APPENDIX - 3 : HYDROLOGICAL AND HYDRAULIC ANALYSIS

APPENDIX - 3. HYDROLOGICAL AND HYDRAULIC ANALYSIS

LIST OF CONTENTS

3.1 Meteorology

3.1.1 Table and Figure

TABLE 3-1-1 CLIMATOLOGICAL DATA FOR THE PERIOD 1956 - 1985

Station	PRACHIN BURI	Elevation of station above MSL	5 meters
Index Station	48430	Height of barometer above MSL	6 meters
Latitude	14° 03' N.	Height of thermometer above ground	1.20 meters
Longitude	101° 22' E.	Height of wind vane above ground	11.00 meters
		Height of raingauge	0.80 meters

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Pressure (+1000 or 900 mbs.)													
Mean	12.69	11.25	10.19	08.72	07.17	06.62	06.73	06.60	07.69	09.87	11.72	12.73	09.35
Ext. Max.	24.30	22.06	22.28	18.17	14.90	14.25	13.30	13.80	14.65	18.14	20.38	21.48	24.30
Ext. Min.	03.93	01.73	02.17	99.71	99.64	98.10	98.66	99.54	98.20	01.50	04.58	03.96	98.10
Mean daily range	5.18	5.55	5.72	5.31	4.53	3.95	3.73	3.88	4.33	4.46	4.45	4.67	4.65
Temperature (°C)													
Mean	26.8	28.7	30.1	30.5	29.7	29.0	28.5	28.3	26.1	28.2	27.5	26.6	28.3
Mean Max.	32.4	34.1	35.7	36.0	34.4	33.0	32.2	31.8	31.6	31.8	31.8	31.6	33.0
Mean Min.	19.4	22.1	23.9	24.9	25.1	24.9	24.6	24.6	24.3	24.3	22.4	19.9	23.4
Ext. Max.	36.6	38.0	39.6	40.7	40.4	39.8	36.4	34.7	34.8	34.8	35.6	35.8	40.7
Ext. Min.	11.3	15.0	14.6	19.8	21.4	20.8	21.8	22.2	20.0	19.0	14.1	11.5	11.3
Relative Humidity (%)													
Mean	58.4	62.3	63.9	68.4	75.2	78.3	79.9	80.9	81.4	76.4	67.2	60.4	71.1
Mean Max.	83.1	86.2	87.9	89.4	91.4	92.7	93.9	93.9	94.1	90.0	84.5	81.9	89.1
Mean Min.	40.7	43.3	44.5	49.9	59.2	64.5	67.1	68.6	69.1	63.5	52.9	44.7	55.7
Ext. Min.	21.0	16.0	23.0	24.0	30.0	37.0	50.0	48.0	47.0	34.0	25.0	23.0	16.0
Dew Point (°C)													
Mean	17.3	20.0	21.9	23.5	24.4	24.6	24.5	24.5	24.5	23.4	20.5	17.8	22.2
Evaporation (mm.)													
Mean - Pan	146.7	134.8	173.6	167.4	164.5	123.2	147.6	136.6	131.4	129.3	129.9	143.9	1729.1
Cloudiness (0-10)													
Mean	3.7	4.7	5.3	6.3	7.6	8.3	8.4	8.7	8.2	6.6	4.7	3.8	6.4
Sunshine Duration (hr.)													
Mean							No Observation						
Visibility (km.)													
0700 L.S.T.	6.4	5.8	6.1	6.9	8.8	8.9	8.7	8.6	8.8	8.8	8.0	7.3	7.8
Mean	8.3	8.0	8.2	10.2	10.1	10.1	9.9	9.8	10.1	10.3	10.0	9.4	9.5
Wind (knots)													
Prevailing wind	E	E	E	S	E	W	W	W	W	E	E	E	-
Mean wind speed	3.6	3.3	2.9	2.4	2.4	2.1	2.1	2.3	2.2	3.0	4.1	4.3	-
Max. wind speed	38 NE	48 W	53 ESE	55 SE	50 E	55 NW	43 W	42 W	52 W	50 NE	34 NE	34 NE	55 ESE, SE, NW
Rainfall (mm.)													
Mean	9.1	26.8	58.6	123.5	214.7	271.0	318.1	378.0	380.3	177.6	35.7	7.9	2001.3
Mean rainy days	1.1	2.2	4.8	9.7	17.4	19.1	21.7	23.5	21.6	14.7	4.5	0.8	141.1
Greatest in 24 hr.	58.2	65.2	30.6	109.0	125.0	168.0	124.7	161.3	116.9	123.8	59.3	65.5	168.0
Day/Year	22/84	11/70	8/56	18/62	25/58	25/64	15/83	15/70	20/69	6/84	12/67	7/72	25/64
Number of days with													
Haze	24.4	21.6	20.7	14.5	4.3	1.0	0.9	0.7	0.8	4.5	12.2	19.9	125.5
Fog	3.4	2.8	1.3	0.4	0.1	0.0	0.0	0.1	0.0	0.2	1.5	2.2	12.0
Hail	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
Thunderstorm	0.6	2.5	6.8	14.8	18.0	12.9	14.5	14.4	12.8	10.3	2.3	0.2	110.1
Squall	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Remark : Evaporation 1981 - 1985

CLIMATOLOGICAL DATA FOR THE PERIOD 1956 - 1985

Station CHON BURI
Index Station 48459
Latitude 13° 22' N.
Longitude 100° 59' E.

Elevation of station above MSL 1 meters
Height of barometer above MSL 2 meters
Height of thermometer above ground 1.50 meters
Height of wind vane above ground 13.45 meters
Height of raingauge 1.00 meters

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Pressure (+1000 or 900 mbs.)													
Mean	12.27	10.86	09.87	08.34	06.86	06.38	06.51	06.53	07.53	09.59	11.33	12.28	09.03
Ext. Max.	22.57	20.65	19.80	18.00	14.00	12.97	13.35	12.97	14.56	17.22	20.60	20.66	22.57
Ext. Min.	03.74	02.21	02.44	00.26	99.44	97.44	98.72	99.44	98.74	00.64	04.27	03.50	97.44
Mean daily range	4.65	4.64	4.73	4.60	4.26	3.66	3.54	3.77	4.25	4.41	4.34	4.49	4.28
Temperature (°C)													
Mean	25.7	27.3	28.7	29.5	29.2	28.9	28.5	28.3	27.7	27.3	26.7	25.8	27.8
Mean Max.	31.7	32.4	33.5	34.3	33.6	32.7	32.2	31.9	31.6	31.7	31.6	31.7	32.4
Mean Min.	20.1	22.5	24.3	25.4	25.5	25.5	25.1	24.9	24.3	23.6	22.1	20.4	23.6
Ext. Max.	37.5	37.6	37.8	38.8	38.5	37.1	36.1	35.8	35.5	35.9	36.2	36.7	38.8
Ext. Min.	12.1	16.5	17.5	20.4	21.2	20.8	20.5	21.4	21.0	17.9	14.2	12.0	12.0
Relative Humidity (%)													
Mean	67.3	71.2	71.2	71.9	74.8	74.2	75.5	76.4	80.3	79.9	72.7	66.2	73.5
Mean Max.	84.4	87.4	86.8	87.0	88.0	87.2	88.3	89.2	92.2	92.3	88.0	83.3	87.8
Mean Min.	48.8	54.8	55.2	55.3	59.3	60.4	61.4	62.4	65.8	64.3	55.0	47.5	57.5
Ext. Min.	20.0	22.0	19.0	26.0	32.0	42.0	43.0	43.0	46.0	32.0	24.0	22.0	19.0
Dew Point (°C)													
Mean	18.5	21.1	22.5	23.6	24.1	23.7	23.4	23.5	23.7	23.1	20.8	18.4	22.2
Evaporation (mm.)													
Mean - Pan	129.0	128.4	167.4	164.4	153.8	146.8	150.3	129.9	129.8	125.1	118.3	138.7	1681.9
Cloudiness (0-10)													
Mean	4.0	4.3	4.5	5.4	7.3	8.0	8.1	8.4	8.2	7.0	5.2	4.1	6.2
Sunshine Duration (hr.)													
Mean						No Observation							
Visibility (km.)													
0700 L.S.T.	6.1	5.7	6.6	8.2	10.6	11.2	10.7	10.2	9.6	8.5	8.0	7.1	8.5
Mean	7.2	7.1	7.7	9.3	11.9	12.1	11.7	11.2	10.5	10.1	9.4	8.3	9.7
Wind (knots)													
Prevailing wind	E	S	S	S	S	S	S	S	S	NE	NE	NE	-
Mean wind speed	4.7	5.2	5.3	4.8	4.2	4.9	4.6	4.6	3.5	3.5	4.9	5.1	-
Max. wind speed	28 E, ENE	33 W	35 S	40 E, NE	40 W	40 W	40 W	40 W	40 SW, NW	40 NE	40 NE,S	30 NE, ENE	40 E,NE, W,NW,SW
Rainfall (mm.)													
Mean	10.8	26.3	29.7	79.4	151.9	133.5	143.7	163.4	296.2	205.9	61.3	8.8	1310.9
Mean rainy days	1.3	3.0	4.2	8.0	14.2	14.4	16.3	18.5	20.2	17.0	6.7	1.4	125.2
Greatest in 24 hr.	80.8	92.1	33.7	90.9	103.3	132.7	79.1	131.0	186.2	121.5	91.8	37.7	186.2
Day/Year	3/78	25/58	23/80	19/77	7/66	5/84	21/64	27/71	16/81	19/74	4/75	1/70	16/81
Number of days with													
Haze	27.6	23.6	24.0	14.2	1.6	0.6	0.5	1.0	1.2	4.4	14.7	24.1	137.5
Fog	0.9	1.0	0.3	0.2	0.0	0.0	0.0	0.0	0.1	0.2	0.4	0.2	3.3
Hail	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Thunderstorm	0.6	2.2	5.8	13.4	15.2	7.5	8.5	8.9	13.6	12.2	3.9	0.5	92.3
Squall	0.0	0.0	0.0	0.1	0.0	0.2	0.0	0.0	0.0	0.1	0.0	0.1	0.5

Remark : Evaporation 1981 - 1985

CLIMATOLOGICAL DATA FOR THE PERIOD 1956 - 1985

Station	KO SICHANG	Elevation of station above MSL	25 meters
Index Station	48460	Height of barometer above MSL	26 meters
Latituds	13° 10' N.	Height of thermometer above ground	1.20 meters
Longitude	100° 48' E.	Height of wind vane above ground	12.40 meters
		Height of raingauge	0.80 meters

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Pressure (+1000 or 900 mbs.)													
Mean	12.58	11.31	10.42	08.94	07.29	06.81	06.85	06.84	07.84	09.76	11.37	12.02	09.34
Ext. Max.	23.08	20.21	20.04	17.05	16.12	14.22	13.96	14.11	15.03	18.63	20.55	20.66	23.08
Ext. Min.	05.35	02.70	03.42	00.86	99.68	98.19	98.60	00.14	98.79	01.98	04.62	04.34	98.19
Mean daily range	4.39	4.40	4.57	4.48	4.08	3.47	3.34	3.57	4.13	4.34	4.22	4.24	4.10
Temperature (°C)													
Mean	24.5	25.7	26.8	27.8	27.6	27.2	26.7	26.6	26.0	25.6	25.2	24.5	26.2
Mean Max.	29.7	30.6	31.7	33.0	32.3	31.8	31.3	31.2	30.6	30.4	30.1	29.7	31.0
Mean Min.	22.1	24.3	25.8	26.9	26.7	26.7	26.2	26.0	25.1	24.5	23.7	22.4	25.0
Ext. Max.	34.8	34.4	35.8	36.9	36.2	35.4	34.5	33.7	34.8	33.0	33.6	33.2	36.9
Ext. Min.	15.2	18.4	20.0	21.2	22.3	21.8	21.6	21.9	21.8	19.0	15.5	15.0	15.0
Relative Humidity (%)													
Mean	67.5	72.5	72.9	72.3	74.4	73.4	74.7	75.2	79.0	79.0	71.6	65.3	73.2
Mean Max.	81.7	85.0	84.7	83.7	83.9	81.9	83.6	84.1	88.6	88.9	82.3	77.7	83.8
Mean Min.	56.5	62.0	63.6	62.6	65.9	66.2	67.2	67.4	70.2	69.7	62.3	55.5	64.1
Ext. Min.	29.0	31.0	27.0	39.0	43.0	52.0	54.0	52.0	49.0	39.0	34.0	29.0	27.0
Dew Point (°C)													
Mean	19.6	22.1	23.5	24.5	24.6	24.1	23.9	23.9	24.1	23.6	21.5	19.2	22.9
Evaporation (mm.)													
Mean - Pan						No Observation							
Cloudiness(0-10)													
Mean	3.8	4.3	4.3	4.8	7.1	7.9	8.1	8.4	8.2	7.0	5.3	4.0	6.1
Sunshine Duration(hr.)													
Mean						No Observation							
Visibility (km.)													
0700 L.S.T.	7.4	7.3	7.8	9.2	10.7	11.2	10.8	10.9	10.3	9.6	9.6	8.7	9.5
Mean	9.0	8.9	9.3	10.5	11.8	12.3	11.9	11.9	11.6	11.0	11.0	10.2	10.8
Wind (knots)													
Prevailing wind	W	W	S,SW	S	W	W	W	W	W	NE	NE	NE	-
Mean wind speed	5.8	5.2	5.6	5.2	5.2	6.3	5.9	6.2	4.2	4.7	7.3	7.4	-
Max. wind speed	35 NE	27 NE	33 W, WNW	40 NE	50 W	45 W	50 W	50 W	48 W	34 W	28 NNE	32 E	50 W
Rainfall (mm.)													
Mean	8.2	28.1	37.0	47.4	170.0	113.1	128.2	118.3	290.1	236.5	67.0	12.7	1256.6
Mean rainy days	1.1	3.0	3.1	5.1	13.0	11.7	13.9	14.2	18.4	15.8	7.0	1.8	108.1
Greatest in 24 hr.	48.3	89.6	106.2	78.5	105.2	192.4	100.7	80.2	190.2	196.3	121.7	71.7	196.3
Day/Year	26/85	21/78	26/82	15/78	6/84	16/78	31/83	23/76	16/81	9/74	30/70	1/70	9/74
Number of days with													
Haze	19.9	12.0	11.8	9.0	1.7	0.3	0.2	0.3	0.4	1.4	7.8	17.1	81.9
Fog	1.8	0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.4	0.9	3.7
Hail	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Thunderstorm	1.0	4.1	8.7	15.0	18.4	8.2	9.9	7.7	16.5	16.6	6.7	0.9	113.7
Squall	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.3

Remark : Data for 1959 - 1965

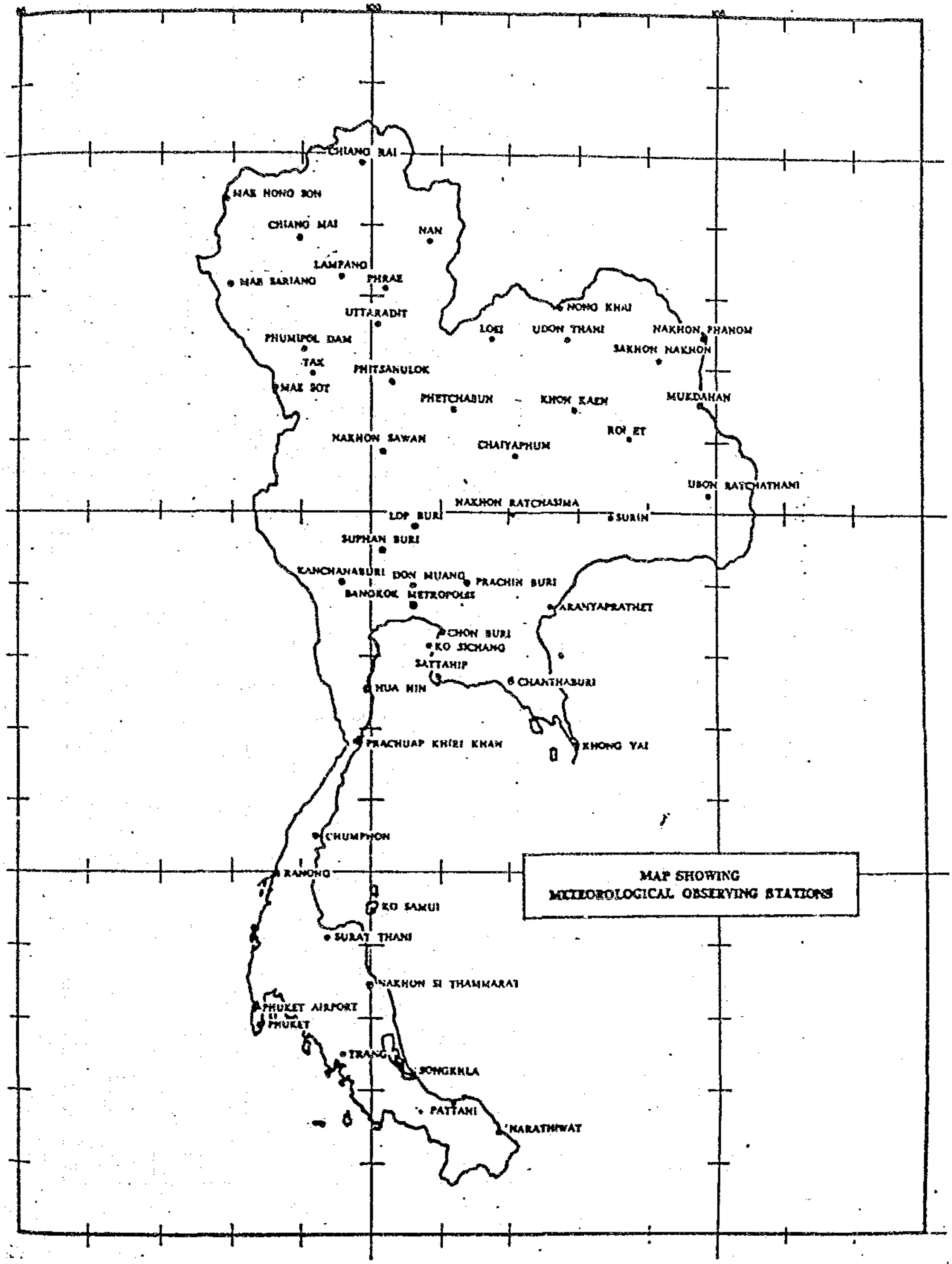
CLIMATOLOGICAL DATA FOR THE PERIOD 1956 - 1985

