,853	1,390	29,190	6,831	6,133	12,964		2,395	18,080	224	

Table C4-9

Calculation of Water Balance in the Wet year of 1977
which is corresponding to 5 years Return Period
in the Probability of Exceedance for Data of Annual Rainfall at the CSDB. (Case B)

No. 1

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Year	Month	Pentad	Rainfall	Crop Req.		Run-off to Pond		Irrigation Req.			Balance				
				Upland	Paddy	Ro	Volume	Upland	Paddy	Total	Pond volume	Shortage	Spill out	Pump Ope.	Remarks
			mm	mm	mm	mm	m^3	m^3	m^3	m^3	m^3	m^3	m^3	hr	Rmax(mm/day)
1977	Jan.	5	42	6	10	16	336	58	33	91	245		0		
		5	89	6	10	44	924	58	33	91	1,000		78		
		5	18	12	20	2	42	116	66	182	860		0		
		5	182	0	0	100	2,100	0	0	0	1,000		1,960		54
		5	102	6	10	52	1,092	58	33	91	1,000		1,001		60
		6	169	6	10	91	1,911	58	33	91	1,000		1,820		80
	Sub-total		602	36	60	305	6,405	348	198	546			4,859		
	Feb.	5	133	6	10	71	1,491	58	33	91	1,000		1,400		55
		5	133	3	5	71	1,491	29	17	46	1,000		1,445		65
		5	128	6	10	68	1,428	58	33	91	1,000		1,337		77
		5	12	12	20	0	0	116	66	182	818		0		
		5	46	6	0	19	399	58	0	58	1,000		159		19
		3	15	3	0	0	0	29	0	29	971		0		
	Sub-total		467	36	45	229	4,809	348	149	497			4,341		
	Mar.	5	63	6	0	29	609	58	0	58	1,000		522		44
		5	78	4	0	38	798	39	0	39	1,000		759		54
		5	99	0	36	50	1,050	0	119	119	1,000		931		35
		5	64	0	61	29	609	0	202	202	1,000		407		22
		5	105	2	6	54	1,134	19	20	39	1,000		1,095		53
		6	136	2	6	71	1,491	19	20	39	1,000		1,452		60
	Sub-total		545	14	109	271	5,691	135	361	496			5,166		

Table C4-9

Calculation of Water Balance in the Wet year of 1977 which is corresponding to 5 years Return Period in the Probability of Exceedance for Data of Annual Rainfall at the CSDB. (Case B)

No. 2

(1) Year	(2) Month	(3) Pentad	(4) Rainfall	(5) Crop Req. Upland	(6) Crop Req. Paddy	(7) Run-off to Pond Ro	(8) Run-off to Pond Volume	(9) Irrigation Req. Upland	(10) Irrigation Req. Paddy	(11) Irrigation Req. Total	(12) Balance Pond volume	(13) Balance Shortage	(14) Balance Spill out	(15) Balance Pump Ope.	(16) Remarks Rmax(mm/day)
			mm	mm	mm	mm	m^3	m^3	m^3	m^3	m^3	m^3	m^3	hr	
1977	Apr.	5	44	8	24	17	357	77	79	156	1,000		201		37
		5	77	4	12	37	777	39	40	79	1,000		698		33
		5	74	2	6	35	735	19	20	39	1,000		696		29
		5	162	6	18	88	1,848	58	60	118	1,000		1,730		84
		5	93	6	12	47	987	58	40	98	1,000		889		37
		5	82	9	18	40	840	87	60	147	1,000		693		39
	Sub-total		532	35	90	264	5,544	338	299	637			4,907		
	May	5	50	6	12	21	441	58	40	98	1,000		343		24
		5	117	3	6	61	1,281	29	20	49	1,000		1,232		48
		5	87	3	6	43	903	29	20	49	1,000		854		36
		5	22	9	18	4	84	87	60	147	937		0		
		5	77	9	18	37	777	87	60	147	1,000		567		60
		6	12	18	24	0	0	174	79	253	747		0		
	Sub-total		365	48	84	166	3,486	464	279	743			2,996		
	Jun.	5	91	6	10	46	966	58	33	91	1,000		622		56
		5	153	6	10	83	1,743	58	33	91	1,000		1,652		73
		5	94	9	15	47	987	87	50	137	1,000		850		80
		5	9	15	20	0	0	145	66	211	789		0		
		5	5	15	20	0	0	145	66	211	578		0		
		5	0	15	20	0	0	145	66	211	367		0		
	Sub-total		352	66	95	176	3,696	638	314	952			3,124		

Table C4-9

Calculation of Water Balance in the Wet year of 1977
which is corresponding to 5 years Return Period
in the Probability of Exceedance for Data of Annual Rainfall at the CSDB. (Case B)

No. 3

(1) Year	(2) Month	(3) Pentad	(4) Rainfall	(5) Crop Req.	(6)	(7) Run-off to Pond	(8)	(9) Irrigation Req.	(10)	(11)	(12) Balance	(13)	(14)	(15)	(16)
			mm	Upland mm	Paddy mm	Ro mm	Volume m3	Upland m3	Paddy m3	Total m3	Pond volume m3	Shortage m3	Spill out m3	Pump Ope. hr	Remarks Rmax(mm/day)
1977	Jul.	5	6	16	0	0	0	154	0	154	213				
		5	0	20	0	0	0	193	0	193	20				
		5	0	15	0	0	0	145	0	145	0	125		12	
		5	7	15	0	0	0	145	0	145	0	145		13	
		5	0	15	0	0	0	145	0	145	0	145		13	
		6	71	6	0	32	672	58	0	58	614				
Sub-total			84	87	0	32	672	840	0	840		415		38	
	Aug.	5	3	10	10	0	0	97	33	130	484				
		5	36	8	8	13	273	77	26	103	654				
		5	41	6	6	16	336	58	20	78	912				
		5	1	15	15	0	0	145	50	195	717				
		5	9	12	12	0	0	116	40	156	561				
		6	45	12	12	18	378	116	40	156	783				
Sub-total			135	63	63	47	987	609	209	818					
	Sep.	5	53	16	16	23	483	154	53	207	1,000		59		49
		5	0	20	20	0	0	193	66	259	741		0		
		5	66	12	12	31	651	116	40	156	1,000		236		35
		5	128	8	8	68	1,428	77	26	103	1,000		1,325		69
		5	1	20	20	0	0	193	66	259	741		0		
		5	0	20	20	0	0	193	66	259	482		0		
Sub-total			248	96	96	122	2,562	920	317	1,243			1,620		

Table C4-9

Calculation of Water Balance in the Wet year of 1977 which is corresponding to 5 years Return Period in the Probability of Exceedance for Data of Annual Rainfall at the CSDB. (Case B)

No. 4

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Year	Month	Pentad	Rainfall	Crop Req.		Run-off to Pond		Irrigation Req.			Balance				
				Upland	Paddy	Ro	Volume	Upland	Paddy	Total	Pond volume	Shortage	Spill out	Pump Ope.	Remarks
			mm	mm	mm	mm	m^3	m^3	m^3	m^3	m^3	m^3	m^3	hr	Rmax(mm/day)
1977	Oct.	5	11	16	12	0	0	154	40	194	288				
		5	45	16	16	18	378	154	53	207	459				
		5	3	20	20	0	0	193	66	259	200				
		5	8	12	12	0	0	116	40	156	44				
		5	74	16	16	35	735	154	53	207	572				
		6	87	16	16	41	861	154	53	207	1,000		226		45
	Sub-total		228	92	92	94	1,974	925	305	1,230			226		
	Nov.	5	140	2	30	75	1,575	19	99	118	1,000		1,457		82
		5	214	0	0	119	2,499	0	0	0	1,000		2,499		48
		5	26	4	18	7	147	39	60	99	1,000		48		15
		5	13	6	18	0	0	58	60	118	882		0		
		5	35	12	24	12	252	116	79	195	939		0		
		5	67	6	12	31	651	58	40	98	1,000		492		47
	Sub-total		495	30	102	244	5,124	290	338	628			4,496		
	Dec.	5	20	12	24	3	63	116	79	195	868		0		
		5	99	9	18	50	1,050	87	60	147	1,000		771		80
		5	42	9	18	16	336	87	60	147	1,000		189		25
		5	46	6	12	19	399	58	40	98	1,000		301		30
		5	55	9	18	24	504	87	60	147	1,000		357		40
		6	23	12	24	3	63	116	79	195	868		0		
	Sub-total		285	57	114	115	2,415	551	378	929			1,618		
	Total		4,338	664	950	2,065	43,365	6,412	3,147	9,559		415	33,353	38	

Table C4-10

Calculation of Water Balance in the Dry year of 1988 which is corresponding to 5 years Return Period in the Probability of Non Exceedance for Data of Annual Rainfall at the CSDB. (Case B)

No. 1

(1) Year	(2) Month	(3) Pentad	(4) Rainfall	(5) Crop Req.	(6)	(7) Run-off to Pond	(8)	(9) Irrigation Req.	(10)	(11)	(12) Balance	(13)	(14)	(15)	(16)
				Upland	Paddy	Ro	Volume	Upland	Paddy	Total	Pond volume	Shortage	Spill out	Pump Ope.	Remarks
			mm	mm	mm	mm	m^3	m^3	m^3	m^3	m^3	m^3	m^3	hr	Rmax(mm/day)
1988	Jan.	5	95	9	15	48	1,008	87	50	137	871		0		73
		5	10	15	20	0	0	145	66	211	660		0		
		5	55	9	15	24	504	87	50	137	1,000		27		45
		5	158	3	5	86	1,806	29	17	46	1,000		1,760		89
		5	47	6	10	19	399	58	33	91	1,000		308		23
		6	69	6	10	32	672	58	33	91	1,000		581		37
	Sub-total		434	48	75	209	4,389	464	249	713			2,676		
	Feb.	5	43	9	15	17	357	87	50	137	1,000		220		29
		5	31	9	15	10	210	87	50	137	1,000		73		15
		5	22	12	20	4	84	116	66	182	902		0		
		5	68	6	10	32	672	58	33	91	1,000		483		28
		5	65	9	0	30	630	87	0	87	1,000		543		43
		4	151	3	0	83	1,743	29	0	29	1,000		1,714		67
	Sub-total		380	48	60	176	3,696	464	199	663			3,033		
	Mar.	5	63	9	0	29	609	87	0	87	1,000		522		45
		5	69	6	0	32	672	58	0	58	1,000		614		41
		5	89	4	72	44	924	39	238	277	1,000		647		61
		5	15	0	110	0	0	0	364	364	636		0		
		5	62	4	12	28	588	39	40	79	1,000		145		32
		6	46	6	18	17	357	58	60	118	1,000		239		18
	Sub-total		344	29	212	150	3,150	281	702	983			2,167		

Table C4-10

Calculation of Water Balance in the Dry year of 1988
which is corresponding to 5 years Return Period
in the Probability of Non Exceedance for Data of Annual Rainfall at the CSDB. (Case B)