Station	ARANYAPRATHET	Elevation of station above MSL	47	meters
Index Station	48462	Height of barometer above MSL	49	meters
Latitude	13° 42' N.	Height of thermometer above ground	1.20	meters
Longitude	102° 35' E.	Height of wind vane above ground	13.00	meters
		Height of raingauge	0.80	meters

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Pressure (+1000 or 900 mbs.)													
Mean	13.21	11.49	10.27	08.91	07.56	06.91	06.93	06.88	08.02	10.32	12.26	13.33	09.67
Ext. Max.	25.90	22.53	22.18	19.37	15.00	14.10	13.34	14.27	15.03	17.77	20.68	22.78	23.90
Ext. Min.	03.45	01.46	02.22	99.66	00.14	97.93	98.17	99.52	99.73	01.30	04.20	04.25	97.93
Mean daily range	5.10	5.59	5.75	5.34	4.62	3.83	3.67	3.95	4.37	4.49	4.44	4.63	4.65
Temperature (°C)													
Mean	25.4	27.8	29.4	29.8	28.9	28.2	27.5	27.3	27.2	27.1	26.1	25.0	27.5
Mean Max.	32.1	34.3	36.0	36.3	34.8	33.2	32.4	32.0	31.9	31.9	31.7	31.1	33.1
Mean Min.	18.1	21.3	23.5	24.5	24.6	24.3	23.9	23.9	23.8	23.2	21.1	18.6	22.6
Ext. Max.	37.5	39.7	40.0	41.7	41.4	39.8	36.3	35.7	35.5	35.3	36.5	36.0	41.7
Ext. Min.	7.6	12.5	15.7	17.0	21.5	20.3	21.0	20.7	20.5	17.0	12.9	10.0	7.6
Relative Humidity (%)													
Mean	64.7	65.2	66.6	70.8	78.1	81.0	82.9	83.7	84.7	81.3	75.4	69.4	75.3
Mean Max.	86.5	86.8	87.8	88.8	92.4	93.4	94.1	94.9	95.5	94.3	90.9	88.6	91.2
Mean Min.	42.1	42.6	42.7	47.5	56.9	62.1	64.9	66.4	67.3	63.0	56.6	48.8	55.1
Ext. Min.	23.0	21.0	22.0	26.0	30.0	40.0	44.0	52.0	42.0	33.0	28.0	28.0	21.0
Dew Point (°C)													
Mean	17.1	19.6	21.5	23.0	24.1	24.1	24.0	24.0	24.0	23.1	20.9	18.2	22.0
Evaporation (mm.)													
Mean - Pan	147.6	154.3	186.7	194.3	170.2	135.1	149.3	143.5	134.7	136.7	123.5	128.8	1804.7
Cloudiness (0-10)													
Mean	3.8	4.6	4.9	5.8	6.7	7.8	8.0	8.4	8.0	6.8	5.1	4.1	6.2
Sunshine Duration (hr.)													
Mean						No Observation							
Visibility (km.)													
0700 L.S.T.	6.2	7.2	8.8	10.1	11.4	11.3	11.5	11.1	10.9	10.2	9.2	7.3	9.6
Mean	10.3	10.0	10.4	11.5	12.2	12.2	12.3	12.1	12.0	12.1	11.9	11.0	11.5
Wind (knots)													
Prevailing wind	NE	W	W	W	W	W	W	W	W	W	NE	NE	-
Mean wind speed	2.5	2.5	2.5	2.3	2.0	2.3	2.4	2.6	2.1	2.0	2.4	2.7	-
Max. wind speed	25 NE	26 SW	50 S	48 N,S	46 E	30 S,W, WNW	41 W	35 SW, WNW	38 SSE	30 N, NNE	25 NE	24 NE	50 S
Rainfall (mm.)													
Mean	8.5	28.0	49.1	92.5	176.8	180.0	193.3	210.2	293.0	194.2	49.7	6.6	1481.9
Mean rainy days	1.3	3.0	5.1	8.8	16.4	18.0	19.4	20.7	19.8	15.3	6.0	1.3	135.1
Greatest in 24 hr.	85.5	90.0	72.7	129.7	94.1	116.5	66.5	107.3	108.5	107.7	97.9	51.3	129.7
Day/Year	15/70	24/65	5/85	23/68	23/66	26/80	10/83	23/82	5/72	23/70	3/63	4/70	23/68
Number of days with													
Haze	21.3	20.2	19.5	11.9	3.1	0.5	0.7	0.3	0.1	2.5	6.2	14.7	101.0
Fog	6.0	3.2	0.8	0.2	0.4	0.1	0.2	0.3	0.3	1.4	2.0	3.9	18.8
Hail	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Thunderstorm	0.3	2.3	6.9	12.2	15.4	9.7	9.0	7.9	10.5	7.5	1.6	0.1	83.4
Squall	0.0	0.0	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3

Remark : Evaporation 1976 - 1985

FIGURE 3-1-1 METEOROLOGICAL OBSERVATION MAP



3.2 Tidal Water Level

3.2.1 Table

TABLE 3−2−1 NON−HARMONIC TIDAL QUANTITY BANG PAKONG

(M.S.L)

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	Mean
Hest H.W.	1.75	1.75	2.02	1.78	1.83	1.79	1.78	1.66	1.86	1.78	2.02
M.H.H.W.	1.23	1.25	1.27	1.25	1.23	1.21	1.25	1.20	1.23	1.21	1.23
M.L.H.W.	0.77	0.78	0.88	0.74	0.81	0.71	0.82	0.75	0.73	0.74	0.77
M.H.W.S.	1.15	1.26	1.29	1.32	1.34	1.25	1.29	1.26	1.28	1.29	1.27
M.H.W.	0.94	1.11	1.16	1.12	1.17	1.09	1.15	1.09	1.09	1.13	1.11
M.H.W.N.	0.94	1.00	1.08	1.01	1.01	0.98	1.05	1.00	0.92	0.98	1.00
M.T.L.	0.16	0.12	0.18	0.13	0.09	0.08	0.13	0.14	0.09	0.12	0.12
M.S.L.	0.18	0.20	0.18	0.17	0.15	0.12	−	0.14	0.15	0.17	0.16
M.L.W.N.	− 0.62	− 0.73	− 0.82	− 0.78	− 0.91	− 0.86	− 0.83	− 0.84	− 0.88	− 0.90	− 0.82
M.L.W.	− 0.63	− 0.71	− 0.81	− 0.85	− 0.98	− 0.92	− 0.88	− 0.86	− 0.91	− 0.91	− 0.85
M.L.W.S.	− 0.67	− 0.73	− 0.91	− 1.02	− 1.12	− 1.03	− 0.97	− 0.95	− 1.03	− 1.06	− 0.95
M.H.L.W.	− 0.04	− 0.13	− 0.10	− 0.20	− 0.31	− 0.24	− 0.21	− 0.16	− 0.15	− 0.34	− 0.19
M.L.L.W.	− 1.02	− 1.03	− 1.08	− 1.09	− 1.31	− 1.17	− 1.13	− 1.12	− 1.02	− 1.11	− 1.09
Lest L.W.	− 1.56	− 1.51	− 1.56	− 1.61	− 1.64	− 1.65	− 1.60	− 1.58	− 1.61	− 1.67	− 1.67
Mean.	− 0.83	− 0.53	− 0.53	− 0.54	− 0.36	− 0.49	− 0.47	− 0.55	− 0.50	− 0.46	− 0.53

TABLE 3-2-2 OBSERVED TIDAL WATER LEVEL IN OCTOBER 1983

	0 12	1 13	2 14	3 15	4 16	5 17	6 18	7 19	8 20	9 21	10 22	11 23 TIME
OCT.1	-0.30	-0.54	-0.77	-0.94	-1.06	-1.12	-1.13	-0.94	-0.67	-0.22	0.02	0.42
	0.61	0.81	0.86	0.91	0.82	1.00	0.59	0.59	0.63	0.49	0.42	0.22
2	0.03	-0.08	-0.37	-0.58	-0.75	-0.84	-0.93	-0.92	-0.84	-0.44	-0.07	0.22
	0.50	0.75	0.98	1.19	1.13	1.10	1.03	0.92	0.77	0.60	0.42	0.35
3	0.10	0.02	-0.10	-0.30	-0.49	-0.65	-0.77	-0.84	-0.89	-0.90	-0.70	-0.46
	-0.06	0.42	0.86	1.15	1.34	1.35	1.34	1.23	0.94	0.70	0.38	0.26
4	0.22	0.21	0.21	0.17	0.05	-0.14	-0.31	-0.54	-0.70	-0.81	-0.84	-0.62
	-0.30	0.24	0.78	1.21	1.54	1.66	1.57	1.30	0.99	0.73	0.46	0.22
5	0.24	0.23	0.49	0.53	0.59	0.45	0.23	-0.14	-0.41	-0.66	-0.80	-0.84
	-0.66	-0.12	0.37	0.97	1.30	1.45	1.42	1.18	0.77	0.44	0.06	-0.07
6	-0.30	-0.14	0.22	0.58	0.76	0.82	0.62	0.31	-0.14	-0.49	-0.73	-0.88
	-0.98	-0.78	-0.12	0.60	1.15	1.38	1.45	1.30	0.84	0.36	-0.06	-0.34
7	-0.47	-0.66	-0.36	0.26	0.77	0.94	0.95	0.78	0.38	-0.06	-0.43	-0.70
	-0.85	-0.91	-0.58	0.17	0.87	1.23	1.33	1.30	0.98	0.46	0.99	-0.34
8	-0.63	-0.77	-0.77	-0.36	0.47	1.02	1.20	1.19	0.98	0.58	0.06	-0.31
	-0.57	-0.70	-0.58	-0.18	0.50	1.05	1.18	1.13	0.83	0.38	-0.07	-0.42
9	-0.72	-0.90	-1.01	-1.02	-0.32	0.46	0.94	1.14	1.11	0.83	0.42	-0.03
	-0.35	-0.57	-0.63	-0.34	0.15	0.76	1.09	1.18	1.02	0.51	0.14	-0.30
10	0.36	0.17	0.04	-0.05	0.17	0.08	0.84	1.22	1.35	1.37	1.05	0.62
	0.25	-0.06	-0.14	-0.11	0.26	0.70	1.05	1.23	1.06	0.66	0.46	-0.14
11	-0.51	-0.74	-0.89	-0.98	-1.03	-0.58	0.23	0.86	1.11	1.26	1.22	0.99
	0.59	0.24	0.04	0.02	0.20	0.46	0.77	0.95	0.93	0.72	0.30	0.02
12	-0.42	-0.66	-0.83	-0.94	-1.01	-0.83	-0.17	0.50	0.98	1.24	1.38	1.31
	1.07	0.79	0.55	0.46	0.46	0.54	0.77	0.99	0.94	0.90	0.46	0.11
13	-0.22	-0.52	-0.72	-0.87	-0.96	-0.98	-0.66	-0.11	0.43	0.78	1.02	1.08
	1.15	0.82	0.66	0.54	0.46	0.52	0.62	0.70	0.78	0.62	0.42	0.13
14	-0.22	-0.50	-0.69	-0.82	-0.93	-0.98	-0.91	-0.47	0.05	0.50	0.81	1.02
	1.08	1.14	1.04	0.90	0.80	0.74	0.74	0.66	0.54	0.49	0.28	0.22
15	-0.06	-0.28	-0.51	-0.70	-0.80	-0.83	-0.82	-0.61	-0.24	0.15	0.44	0.71
	0.91	0.97	1.03	1.02	0.93	0.84	0.78	0.72	0.71	0.61	0.46	0.18
16	-0.03	-0.18	-0.32	-0.50	-0.62	-0.74	-0.74	-0.70	-0.53	-0.32	0.03	0.34
	0.62	0.87	1.02	1.09	1.02	1.01	0.81	0.58	0.37	0.25	0.10	0.02
17	-0.03	-0.14	-0.20	-0.25	-0.36	-0.45	-0.54	-0.63	-0.61	-0.55	-0.34	-0.04
	0.23	0.50	0.78	0.96	1.03	0.94	0.75	0.62	0.37	0.18	0.01	-0.02
18	0.02	0.09	0.14	0.13	-0.07	-0.08	-0.33	-0.42	-0.53	-0.49	-0.51	-0.09
	0.24	0.74	1.15	1.38	1.45	1.48	1.18	0.94	0.67	0.36	0.26	0.12
19	0.18	0.21	0.34	0.34	0.51	0.41	0.22	-0.14	-0.31	-0.41	-0.50	-0.47
	-0.10	0.36	0.77	1.10	1.20	1.30	1.12	0.81	0.38	0.12	-0.15	-0.27
20	-0.34	-0.15	0.17	0.42	0.59	0.60	0.49	0.22	-0.10	-0.32	-0.51	-0.52
	-0.42	-0.03	0.54	1.02	1.25	1.34	1.24	0.90	0.48	0.08	-0.21	-0.41
21	-0.42	-0.19	0.25	0.68	0.98	1.06	1.01	0.66	0.26	-0.09	-0.33	-0.51
	-0.57	-0.22	0.29	0.82	1.13	1.30	1.18	0.86	0.42	0.06	-0.23	-0.46
22	-0.64	-0.59	-0.30	0.28	0.80	1.06	1.10	0.89	0.58	0.22	-0.07	-0.37
	-0.43	-0.26	0.18	0.62	1.02	1.17	1.07	0.90	0.47	0.02	-0.32	-0.55
23	-0.74	-0.80	-0.54	0.00	0.62	1.02	1.19	1.17	0.98	0.59	0.24	-0.05
	-0.25	-0.29	-0.09	0.26	0.77	1.07	1.09	0.90	0.51	0.06	-0.32	-0.58
24	-0.78	-0.89	-0.93	-0.59	0.24	0.87	1.23	1.35	1.33	1.01	0.62	0.22
	-0.05	-0.19	-0.20	0.06	0.49	0.85	0.99	0.90	0.57	0.18	-0.22	-0.52
25	-0.74	-0.85	-0.92	-0.91	-0.31	0.45	1.06	1.33	1.46	1.34	1.00	0.59
	0.25	0.06	-0.05	0.09	0.46	0.86	1.07	1.11	0.82	0.37	-0.10	-0.42
26	-0.66	-0.79	-0.88	-0.93	-0.67	0.08	0.80	1.28	1.46	1.55	1.37	1.00
	0.68	0.44	0.33	0.38	0.58	0.86	1.05	1.18	0.90	0.57	0.10	-0.28
27	-0.56	-0.70	-0.81	-0.87	-0.85	-0.36	0.35	0.86	1.22	1.44	1.34	1.11
	0.79	0.59	0.45	0.35	0.44	0.76	0.89	1.01	0.90	0.62	0.22	-0.23
28	-0.54	-0.70	-0.81	-0.89	-0.93	-0.85	-0.34	0.34	0.89	1.24	1.46	1.54
	1.44	1.29	1.18	1.04	1.06	1.06	1.10	1.11	1.03	0.84	0.50	0.12
29	-0.23	-0.46	-0.64	-0.76	-0.82	-0.78	-0.59	-0.13	0.43	0.83	1.15	1.31
	1.39	1.38	1.25	1.22	1.05	1.02	0.92	0.88	0.83	0.70	0.46	0.20
30	-0.10	-0.38	-0.58	-0.73	-0.82	-0.86	-0.83	-0.66	-0.26	0.10	0.50	0.75
	0.97	1.13	1.17	1.13	1.02	0.86	0.74	0.65	0.60	0.56	0.51	0.27
31	-0.03	-0.22	-0.38	-0.62	-0.76	-0.82	-0.89	-0.89	-0.74	-0.43	0.06	0.56
	1.03	1.38	1.46	1.51	1.42	1.23	0.97	0.73	0.48	0.34	0.35	0.40