No. 2

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Year	Month	Pentad	Rainfall	Crop Req.		Run-off to Pond		Irrigation Req.			Balance				
				Upland	Paddy	Ro	Volume	Upland	Paddy	Total	Pond volume	Shortage	Spill out	Pump Ope.	Remarks
			mm	mm	mm	mm	m^3	m^3	m^3	m^3	m^3	m^3	m^3	hr	Rmax(mm/day)
1988	Apr.	5	30	6	18	9	189	58	60	118	1,000		71		17
		5	73	4	12	35	735	39	40	79	1,000		656		37
		5	123	6	18	65	1,365	58	60	118	1,000		1,247		78
		5	92	6	18	46	966	58	60	118	1,000		848		75
		5	35	12	24	12	252	116	79	195	1,000		57		35
		5	92	9	18	46	966	87	60	147	1,000		819		83
	Sub-total		445	43	108	213	4,473	416	359	775			3,698		
	May	5	77	6	12	37	777	58	40	98	1,000		679		37
		5	66	9	18	31	651	87	60	147	1,000		504		55
		5	124	3	6	65	1,365	29	20	49	1,000		1,316		77
		5	47	6	12	19	399	58	40	98	1,000		301		33
		5	21	12	24	4	84	116	79	195	889		0		
		6	36	12	24	11	231	116	79	195	925		0		
	Sub-total		371	48	96	167	3,507	464	318	782			2,800		
	Jun.	5	66	12	20	31	651	116	66	182	1,000		394		64
		5	51	6	10	22	462	58	33	91	1,000		371		27
		5	21	12	20	4	84	116	66	182	902		0		
		5	3	15	25	0	0	145	83	228	674		0		
		5	7	12	20	0	0	116	66	182	492		0		
		5	0	15	25	0	0	145	83	228	264		0		
	Sub-total		148	72	120	57	1,197	696	397	1,093			765		

Table C4-10

Calculation of Water Balance in the Dry year of 1988 which is corresponding to 5 years Return Period in the Probability of Non Exceedance for Data of Annual Rainfall at the CSDB. (Case B)

No. 3

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Year	Month	Pentad	Rainfall	Crop Req.		Run-off to Pond		Irrigation Req.			Balance				
				Upland	Paddy	Ro	Volume	Upland	Paddy	Total	Pond volume	Shortage	Spill out	Pump Ope.	Remarks
			mm	mm	mm	mm	m^3	m^3	m^3	m^3	m^3	m^3	m^3	hr	Rmax(mm/day)
1988	Jul.	5	6	16	0	0	0	154	0	154	110				
		5	7	16	0	0	0	154	0	154	0	44		4	
		5	0	15	0	0	0	145	0	145	0	145		14	
		5	73	12	0	35	735	116	0	116	619				
		5	3	15	0	0	0	145	0	145	474				
		6	0	12	0	0	0	116	0	116	358				
Sub-total			89	86	0	35	735	830	0	830		189		18	
	Aug.	5	42	6	6	16	336	58	20	78	616				
		5	64	8	8	29	609	77	26	103	1,000		122		63
		5	69	6	6	32	672	58	20	78	1,000		594		41
		5	0	15	15	0	0	145	50	195	805				
		5	25	12	12	6	126	116	40	156	775				
		6	0	18	18	0	0	174	60	234	541				
Sub-total			200	65	65	83	1,743	628	216	844			716		
	Sep.	5	3	20	20	0	0	193	66	259	282				
		5	1	20	20	0	0	193	66	259	23				
		5	26	12	12	7	147	116	40	156	14				
		5	15	16	16	0	0	154	53	207	0	193		18	
		5	17	16	16	1	21	154	53	207	0	186		18	
		5	18	16	16	2	42	154	53	207	0	165		16	
Sub-total			80	100	100	10	210	964	331	1,295		544		52	

Table C4-10

Calculation of Water Balance in the Dry year of 1988
which is corresponding to 5 years Return Period
in the Probability of Non Exceedance for Data of Annual Rainfall at the CSDB. (Case B)

No. 4

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Year	Month	Pentad	Rainfall	Crop Req.		Run-off to Pond		Irrigation Req.			Balance				
				Upland	Paddy	Ro	Volume	Upland	Paddy	Total	Pond volume	Shortage	Spill out	Pump Ope.	Remarks
			mm	mm	mm	mm	m^3	m^3	m^3	m^3	m^3	m^3	m^3	hr	Rmax(mm/day)
1988	Oct.	5	4	20	20	0	0	193	66	259	0	259		24	
		5	5	15	15	0	0	145	50	195	0	195		18	
		5	73	6	6	35	735	58	20	78	657				
		5	83	6	6	41	861	58	20	78	1,000		440		53
		5	9	8	8	0	0	77	26	103	897		0		
		6	66	8	8	29	609	77	26	103	1,000		403		36
	Sub-total		240	63	63	105	2,205	608	208	816		454	843	42	
	Nov.	5	51	4	75	22	462	39	248	287	1,000		175		21
		5	43	6	91	17	357	58	301	359	998		0		
		5	21	4	12	4	84	39	40	79	1,000		3		
		5	1	10	30	0	0	97	99	196	804				
		5	18	12	24	2	42	116	79	195	651				
		5	17	12	24	1	21	116	79	195	477				
	Sub-total		151	48	256	46	966	465	846	1,311			178		
	Dec.	5	41	9	18	16	336	87	60	147	666				
		5	44	12	24	17	357	116	79	195	828				
		5	99	3	6	50	1,050	29	20	49	1,000		829		45
		5	109	6	12	56	1,176	58	40	98	1,000		1,078		59
		5	5	12	30	0	0	116	99	215	785				
		6	9	15	30	0	0	145	99	244	541				
	Sub-total		307	57	120	139	2,919	551	397	948			1,907		
	Total		3,189	707	1,275	1,390	29,190	6,831	4,222	11,053		1,187	18,783	112	

4. Drainage Plan

4.1 General

Rainfall on terraced experimental fields shall be drained to the surrounding drainage canal network connected to the farm pond. Excessed water from the farm pond shall be drained to the existing drainage canal along the National road : Jalan Raya Darmaga. Rainfall on the soil conservation experiment fields, workstation and workshop and part of link road shall be drained through the drainage canal toward the Cihideung River.

4.2 Design modulus of drainage

The design modulus of the drainage facilities has been decided in consideration of the importance of their functions in refering the short duration rainfall intensity (Table C1-15) as follows :

(1)	drainage canals to drain fully 10-Yr, 15 minutes rainfall intensity :	183.5 mm/hr
(2)	lysimeter (a precise mesurment fields) and side drainage canal of the link road to drain fully 100-Yr, 5 minutes rainfall intensity :	289.3 mm/hr
(3)	spillway of the farm pond to drain fully 100-Yr, 30 minutes rainfall intensity :	183.5 mm/hr

Therefore, the design modulus of drainage are calculated as follows :

(1) drainage canals
$q = 100 \times 183.5 \times 10^{-3} / 3,600 = 0.0051\ m^3/sec\ /100\ m^2$

(2) lysimeter and side drainage of link road
$q = 100 \times 289.3 \times 10^{-3} / 3,600 = 0.0080\ m^3/sec\ /100\ m^2$

(3) spillway of farm pond
$q = 100 \times 98.6 \times 10^{-3} / 3,600 = 0.0027\ m^3/sec\ /100\ m^2$

4.3 Measurement devices to be installed in the drainage network for future water balance study

Measurement devices at the paddy experimental fields and lysimeter are proposed to be a kind of rectangular weir.

For the purpose, the dimension and discharge are calculated by the Itaya weir formula as follows :

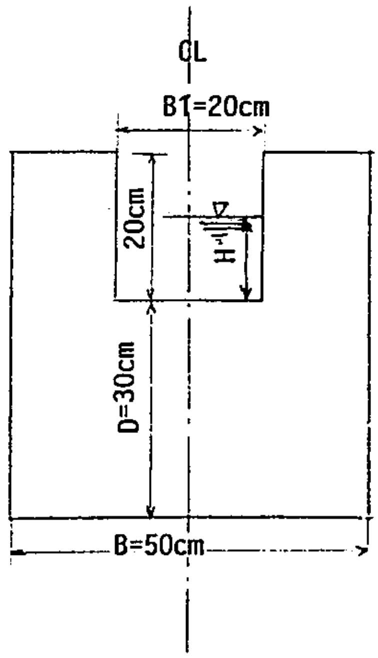
$$Q = C \times B \times H^{1.5}$$

$$\text{where } C = 1.785 + \frac{0.00295}{H} + \frac{0.237 \cdot H}{D} - 0.428 \cdot \sqrt{\frac{(B-B1) \cdot H}{B \cdot D}} + 0.034 \cdot \sqrt{\frac{B}{D}}$$

Q	:	Overflow discharge in m^3/sec
B	:	Canal width in m
B1	:	Overflow width in m
D	:	Damming up height in m

When B1 = 0.2 m, B = 0.5 m, D = 0.3 m, the overflow discharge Q is calculated as follows :

H	Q
0.01	0
0.02	0.001
0.03	0.002
0.04	0.003
0.05	0.004
0.06	0.005
0.07	0.007
0.08	0.008
0.09	0.009
0.1	0.011
0.11	0.013
0.12	0.014
0.13	0.016
0.14	0.018
0.15	0.002
0.16	0.022
0.17	0.024
0.18	0.026
0.19	0.029
0.2	0.031



Appendix C5 Bill of Quantities

Division	Work Item	Amount (Rp.)
Division-I	Land Levelling	26,005,000
Division-II	Link Road	35,894,000
Division-III	Farm Pond	32,445,000
Division-IV	Irrigation Canal	6,610,000
Division-V	Drainage Canal	72,195,000
Division-VI	Soil Conservation Test Field	25,731,000
Division-VII	Irrigation Test Field - Paddy Field	2,420,000
Division-VIII	Irrigation Test Field - Upland	1,538,000
Division-IX	Tractor Test Field	487,000
Division-X	Tractor Test Road	13,344,000
	Grand Total	216,669,000

Division-I: Land Levelling

Bill No.	Item	Unit	Q'ty	Unit Price (Rp.)	Amount (Rp.)	Remarks
I-1	Tractor Test Road Area and Link Road Area (BN: No.2+23.0 - BW: No.1) (A = 6,500 m^2)					
1-1	Excavation (Top Soil)	m^3	1,950	1,381	2,692,950	No. Eq-1-2
1-2	Excavation	m^3	1,935	1,654	3,200,490	No. Eq-1-3
1-3	Spreading	m^3	1,935	691	1,337,085	No. Eq-3-3
	I-1 Sub-Total				7,230,525	
I-2	Paddy Field Area, Farm Pond Area and Link Road Area (A: No. 0 - A: No. 2 + 35.0) (A = 8,300 m^2)					
2-1	Excavation (Top Soil)	m^3	2,310	1,381	3,190,110	No. Eq-1-2
2-2	Excavation	m^3	2,300	1,654	3,804,200	No. Eq-1-3
2-3	Spreading	m^3	2,300	691	1,589,300	No. Eq-3-3
	I-2 Sub Total				8,583,610	
I-3	Upland Area (A = 5,300 m^2)					
3-1	Excavation	m^3	20.0	1,654	33,080	No. Eq-1-3
3-2	Spreading	m^3	4,000.0	691	2,764,000	No. Eq-3-3
	I-3 Sub-Total				2,797,080	
I-4	Tractor Test Field Area and Link Road Area (A: No.2 + 35.0 - B: No.0) (A = 5,700 m^2)					
4-1	Excavation	m^3	1,290.0	1,654	2,133,660	No. Eq-1-3
4-2	Spreading	m^3	3,200.0	691	2,211,200	No. Eq-3-3
	I-4 Sub-Total				4,344,860	
I-5	Soil Conservation Test Field Area and Link Road Area (BW: No.1 - BW: No.1 + 20.0 & C: No.0 - C: No.1 + 20.0) (A = 3,200 m^2)					
5-1	Excavation	m^3	1,300.0	1,654	2,150,200	No. Eq-1-3
5-2	Spreading	m^3	1,300.0	691	898,300	No. Eq-3-3
	I-5 Sub-Total				3,048,500	
	Division-I Total				26,004,575	(Say 26,005,000)