3.3 Salinity

3.3.1 Figure

FIGURE 3-3-1 RELATIONSHIP BETWEEN DISTANCE OF SALTWATER INTRUSION AND ITS DISCHARGE (1)

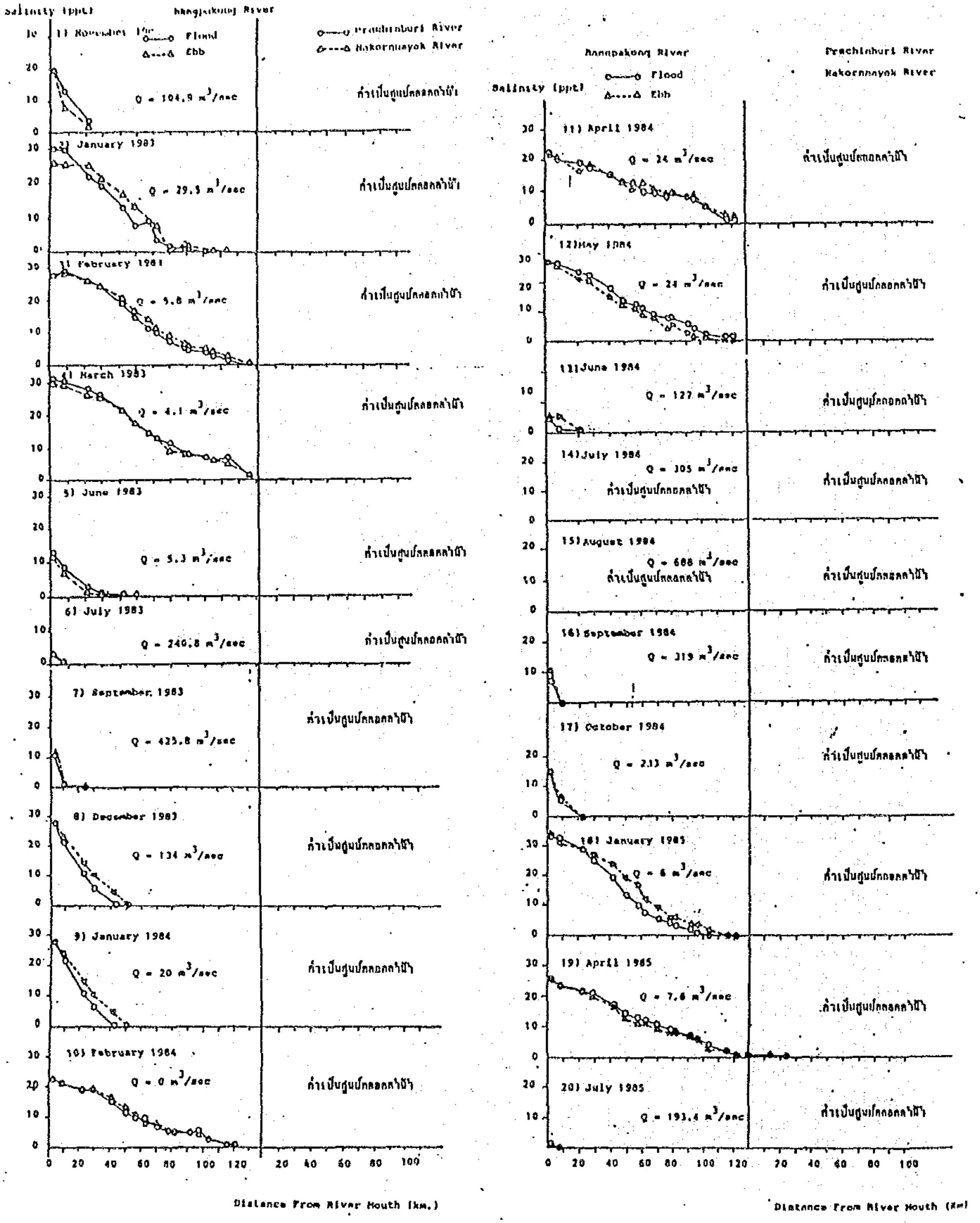
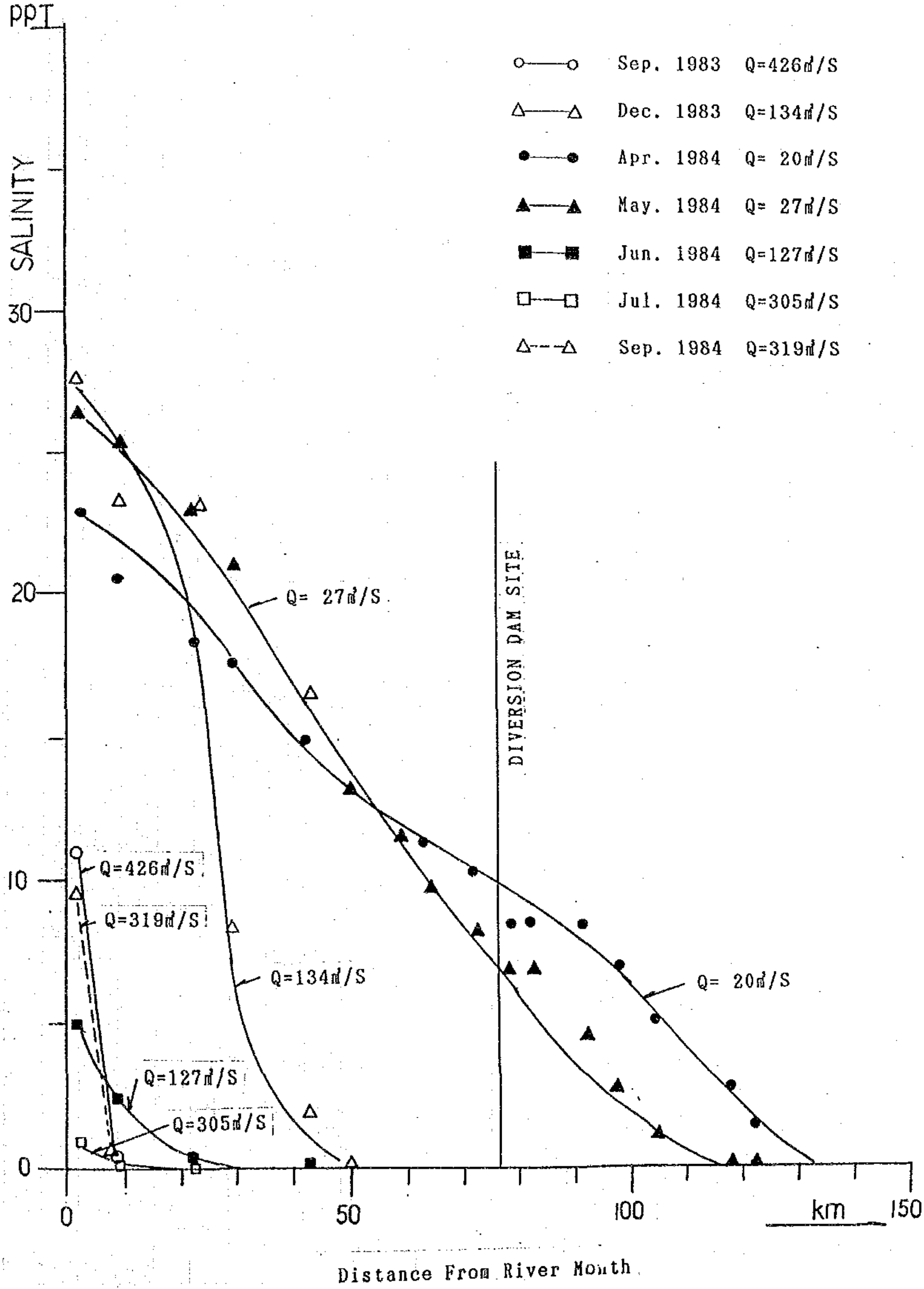


FIGURE 3-3-2 RELATIONSHIP BETWEEN DISTANCE OF SALTWATER INTPUSION AND ITS DISCHARGE (2)



3.4 Rainfall Analysis

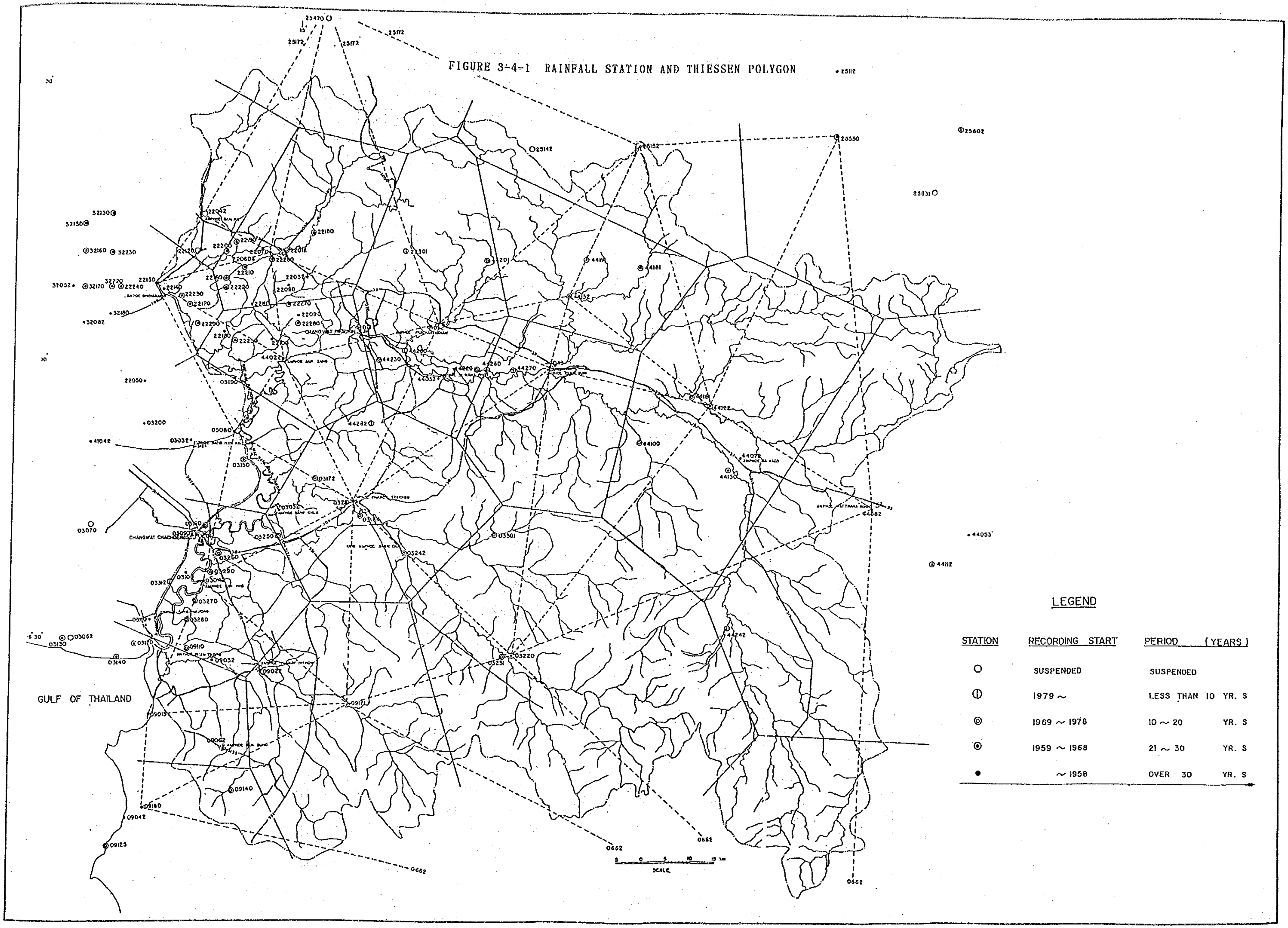
3.4.1 Rainfall Stations Representing Watershed

TABLE 3-4-1 THIESSEN AREAL RATIO

Block No.	C. Area (km²)	Station Code (Thiessen %)																			
		03042	03080	03210	03220	09013	09160	09171	44022	44043	44062	44082	44122	44132	06062	25152	25172	25530	22042	22070	22150
LBP - 1	35	-	-	-	-	100	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	119	87	10	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3	526	68	-	32	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4	142	37	-	-	-	63	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5	279	-	-	-	-	80	5	15	-	-	-	-	-	-	-	-	-	-	-	-	-
6	80	44	-	-	-	-	-	56	-	-	-	-	-	-	-	-	-	-	-	-	-
7	501	-	-	-	-	-	29	71	-	-	-	-	-	-	-	-	-	-	-	-	-
8	182	36	-	-	-	-	-	64	-	-	-	-	-	-	-	-	-	-	-	-	-
9	88	-	-	-	-	-	-	100	-	-	-	-	-	-	-	-	-	-	-	-	-
10	85	-	-	-	-	-	-	100	-	-	-	-	-	-	-	-	-	-	-	-	-
11	184	-	-	-	5	-	-	95	-	-	-	-	-	-	-	-	-	-	-	-	-
12	344	-	-	-	13	-	-	87	-	-	-	-	-	-	-	-	-	-	-	-	-
13	56	82	-	18	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
14	201	-	-	5	-	-	-	95	-	-	-	-	-	-	-	-	-	-	-	-	-
15	65	-	-	89	-	-	-	11	-	-	-	-	-	-	-	-	-	-	-	-	-
16	199	-	-	75	10	-	-	15	-	-	-	-	-	-	-	-	-	-	-	-	-
17	20	-	-	100	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
KTL - 1	32	-	-	100	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	86	-	-	100	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3	69	-	-	100	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4	137	-	-	42	58	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5	617	-	-	8	87	-	-	-	-	5	-	-	-	-	-	-	-	-	-	-	-
6	181	-	-	-	72	-	-	-	-	28	-	-	-	-	-	-	-	-	-	-	-
7	395	-	-	-	88	-	-	12	-	-	-	-	-	-	-	-	-	-	-	-	-
8	391	-	-	-	100	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9	585	-	-	-	100	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Block No.	C. Area (km²)	Thiessen (%)																			
		03042	03080	03210	03220	09013	09160	09171	44022	44043	44062	44082	44122	44132	06062	25152	25172	25530	22042	22070	22150
UBP - 1	1,060	-	14	44	-	-	-	-	24	-	18	-	-	-	-	-	-	-	-	-	-
2	446	-	7	-	-	-	-	-	25	-	44	-	-	-	-	-	-	-	-	24	-
3	750	-	-	9	-	-	-	-	-	60	28	-	-	3	-	-	-	-	-	-	-
4	394	-	-	-	-	-	-	-	-	-	95	-	-	5	-	-	-	-	-	-	-
5	107	-	-	-	-	-	-	-	-	-	82	-	-	18	-	-	-	-	-	-	-
NGN - 1	498	-	-	-	-	-	-	-	42	-	-	-	-	-	-	-	-	-	2	37	19
2	369	-	4	-	-	-	-	-	10	-	-	-	-	-	-	-	-	-	24	10	52
3	345	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	66	34	-
4	114	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	39	-	61	-	-
5	456	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	22	-	4	74	-
6	151	-	-	-	-	-	-	-	-	-	61	-	-	-	-	-	2	-	-	37	-
MPP - 1	970	-	-	-	7	-	-	-	-	44	-	-	49	-	-	-	-	-	-	-	-
MNM - 1	917	-	-	-	-	-	-	-	-	8	-	-	14	75	-	3	-	-	-	-	-
2	159	-	-	-	-	-	-	-	-	-	22	-	-	78	-	-	-	-	-	-	-
3	273	-	-	-	-	-	-	-	-	-	22	-	-	11	-	42	25	-	-	-	-
4	174	-	-	-	-	-	-	-	-	-	-	-	-	17	-	83	-	-	-	-	-
5	68	-	-	-	-	-	-	-	-	-	-	-	-	-	-	100	-	-	-	-	-
6	96	-	-	-	-	-	-	-	-	-	-	-	-	-	-	100	-	-	-	-	-
7	232	-	-	-	-	-	-	-	-	-	-	-	100	-	-	-	-	-	-	-	-
8	64	-	-	-	-	-	-	-	-	-	-	-	38	8	-	54	-	-	-	-	-
9	147	-	-	-	-	-	-	-	-	-	-	-	67	-	-	-	-	33	-	-	-
KPS - 1	390	-	-	-	-	-	-	-	-	-	-	33	67	-	-	-	-	-	-	-	-
2	801	-	-	-	29	-	-	-	-	-	-	63	8	-	-	-	-	-	-	-	-
3	838	-	-	-	11	-	-	-	-	-	-	54	-	-	35	-	-	-	-	-	-
4	614	-	-	-	23	-	-	-	-	-	-	19	-	-	58	-	-	-	-	-	-
UPP - 1	588	-	-	-	-	-	-	-	-	-	-	11	89	-	-	-	-	-	-	-	-
2	774	-	-	-	-	-	-	-	-	-	-	77	23	-	-	-	-	-	-	-	-
3	266	-	-	-	-	-	-	-	-	-	-	43	11	-	-	-	-	46	-	-	-