Division-II: Link Road

Bill No.	Item	Unit	Q'ty	Unit Price (Rp.)	Amount (Rp.)	Remarks
II-1	Link Road: A (B = 5.0m, L = 180.0m)					
1-1	Spreading	m^3	489.6	691	338,314	No. Eq-3-3
1-2	Compaction	m^3	489.6	1,456	712,858	No. Eq-4
1-3	Sub Base Course (t = 150)	m^2	900.0	2,778	2,500,200	No. 14
1-4	Form Work	m^2	252.0	8,108	2,043,216	No. 8
1-5	Concrete	m^3	23.4	98,646	2,308,316	No. 7-2
1-6	Asphalt Pavement (t = 50)	m^2	900.0	7,531	6,777,900	No. 11
1-7	Wet Masonry	m^2	10.0	52,531	525,310	No. 19
	II-1 Sub-Total				15,206,114	
II-2	Link Road: B (B = 4.0m, L = 204.0m) & C (B = 4.0 m, L = 70.0 m)					
2-1	Spreading	m^3	663.1	691	458,202	No. Eq-3-2
2-2	Compaction	m^3	663.1	1,456	965,474	No. Eq-4
2-3	Sub Base Course (t = 150)	m^2	1,096.0	2,778	3,044,688	No. 14
2-4	Form Work	m^2	383.6	8,108	3,110,229	No. 8
2-5	Concrete	m^3	35.6	98,646	3,511,798	No. 7-2
2-6	Asphalt Pavement (t = 50)	m^2	1,096.0	7,531	8,253,976	No. 11
	II-2 Sub-Total				19,344,367	
II-3	Gate, Setting & Base					
3-1	Gate, Setting & Base	L.S.	1.0		1,344,000	
	II-3 Sub-Total				1,344,000	
	Division-II Total				35,894,481	(Say 35,894,000)

Division-III: Farm Pond

Bill No.	Item	Unit	Q'ty	Unit Price (Rp.)	Amount (Rp.)	Remarks
III-1	Farm Pond (V = 1,000 m^3)					
1-1	Excavation (by Equip.)	m^3	1,725.0	3,126	5,392,350	No. Eq-2-3
1-2	Excavation	m^3	81.0	3,025	245,025	No. 1-1
1-3	Hauling	m^3	210.0	1,326	278,460	No. 2-1
1-4	Compaction	m^3	210.0	1,606	337,260	No. 5
1-5	Smoothing	m^2	900.0	1,826	1,643,400	No. 4
1-6	Stone Masonry	m^2	194.0	16,664	3,232,816	No. 10
	III-1 Sub-Total				11,129,311	
III-2	Spillway					
2-1	Excavation	m^3	130.6	3,126	408,256	No. Eq-2-3
2-2	Form Work	m^2	175.1	8,108	1,419,711	No. 8
2-3	Reinforcement-Bar	ton	2.0	1,727,500	3,455,000	No. 9
2-4	Concrete	m^3	40.5	93,710	3,795,255	No. 7-1
2-5	Backfill	m^3	55.6	1,606	89,294	No. 13
	III-2 Sub-Total				9,167,516	
III-3	Pump, Catch Basin, Stairs & Suction Box					
3-1	Excavation	m^3	13.4	3,025	40,535	No. 1-1
3-2	Form Work	m^2	24.5	8,108	198,646	No. 8
3-3	Reinforcement-Bar	ton	0.2	1,727,500	345,500	No. 9
3-4	Concrete	m^3	4.1	93,710	384,211	No. 7-1
3-5	Backfill	m^3	6.4	1,606	10,278	No. 13
3-6	Pump No. 1 (Farm Pond), Setting & Base	L.S.	1.0		1,709,000	
3-7	Pump No. 2 (Cihideung River), Setting & Base	L.S.	1.0		5,764,000	
	III-3 Sub-Total				8,452,170	
III-4	Inlet (3 nos.)					
4-1	Excavation	m^3	63.0	3,126	196,938	No. Eq-2-3
4-2	Form Work	m^2	123.2	8,108	998,906	No. 8
4-3	Reinforcement-Bar	ton	0.7	1,727,500	1,209,250	No. 9
4-4	Concrete	m^3	13.0	93,710	1,218,230	No. 7-1
4-5	Backfill	m^3	45.0	1,606	72,270	No. 13
	III-4 Sub-Total				3,695,594	
	Division-III Total				32,444,591	(Say 32,445,000)

Division-IV: Irrigation Canal

Bill No.	Item	Unit	Q'ty	Unit Price (Rp.)	Amount (Rp.)	Remarks
IV-1	Irrigation Canal (L = 96.0 m)					
1-1	Excavation	m^3	35.5	3,025	107,388	No. 1-1
1-2	Form Work	m^2	144.0	8,108	1,167,552	No. 8
1-3	Reinforcement-Bar	ton	0.9	1,727,500	1,554,750	No. 9
1-4	Concrete	m^3	17.3	93,710	1,621,183	No. 7-1
1-5	Backfill	m^3	18.2	1,606	29,229	No. 13
	IV-1 Sub-Total				4,480,102	
IV-2	Concrete Box (1 m x 1 x 1 x 1 nos. & 0.5 m x 0.5 x 0.5 x 7 nos.)					
2-1	Excavation	m^3	23.1	3,025	69,878	No. 1-1
2-2	Form Work	m^2	26.6	8,108	215,673	No. 8
2-3	Reinforcement-Bar	ton	0.2	1,727,500	345,500	No. 9
2-4	Concrete	m^3	3.3	93,710	309,243	No. 7-1
2-5	Backfill	m^3	17.4	1,606	27,944	No. 13
	IV-2 Sub-Total				968,238	
IV-3	Crossing of Farm Road (3 nos.)					
3-1	Excavation	m^3	17.6	3,025	53,240	No. 1-1
3-2	Concrete	m^3	5.0	93,710	468,550	No. 7-1
3-3	Concrete Pipe (ø300)	m	18.0	34,626	623,268	No. 18
3-4	Backfill	m^3	10.3	1,606	16,542	No. 13
	IV-3 Sub-Total				1,161,600	
	Division-IV Total				6,609,940	(Say 6,610,000)

Division-V: Drainage Canal

Bill No.	Item	Unit	Q'ty	Unit Price (Rp.)	Amount (Rp.)	Remarks
V-1	Drainage Canal: U-Gutter (L = 1,051.0)					
1-1	Excavation	m^3	620.5	3,126	1,939,683	No. Eq-2-3
1-2	Concrete Pipe ø500 (Half)	m	1,051.0	27,825	29,244,075	No. 12
1-3	Form Work	m^2	1,261.0	8,108	10,224,188	No. 9
1-4	Concrete	m^3	105.1	93,710	9,848,921	No. 7-1
1-5	Backfill	m^3	525.5	1,606	843,953	No. 13
1-6	Smoothing	m^2	1,220.7	1,826	2,228,998	No. 4
	V-1 Sub-Total				54,329,818	
V-2	Drainage Canal: Open Ditch (L = 400.0 m)					
2-1	Excavation	m^3	200.0	3,126	625,200	No. Eq-2-3
2-2	Smoothing	m^2	764.0	1,826	1,395,064	No. 4
	V-2 Sub-Total				2,020,264	
V-3	Drainage Canal: Conc.-Pipe (L = 120.0 m)					
3-1	Excavation	m^3	192.0	3,126	600,192	No. Eq-2-3
3-2	Form Work	m^2	72.0	8,108	583,776	No. 9
3-3	Concrete	m^3	32.4	93,710	3,036,204	No. 7-1
3-4	Concrete Pipe (ø500)	m	120.0	56,175	6,741,000	No. 16
3-5	Backfill	m^3	84.0	1,606	134,904	No. 13
	V-3 Sub-Total				11,096,076	
V-4	Concrete Box (31 nos.)					
4-1	Excavation	m^3	85.3	3,025	258,033	No. 1-1
4-2	Form Work	m^2	185.3	8,108	1,502,412	No. 8
4-3	Reinforcement-Bar	ton	0.8	1,727,500	1,382,000	No. 9
4-4	Concrete	m^3	16.2	93,710	1,518,102	No. 7-1
4-5	Backfill	m^3	55.1	1,606	88,491	No. 13
	V-4 Sub-Total				4,749,038	
	Division-V Total				72,195,196	(Say 72,195,000)

Division-VI: Soil Conservation Test Field

Bill No.	Item	Unit	Q'ty	Unit Price (Rp.)	Amount (Rp.)	Remarks
VI-1	Soil Conservation Test Field - Plot A, B & C (25.0 m x 20.0 m x 3 plots)					
1-1	Excavation	m^3	112.0	3,126	350,112	No. Eq-2-3
1-2	Form Work	m^2	216.5	8,108	1,755,382	No. 8
1-3	Reinforcement-Bar	ton	3.0	1,727,500	5,182,500	No. 9
1-4	Concrete	m^3	59.2	93,710	5,547,632	No. 7-1
1-5	Backfill	m^3	167.1	1,606	268,363	No. 13
	IV-1 Sub-Total				13,103,989	
VI-2	Sedimentation Tank - Plot A, B & C (L = 61.2 m)					
2-1	Excavation	m^3	123.0	3,126	384,498	No. Eq-2-3
2-2	Form Work	m^2	140.8	8,108	1,141,606	No. 8
2-3	Reinforcement-Bar	ton	1.1	1,727,500	1,900,250	No. 9
2-4	Concrete	m^3	21.4	93,710	2,005,394	No. 7-1
2-5	Backfill	m^3	6.1	1,606	9,797	No. 13
	VI-2 Sub-Total				5,441,545	
VI-3	Soil Conservation Test Field - Plot D & E (25.0 m x 10.0 m x 2 plots)					
3-1	Excavation	m^3	34.5	3,126	107,847	No. Eq-2-3
3-2	Form Work	m^2	76.2	8,108	617,830	No. 8
3-3	Reinforcement-Bar	ton	1.2	1,727,500	2,073,000	No. 9
3-4	Concrete	m^3	24.9	93,710	2,333,379	No. 7-1
3-5	Backfill	m^3	95.9	1,606	154,015	No. 13
	VI-3 Sub-Total				5,286,071	
VI-4	Sedimentation Tank - Plot D & E (L = 20.9 m)					
4-1	Excavation	m^3	42.0	3,126	131,292	No. Eq-2-3
4-2	Form Work	m^2	48.1	8,108	389,995	No. 8
4-3	Reinforcement-Bar	ton	0.4	1,727,500	691,000	No. 9
4-4	Concrete	m^3	7.3	93,710	684,083	No. 7-1
4-5	Backfill	m^3	2.1	1,606	3,373	No. 13
	VI-4 Sub-Total				1,899,743	
	Division-VI Total				25,731,348	(Say 25,731,000)

Division-VII: Irrigation Test Field - Paddy Field

Bill No.	Item	Unit	Q'ty	Unit Price (Rp.)	Amount (Rp.)	Remarks
VII-1	Paddy Field (25.0m x 30.0m x 4 plots)					
1-1	Excavation	m^3	690.0	1,654	1,141,260	No. Eq-1-3
1-2	Spreading	m^3	690.0	691	476,790	No. Eq-3-3
1-3	Smoothing	m^2	186.0	1,826	339,636	No. 4
1-4	Spreading (Top Soil)	m^3	600.0	684	410,400	No. Eq-3-2
	VII-I Sub-Total				2,368,086	
VII-2	Weir at Outlet for Irrigation Water (4 nos.)					
2-1	Excavation	m^3	1.7	3,025	5,143	No. 1-1
2-2	Form Work	m^2	2.6	8,108	21,081	No. 8
2-3	Concrete	m^3	0.2	93,710	18,742	No. 7-1
2-4	Backfill	m^3	1.6	1,606	2,570	No. 13
	VII-2 Sub-Total				47,536	
VII-3	Weir at Inlet for Irrigation Water (4 nos.)					
3-1	Concrete	m^3	0.02	93,710	1,874	No. 7-1
3-2	Form Work	m^2	0.3	8,108	2,432	No. 8
	VII-3 Sub-Total				4,306	
	Division-VII Total				2,419,928	(Say 2,420,000)