FIGURE 3-4-1 RAINFALL STATION AND THIESSEN POLYGON



3.4.2 Basic Statistics of Rainfall

TABLE 3-4-2 ANNUAL RAINFALL

(mm)

	03042	03080	03210	03220	09013	09160	09171	44022	44043	44062	44082	44122	44132	06062	25152	25172	25530	22042	22070	22150
1968	1022.2	1416.8	1033.6	(953.8)	1071.9	1312.6	1277.2	1327.5	1203.6	2013.2	1251.0	1602.7	1624.6	1617.4	—	833.8	740.0	1390.3	1553.4	1344.4
1969	1134.6	1319.8	1161.1	(1044.5)	1120.3	1257.5	1405.6	1383.7	1373.7	2079.8	1525.7	(1395.0)	2651.4	1720.2	—	1074.5	1322.9	(1774.2)	2358.5	1654.2
1970	1379.3	1629.4	1556.4	2134.8	1225.0	1429.5	1452.2	1708.6	1780.2	2425.0	1751.7	1855.3	1589.6	1253.8	—	1296.0	1492.8	2145.6	2317.7	2336.8
1971	1447.1	1492.3	1527.5	1218.2	1346.1	1402.8	1476.4	1625.3	1691.6	1749.6	1371.9	1613.5	2003.9	1385.0	(1225.3)	828.2	979.1	1846.9	2147.6	1378.9
1972	888.1	1141.8	1436.1	1018.7	1183.4	1077.3	1287.0	1759.6	1583.3	1926.6	1730.1	1997.6	2297.3	2121.0	1508.9	1349.5	966.2	1939.0	2310.0	1705.2
1973	1075.1	1385.7	906.8	990.1	1241.3	1056.0	1272.7	1339.6	1495.8	1278.7	1422.7	1619.2	2004.6	1796.3	879.0	950.5	830.8	1473.0	1659.3	1047.3
1974	1334.2	1206.9	1506.8	884.7	1699.8	1594.6	1567.1	1261.9	1766.3	1721.4	1465.9	1818.6	2599.8	2070.4	1136.2	1164.6	1139.8	1856.4	1547.5	1880.8
1975	695.6	1407.7	—	(0.0)	1246.6	1086.0	1364.7	1643.0	1616.6	1366.6	1439.9	1727.2	3230.5	2008.0	1417.8	1467.4	1059.9	2236.8	2243.2	1672.8
1976	1066.1	1178.3	(1559.2)	1303.9	1472.9	(1464.4)	(1213.1)	1406.1	2233.5	1582.2	1706.2	2730.9	2326.5	1742.3	1489.1	1318.9	1344.9	1946.0	2430.0	1914.2
1977	1062.5	1135.1	1133.8	1292.6	968.9	1034.6	957.4	1263.0	1565.2	1656.5	1055.6	2319.9	2082.8	1381.8	850.5	1001.3	1071.8	1510.9	1312.8	1339.4
1978	1174.9	1523.0	1305.0	(1602.9)	1483.1	1456.0	1261.3	1412.6	1749.5	1670.9	1081.4	2413.5	2625.8	(623.4)	1493.1	1092.6	1165.7	1735.4	1828.9	1402.4
1979	685.6	1074.9	(953.9)	(1456.2)	740.9	847.8	783.5	1516.6	1596.1	1401.9	1296.4	2617.7	(715.6)	1343.6	1951.7	1629.8	558.6	1212.2	1497.3	904.8
1980	1112.1	1419.7	1273.9	1486.7	1265.5	1475.8	1140.0	2062.0	1994.0	1954.6	1323.1	2944.1	2466.3	1612.8	1426.1	1418.9	1038.2	1894.0	2114.7	1534.0
1981	1253.5	1366.7	1189.6	2378.1	1543.8	1638.8	1235.2	2185.3	1831.6	2362.7	1481.2	2468.1	2702.4	1912.4	(1111.6)	2221.4	874.9	1713.1	1992.5	1314.7
1982	1415.8	1389.9	1015.4	1142.7	1318.3	1256.6	1112.0	1910.0	1745.5	1674.0	1418.2	2685.0	1916.2	1656.4	—	2017.8	892.2	1606.4	2260.2	1205.3
1983	1450.2	1421.5	1990.1	1604.1	1501.1	1278.2	1529.9	1994.0	2143.4	1889.9	1772.4	2758.6	1877.4	1853.8	—	2054.2	1235.0	1925.0	2676.4	1973.0
1984	960.6	1132.5	1635.2	1036.2	—	(605.5)	1128.6	1574.2	1573.9	1661.1	1371.3	2540.2	—	1676.3	(1044.0)	2330.4	859.9	1506.1	1786.8	996.2
1985	1029.0	1112.1	1176.4	1285.8	(1072.2)	1101.6	936.4	2111.7	1572.4	1789.5	1517.7	(2481.0)	(1916.8)	1949.2	—	2007.1	964.5	1798.9	2023.3	1325.8
1986	1303.1	1177.6	1557.5	1327.4	1153.6	1098.9	1264.4	1886.4	1719.8	1756.3	1423.2	2400.3	1502.1	2052.5	(1119.8)	1726.7	1082.9	1058.6	2461.8	1491.9
1987	862.4	1269.4	1044.8	952.1	1487.5	1259.9	1173.6	(896.3)	1272.9	1700.6	1303.0	1868.3	1809.8	1837.9	1169.8	2107.1	1028.1	(767.6)	1227.7	907.6
1988	1433.0	(620.4)	1686.8	1470.8	1622.7	1576.3	1493.1	1561.9	1983.0	(2206.1)	1695.1	1732.2	1993.9	1643.1	1156.1	2181.1	1094.1	1465.0	2350.8	1519.9
1989	921.8	1113.6	1310.6	903.4	733.7	912.2	1255.2	1297.8	1720.4	1834.5	1112.2	1225.6	1901.5	1409.1	932.7	1490.8	1109.4	1218.8	1933.2	1081.4
1990	1127.5	1035.7	1530.1	1171.2	636.6	1161.5	969.3	1213.7	1714.1	1900.3	1200.0	1633.9	1796.9	1724.1	1219.1	1184.8	444.6	1412.0	1907.8	1495.8
Max.	1450.2	1523.0	1990.1	2378.1	1699.8	1638.8	1567.1	2185.3	2233.5	2425.0	1772.4	2758.6	3230.5	2121.0	1951.7	2221.4	1492.8	2145.6	2676.4	2336.8
Min.	685.6	1074.9	906.8	884.7	636.6	847.8	783.5	1213.7	1203.6	1278.7	1055.6	1602.7	1502.1	1253.8	850.5	828.2	444.6	1212.2	1312.8	904.8
Mean	1123.2	1288.7	1348.9	1311.2	1241.1	1253.1	1242.9	1611.1	1692.5	1790.7	1422.4	2122.5	2150.2	1716.7	1279.2	1511.2	1012.9	1661.1	1997.5	1453.3
S. D.	223.5	162.0	267.9	391.4	285.1	218.2	202.4	296.0	241.3	273.6	206.1	482.3	436.9	245.0	297.5	468.1	233.3	306.1	384.3	352.2
C. V.	0.199	0.126	0.020	0.299	0.230	0.174	0.163	0.183	0.143	0.153	0.145	0.227	0.020	0.143	0.233	0.310	0.230	0.184	0.192	0.242

Note ; S.D. = Standard Deviation C.V. = Coefficient of Variation ( ) = Figures with ( ) are in case that some data were not available.

TABLE 3-4-3 MAXIMUM SEVEN DAYS RAINFALL (1)

(mm)

Code	03042		03080		03210		03220		09013		09160		09171		44022		44043		44062	
Year	Rain	Date	Rain	Date	Rain	Date	Rain	Date	Rain	Date	Rain	Date	Rain	Date	Rain	Date	Rain	Date	Rain	Date
1968	157.0	31 Jul	207.3	30 Jul	125.6	15 Apr	154.1	17 Sep	112.4	20 Sep	145.4	4 May	224.7	19 Sep	181.6	31 Jul	157.2	10 Sep	317.3	29 Jul
1969	183.6	28 May	179.0	15 Sep	159.3	16 Sep	187.6	15 Sep	206.0	15 Sep	147.9	4 Sep	145.9	13 Sep	149.4	28 Sep	168.7	15 Jul	227.4	16 Sep
1970	210.7	17 Jun	138.0	17 Jun	235.0	19 Jun	195.2	18 Jun	98.2	29 Nov	173.6	29 Nov	148.4	6 Jun	185.2	27 Sep	250.7	13 Aug	476.2	13 Aug
1971	176.3	27 Aug	181.6	17 May	260.5	12 Jun	239.9	26 Aug	226.0	26 Aug	187.5	26 Aug	183.9	26 Aug	174.3	11 Jun	198.8	11 Jun	219.9	14 Jun
1972	194.8	4 Sep	198.8	22 Jun	193.3	1 Jun	156.9	4 Sep	186.4	2 Sep	163.4	4 Sep	161.5	5 Sep	174.0	4 Sep	248.3	4 Sep	167.5	16 Sep
1973	95.9	16 Sep	340.6	16 Sep	125.8	18 Sep	131.9	20 Sep	197.0	13 Sep	123.9	3 Oct	196.3	30 Jul	137.6	16 Sep	159.2	5 Jul	151.1	18 Aug
1974	180.2	17 Oct	121.0	8 Oct	175.7	5 Oct	120.8	17 Apr	280.3	15 Oct	324.7	5 Oct	202.8	17 Oct	142.4	27 Aug	208.9	5 Oct	174.8	20 Jul
1975	109.6	31 Aug	183.4	29 Aug	—	—	—	—	137.7	12 Sep	128.7	14 Aug	147.1	10 Jul	267.0	8 Jul	183.7	7 Jul	204.9	7 Aug
1976	127.6	12 Sep	134.5	29 Aug	—	—	186.9	20 Jul	170.4	31 Aug	—	—	142.7	25 Oct	183.0	22 Sep	225.1	21 Jul	188.1	22 Aug
1977	122.0	1 May	159.9	15 Sep	155.9	18 Jun	124.4	22 Jul	98.5	19 Apr	107.2	2 Oct	105.0	23 Jul	128.6	15 Sep	179.2	5 Sep	173.7	7 Sep
1978	130.2	11 Sep	201.8	16 Feb	—	—	—	—	292.0	14 Sep	219.2	15 Sep	178.4	15 Sep	197.8	5 Jul	173.1	26 Sep	218.6	18 Jun
1979	104.3	3 May	133.9	18 Sep	—	—	—	—	130.2	24 Oct	142.4	14 Sep	153.4	24 Sep	248.0	19 Sep	214.6	17 May	222.0	19 May
1980	119.0	4 Aug	177.0	5 Sep	171.1	29 Sep	181.5	21 Jul	140.8	21 Aug	152.4	25 Jul	120.7	9 Jun	249.8	19 Jun	221.5	20 Jul	226.7	22 Jul
1981	202.9	15 Sep	158.2	19 May	120.2	12 Sep	435.5	16 Sep	372.0	15 Sep	224.2	15 Sep	172.2	15 Sep	344.0	12 Jul	157.8	18 Jul	396.8	3 Aug
1982	112.0	22 Jul	170.9	28 Sep	104.3	4 Aug	122.8	19 Aug	232.1	6 Jun	166.5	28 Sep	93.2	4 Jun	275.5	28 Sep	202.4	18 Aug	207.5	18 Aug
1983	239.3	13 Aug	184.4	13 Aug	299.4	3 Aug	217.5	3 Aug	185.0	2 Aug	203.5	14 Oct	154.0	3 Aug	202.0	26 Sep	279.4	26 Sep	170.4	15 Jul
1984	165.8	3 Jun	129.6	3 Oct	185.2	7 Aug	113.0	3 Jun	—	—	—	—	131.5	8 Jul	280.0	8 Aug	143.5	6 Aug	210.4	3 Oct
1985	238.7	14 Sep	133.3	15 Apr	127.3	21 Oct	121.4	23 Jul	—	—	128.7	28 Sep	160.1	6 May	459.8	14 Sep	184.9	13 Sep	236.4	15 Sep
1986	191.4	9 May	182.6	4 Sep	220.7	5 Aug	198.7	9 Aug	147.6	1 Oct	145.5	5 May	120.1	5 Aug	347.0	20 Jul	188.7	5 Sep	205.8	4 Sep
1987	174.4	20 Sep	149.3	16 Sep	106.9	19 Apr	166.2	26 Sep	261.1	8 Oct	129.7	26 Sep	135.3	27 Jul	—	—	136.4	5 Sep	173.5	1 Sep
1988	249.5	16 Oct	—	—	178.5	16 Oct	141.5	13 Oct	167.1	15 Jul	253.9	13 Oct	244.1	12 Oct	186.1	11 Jun	230.0	7 Jun	—	—
1989	123.8	17 Aug	186.5	9 Aug	163.7	10 Aug	142.5	10 Aug	156.1	7 Sep	111.2	18 Sep	86.0	11 Jun	176.4	7 Sep	259.9	9 Aug	205.2	9 Aug
1990	199.2	1 Oct	134.3	24 Sep	342.2	29 Sep	199.9	1 Oct	116.2	14 Sep	220.5	30 Sep	137.6	28 Sep	273.1	3 Oct	218.0	1 Oct	330.9	2 Oct

Note ; January to December

MAXIMUM SEVEN DAYS RAINFALL (2)

(mm)

Code	44082		44122		44132		06062		25152		25172		25530		22042		22070		22150	
Year	Rain	Date	Rain	Date	Rain	Date	Rain	Date	Rain	Date	Rain	Date	Rain	Date	Rain	Date	Rain	Date	Rain	Date
1968	130.5	29 May	126.3	22 Jul	203.1	29 Jun	238.0	4 Aug	–	–	107.1	29 Jul	86.9	10 Sep	193.7	29 Jul	264.6	29 Jul	125.3	30 Apr
1969	221.4	3 Sep	–	–	274.6	2 Sep	262.8	18 Sep	–	–	286.3	16 Sep	307.0	15 Sep	–	–	242.2	28 Sep	237.1	15 Sep
1970	162.1	22 Aug	191.0	17 Jun	141.1	8 Jul	217.7	12 Jul	–	–	139.3	21 Sep	112.0	28 May	206.7	31 Jul	214.0	17 Jun	230.1	29 Jul
1971	142.8	15 Sep	150.7	6 Jun	171.2	10 Aug	166.9	21 Aug	–	–	111.6	5 Oct	129.4	25 Oct	180.3	26 Aug	281.4	3 Jul	156.1	29 Aug
1972	171.5	5 Apr	301.3	4 Sep	379.3	4 Sep	309.8	7 Aug	222.4	4 Sep	230.4	4 Sep	150.6	1 Sep	191.8	28 Sep	220.4	4 Sep	218.6	4 Sep
1973	161.7	23 Sep	163.5	16 Sep	329.9	11 Sep	183.0	13 Jun	111.3	15 Sep	90.5	23 Sep	135.3	16 Sep	155.0	12 Jun	171.4	23 Sep	80.0	18 Jul
1974	146.6	18 Mar	187.8	6 Oct	217.5	8 Jun	233.9	14 Aug	86.2	19 Apr	145.4	5 Oct	119.5	8 Oct	180.8	19 Sep	163.4	19 Jul	214.4	9 Apr
1975	131.1	5 Aug	215.9	8 Oct	306.6	5 Jul	216.1	11 Aug	150.2	28 Sep	175.1	9 Aug	101.4	10 Jul	248.0	27 Aug	260.3	9 Jul	218.6	9 Jul
1976	137.8	30 Aug	388.9	28 Jun	270.9	23 Aug	178.4	19 Jul	170.8	24 Aug	145.5	25 Oct	214.5	25 Oct	178.3	30 Jun	412.6	25 Aug	274.4	25 Aug
1977	120.2	5 Sep	240.3	21 Jul	239.1	22 Jul	205.9	21 Jul	138.8	4 Sep	117.9	30 Aug	144.2	20 May	147.2	17 Sep	189.9	25 Jul	173.0	16 Sep
1978	127.0	23 May	265.4	20 Jul	361.8	26 Sep	–	–	177.6	26 Sep	200.6	23 Sep	222.1	5 Jul	211.9	9 Sep	177.8	19 Jul	144.6	7 Sep
1979	223.5	22 Sep	398.5	27 Jun	–	–	281.4	27 Jun	314.8	22 Sep	405.4	23 Sep	109.4	23 Sep	161.2	19 Aug	183.9	19 Sep	157.7	22 Aug
1980	127.6	29 Sep	422.8	15 Jun	226.5	24 Aug	204.6	19 May	133.5	23 Sep	265.9	22 Sep	–	–	193.5	27 Sep	195.6	22 Aug	193.3	9 Sep
1981	140.5	18 Jun	268.5	19 Sep	214.9	19 Sep	156.5	5 Aug	–	–	202.2	1 Jul	102.4	18 Sep	231.8	30 Aug	160.9	3 Aug	273.2	17 Sep
1982	165.9	18 Aug	350.1	17 Aug	172.2	3 Sep	135.6	16 Aug	–	–	257.8	3 Sep	198.6	4 Sep	156.7	24 Sep	235.7	19 Sep	183.0	2 Sep
1983	171.7	24 Sep	417.8	26 Sep	273.3	2 Aug	272.4	25 May	–	–	458.5	10 Oct	152.1	3 Sep	199.6	3 Aug	299.2	9 Oct	261.6	13 Oct
1984	244.0	7 Aug	345.3	8 Aug	–	–	176.9	28 Aug	–	–	275.7	4 Aug	77.0	4 Sep	261.8	6 Jul	242.6	6 Jul	104.2	6 Oct
1985	207.2	23 Apr	–	–	–	–	289.9	18 Jun	–	–	265.0	8 Oct	78.5	22 Jul	254.4	1 Sep	294.6	9 Jul	295.4	14 Sep
1986	192.5	28 Sep	316.8	4 May	173.5	4 Sep	373.5	18 May	–	–	260.5	29 Sep	193.5	26 Sep	141.6	6 Sep	371.4	14 Aug	246.2	4 Sep
1987	185.6	15 Jun	145.9	15 Jun	226.0	4 Sep	351.6	16 Aug	186.5	4 Sep	321.3	5 Sep	127.7	4 Sep	148.5	15 Sep	222.1	5 Sep	103.7	23 Apr
1988	165.4	11 Jul	149.9	2 Jun	214.7	11 Jun	178.6	14 Sep	189.9	12 Oct	340.4	16 Sep	116.2	11 May	198.7	12 Jun	375.4	11 Jun	162.3	12 Jun
1989	102.1	20 Aug	140.0	8 Aug	289.8	21 Jun	179.9	9 Aug	115.6	13 Oct	248.8	7 Aug	122.8	12 May	151.0	9 Aug	293.4	8 Aug	136.5	9 Aug
1990	162.0	28 Sep	244.1	3 Oct	297.2	3 Oct	195.9	3 Oct	220.8	29 Sep	204.2	1 Oct	85.0	17 May	395.0	30 Sep	369.1	28 Sep	379.4	28 Sep

TABLE 3-4-4 PROBABLE SEVEN DAYS RAINFALL BY IWAI METHOD

(mm)

	03042	03080	03210	03220	09013	19160	09171	44022	44043	44062
1/2	160.3	170.0	168.0	162.9	174.4	161.5	150.7	209.2	196.8	210.6
1/5	203.4	206.6	226.5	213.6	237.5	207.5	185.7	279.7	231.0	272.6
1/10	229.6	227.0	267.8	250.0	279.2	238.8	206.2	329.2	250.6	322.8
1/15	243.7	237.5	291.9	271.5	302.7	256.8	217.0	357.8	260.9	354.3
1/20	253.4	244.5	309.2	286.9	319.2	269.5	224.4	378.2	267.9	377.7
1/25	260.8	249.7	322.6	299.0	332.0	279.4	230.0	394.2	273.1	396.5
1/30	266.6	253.9	333.7	308.9	342.3	287.4	234.4	407.3	277.2	412.2
1/50	282.8	265.0	365.1	337.3	371.2	310.1	246.5	444.3	288.4	458.5
1/80	297.3	274.7	394.7	364.2	398.0	331.3	257.2	479.1	298.3	504.2
1/100	304.1	279.1	409.1	377.2	410.7	341.5	262.2	495.9	302.9	526.9
1/150	316.2	287.0	435.5	401.4	433.9	360.1	271.1	526.8	311.0	569.9
1/200	324.8	292.4	454.6	418.9	450.4	373.5	277.3	549.1	316.6	602.0
1/300	336.7	299.8	482.0	444.2	473.9	392.5	285.8	581.1	324.4	649.1
1/500	351.5	308.9	517.4	477.0	503.7	416.9	296.4	622.3	333.9	712.2

(mm)

	44082	44122	44132	06062	25152	25172	25530	22042	22070	22150
1/2	158.2	241.9	241.7	216.7	160.8	211.1	129.1	189.4	241.7	190.5
1/5	190.9	336.6	301.7	274.1	215.7	303.9	176.6	233.3	308.6	255.3
1/10	211.1	398.7	338.3	312.3	252.0	366.8	209.8	263.2	352.6	295.6
1/15	222.1	433.6	358.1	333.9	272.5	402.7	229.1	280.4	377.4	317.1
1/20	229.6	458.0	371.6	349.1	286.9	428.1	242.8	292.5	394.7	331.9
1/25	235.4	476.8	381.9	360.8	298.0	447.8	253.5	301.9	408.0	343.1
1/30	240.0	492.1	390.2	370.4	307.0	463.8	262.3	309.6	418.9	352.1
1/50	252.7	534.7	412.8	397.1	332.3	508.9	287.2	331.3	449.2	376.7
1/80	264.1	573.9	433.2	421.8	355.6	550.9	310.5	351.6	477.1	398.8
1/100	269.5	592.5	442.7	433.5	366.7	570.9	321.8	361.3	490.3	409.2
1/150	279.2	626.5	459.8	455.0	387.0	607.7	342.5	379.0	514.5	427.8
1/200	286.0	650.7	471.9	470.4	401.5	634.1	357.5	391.8	531.7	440.9
1/300	295.5	684.9	488.6	492.2	422.0	671.7	378.9	410.1	556.1	459.1
1/500	307.4	728.3	509.6	519.9	448.1	719.7	406.5	433.4	587.1	481.8

Note ; From Januray to December

TABLE 3-4-5 MAXIMUM THREE DAYS RAINFALL (1)

(mm)

Code	03042		03080		03210		03220		09013		09160		09171		44022		44043		44062	
Year	Rain	Date	Rain	Date	Rain	Date	Rain	Date	Rain	Date	Rain	Date	Rain	Date	Rain	Date	Rain	Date	Rain	Date
1968	58.2	7 May	88.8	24 Apr	109.4	15 Apr	101.2	25 Apr	44.8	27 Apr	94.8	8 May	82.4	29 May	95.4	17 Apr	31.3	23 Mar	69.2	4 May
1969	124.4	30 May	63.9	29 May	36.2	30 May	69.1	29 May	36.1	16 Mar	103.3	30 May	57.2	13 Apr	67.3	6 May	105.9	1 May	68.4	21 May
1970	104.2	3 May	77.0	23 Mar	83.5	22 Mar	129.6	22 Mar	87.2	3 Apr	113.2	30 Nov	65.0	14 May	79.1	22 Mar	78.8	17 May	130.6	26 Apr
1971	94.2	18 Apr	124.0	20 May	49.6	3 May	69.8	26 Apr	88.5	28 May	114.3	18 Apr	63.6	24 Feb	57.8	16 May	59.6	26 Apr	52.6	25 Apr
1972	62.0	14 Nov	88.6	10 Apr	56.1	24 Apr	88.2	3 Apr	65.1	5 Nov	67.6	14 Nov	75.9	3 Apr	99.7	8 Apr	77.0	7 Dec	82.9	13 May
1973	79.9	24 Mar	88.5	20 May	69.6	5 May	47.1	21 May	50.4	30 May	40.9	2 May	68.3	5 May	81.6	21 May	39.6	5 May	91.5	20 Apr
1974	96.2	4 Nov	56.1	25 Apr	93.6	3 May	98.0	17 Apr	84.7	23 Apr	86.8	17 May	48.4	4 Nov	67.9	24 Apr	107.0	17 Mar	108.7	4 Nov
1975	60.0	24 May	59.5	1 May	–	–	–	–	91.8	4 Nov	44.1	1 May	91.2	24 May	104.0	1 May	98.2	22 May	43.8	4 Nov
1976	65.5	31 Mar	52.4	30 Apr	–	–	42.0	25 Mar	85.3	1 Nov	65.7	7 Feb	62.8	2 May	73.0	28 Apr	94.3	4 May	44.8	20 Apr
1977	81.9	5 May	84.7	1 May	105.8	1 May	39.2	3 Mar	90.9	19 Apr	60.7	19 Apr	48.9	23 May	57.3	1 May	52.3	23 May	85.7	29 May
1978	81.6	10 May	189.0	16 Feb	59.7	23 May	71.8	20 Mar	80.8	3 Jan	85.1	1 Feb	87.8	10 May	56.5	7 Nov	83.2	26 May	135.5	27 May
1979	95.9	3 May	104.8	20 May	62.9	18 May	–	–	36.6	5 May	85.4	23 Apr	64.6	22 Apr	113.0	10 May	163.3	18 May	199.5	19 May
1980	64.5	24 Mar	53.8	16 Apr	51.1	8 Nov	145.4	6 Nov	33.7	23 Mar	73.0	16 Apr	44.5	23 Mar	85.1	21 May	51.4	19 May	66.8	19 May
1981	88.7	24 Feb	72.1	24 May	48.8	7 Nov	150.6	25 Mar	163.8	20 May	126.9	11 Apr	73.7	21 Apr	67.0	26 May	70.6	26 Mar	115.5	18 May
1982	92.4	13 Apr	69.3	13 Apr	51.8	1 Dec	82.1	15 Apr	65.7	14 May	106.0	26 Mar	68.2	23 Apr	95.0	7 Apr	74.7	22 May	36.5	22 May
1983	71.4	29 May	77.9	28 May	100.7	25 May	61.0	28 May	70.7	8 Nov	47.7	1 May	81.3	25 Apr	127.5	29 May	49.4	26 May	97.0	31 May
1984	59.1	27 May	70.9	16 Apr	115.7	12 May	68.8	13 May	–	–	135.5	14 Nov	71.7	13 Feb	110.0	8 Apr	115.4	26 May	54.1	16 May
1985	46.5	8 May	133.3	15 Apr	78.0	17 Apr	72.7	16 May	102.3	9 Nov	94.2	29 May	119.1	6 May	125.8	26 May	125.0	15 Apr	87.8	29 Apr
1986	181.9	9 May	86.5	7 May	96.6	8 May	102.4	9 May	124.4	8 May	118.1	8 May	93.3	6 May	99.0	7 May	93.6	8 May	99.7	8 May
1987	105.4	1 Nov	60.0	1 May	93.1	1 Nov	84.0	31 Mar	81.2	5 May	43.6	10 Nov	53.2	30 Apr	76.0	19 May	53.4	29 May	75.3	28 May
1988	96.4	11 Apr	–	–	79.6	12 May	73.2	12 Apr	101.4	14 May	65.7	24 Apr	88.2	4 Mar	68.7	5 May	101.2	26 Feb	181.0	30 Apr
1989	72.4	6 Nov	52.5	26 Apr	79.2	21 May	96.8	17 May	63.1	5 Nov	58.5	9 May	39.4	28 May	83.7	15 May	86.2	12 May	90.0	12 May
1990	65.8	23 May	56.7	26 Apr	95.6	12 Mar	82.1	22 May	75.6	11 May	92.5	4 Mar	52.4	26 Apr	64.2	9 Nov	73.1	25 May	92.5	21 May

Note ; From November to May

MAXIMUM THREE DAYS RAINFALL (2)

(mm)

Code	44082		44122		44132		06062		25152		25172		25530		22042		22070		22150	
Year	Rain	Date	Rain	Date	Rain	Date	Rain	Date	Rain	Date	Rain	Date	Rain	Date	Rain	Date	Rain	Date	Rain	Date
1968	78.4	19 Apr	86.8	28 May	54.2	28 Apr	63.5	18 Apr	–	–	63.3	11 Mar	48.4	29 May	109.7	24 Feb	64.7	29 Apr	103.0	23 Feb
1969	67.9	26 May	80.9	2 May	115.6	13 Jan	71.3	2 Nov	–	–	64.9	21 May	90.4	25 Apr	91.2	11 Apr	112.4	4 May	59.1	16 Mar
1970	106.0	26 Apr	73.3	3 May	37.9	26 Apr	75.1	4 Dec	–	–	52.0	12 Apr	112.0	28 May	68.7	4 May	98.3	24 Apr	121.7	21 May
1971	40.1	29 May	54.9	9 Apr	51.7	11 May	90.2	27 Dec	87.3	11 Apr	60.9	16 May	24.5	2 May	91.4	26 Feb	80.4	18 May	43.0	13 May
1972	156.1	5 Apr	97.1	5 Apr	33.1	16 May	74.4	17 Nov	65.9	21 Feb	70.9	29 Mar	111.1	22 Mar	78.6	14 Nov	114.4	3 Apr	89.4	24 Apr
1973	42.2	12 Nov	74.3	22 Mar	49.2	22 May	135.8	12 Nov	30.0	21 May	62.6	5 May	31.7	30 May	76.6	1 May	104.7	20 Apr	56.3	12 May
1974	142.9	18 Mar	100.6	19 May	93.4	18 Mar	67.4	25 May	58.7	23 Apr	88.2	4 Nov	49.5	17 May	89.0	4 Nov	50.7	8 Apr	153.4	9 Apr
1975	61.3	26 May	79.3	11 May	65.3	27 May	55.7	26 May	120.6	21 May	57.5	14 Nov	85.7	15 Mar	69.5	5 Dec	62.3	21 May	50.6	10 Jan
1976	59.1	27 Apr	117.8	2 Nov	52.6	22 May	89.0	22 May	50.0	13 Mar	41.4	6 May	90.5	23 Mar	65.1	21 May	63.4	2 Nov	80.4	20 Mar
1977	47.1	24 May	90.9	22 May	97.2	29 May	45.4	3 May	75.2	27 Nov	62.4	30 Mar	102.0	5 May	93.8	14 May	77.4	29 May	55.8	27 Nov
1978	79.4	11 May	67.1	6 May	66.6	11 Apr	75.9	27 May	93.7	3 May	69.4	13 May	117.8	12 May	69.9	25 Fbg	87.2	25 Feb	61.2	25 Feb
1979	78.1	20 May	99.4	10 May	–	–	87.1	19 May	125.3	27 May	94.3	7 May	74.2	19 May	60.9	21 May	112.7	10 Apr	37.8	18 May
1980	81.9	7 May	117.4	21 Apr	66.8	8 Feb	112.0	20 May	95.0	21 May	96.1	15 Mar	58.4	15 May	61.5	15 Mar	118.6	7 May	33.2	7 Apr
1981	109.9	23 May	138.1	23 May	71.1	25 Mar	77.9	28 Feb	48.6	29 Apr	130.8	18 May	77.7	2 Mar	119.5	18 May	118.1	7 May	38.2	18 May
1982	102.2	14 Apr	139.2	17 May	63.1	10 May	81.4	5 May	–	–	183.3	23 May	111.4	30 Nov	54.5	14 May	75.6	30 Nov	115.5	30 Nov
1983	55.5	26 Apr	60.2	29 May	34.3	29 May	168.2	27 May	–	–	102.4	10 Nov	89.5	30 Apr	90.0	12 May	178.9	2 May	84.7	25 May
1984	101.9	21 Mar	70.4	21 Apr	–	–	160.5	21 Mar	118.2	23 May	123.8	24 Feb	39.5	11 May	96.1	27 May	83.8	21 Apr	86.6	18 May
1985	170.0	24 Apr	182.5	16 Apr	126.8	14 May	93.7	28 May	–	–	119.0	7 May	57.1	23 Mar	80.2	4 Apr	74.5	21 Mar	117.8	7 May
1986	102.5	2 May	197.0	8 May	74.2	8 May	228.7	21 May	70.6	21 May	150.6	29 Apr	83.9	10 Apr	116.0	8 May	97.6	22 Apr	163.1	4 May
1987	73.0	27 Mar	70.7	30 May	68.5	4 May	98.3	13 May	66.5	29 Apr	65.2	26 Mar	85.1	26 Mar	60.3	15 Apr	44.7	26 Mar	68.5	28 Apr
1988	58.6	30 Apr	107.2	12 Apr	84.6	12 Apr	70.6	4 May	62.2	15 Feb	161.8	12 May	89.4	11 May	81.6	23 May	181.2	23 May	106.0	17 Feb
1989	84.4	19 May	57.7	26 May	130.3	12 May	95.4	10 Feb	73.5	12 May	75.6	6 May	102.8	14 May	50.0	23 May	72.2	27 May	77.9	5 Mar
1990	62.4	18 Apr	59.0	28 Apr	57.6	1 Nov	87.0	28 May	39.1	16 Mar	92.2	16 Jan	56.3	26 Apr	80.0	23 May	68.1	7 May	237.6	23 May

TABLE 3-4-6 PROBABLE THREE DAYS RAINFALL

(mm)