Division-VIII: Irrigation Test field - Upland

Bill No.	Item	Unit	Q'ty	Unit Price (Rp.)	Amount (Rp.)	Remarks
VIII-1	Upland (30.0 m x 90.0 m x 1 plot)					
1-1	Spreading (Top Soil)	m^3	440.0	684	300,960	No. Eq-3-2
1-2	Hauling (Top Soil)	m^3	100.0	1,326	132,600	No. 2-1
	VIII-1 Sub-Total				433,560	
VIII-2	Farm Road: E (B = 3.0 m, L = 100.0 m)					
2-1	Spreading	m^3	43.0	691	29,713	No. Eq-3-3
2-2	Compaction	m^3	43.0	1,456	62,608	No. Eq-4
2-3	Sub Base Course (t = 150)	m^2	300.0	2,778	833,400	No. 14
2-4	Smoothing	m^2	98.0	1,826	178,948	No. 4
	VIII-2 Sub-Total				1,104,669	
	Division-VIII Total				1,538,229	(Say 1,538,000)

Division-IX: Tractor Test Field

Bill No.	Item	Unit	Q'ty	Unit Price (Rp.)	Amount (Rp.)	Remarks
IX-1	Tractor Test Field (86.0 m x 35.0 m x 1 plot)					
1-1	Spreading (Top Soil)	m^3	480.0	684	328,320	No. Eq-3-2
1-2	Hauling	m^3	120.0	1,326	159,120	No. 2-1
	IX-1 Sub-Total				487,440	
	Division-IX Total				487,440	(Say 487,000)

Division-X: Tractor Test Road

Bill No.	Item	Unit	Q'ty	Unit Price (Rp.)	Amount (Rp.)	Remarks
X-1	Tractor Test Road: D: Concrete Pave. (B = 3.0 m, L = 150.0 m)					
1-1	Spreading	m^3	231.0	691	159,621	No. Eq-3-3
1-2	Compaction	m^3	231.0	1,456	336,336	No. Eq-4
1-3	Sub Base Course (t = 200)	m^2	450.0	3,702	1,665,900	No. 15
1-4	Form Work	m^2	36.0	8,108	291,888	No. 8
1-5	Wire Mesh	m^2	450.0	5,968	2,685,600	No. 17
1-6	Concrete	m^3	54.0	98,646	5,326,884	No. 7-2
1-7	Smoothing	m^2	366.0	1,826	668,316	No. 4
	X-1 Sub-Total				11,134,545	
X-2	Tractor Test Road: Gravel Pave. (B = 3.0 m, L = 150.0 m)					
2-1	Spreading	m^3	65.0	691	44,915	No. Eq-3-3
2-2	Compaction	m^3	65.0	1,456	94,640	No. Eq-4
2-3	Sub Base Course (t = 150)	m^2	450.0	2,778	1,250,100	No. 14
2-4	Smoothing	m^2	147.0	1,826	268,422	No. 4
	X-2 Sub-Total				1,658,077	
X-3	Tractor Test Road: Earth Road (B = 3.0 m, L = 150.0 m)					
3-1	Spreading	m^3	132.0	691	91,212	No. Eq-3-3
3-2	Compaction	m^3	132.0	1,456	192,192	No. Eq-4
3-3	Smoothing	m^2	147.0	1,826	268,422	No. 4
	X-3 Sub-Total				551,826	
	Division-X Total				13,344,448	(Say 13,344,000)

Appendix C6 Labour Cost and Material Cost

LABOUR COST

Item	Unit	Unit Price (Rp.)
Labour	m.d	3,500
Foreman	m.d	5,000
Carpenter	m.d	4,000
Head of Carpenter	m.d	5,000
Stone Worker	m.d	4,000
Head of Stone Worker	m.d	5,000
Steel Worker	m.d	4,500
Head of Steel Worker	m.d	5,000
Asphalt Worker	m.d	4,000
Driver	m.d	4,000
Operator (Heavy Equipment)	m.d	5,000
Assistant Operator	m.d	4,000
Mechanical	m.d	4,000
Electrical	m.d	5,000

MATERIAL COST

Item	Unit	Unit Price (Rp.)	Remarks
Sand	m^3	12,500	
Gravel	m^3	12,500	
Gravel for Pavement	m^3	13,000	
Stone	m^3	15,000	
Lumber	m^3	150,000	
Reinforced Iron Bar	kg	750	
Nail	kg	1,500	
Wire for Binding	kg	1,250	
Cement	bag	4,650	40 kg
Asphalt Pitch	ton	49,500	
Tack Coat	m^2	1,020	
Gasoline	lit	385	
Diesel	lit	200	
Concrete Pipe ø500 mm	pc	50,000	L = 1 m
Concrete Pipe ø300 mm	pc	145,150	L = 4.72 m
PVC Pipe ø2"	stick	22,200	L = 4 m
PVC Pipe ø4"	stick	67,000	L = 4 m
Wire Mesh	m^2	5,400	

Appendix C7 Unit Price

LIST OF UNIT PRICE

Item	Unit	Unit Price (Rp.)
1. Unit Price by Manpower		
No. 1 Excavation by Manpower		
No. 1-1 Normal Soil	m^3	3,025
No. 1-2 Hard Soil	m^3	4,032
No. 2 Hauling by Manpower		
No. 2-1 Distance (L) less than 30 m	m^3	1,326
No. 2-2 Distance (L) more than 30 m	m^3	14L + 1,050
No. 4 Smoothing of Face Excavated or Filled up	m^2	1,826
No. 5 Compacting by Manpower	m^3	1,606
No. 6 Compacting by Compactor	m^3	1,169
No. 7 Concrete Mixed by Portable Concrete Mixer		
No. 7-1 $\sigma 28 = 175\ kg/cm^2$	m^3	93,710
No. 7-2 $\sigma 28 = 225\ kg/cm^2$	m^3	98,646
No. 8 Wooden Form of Concrete	m^2	8,108
No. 9 Processing & Assembling of Reinforced Iron Bar	ton	1,727,500
No. 10 Stone Masonry	m^2	16,664
No. 11 Asphalt Pavement (t = 50 mm)	m^2	7,531
No. 12 Half Concrete Pile (ø500)	m	27,825
No. 13 Backfill by Manpower	m^3	1,606
No. 14 Sub Base Course (t = 150 mm)	m^2	2,778
No. 15 Sub Base Course (t = 200 mm)	m^2	3,702
No. 16 Concrete Pipe (ø500)	m	56,175
No. 17 Wire Mesh	m^2	5,968
No. 18 Concrete Pipe (ø300)	m	34,626
No. 19 Wet Masonry	m^2	52,531

Item	Unit	Unit Price (Rp.)
2. Unit Price by Using Construction Equipment		
No. Eq-1 Excavation by Bulldozer (11 ton)		
No. Eq-1-1 Sand	m^3	1,183
No. Eq-1-2 Normal Soil	m^3	1,381
No. Eq-1-3 Clayey Soil	m^3	1,654
No. Eq-2 Excavation by Back-hoe Shovel (0.35 m^3)		
No. Eq-2-1 Sand	m^3	2,458
No. Eq-2-2 Normal Soil	m^3	2,430
No. Eq-2-3 Clayey Soil	m^3	3,126
No. Eq-3 Spreading by Bulldozer (11 ton)		
No. Eq-3-1 Sand	m^3	615
No. Eq-3-2 Normal Soil	m^3	684
No. Eq-3-3 Clayey Soil	m^3	691
No. Eq-4 Compaction by Vibration Roller (3 ton)	m^3	1,456
3. Operation Cost of Construction Equipment		
No. OP-1 Bulldozer (11 ton)	day	325,234
No. OP-2 Back-hoe Shovel (0.35 m^3)	day	409,850
No. OP-3 Vibration Roller (3 ton)	day	181,514

Breakdown of Unit Price

No. 1-1 Excavation by Manpower
(Soil Condition: Normal Soil)

Rp. 3,025/m^3

Item	Q'ty	Unit	Unit Cost	Cost	Remarks
Labour	0.75	m.d	3,500	2,625	
Foreman	0.025	m.d	5,000	125	
Temporary Works	10	%		275	
Total				3,025	

No. 1-2 Excavation by Manpower
(Soil Condition: Hard Soil)

Rp. 4,032/m^3

Item	Q'ty	Unit	Unit Cost	Cost	Remarks
Labour	1.0	m.d	3,500	3,500	
Foreman	0.033	m.d	5,000	165	
Temporary Works	10	%		367	
Total				4,032	

No. 2-1 Hauling by Manpower
(Distance ≤ 30 m)

Rp. 1,326/m^3

Item	Q'ty	Unit	Unit Cost	Cost	Remarks
Labour	0.33	m.d	3,500	1,155	
Foreman	0.01	m.d	5,000	50	
Temporary Works	10	%		121	
Total				1,326	

No. 2-2 Hauling by Manpower
(Distance > 30 m)

Item	Q'ty	Unit	Unit Cost	Cost	Remarks

$$K = \frac{a}{275}(L + 75) \times 1.1$$

where; K = Unit Price,
a = Wages for Labour,
L = Hauling Distance (m)

$$K = \frac{3500}{275}(L + 75) \times 1.1 = 14.0L + 1{,}050 \text{ (Rp.)}$$

No. 4 Smoothing of Face Excavated or Filled up

Rp. 1,826/m^2

Item	Q'ty	Unit	Unit Cost	Cost	Remarks
Labour	0.46	m.d	3,500	1,610	
Foreman	0.01	m.d	5,000	50	
Temporary Works	10	%		166	
Total				1,826	

No. 5 Compacting by Manpower

Rp. 1,606/m^3

Item	Q'ty	Unit	Unit Cost	Cost	Remarks
per 10 m^3					
Labour	4	m.d	3,500	14,000	
Foreman	0.12	m.d	5,000	600	
Temporary Works	10	%		1,460	
Total				16,060/10 m^3	
per m^3				1,606	

No. 6 Compacting by Compactor

Rp. 1,169/m^3

Item	Q'ty	Unit	Unit Cost	Cost	Remarks
per 10 m^3					
1. Worker					
Labour	2.30	m.d	3,500	8,050	
Foreman	0.07	m.d	5,000	350	
Sub-total				8,400	
2. Fuel & Others					
Fuel	0.9	lit	200	180	6 lit/day x 0.15 day
Others	15	%		27	
Sub-total				207	
3. Depreciation & Others	0.15	day	13,457	2,019	
4. Temporary Works & Others	10	%		1,063	
Total				11,689/10 m^3	
per m^3				1,169	

No. 7-1 Concrete ($\sigma28$ = 175 kg/cm^2)
(Mixed by Portable Concrete Mixer)

Rp. 93,710/m^3

Item	Q'ty	Unit	Unit Cost	Cost	Remarks
1. Material					
Gravel	0.82	m3	12,500	10,250	
Cement	8.75	bag	4,650	40,688	
Sand	0.55	m^3	12,500	6,875	
Sub-total				57,813	
2. Worker					
Labour	7.0	m.d	3,500	24,500	
Foreman	0.23	m.d	5,000	1,150	
Sub-total				25,650	
3. Fuel & Others					
Mixer Fuel	0.22	lit	200	44	
Others	20	%		9	
Vibrator Fuel	0.22	lit	200	44	
Others	20	%		9	
Sub-total				106	
4. Depre. & Main.					
Mixer	0.061	day	20,742	1,265	
Vibrator	0.071	day	5,027	357	
Sub-total				1,622	
5. Temporary Works & Others	10	%		8,519	
Total				93,710	

No. 7-2 Concrete ($\sigma 28$ = 225 kg/cm^2)
(Mixed by Portable Concrete Mixer) Rp. 98,646/m^3

	Item	Q'ty	Unit	Unit Cost	Cost	Remarks
1.	Material					
	Gravel	0.88	m^3	12,500	11,000	
	Cement	9.5	bag	4,650	44,175	
	Sand	0.57	m^3	12,500	7,125	
	Sub-total				62,300	
2.	Worker	1	Complete		25,650	No. 7-1
3.	Fuel & Others	1	Complete		106	No. 7-1
4.	Depre. & Main.	1	Complete		1,622	No. 7-1
5.	Temporary Works & Others	10	%		8,968	
	Total				98,646	