	03042	03080	03210	03220	09013	19160	09171	44022	44043	44062
1/2	78.8	74.0	75.7	80.2	74.3	80.7	68.3	81.6	78.6	84.3
1/5	103.3	99.7	96.3	107.6	101.9	106.6	84.6	101.4	106.1	123.6
1/10	120.7	119.9	107.9	125.1	119.3	122.3	94.1	114.3	122.8	151.5
1/15	130.9	132.3	114.0	134.7	128.8	130.7	99.0	121.4	131.9	167.8
1/20	138.2	141.4	118.0	141.4	135.4	136.4	102.3	126.4	138.0	179.4
1/25	143.9	148.7	121.0	146.5	140.0	140.7	104.8	130.2	142.7	188.6
1/30	148.6	154.8	123.4	150.6	144.5	144.2	106.8	133.3	146.5	196.1
1/50	162.0	172.5	129.9	162.1	155.6	153.7	112.2	142.0	156.8	217.4
1/80	174.6	189.8	135.5	172.5	165.8	162.2	116.9	149.9	166.0	237.6
1/100	180.7	198.4	138.1	177.4	170.6	166.2	119.1	153.6	170.3	247.4
1/150	192.0	214.5	142.8	186.4	179.2	173.3	123.0	160.4	178.1	265.4
1/200	200.2	226.4	145.9	192.7	185.3	178.3	125.7	165.3	183.5	278.4
1/300	212.0	243.8	150.3	201.6	193.9	185.2	129.4	172.1	191.1	297.2
1/500	227.2	266.9	155.7	212.8	204.6	193.8	134.0	180.8	200.6	321.4

(mm)

	44082	44122	44132	06062	25152	25172	25530	22042	22070	22150
1/2	78.3	86.7	66.4	86.7	72.3	82.4	72.1	78.6	86.4	69.9
1/5	109.8	120.1	91.9	120.2	97.8	116.3	103.3	95.7	117.5	99.8
1/10	131.6	146.0	108.8	144.8	113.3	140.7	124.6	106.0	138.9	120.0
1/15	144.2	161.8	118.4	159.4	121.6	155.1	136.8	111.5	151.2	131.4
1/20	153.1	173.4	125.1	169.9	127.3	165.5	145.5	115.3	160.0	139.5
1/25	160.1	182.6	130.3	178.2	131.7	173.6	152.2	118.2	166.8	145.8
1/30	165.8	190.3	134.5	185.1	135.1	180.3	157.7	120.5	172.4	150.9
1/50	181.9	212.6	146.3	204.7	144.6	199.4	173.2	126.8	188.1	165.3
1/80	197.0	234.3	157.2	223.5	153.1	217.5	187.6	132.5	202.9	178.7
1/100	204.3	245.0	162.4	232.6	157.1	226.3	194.8	135.1	209.9	185.1
1/150	217.6	265.0	171.9	249.6	164.2	242.6	207.3	139.8	222.9	196.7
1/200	227.3	279.8	178.7	262.0	169.2	254.4	216.4	143.1	232.3	205.1
1/300	241.0	301.3	188.3	279.8	176.2	271.4	229.5	147.7	245.7	217.0
1/500	258.7	329.8	200.5	303.1	184.9	293.6	246.2	153.5	262.9	232.3

Note ; From November to May

3.4.3 Design Rainfall

TABLE 3－4－7 CONTINUOUS PRECIPITATION DAYS

	20 Oct. 1990		23 Sep. 1969		20 Oct. 1983		3 Oct. 1978		21 Sep. 1972	
	Days	Date	Days	Date	Days	Date	Days	Date	Days	Date
03042	2	1～2 Oct.	3	19～21 Sep.	2	18～19 Oct.	2	28～29 Sep.	6	4～9 Sep.
03080	2	1～2 Oct.	8 (4)	14～21 Sep.	9 (9)	7～15 Oct.	4	26～29 Sep.	6	3～8 Sep.
03210	2	3～4 Oct.	8 (3)	16～23 Sep.	2	10～11 Oct.	4	28 Sep.～1 Oct.	5	5～9 Sep.
03220	3	3～5 Oct.	2	20～21 Sep.	7	8～14 Oct.	7	16～22 Sep.	7	4～10 Sep.
09013	－	－	3	19～21 Sep.	6	8～13 Oct.	4	27～30 Sep.	5	4～8 Sep.
09160	3	3～5 Oct.	7	15～21 Sep.	4	17～20 Oct.	9 (7)	15～23 Sep.	4	4～7 Sep.
09171	3	2～4 Oct.	5	17～21 Sep.	6	4～9 Oct.	11 (4)	15～25 Sep.	11 (4)	4～14 Sep.
44022	3	3～5 Oct.	1	20 Sep.	5	9～13 Oct.	1	29 Sep.	5	4～8 Sep.
44043	5	1～5 Oct.	6	15～20 Sep.	11 (2)	8～18 Oct.	6	26 Sep.～1 Oct.	4	4～7 Sep.
44062	4	2～5 Oct.	5	16～20 Sep.	3	2～4 Oct.	2	30 Sep.～1 Oct.	4	4～7 Sep.
44082	2	3～4 Oct.	3	19～21 Sep.	6	8～13 Oct.	5	27 Sep.～1 Oct.	4	4～7 Sep.
44122	7	30 Sep.～6 Oct.	13 (7)	10～22 Sep.	6	8～13 Oct.	5	27 Sep.～1 Oct.	4	4～7 Sep.
44132	7	3～9 Oct.	5	13～17 Sep.	10 (3)	12～21 Oct.	14 (14)	19 Sep.～2 Oct.	6	4～9 Sep.
06062	3	3～5 Oct.	2	20～21 Sep.	10 (7)	6～15 Oct.	－	－	8 (7)	2～9 Sep.
25152	10 (3)	26 Sep.～5 Oct.	－	－	－	－	6	25～30 Sep.	8 (7)	3～10 Sep.
25172	5	1～5 Oct.	6	16～21 Sep.	8 (6)	8～15 Oct.	7	15～21 Sep.	7	4～10 Sep.
25530	0	－	7	15～21 Sep.	6	8～13 Oct.	4	17～20 Sep.	8 (5)	1～8 Sep.
22042	2	3～4 Oct.	3	19～21 Sep.	16 (16)	8～23 Oct.	5	27 Sep.～1 Oct.	4	4～7 Sep.
22070	2	3～4 Oct.	5	12～16 Sep.	5	9～13 Oct.	4	27～30 Sep.	5	4～8 Sep.
22150	2	3～4 Oct.	6	17～22 Sep.	9 (7)	7～15 Oct.	8 (1)	15～22 Sep.	5	4～8 Sep.

Note : (Rain) < 5.0mm/day Rain < 1.0mm/day

TABLE 3-4-8 DAILY RAINFALL IN OCTOBER 1983

(mm)

	03042	03080	03210	03220	09013	09160	09171	44022	44043	44062	44082	44122	44132	06062	25142	25172	25530	22042	22070	22150
10－1	6.4	10.2	8.0	9.1	0.1	0.0	4.2	25.0	1.6	0.0	0.0	33.1	11.3	3.7	0.0	0.0	4.2	22.6	5.6	0.0
2	4.6	11.9	0.0	0.0	9.0	〃	2.5	30.5	19.8	11.2	11.6	10.8	10.3	8.4	〃	0.5	4.0	12.2	13.4	6.7
3	3.1	12.5	20.5	7.1	25.4	0.1	40.6	10.0	56.3	66.0	28.9	20.0	76.8	7.9	7.0	25.4	7.0	22.5	43.5	23.4
4	2.1	0.0	11.0	0.0	0.5	0.4	0.0	0.0	3.9	10.0	20.3	0.0	31.0	85.2	0.0	0.5	4.6	0.0	0.0	2.3
5	19.6	〃	2.0	〃	0.0	0.2	〃	25.5	0.9	0.0	0.0	〃	0.0	0.0	〃	0.0	45.2	〃	13.1	0.0
6	0.0	〃	0.0	6.2	〃	0.0	2.6	0.0	0.0	〃	〃	〃	〃	7.4	〃	〃	0.8	〃	0.9	〃
7	〃	13.0	〃	0.0	〃	〃	0.0	10.0	〃	〃	〃	〃	〃	8.1	11.8	〃	0.0	〃	0.0	5.7
8	〃	12.4	〃	9.1	3.2	7.4	〃	0.0	6.0	5.8	6.7	26.0	25.3	17.6	19.0	7.9	4.8	14.5	〃	2.4
9	〃	24.0	〃	1.0	13.0	4.5	63.1	35.5	2.9	11.2	13.1	31.8	4.0	16.0	5.2	3.9	2.3	22.5	43.2	22.8
10	35.1	38.6	80.4	44.1	13.2	18.7	21.8	40.0	51.3	60.2	49.5	97.5	88.0	12.7	68.2	111.0	55.1	62.5	70.5	83.2
11	16.2	45.6	40.4	49.3	15.6	7.8	25.6	60.0	1.0	0.0	2.8	4.9	0.0	6.4	6.9	59.0	2.4	26.6	92.3	16.7
12	8.2	5.7	0.0	2.8	18.8	0.0	0.3	15.0	8.2	〃	48.5	1.8	51.0	48.8	1.4	110.0	41.0	35.8	9.5	5.6
13	0.0	18.7	40.0	36.7	40.1	〃	10.0	20.5	5.2	〃	33.3	43.9	26.3	2.3	0.0	136.7	5.7	22.6	56.2	22.4
14	14.5	10.0	15.5	21.0	0.0	36.8	0.7	0.0	2.9	15.0	0.0	0.0	52.6	14.7	〃	8.3	0.4	10.2	0.0	22.6
15	0.0	8.4	0.0	0.0	10.3	7.6	0.0	15.0	21.8	16.5	〃	24.5	3.7	7.4	14.4	33.5	21.3	16.2	27.5	107.4
16	40.1	0.0	6.5	2.7	0.0	0.0	〃	0.0	2.6	0.0	8.0	0.0	3.0	0.0	0.0	0.0	0.0	12.1	0.0	0.0
17	0.0	11.5	0.0	0.0	6.0	17.6	26.1	30.5	55.3	〃	65.9	85.3	37.6	48.4	15.1	〃	27.7	5.2	28.2	35.5
18	25.6	40.0	45.5	41.1	50.1	132.0	37.6	0.0	34.1	23.0	5.0	18.8	9.0	39.4	28.0	49.6	21.7	22.3	73.9	31.4
19	56.6	3.3	40.4	44.9	25.8	6.9	1.5	〃	0.7	30.5	0.0	0.0	1.3	28.7	2.3	0.0	0.0	8.6	0.0	42.3
※ 20	0.0	0.0	8.5	0.0	0.1	2.6	7.8	〃	6.7	25.0	6.8	25.6	7.2	25.1	0.0	〃	5.7	29.5	4.2	0.0
21	〃	〃	0.5	〃	14.5	0.9	0.0	〃	0.0	0.0	0.0	0.0	7.1	0.0	〃	1.3	0.0	6.2	0.0	〃
22	〃	〃	0.0	〃	0.9	9.6	11.0	〃	0.8	〃	〃	66.0	0.4	〃	6.6	3.2	7.0	15.8	〃	〃
23	〃	〃	〃	3.3	4.2	27.9	51.5	〃	0.0	〃	〃	0.0	0.0	〃	0.0	0.0	0.0	8.5	〃	〃
24	〃	〃	〃	0.0	0.0	0.0	0.0	〃	〃	〃	〃	8.3	〃	〃	〃	〃	〃	0.0	〃	〃
25	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	〃	0.0	〃	〃	〃	〃	〃	5.2	〃	〃
26	〃	〃	〃	〃	40.9	9.4	38.9	〃	〃	〃	〃	〃	〃	〃	6.2	12.5	〃	19.5	〃	〃
27	31.2	〃	〃	〃	3.8	0.0	0.0	〃	〃	〃	〃	〃	〃	〃	1.3	0.0	〃	0.0	〃	〃
28	0.0	〃	〃	〃	2.9	0.6	〃	〃	〃	〃	〃	2.7	〃	〃	7.8	13.1	0.5	〃	〃	〃
29	〃	〃	〃	〃	0.0	0.0	〃	〃	〃	〃	〃	0.0	〃	2.3	0.0	0.0	0.0	2.3	〃	〃
30	〃	〃	〃	2.7	11.4	4.5	7.6	〃	〃	〃	〃	7.5	0.1	14.6	5.6	4.8	〃	3.5	〃	3.2
31	5.1	〃	〃	0.0	0.3	0.2	0.0	〃	〃	〃	10.0	0.0	0.0	0.0	0.0	2.2	〃	0.0	〃	0.0

Note ; ※ Peak Discharge at kgt.3

TABLE 3-4-9 DESIGN RAINFALL DISTRIBUTION PATTERN (W=1/50)

(mm)

Day	03042		03080		03210		03220		09013		09160		09171		44022		44043		44062	
	Ob.	De.	Ob.	De.	Ob.	De.	Ob.	De.	Ob.	De.	Ob.	De.	Ob.	De.	Ob.	De.	Ob.	De.	Ob.	De.
1	0.0	0.0	24.0	42.1	0.0	0.0	1.0	2.2	13.0	43.5	4.5	18.5	63.1	128.0	35.5	84.8	2.9	9.0	11.2	49.9
2	35.1	134.2	38.6	67.7	80.4	166.5	44.1	96.0	13.2	44.1	18.7	76.9	21.8	44.2	40.0	95.6	51.3	158.5	60.2	268.3
3	16.2	61.9	45.6	80.0	40.4	83.7	49.3	107.4	15.6	52.2	7.8	32.1	25.6	51.9	60.0	143.3	1.0	3.1	0.0	0.0
4	8.2	31.3	5.7	10.1	0.0	0.0	2.8	6.1	18.8	62.9	0.0	0.0	0.3	0.7	15.0	35.8	8.2	25.3	0.0	0.0
5	0.0	0.0	18.7	32.8	40.0	82.8	36.7	79.8	40.1	134.1	0.0	0.0	10.0	20.3	20.5	49.0	5.2	16.1	0.0	0.0
6	14.5	55.4	10.0	17.6	15.5	32.1	21.0	45.7	0.0	0.0	36.8	151.2	0.7	1.4	0.0	0.0	2.9	9.0	15.0	66.3
7	0.0	0.0	8.4	14.7	0.0	0.0	0.0	0.0	10.3	34.4	7.6	31.3	0.0	0.0	15.0	35.8	21.8	67.4	16.5	73.5
Total	74.0	282.8	151.0	265.0	176.3	365.1	154.9	337.3	111.0	371.2	75.4	310.1	121.5	246.5	186.0	444.3	93.3	288.4	102.9	458.5

(mm)

Day	44082		44122		44132		06062		25152		25172		25530		22042		22070		22150	
	Ob.	De.	Ob.	De.	Ob.	De.	Ob.	De.	Ob.	De.	Ob.	De.	Ob.	De.	Ob.	De.	Ob.	De.	Ob.	De.
1	13.1	22.9	31.8	83.2	4.0	7.3	16.0	58.7	5.2	18.0	3.9	4.3	2.3	5.2	22.5	38.0	43.2	64.8	22.8	30.6
2	49.5	84.9	97.5	255.1	88.0	161.0	12.7	46.6	68.2	235.8	111.0	122.2	55.1	123.4	62.5	105.4	70.5	105.8	83.2	111.7
3	2.8	4.8	4.9	12.8	0.0	0.0	6.4	23.5	6.9	23.9	59.0	65.0	2.4	5.4	26.6	44.9	92.3	138.5	16.7	22.4
4	48.5	83.3	1.8	4.7	51.0	93.3	48.8	178.9	1.4	4.8	110.0	121.1	41.0	91.8	35.8	60.4	9.5	14.4	5.6	7.5
5	33.3	57.2	43.9	114.8	26.3	48.1	2.3	8.4	0.0	0.0	136.7	150.3	5.7	12.8	22.6	38.1	56.2	84.4	22.4	30.1
6	0.0	0.0	0.0	0.0	52.6	96.3	14.7	53.9	0.0	0.0	8.3	9.1	0.4	0.9	10.2	17.2	0.0	0.0	22.6	30.3
7	0.0	0.0	24.5	64.1	3.7	6.8	7.4	27.1	14.4	49.8	33.5	36.9	21.3	47.7	16.2	27.3	27.5	41.3	107.4	144.1
Total	147.2	252.7	204.4	534.7	225.6	412.8	108.3	397.1	96.1	332.3	462.4	508.9	128.2	287.2	196.4	331.3	299.2	449.2	280.7	376.7