No. 8 Wooden Form of Concrete

Rp. 8,108/m²

Item	Q'ty	Unit	Unit Cost	Cost	Remarks
per 10 m^2					
1. Form					
Wooden Plate	0.196	m^3	150,000	29,400	(1)
Wooden Frame	0.113	m^3	150,000	16,950	(2)
Iron Nail	3.0	kg	1,500	4,500	(3)
Sub-Total 1				50,850	(4)=(1)+(2)+(3)
Depre. Cost of 1	30	%		15,255	(5)
2. Support					
Square Lumber	0.339	m^3	150,000	50,850	(6)
Log	0.154	m^3	150,000	23,100	(7)
Sub-Total 2				73,950	(8)=(6)+(7)
Depre. Cost of 2	20	%		14,790	(9)
3. Other Materials					
Nail & Others	1.1	kg	1,500	1,650	(10)
Wire	0.8	kg	1,250	1,000	(11)
Oil Paint	0.15	lit	1,000	150	(12)
Others	3	%		985	(13)=(5)+(9)+(10)+(11)+(12)
Sub-Total				3,785	(14)
4. Worker					
Carpenter	3.36	m.d	4,000	13,440	(15)
Labour	4.14	m.d	3,500	14,490	(16)
Foreman	0.12	m.d	5,000	600	(17)
Sub-Total				28,530	(18)
5. Trans. of Materials	15	%		18,720	(19)=(4)+(8)
Total				81,080/10m^2	(20)=(5)+(9)+(14)+(18)+(19)
per m^2				8,108	

No. 9 Processing & Assembling of Reinforced Iron Bar

Rp. 1,727,500/ton

Item	Q'ty	Unit	Unit Cost	Cost	Remarks
per 100 kg					
1. Materials					
Reinforced I.B.	110	kg	750	82,500	
Wire for Binding	2	kg	1,250	2,500	
Sub-Total				85,000	
2. Process. & Assembl.					
Steel Worker	12	m.d	4,500	54,000	
Labour	9	m.d	3,500	31,500	
Head	0.45	m.d	5,000	2,250	
Sub-Total				87,750	
Total				172,750/100 kg	
per ton				1,727,500	

No. 10 Stone Masonry

Rp. 16,664/m2

Item	Q'ty	Unit	Unit Cost	Cost	Remarks
1. Materials					
Stone	0.385	m3	15,000	5,775	
Gravel	0.33	m3	12,500	4,125	
Sub-Total				9,900	
2. Worker					
Stone Worker	0.64	m.d	4,000	2,560	
Labour	0.58	m.d	3,500	2,030	
Sub-Total				4,590	
3. Others	15	%		2,174	
Total				16,664	

No. 11 Asphalt Pavement (t = 50 mm)

Rp. 7,531/m^2

Item	Q'ty	Unit	Unit Cost	Cost	Remarks
per 100 m^2					
1. Worker					
Asphalt Worker	24.07	m.d	4,000	96,280	
Labour	22.52	m.d	3,500	78,820	
Sub-Total				175,100	
2. Materials					
Asphalt Pitch	9.38	ton	49,500	464,310	
Gasoline	2.1	lit	385	809	
Sub-Total				465,119	
3. Fuel & Others					
Gasoline	5.13	lit	385	1,975	
Others	10	%		198	
Sub-Total				2,173	
4. Depre. & Main.					
Tamper/Rammer	1.25	day	10,000	12,500	
5. Temporary Works & Others	15	%		98,234	
Total				753,126/100 m^2	
per m^2				7,531	

No. 12 Half Concrete Pipe (ø500 mm)

Rp. 27,825/m

Item	Q'ty	Unit	Unit Cost	Cost	Remarks
1. Materials					
Half Concrete Pipe	1	m	25,000	25,000	
2. Worker					
Labour	0.4	m.d	3,500	1,400	
Foreman	0.02	m.d	5,000	100	
Sub-total				1,500	
3. Temporary Works & Others	5	%		1,325	
Total				27,825	

No. 13 Backfill by Manpower

Rp. 1,606/m^3

Item	Q'ty	Unit	Unit Cost	Cost	Remarks
per 10 m^3					
Labour	4	m.d	3,500	14,000	
Foreman	0.12	m.d	5,000	600	
Temporary Works	10	%		1,460	
Total				16,060/10 m^3	
per m^3				1,606	

No. 14 Sub Base Course (t = 150 mm)

Rp. 2,778/m²

Item	Q'ty	Unit	Unit Cost	Cost	Remarks
per 100 m²					
1. Material					
Gravel	16.5	m^3	13,000	214,500	
2. Worker					
Labour	11.0	m.d	3,500	38,500	
Foreman	0.15	m.d	5,000	750	
Sub-Total				39,250	
3. Compaction	16.5	m^3	1,456	24,024	No. Eq-4
Total				277,774/100 m²	
per m²				2,778	

No. 15 Sub Base Course (t = 200 mm)

Rp. 3,702/m²

Item	Q'ty	Unit	Unit Cost	Cost	Remarks
per 100 m²					
1. Material					
Gravel	22.0	m^3	13,000	286,000	
2. Worker					
Labour	14.7	m.d	3,500	51,450	
Foreman	0.15	m.d	5,000	750	
Sub-Total				52,200	
3. Compaction	22.0	m^3	1,456	32,032	No. Eq-4
Total				370,232/100 m2	
per m²				3,702	

No. 16 Concrete Pipe (ø500 mm)

Rp. 56,175/m

Item	Q'ty	Unit	Unit Cost	Cost	Remarks
per 10 pieces (10 m)					
1. Material					
Concrete Pipe	10	nos.	50,000	500,000	
2. Worker					
Labour	10	m.d	3,500	35,000	
3. Temporary Works & Others	5	%		26,750	
Total				561,750/10 m	
per m				56,175	

No. 17 Wire Mesh

Rp. 5,968/m^2

Item	Q'ty	Unit	Unit Cost	Cost	Remarks
per 100 m^2					
1. Material					
Wire Mesh	110	m^2	5,400	594,000	
2. Worker					
Labour	0.8	m/d	3,500	2,800	
Total				596,800/100 m^2	
per m^2				5,968	

No. 18 Concrete Pipe (ø300 mm)

Rp. 34,626/m

Item	Q'ty	Unit	Unit Cost	Cost	Remarks
per 1 piece (4.72 m)					
1. Material					
Concrete Pipe	1	nos.	145,150	145,150	
2. Worker					
Labour	3	m.d	3,500	10,500	
3. Temporary Works &					
Others	5	%		7,783	
Total				163,433/4.72 m	
per m				34,626	

No. 19 Wet Masonry

Rp. 52,531/m^2

Item	Q'ty	Unit	Unit Cost	Cost	Remarks
per 10 m^2					
1. Materials					
Stone	3.5	m^3	15,000	52,500	
Gravel	3.0	m^3	12,500	37,500	
Concrete	3.6	m^3	93,710	337,356	No. 7-1
VP (ϕ50 mm)	1.5	m	5,550	8,325	
Sub-Total				435,681	
2. Worker					
Stone Worker	3.30	m.d	4,000	13,200	
Labour	7.05	m.d	3,500	24,675	
Foreman	0.80	m.d	5,000	4,000	
Sub-Total				41,875	
3. Others	10	%		47,756	
Total				525,312/10 m^2	
per m^2				52,531	

No. Eq-1 Excavation by Bulldozer (11 ton)

Item		Q'ty	Unit	Cost (Rp.)	Remarks
Operation Cost				325,234	OP-1
Temporary Works		10	%	32,523	
Total				357,757	
Eq-1-1	Sand	1	m^3	1,183	Production 302.4 m^3/d
Eq-1-2	Normal Soil	1	m^3	1,381	Production 259.0 m^3/d
Eq-1-3	Clayey Soil	1	m^3	1,654	Production 216.3 m^3/d

No. Eq-2 Excavation by Back-hoe Shovel (0.35 m^3)

Item		Q'ty	Unit	Cost (Rp.)	Remarks
Operation Cost				409,850	OP-2
Temporary Works		10	%	40,985	
Total				450,835	
Eq-2-1	Sand	1	m^3	2,458	Production 183.4 m^3/d
Eq-2-2	Normal Soil	1	m^3	2,430	Production 185.5 m^3/d
Eq-2-3	Clayey Soil	1	m^3	3,126	Production 144.2 m^3/d

No. Eq-3 Spreading by Bulldozer (11 ton)

Item		Q'ty	Unit	Cost (Rp.)	Remarks
Operation Cost				325,234	OP-1
Temporary Works		10	%	32,523	
Total				357,757	
Eq-3-1	Sand	1	m^3	615	Production 582.1 m^3/d
Eq-3-2	Normal Soil	1	m^3	684	Production 523.3 m^3/d
Eq-3-3	Clayey Soil	1	m^3	691	Production 517.4 m^3/d

No. Eq-4 Compaction by Vibration Roller (3 ton)

Item	Q'ty	Unit	Cost (Rp.)	Remarks
Operation Cost			181,514	OP-3
Temporary Works	10	%	18,151	
Total			199,665	
Eq-4	1	m^3	1,456	Production 137.1 m^3/d

No. OP-1 Operation Cost of 11 ton Bulldozer

Rp. 325,234/day

Item	Q'ty	Unit	Unit Cost	Cost	Remarks
1. Worker					
Operator	1.0	m.d	5,000	5,000	
Assistance	0.5	m.d	4,000	2,000	
Sub-Total				7,000	
2. Fuel & Others					
Diesel Oil	59.5	lit	200	11,900	
Others	30	%		3,570	
Sub-Total				15,470	
3. Depreciation	7	hr	43,252	302,764	
Total				325,234	

No. OP-2 Operation Cost of 0.35 m^3 Back-hoe Shovel

Rp. 409,850/day

	Item	Q'ty	Unit	Unit Cost	Cost	Remarks
1.	Worker					
	Operator	1.0	m.d	5,000	5,000	
	Assistance	0.5	m.d	4,000	2,000	
	Sub-Total				7,000	
2.	Fuel & Others					
	Diesel Oil	35.0	lit	200	7,000	
	Others	30	%		2,100	
	Sub-Total				9,100	
3.	Depreciation	7	hr	56,250	393,750	
	Total				409,850	

No. OP-3 Operation Cost of Vibration Roller 3 ton

Rp. 181,514/day

	Item	Q'ty	Unit	Unit Cost	Cost	Remarks
1.	Worker					
	Operator	1.0	m.d	5,000	5,000	
	Assistance	0.5	m.d	4,000	2,000	
	Sub-Total				7,000	
2.	Fuel & Others					
	Diesel Oil	8.9	lit	2,000	1,780	
	Others	30	%		534	
	Sub-Total				2,314	
3.	Depreciation	7	hr	24,600	172,200	
	Total				181,514	

Appendix C8 General Plan of the Agro-civil Engineering Tests and Farm Machinery Tests Fields

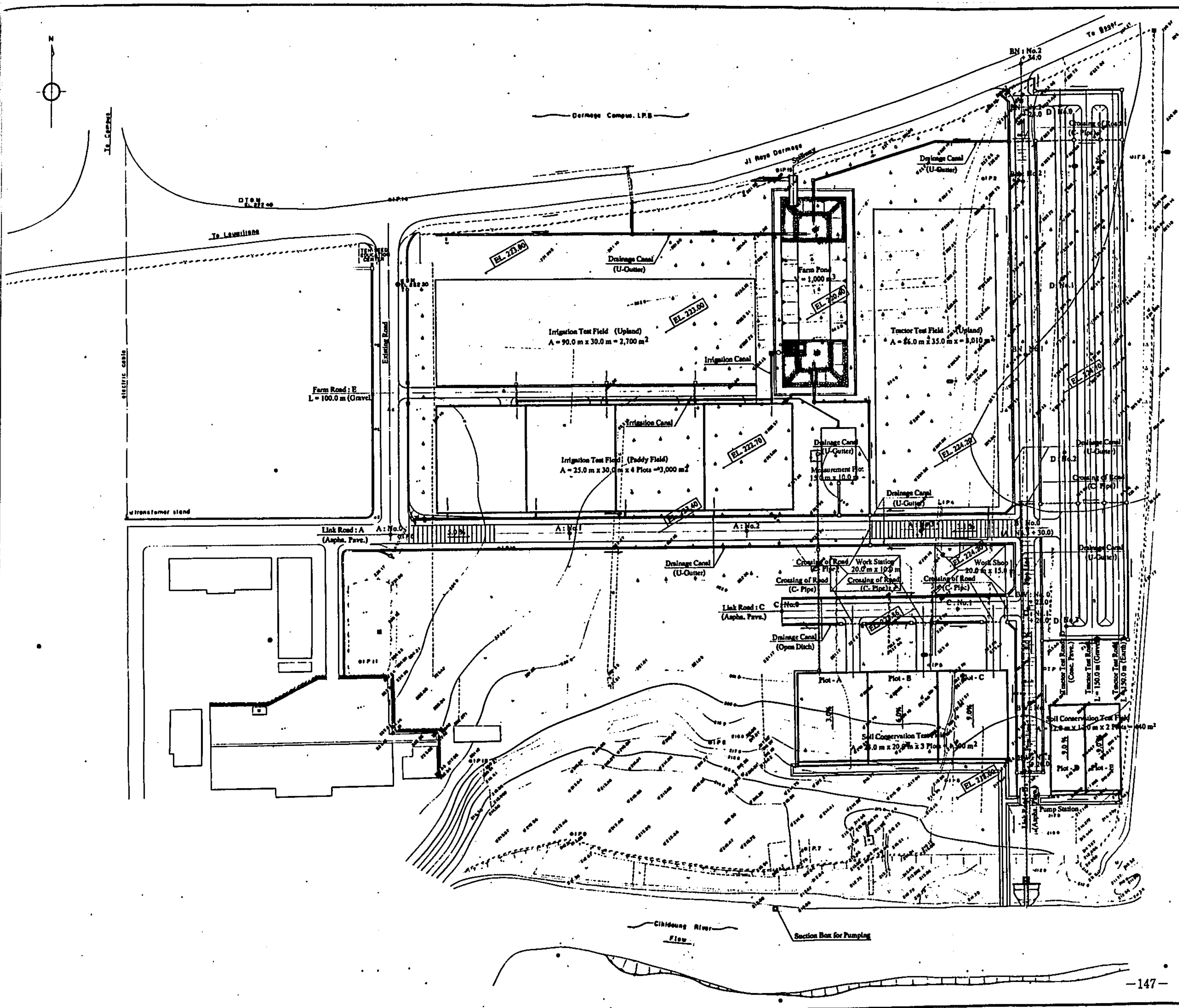
Based on the Basic Plan which was described in the Letter of Team Leader of the Detailed Design Survey Team of JICA dated January 16, 1990, general plan of the agro-civil engineering tests and farm machinery tests fields has been prepared at the depth of the detailed design study, as shown in Drawing C8-1.

After deliberation on basic needs, urgency and priority for the components of the general plan as well as their required construction cost in comparison with available fund, the components of the Model Infrastructure Improvements Works have been decided as follows :

1. land leveling and land preparation,
2. link road,
3. drainage facilities,
4. irrigation facilities (excluding the Cihideung pump station and its related pipe line except pump machine)
5. soil conservation test fields,
6. paddy irrigation tests fields,
7. upland irrigation tests fields,
8. tractor test field, and
9. tractor test roads.

Accordingly, the following components of the said general plan shall be left behind in further consideration on the self-construction of the Indonesian side :

1. measurement plot (lysimeter)
2. the Cihideung pump station and its related pipe line except pump machine,
3. workshop and workstation, and
4. others, if any.



Note

1. Locations of facilities are subject to change by the Expert.

S = 1/500

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General plan of the Agro-civil Engineering Test and Farm Machinery Test	
PREPARED BY	DRAWING NO.
CHECKED BY	C8 - 1

Appendix C9 Measurement Plot

1. Site allocation

The site for the measurement plot has been allocated to the surrounding area by the farm pond in the north, the tractor test field in the east, the link road in the south and the paddy experimental field in the west. The available land is about 17 m in width and 26 m in length.

2. Structure

This is used for study on the water balance at a paddy field. It is made of watertight reinforeced concrete with outflow measurement devices for amounts of surface water and percolated water.

The dimensions of the structure are 10 m in width, 15 m in length and 2 m in height. The structural framework consists of reinforeced concrete walls and a bottom slab. Two rectangular weirs are provided at the inlet and the outlet canals respectively in order to measure amounts of water comming into and going out from the measurement plot. The percolated water into the soil is collected with perforated PVC pipes installed on the bottom slab and measured it at the outlet box by bulk. While, the inside of the measurement plot is filled with arable soil on filter with adequate thickness of gravel and sand.

3. Design

The rates of irrigation water necessary for the experiments in the measurement plot are the same as the paddy experiment fields. The irrigation water is supplied from the farm pond.

For surface drainage during heavy rainfall concentration, the maximum capacity of the measurement weir was decided with the following criteria:

$Q = R_5^{100} \cdot A$

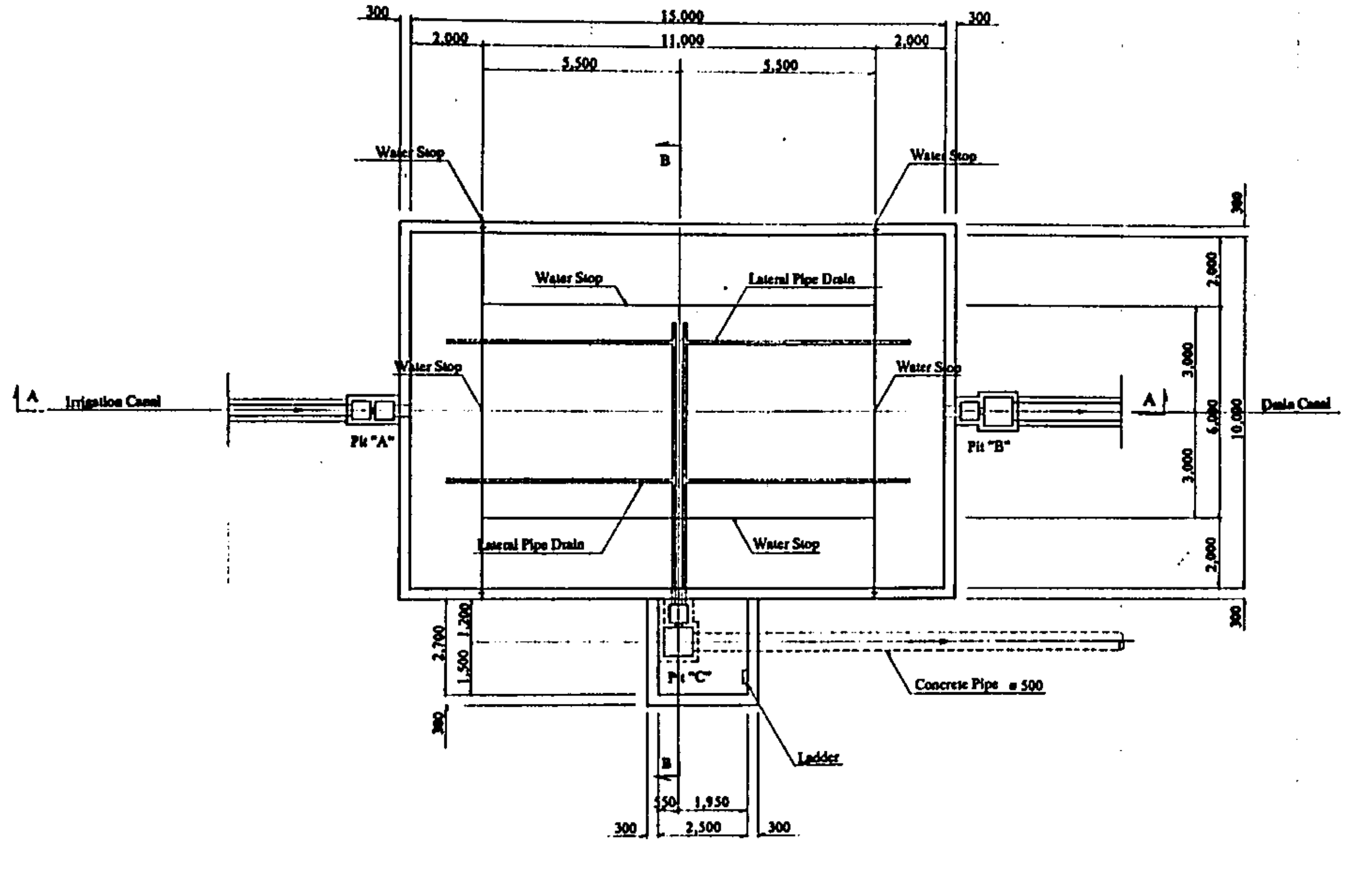
Where ;	Q	:	Design discharge
	R_5^{100}	:	5 minutes rainfall intensity of 100 years return period = 289.3 mm/hr
	A	:	Catchment area = 150 m^2
Therefore ;	Q	=	289.3 mm/hr x 150 m^2
		=	0.012 m^3/sec

The dimension of the drainage canal of concrete flume is :

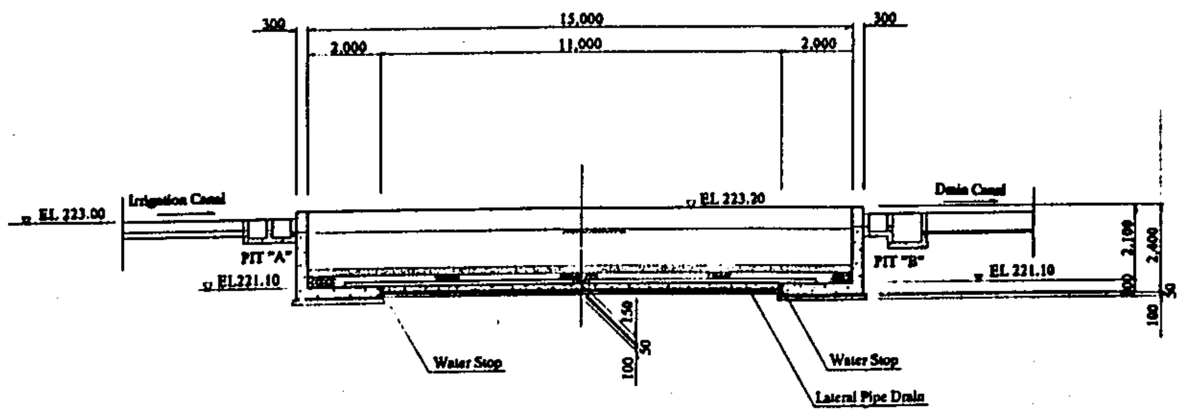
Q = 0.012 m^3/sec,	Canal width = 0.5 m,	Canal slope = 0.001
n = 0.015,	Water depth = 0.08 m,	Canal depth = 0.3 m

The structure is designed as shown in Drawing C9-1.