Note : Ob.=Observation De.=Design Rainfall

TABLE 3-4-10 DAILY RAINFALL IN MAY 1986

	03042	03080	03210	03220	09013	09160	09171	44022	44043	44062	44082	44122	44132	06062	25142	25172	25530	22042	22070	22150
MAY 1	0	0	0	0	34.7	12.1	1.6	26.3	2.7	0	0	0	0	0	0	0.4	0	0	1.5	0
2	0	0	3.0	0	0	0	0	0	5.5	0	5.1	0	0.2	0	0	0	4.6	0	18.2	0
3	0	0	0	0	0	0	6.6	0	0.2	0	0	0	0	0	25.0	43.5	43.5	0	0	0
4	0	6.7	36.4	0	0	0	0	74.5	19.8	61.4	97.4	92.4	58.2	0	27.5	4.1	6.0	0	8.3	113.6
5	21.4	9.3	6.0	1.9	3.4	8.1	0	0	0	0	0	17.3	0	0	0	0.5	0	0	0	4.2
6	0	3.0	0	0	12.7	19.3	0	0	0	0	0	5.1	0	9.5	37.5	0.8	2.5	0	10.3	0
7	0	10.4	2.5	1.0	0.8	0	0	20.0	0.6	0	0	5.0	0	14.7	2.9	1.0	0	5.3	10.5	12.4
8	0	30.0	35.5	0	56.4	50.4	38.6	10.7	44.8	30.2	19.6	57.5	15.9	30.8	34.0	25.4	2.7	35.7	19.7	48.2
9	80.1	46.1	55.8	49.6	62.3	55.9	53.5	68.3	27.6	42.0	57.5	102.0	33.8	52.7	17.2	25.6	25.2	39.8	23.5	0
10	91.2	5.2	5.3	35.0	5.7	11.8	1.2	0	21.2	27.5	3.1	37.5	24.5	30.7	3.5	0.6	8.7	40.5	18.2	0
11	10.6	0	0	17.8	0	0	0	0	0	0	0	2.9	3.2	37.6	0	6.6	0.3	0	7.5	0
※ 12	9.5	0	0	0	0	0	2.1	0	5.7	12.7	0	8.0	0.1	2.7	0	1.1	5.5	0	6.7	0
13	0	0	10.1	7.9	13.4	7.6	5.1	0	3.1	0	0	4.3	6.4	6.8	0	11.3	1.8	0	0	0
14	0	3.0	0	0.4	0	0	0	0	0	0	0	2.4	0	5.2	0	0	0	0	28.3	38.1
15	0	1.5	0	0	0	0	0	25.3	0	0	0	0	0	0	0	0	0	0	0	0
16	0	26.5	0	0	0	0	0	0	0.7	10.7	0	0	6.4	2.8	0	0	0	0	2.1	0
17	0	0	0	0	0	0	0	0	0	0	2.8	0	0	0	0	0	0	0	0	0
18	0	0	0	0	0	0	0	0	0	0	0	0	0	26.4	0	0	2.5	0	0	0
19	0	0	8.0	0	0	0	0.6	23.2	4.0	60.0	0	0	26.7	38.9	0	0	1.9	0	0	0
20	8.1	0	0	0	0	0	0	0	0	13.2	11.6	0	3.0	54.6	0	19.5	2.7	0	0	0
21	0	0	8.7	7.3	20.0	0	24.3	0	14.6	11.7	13.7	8.4	9.0	49.6	0	3.4	0	0	0	0
22	0	0	0	0	1.0	8.6	2.4	0	0	0	0.8	0	21.1	74.5	0	8.3	1.1	0	28.2	0
23	0	0	0	0	0.3	0	0	0	44.1	19.5	5.5	10.0	10.5	104.6	0	17.5	2.0	0	11.5	8.6
24	0	0	0	0	0	0	0	0	0	2.5	5.4	9.8	5.4	24.9	10.5	2.1	0	0	0	3.2
25	0	2.3	0.3	4.9	0	0	7.7	0	12.7	0	0	2.8	6.6	13.4	0	27.4	1.7	45.0	12.5	12.3
26	0	0	0	0	0	0	0	0	1.3	0	3.1	0	3.9	4.1	0	0	0	0	0	0
27	0	0	0	0	0	0	0	10.3	0	0	0	0	0	0	0	0	0	0.3	11.8	4.2
28	0	6.7	0	0	0	0	0	0	1.2	0	0	2.9	0.7	0	19.5	0	0	0	13.9	0
29	0	3.7	0	0	0	0	0	0	0	0	0	0	0.2	0	0	0	0	0	16.5	0
30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

TABLE 3-4-11 DESIGN RAINFALL DISTRIBUTION PATTERN (W=1/2)

(mm)

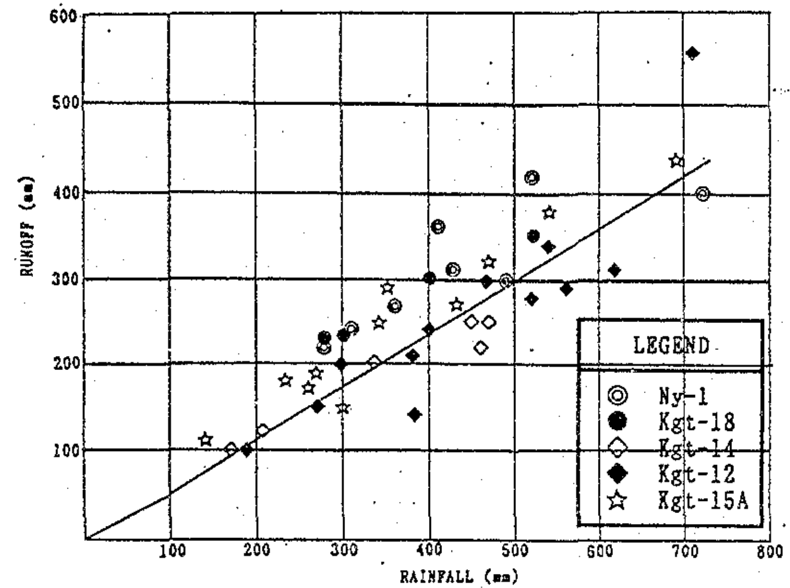
Day	03042		03080		03210		03220		09013		09160		09171		44022		44043		44062	
	Ob.	De.	Ob.	De.	Ob.	De.	Ob.	De.	Ob.	De.	Ob.	De.	Ob.	De.	Ob.	De.	Ob.	De.	Ob.	De.
1	0.0	0.0	30.0	27.3	35.5	27.8	0.0	0.0	56.4	33.7	50.4	34.4	38.6	28.3	10.7	11.1	44.8	37.6	30.2	25.5
2	80.1	36.8	46.1	42.0	55.8	43.7	49.6	47.0	62.3	37.2	55.9	38.2	53.5	39.1	68.3	70.5	27.6	23.2	42.0	35.5
3	91.2	42.0	5.2	4.7	5.3	4.2	35.0	33.2	5.7	3.4	11.8	8.1	1.2	0.9	0.0	0.0	21.2	17.8	27.5	23.3
Total	171.3	78.8	81.3	74.0	96.6	75.7	84.6	80.2	124.4	74.3	118.1	80.7	93.3	68.3	79.0	81.6	93.6	78.6	99.7	84.3

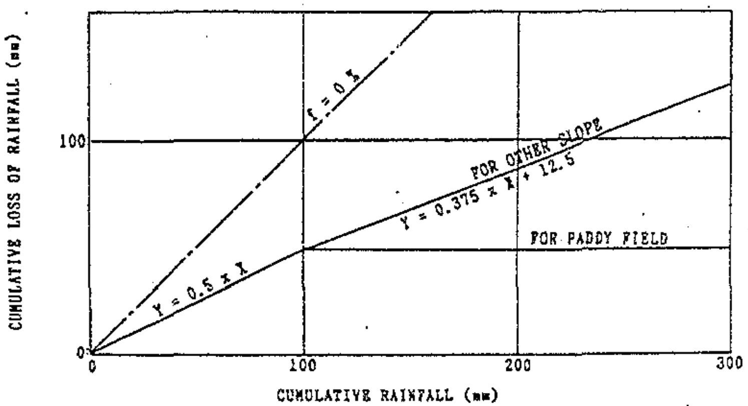
(mm)

Day	44082		44122		44132		06062		25142		25172		25530		22042		22070		22150	
	Ob.	De.	Ob.	De.	Ob.	De.	Ob.	De.	Ob.	De.	Ob.	De.	Ob.	De.	Ob.	De.	Ob.	De.	Ob.	De.
1	19.6	19.1	57.5	25.3	15.9	14.2	30.8	23.4	34.0	44.9	25.4	40.6	2.7	5.3	35.7	24.2	19.7	27.7	48.2	59.9
2	57.5	56.2	102.0	44.9	33.8	30.3	52.7	40.0	17.2	22.7	25.6	40.8	25.2	49.6	39.8	27.0	23.5	33.1	0.0	0.0
3	3.1	3.0	37.5	16.5	24.5	21.9	30.7	23.3	3.5	4.7	0.6	1.0	8.7	17.2	40.5	27.4	18.2	25.6	0.0	0.0
Total	80.2	78.3	197.0	86.7	74.2	66.4	114.2	86.7	54.7	72.3	51.6	82.4	36.6	72.1	116.0	78.6	61.4	86.4	48.2	59.9

Note : Ob. = Observation De. = Design Rainfall

FIGURE 3-4-2 EFFECTIVE RAINFALL





Runoff Coefficient during Flood

Amount of flood runoff was plotted against the amount of flood rainfall at stations. An envelope curve was drawn mainly from the data obtained at the station kgt.12, as shown in Figure This envelope curve was then converted into an equation showing relation between the accumulated storm rainfall and rainfall loss as under:

$SL = 0.5 \times SR$, when $SR < 100$ mm

$SL = 0.375 \times SR + 12.5$, when $SR > 100$ mm

where, SL : Cumulative loss of rainfall (mm)

SR : Cumulative rainfall (mm)

Effective Rainfall

Effective rainfall is, then, calculated as follows:

$SRE_t = SR_t - SL_t$

$RE_t = SRE_t - SRE_{t-1}$

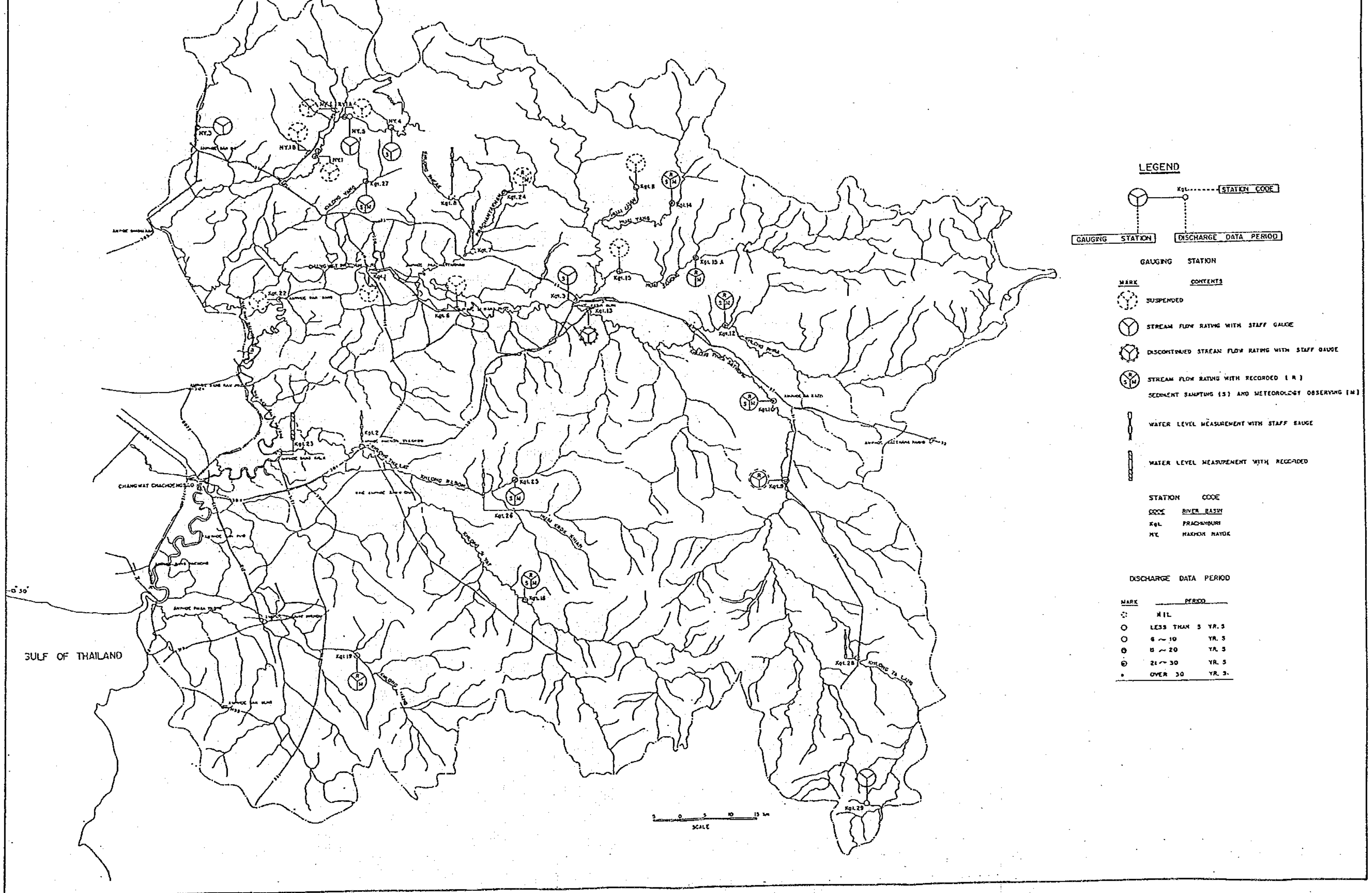
where, SRE : Cumulative effective rainfall (mm)

t, t-1: time

3. 5 Runoff Analysis

3. 5. 1 River Gauging Station

FIGURE 3-5-1 RIVER GAUGING STATION



3.5.2 Basic Statistics of River Discharge

TABLE 3-5-1 MONTHLY RUNOFF DISCHARGE AT KGT. 3

(MCM)

	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Annual
1967	3.445	42.075	68.651	420.509	1,149.293	742.262	920.419	82.771	31.143	9.165	4.360	3.779	3,477.872
1968	7.506	52.694	39.158	102.211	500.688	423.187	238.982	33.715	20.966	5.167	2.725	0.894	1,427.894
1969	0.778	6.527	125.861	643.939	810.259	1,531.354	686.189	118.282	40.522	15.664	6.419	3.280	3,989.072
1970	5.720	17.215	173.150	453.254	808.013	890.433	420.682	104.803	66.701	16.403	7.089	6.117	2,969.585
1971	4.972	18.459	457.229	481.766	609.898	990.144	559.526	193.190	43.235	16.844	8.342	5.580	3,389.195
1972	26.736	8.286	45.356	237.859	599.184	1,506.298	890.093	275.789	111.974	25.440	8.882	5.020	3,740.917
1973	3.439	9.219	36.003	298.322	471.571	1,242.950	961.546	182.736	53.568	19.837	13.478	29.112	3,321.782
1974	64.368	121.046	240.278	149.645	646.963	643.421	1,301.875	265.680	51.322	14.221	4.722	4.765	3,508.306
1975	6.267	16.589	282.182	609.120	875.318	903.398	887.760	111.456	44.340	16.585	10.043	7.430	3,770.491
1976	5.918	14.589	162.605	717.552	769.133	1,148.342	600.826	508.032	67.392	22.965	10.333	7.854	4,035.541
1977	6.575	13.426	29.912	235.958	454.550	1,016.150	485.914	121.219	42.457	13.081	5.694	4.475	2,429.421
1978	4.72	76.98	279.23	811.07	1,020.17	1,021.85	1,038.46	84.85	39.36	14.54	4.16	1.11	4,396.50
1979	1.58	37.15	90.34	659.27	462.00	384.07	499.39	35.55	22.95	6.04	2.16	1.39	2,201.89
1980	5.67	10.78	188.27	416.41	585.19	1,086.45	898.98	234.57	61.72	24.15	12.74	22.16	3,547.09
1981	10.69	70.84	290.49	544.16	909.43	685.27	762.84	269.20	81.13	23.88	12.94	7.94	3,668.82
1982	12.96	14.71	75.08	328.12	901.66	1,203.80	574.27	153.40	53.11	11.46	4.05	2.98	3,335.61
1983	1.93	6.70	75.25	215.40	1,265.09	907.57	1,946.99	261.76	39.03	8.16	0.03	0.00	4,727.90
1984	6.960	22.413	177.320	223.630	745.925	654.593	629.566	73.578	31.029	6.774	2.968	1.387	2,576.142
1985	9.12	154.62	390.21	543.44	613.71	889.43	511.26	180.29	62.70	13.72	6.00	2.45	3,376.94
1986	6.07	231.55	165.01	382.63	760.09	1,031.64	1,188.56	155.52	51.48	17.69	7.32	4.65	4,002.21
1987	10.17	25.05	80.00	116.19	154.85	932.67	407.51	178.33	66.22	20.82	16.56	11.06	2,019.40
1988	9.43	67.05	503.88	387.92	688.66	568.27	1,122.48	182.42	56.38	19.07	11.01	8.23	3,624.79
1989	8.415	63.276	189.215	261.963	797.449	623.054	368.955	88.160	41.956	16.433	7.668	23.035	2,489.580
1990	11.42	38.30	54.27	92.21	247.90	629.44	1,952.93	280.88	62.93	27.52	12.81	9.67	3,420.27
Max.	64.368	231.55	503.88	811.07	1,265.09	1,531.354	1,952.93	508.032	111.974	27.52	16.56	29.112	4,727.90
Min.	0.778	6.527	29.912	92.21	247.90	384.07	238.982	33.715	20.966	5.167	0.03	0.00	1,427.894
Mean	9.786	47.481	175.790	393.023	701.958	902.335	500.671	174.008	51.817	16.068	7.604	7.582	3,307.384
S. D.	12.450	53.196	131.461	198.521	252.893	294.256	453.970	102.205	19.279	6.124	4.120	7.267	761.296
C. V.	1.272	1.120	0.748	0.505	2.776	0.326	0.907	0.587	2.688	0.381	0.542	0.958	0.230