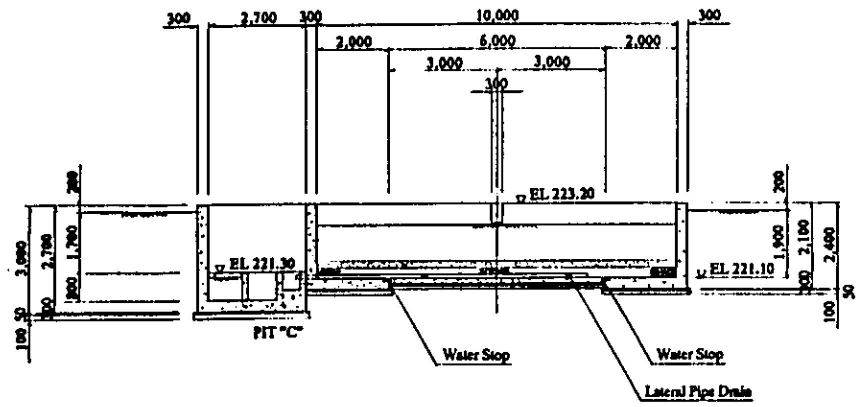
The Cost is estimated at Rp. 28,050,000.



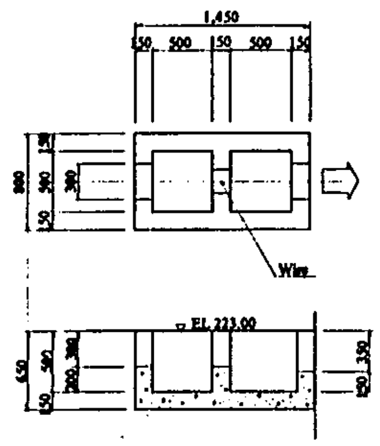
PLAN



SECTION A - A



SECTION B - B



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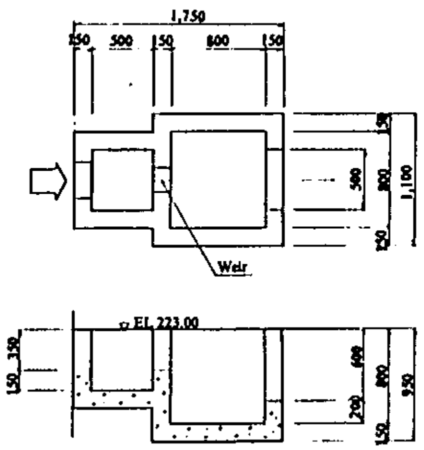

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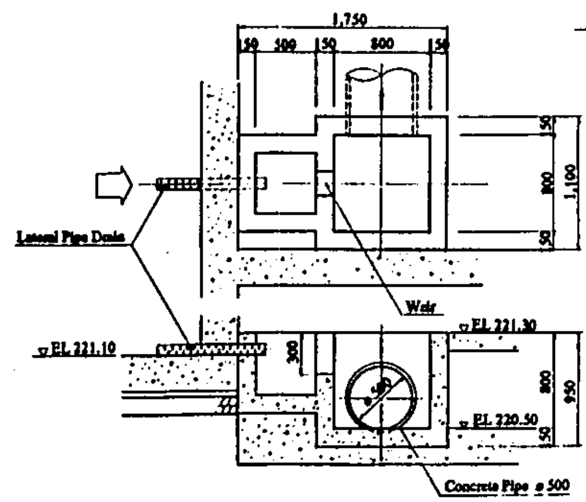

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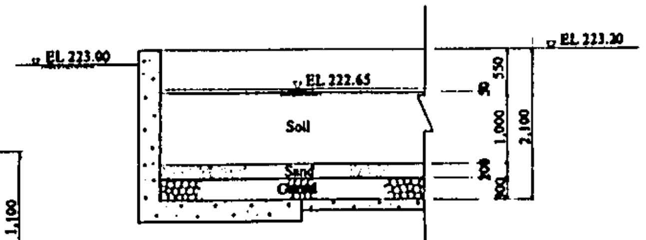

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MEASUREMENT PLOT

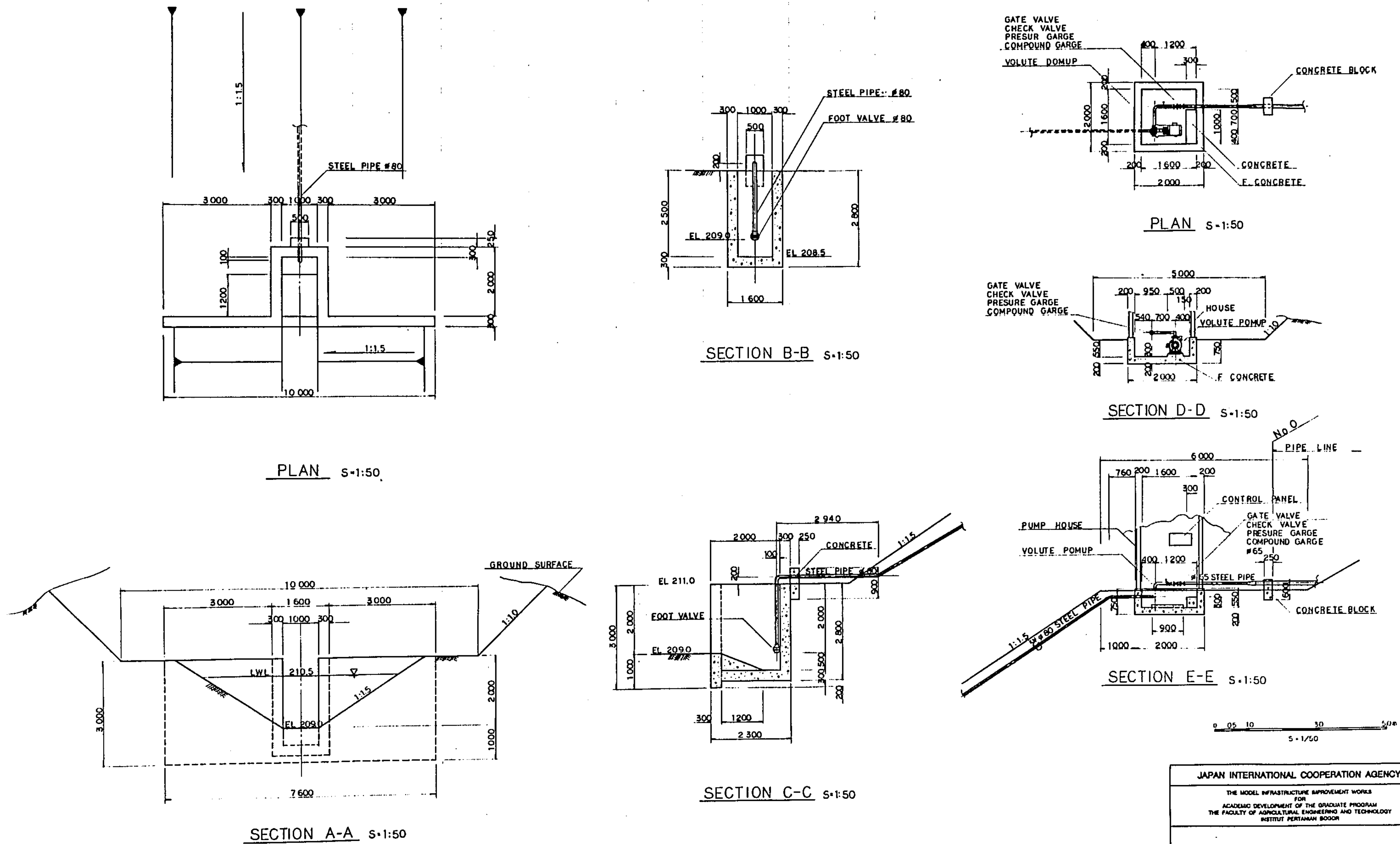
PREPARED BY	DRAWING NO.
CHECKED BY	C9 - 1

Appendix C10 The Cihideung Pump Station

As the result of the water balance calculation the required pump capacity is found at 180 lit/min with 40 mm of pump bore.

The location and the design drawing of the Cihideung pump station and pipe line are shown in Drawing C10-1 and C10-2.

The construction cost is estimated at Rp. 32,831,000 for pump station and Rp. 2,767,000 for pipe line.



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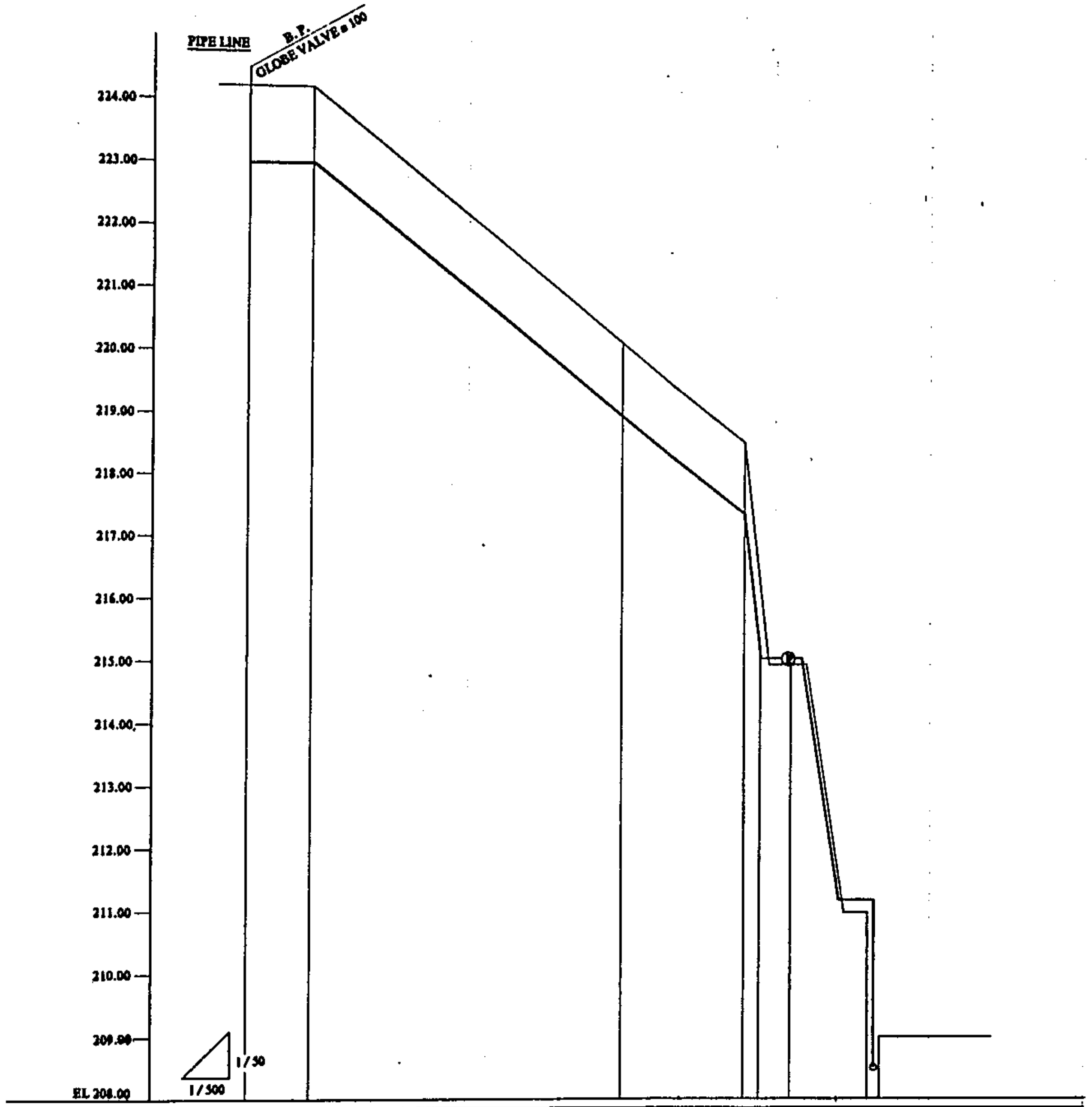
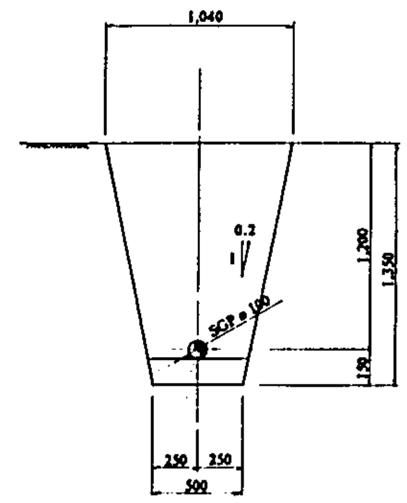
The Cibidewng Pump Station

PREPARED BY	DRAWING NO. C10 - 1
CHECKED BY	



SLOPE	LEVEL		8.00 % L = 70.0 m		100 % L = 2.2 m	LEVEL
PROPOSED HEIGHT (EL)	223.00	223.00	219.00	217.40	215.20	215.20
GROUND HEIGHT (EL)	224.20	224.20	220.20	218.60	216.40	215.00
ACCUMULATED DISTANCE (m)	0.00	10.00	60.00	80.00	82.20	87.50
DISTANCE (m)	0.00	10.00	50.00	20.00	2.20	5.30
STATION	B.P.	B : No.0	BW : No.1	BW : No.1 + 20.0	+ 22.2	E.P.



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PIPE LINE

PREPARED BY	DRAWING NO.
CHECKED BY	C10 - 2

Appendix C11 Workshop / Workstation

The design conditions of the Workshop / Workstation are based on the discussion results during the field survey.

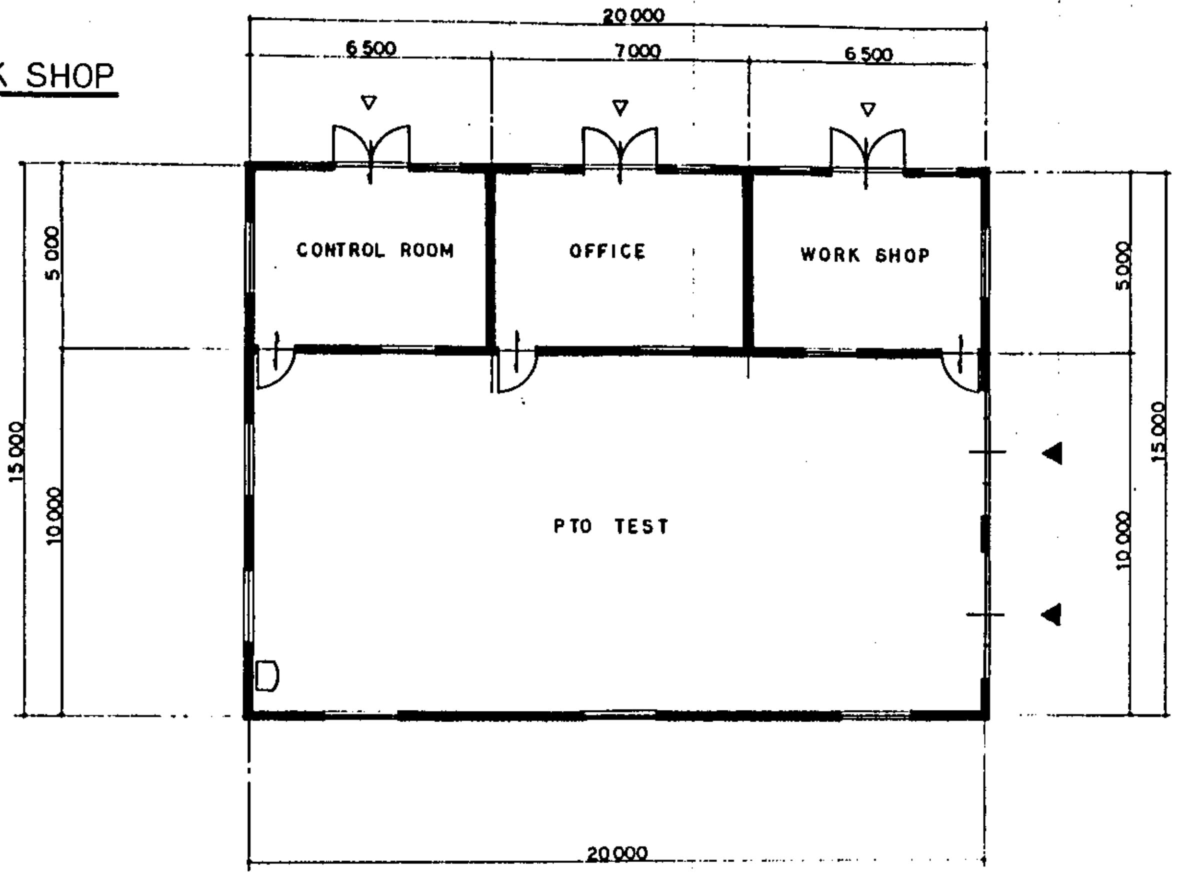
Major elements of the building structures are as follows ;

Floor	:	concrete
Wall	:	concrete blocks with cement mortar finishing
Column	:	reinforced concrete
Roof	:	cement slate roofing

The design of the Workshop / Workstation is shown in Drawing C11-1.

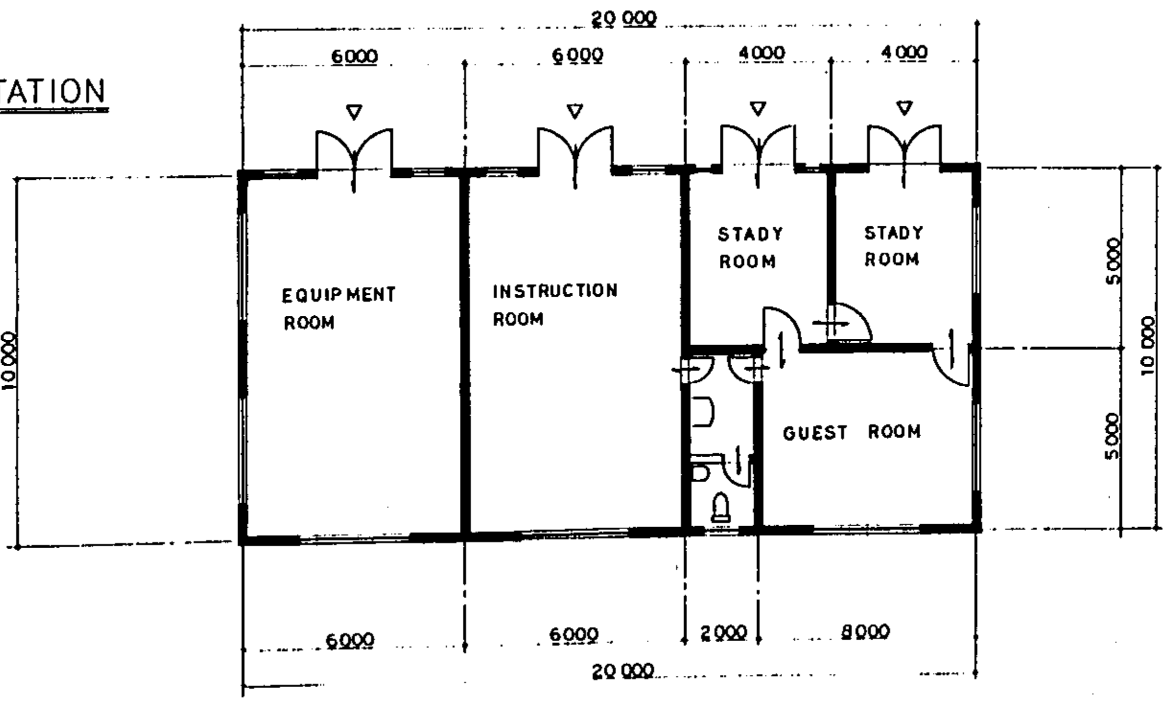
The Construction Cost is estimated at Rp. 138,000,000 in total.

WORK SHOP



PLAN S=1:100

WORK STATION



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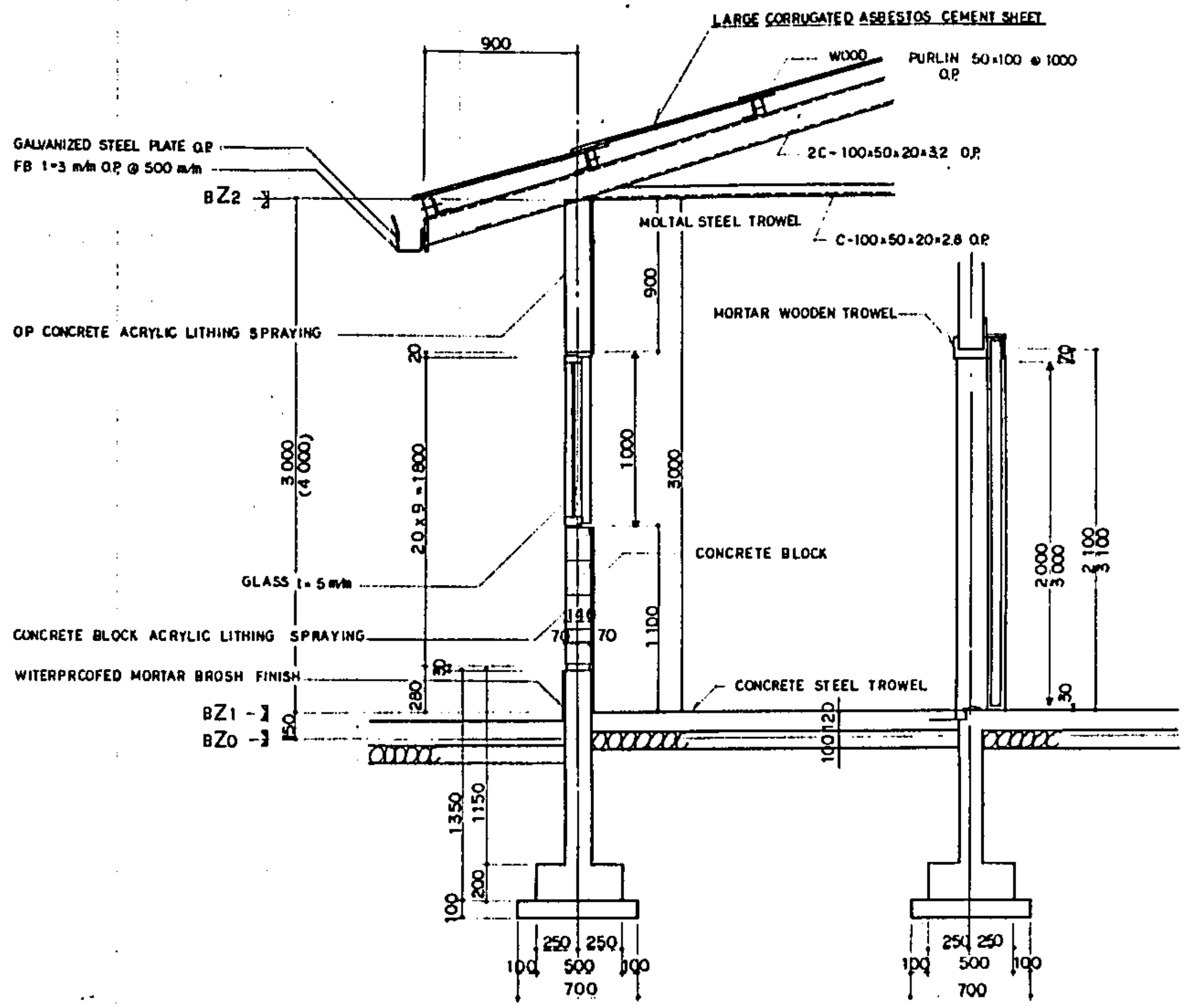

SECTION DETAIL S=1:20

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WORKSHOP AND WORKSTATION

PREPARED BY	DRAWING NO.
CHECKED BY	CII-1

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