Note ; S.D. = Standard Deviation C.V. = Coefficient of Variation

MONTHLY RUNOFF DISCHARGE AT KGT. 18

(MCM)

	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Annual
1967	–	–	–	–	–	–	–	–	–	–	–	–	–
1968	–	–	–	–	–	–	–	–	–	–	–	–	–
1969	–	–	7.837	32.033	32.236	131.524	30.874	4.058	0.442	0.215	0.058	0.00	–
1970	0.141	0.128	26.489	39.500	49.087	83.720	24.073	1.319	0.651	0.052	0.003	0.035	255.198
1971	0.117	1.578	73.787	19.690	121.342	162.670	123.474	25.176	1.168	0.256	0.155	0.175	529.588
1972	1.531	0.324	3.247	1.406	14.188	133.643	44.937	4.324	0.900	0.318	0.153	0.058	205.029
1973	0.000	1.642	2.565	51.296	38.325	155.088	65.953	12.322	0.817	0.057	0.026	0.161	328.254
1974	3.396	118.306	12.385	16.646	34.313	34.645	217.766	50.008	0.869	0.855	0.533	0.511	390.233
1975	0.408	2.766	24.150	56.453	36.747	75.517	147.865	7.181	0.917	0.422	0.314	0.436	353.176
1976	0.260	0.352	0.880	11.819	37.016	134.693	44.940	31.462	1.335	0.470	0.251	0.222	263.700
1977	–	0.510	–	5.532	34.213	43.206	15.898	1.478	0.377	0.798	0.136	0.032	–
1978	0.001	6.932	17.778	109.082	51.030	197.521	73.568	2.840	0.185	0.023	0.000	0.000	458.960
1979	0.000	0.177	4.695	15.770	9.552	25.358	26.594	0.062	0.003	0.000	0.000	0.000	82.423
1980	0.000	0.142	54.181	25.718	66.251	72.773	64.154	8.707	0.649	0.159	0.133	0.104	292.969
1981	0.498	21.128	6.808	4.586	10.212	119.469	57.085	23.132	4.222	1.380	0.626	0.478	249.624
1982	0.480	0.575	1.558	1.269	15.870	53.886	30.949	7.883	2.115	0.465	0.318	0.203	115.570
1983	0.002	0.009	3.295	12.509	97.673	118.228	215.009	17.833	3.181	1.127	1.133	0.606	470.604
1984	0.164	0.424	2.295	4.698	29.471	64.922	76.413	3.883	0.505	0.138	0.060	0.044	183.017
1985	0.100	4.793	4.273	14.599	11.167	42.791	48.504	9.088	1.051	0.497	0.342	0.206	137.413
1986	0.130	29.170	24.119	61.481	101.676	59.636	100.615	8.249	1.255	0.534	0.346	0.284	387.495
1987	0.252	0.881	0.826	1.159	4.071	37.390	41.745	9.585	1.236	0.391	0.429	0.396	38.361
1988	0.187	6.950	43.691	33.895	84.424	58.663	184.886	11.781	1.648	0.550	0.303	0.185	427.162
1989	0.502	0.603	1.082	12.100	16.653	34.139	15.694	1.572	0.611	0.551	0.448	1.175	85.130
1990	0.437	2.127	2.832	20.454	18.986	84.982	231.499	10.540	1.504	0.511	0.256	0.219	375.349
Max.	3.396	118.306	73.787	109.082	121.342	197.521	184.886	50.008	4.222	1.380	1.133	1.175	529.588
Min.	0.001	0.009	0.826	1.159	4.071	34.139	15.898	0.062	0.442	0.000	0.000	0.000	38.361
Mean	0.506	9.501	15.180	25.077	41.614	87.476	85.568	11.477	1.155	0.465	0.296	0.291	279.963
S. D.	0.799	25.389	19.494	25.339	32.296	47.762	68.219	11.635	0.929	0.340	0.259	0.266	140.525
C. V.	1.579	2.672	1.284	1.010	0.776	0.546	0.797	1.014	0.804	0.731	0.875	0.914	0.502

MONTHLY RUNOFF DISCHARGE AT NY. 1, 1B

(MCM)

	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Annual
1967	–	–	–	–	–	–	–	–	–	–	–	–	–
1968	–	–	–	–	–	–	–	–	–	–	–	–	–
1969	–	–	–	–	–	–	–	–	–	–	–	–	–
1970	–	–	–	–	–	–	–	–	–	–	–	–	–
1971	–	–	–	–	–	–	–	–	–	–	–	–	–
1972	–	–	–	–	–	–	–	–	–	–	–	–	–
1973	0.745	3.460	47.377	126.217	191.030	171.590	72.317	23.522	9.720	2.877	1.629	0.886	651.371
1974	2.380	7.962	71.349	94.954	151.200	105.408	107.654	48.038	21.259	8.882	4.242	3.046	626.374
1975	2.040	6.063	201.874	162.778	242.093	136.512	103.594	41.328	16.067	5.574	4.398	1.678	923.996
1976	0.898	32.379	118.022	156.989	215.050	201.744	103.075	56.678	33.129	8.420	2.048	0.778	929.210
1977	0.108	8.549	48.557	140.244	151.200	138.758	61.776	30.326	11.500	1.814	0.600	0.216	593.648
1978	0.000	10.705	97.152	188.378	212.971	121.046	111.944	27.700	2.873	0.829	0.125	0.000	773.724
1979	0.550	8.332	59.545	131.223	200.112	114.201	53.480	9.658	3.325	2.473	1.554	1.161	585.613
1980	2.024	2.935	64.192	166.592	174.790	125.957	101.216	38.229	9.040	2.712	2.127	2.190	692.005
1981	–	–	–	–	–	–	–	–	–	–	–	–	–
1982	–	–	–	–	–	–	–	–	–	–	–	–	–
1983	–	–	–	–	–	–	–	–	–	–	–	–	–
1984	–	–	–	–	–	–	–	–	–	–	–	–	–
1985	–	–	–	–	–	–	–	–	–	–	–	–	–
1986	–	–	–	–	–	–	–	–	–	–	–	–	–
1987	–	–	–	–	–	–	–	–	–	–	–	–	–
1988	–	–	–	–	–	–	–	–	–	–	–	–	–
1989	–	–	–	–	–	–	–	–	–	–	–	–	–
1990	–	–	–	–	–	–	–	–	–	–	–	–	–
Max.	2.380	32.379	201.874	188.378	242.093	201.744	111.944	56.678	33.129	8.882	4.398	3.046	929.210
Min.	0.000	2.935	47.377	94.954	151.200	105.408	53.480	9.658	2.873	0.829	0.125	0.000	585.613
Mean	1.249	10.048	88.509	145.922	192.306	139.402	89.382	34.435	13.364	4.198	2.090	1.422	721.993
S. D.	0.817	8.793	48.490	27.089	29.941	30.082	21.548	13.861	9.398	2.864	1.438	0.888	130.634
C. V.	0.654	0.875	0.548	0.186	0.156	0.216	0.241	0.403	0.703	0.682	0.688	0.624	0.181

MONTHLY RUNOFF DISCHARGE AT NY. 3

(MCM)

	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Annual
1967	–	–	–	–	–	–	–	–	–	–	–	–	–
1968	–	–	–	–	–	–	–	–	–	–	–	–	–
1969	–	–	–	–	–	–	–	–	–	–	–	–	–
1970	–	–	–	–	–	–	–	–	–	–	–	–	–
1971	–	–	–	–	–	–	–	–	–	–	–	–	–
1972	–	–	–	–	–	–	–	–	–	–	–	–	–
1973	–	–	–	–	–	–	–	–	–	–	–	–	–
1974	–	–	–	–	–	–	–	–	–	–	–	–	–
1975	–	–	–	–	–	–	–	–	–	–	–	–	–
1976	–	–	–	–	–	–	–	–	–	–	–	–	–
1977	1.069	0.753	7.121	12.814	34.853	47.968	24.814	6.521	1.887	0.979	0.700	0.524	140.003
1978	0.276	2.163	12.195	36.781	35.010	35.821	34.384	4.073	2.130	0.817	0.410	0.188	164.249
1979	0.244	1.967	3.468	16.775	37.468	48.247	20.294	1.750	1.092	0.514	0.193	0.113	132.124
1980	0.315	0.082	6.667	23.141	44.943	47.994	53.136	9.226	2.397	1.209	0.984	0.803	190.897
1981	–	–	–	–	–	–	–	–	–	–	–	–	–
1982	0.787	0.942	2.181	10.025	23.097	55.626	31.257	5.770	3.612	1.475	0.814	0.636	136.221
1983	0.330	0.410	1.514	7.180	71.510	28.127	79.023	11.720	2.745	3.395	3.760	2.655	212.369
1984	0.816	0.615	2.584	20.834	31.620	38.590	40.061	5.998	3.265	2.950	0.820	0.586	148.738
1985	0.452	0.682	2.354	18.745	29.833	79.722	45.871	21.075	5.761	7.052	5.799	5.407	222.753
1986	4.394	8.222	8.065	27.281	58.393	38.984	50.319	10.123	5.749	3.886	1.454	0.020	216.891
1987	0.025	0.086	0.272	2.549	3.771	–	38.446	12.341	6.563	4.647	3.425	0.877	–
1988	0.189	3.774	24.758	16.970	32.651	34.938	29.177	5.594	2.394	0.695	0.178	0.005	151.324
1989	0.014	0.001	0.064	0.801	30.570	44.087	25.599	4.894	1.446	0.759	0.102	0.119	108.456
1990	0.000	0.483	2.963	4.828	10.171	31.209	66.226	10.893	2.156	0.797	0.097	0.121	129.944
Max.	4.394	8.222	24.758	36.781	71.510	79.722	79.023	21.075	6.563	7.052	5.799	5.407	216.891
Min.	0.000	0.001	0.064	0.801	3.771	31.209	20.294	1.750	1.446	0.514	0.097	0.020	108.456
Mean	0.743	1.552	5.708	15.286	34.145	44.276	41.431	8.460	3.169	2.244	1.441	0.927	162.831
S. D.	1.144	2.180	6.436	9.986	17.035	13.163	16.528	4.775	1.699	1.930	1.702	1.458	36.854
C. V.	1.540	1.405	1.128	0.653	0.499	0.297	0.399	0.564	0.536	0.860	1.181	1.573	0.226

TABLE 3－5－2 PEAK DISCHARGE (1)

(m³/S)

	Kgt. 1 9,209km²	Kgt. 3 7,502km²	Kgt. 6 7,978km²	Kgt. 9 2,279km²	Kgt.10 2,523km²	Kgt.11 34km²	Kgt.12 1,540km²	Kgt.13 5,347km²	Kgt.14 366km²	Kgt.15 789km²
1967	583 Aug.26	725 Oct. 4	609 Oct. 5	—	208 Oct. 4	—	199 Oct. 6	412 Oct. 5	303 Aug.17	359 Oct. 3
1968	450 Aug.18	400 Sep.16	—	—	120 Aug.17	—	116 Aug.16	226 Aug.16	65 Aug.16	156 Sep.14
1969	611 Sep.27	1,111 Sep.23	—	354 Sep.23	250 Sep.24	—	221 Sep.25	—	359 Sep.21	419 Sep.23
1970	—	577 Aug.29	—	262 Aug.28	233 Aug.29	—	156 Aug.31	—	63 Jul.14	206 Aug.27
1971	—	552 Sep. 5	549 Sep. 5	—	358 Sep. 1	—	153 Sep. 4	449 Sep. 5	57 Jun.17	198 Aug.31
1972	—	993 Sep.21	634 Sep.22	246 Sep.30	227 Sep. 9	—	191 Sep.10	484 Sep.21	290 Sep. 7	404 Sep. 8
1973	—	855 Sep.30	575 Oct. 1	322 Nov.17	265 Sep.27	23 Aug.19	202 Oct. 1	483 Oct. 1	115 Sep.11	258 Sep.22
1974	—	952 Oct.16	636 Oct.17	412 Oct.10	704 Oct.11	20 Aug.27	214 Oct.15	966 Oct.16	61 Aug.27	201 Aug.28
1975	—	579 Oct.12	533 Oct.12	289 Oct. 4	301 Oct. 5	17 Sep.11	141 Oct. 8	469 Oct.11	241 Oct. 4	—
1976	—	659 Sep.20	558 Sep.22	405 Sep.15	386 Sep.16	—	165 Sep.18	500 Sep.21	143 Oct.26	—
1977	—	670 Sep.13	530 Sep.15	168 Sep.25	161 Aug.23	—	133 Sep.14	435 Sep.14	87 Sep.11	—
1978	—	1,057 Oct. 3	659 Oct. 4	286 Sep.24	197 Sep.24	—	178 Sep.26	693 Oct. 2	188 Aug. 9	—
1979	—	538 Oct. 1	537 Oct.3	300 Oct. 1	248 Oct. 2	—	165 Oct. 5	477 Oct. 2	66 Sep.29	—
1980	—	514 Sep. 2	—	277 Sep.12	229 Sep.14	—	157 Sep.16	336 Sep. 2	110 Sep.29	—
1981	—	770 Sep.30	—	354 Sep.23	368 Sep.23	—	250 Sep.27	636 Sep.30	72 Aug. 8	—
1982	—	606 Aug.26	—	214 Sep.12	210 Aug.27	—	181 Sep.14	427 Aug.27	119 Sep.11	—
1983	—	1,064 Oct.20	—	409 Oct.20	936 Oct.20	—	487 Oct. 5	751 Oct.23	184 Aug.26	—
1984	—	456 Aug.16	—	211 Oct.10	203 Oct.11	—	162 Aug.15	373 Aug.16	123 Oct.20	—
1985	—	516 Sep.22	—	239 Sep.26	225 Sep.28	—	87 Sep.29	308 Sep.22	—	—
1986	—	792 Oct.11	—	422 Oct. 7	405 Oct. 7	—	205 Oct. 8	729 Oct.10	166 Oct. 2	—
1987	—	538 Sep.13	—	—	185 Sep.14	—	114 Sep.15	335 Sep.15	142 Sep. 7	—
1988	—	613 Oct.25	—	—	786 Oct.19	—	176 Oct.23	582 Oct.25	127 Aug. 1	—
1989	—	604 Aug.15	—	199 Sep.13	159 Sep.14	—	90 Aug.16	372 Aug.16	110 Aug.26	—
1990	—	2,220 Oct. 6	—	541 Oct. 5	1,420 Oct. 6	—	274 Oct. 8	2,272 Oct. 6	373 Oct. 5	—

PEAK DISCHARGE (2)

(m³/S)

	Kgt.15A 530 km²	Kgt.18 951 km²	Kgt.19 535 km²	Kgt.22 Flood Plain	Kgt.24 121 km²	Kgt.25 243 km²	Kgt.27 45 km²	Kgt.29 52 km²
1967	—	—	60 Oct. 3	505 Oct.14	—	—	—	—
1968	96 Sep.15	—	39 Aug. 6	409 Aug.11	—	—	—	—
1969	334 Sep.22	268 Sep.22	96 Sep.22	—	—	—	—	—
1970	132 Sep. 6	138 Sep.22	40 Jun.29	—	—	—	—	—
1971	138 Aug.31	212 Oct.30	168 Oct.12	521 Sep. 8	114 Aug.21	—	—	—
1972	470 Sep.19	129 Sep.25	102 Sep. 8	573 Oct. 7	402 Oct. 4	—	—	—
1973	242 Sep.18	217 Sep.19	59 Sep.19	505 Oct.12	98 Aug.19	—	—	—
1974	121 Oct.12	194 Oct.20	1,261 Oct.19	540 Oct.25	163 Aug.20	—	—	—
1975	118 Jul.11	158 Oct. 5	78 Oct.10	532 Sep.10	607 Aug.26	—	—	—
1976	181 Jul. 2	500 Sep.14	56 Sep.15	553 Sep.28	146 Aug.28	—	—	—
1977	232 Sep.11	101 Sep.24	17 Sep. 2	505 Sep.23	127 Aug.21	—	—	—
1978	247 Oct. 2	301 Sep.19	105 Sep.18	569 Oct.10	280 Jul.25	23 Sep. 5	—	—
1979	126 Sep.25	91 Sep.30	28 Oct. 3	445 Oct.10	89 Sep.24	23 Sep.30	—	—
1980	161 Sep.11	118 sep.24	70 Sep.24	495 Oct. 8	166 Jul. 9	68 Sep.12	—	—
1981	153 Sep.23	171 Sep.23	81 Sep.23	—	173 Aug. 9	29 Aug.10	—	—
1982	211 Sep. 7	55 Sep.11	30 Oct. 2	—	108 Sep.29	32 Aug.26	—	—
1983	231 Oct. 5	383 Oct.20	303 Oct.19	—	99 Aug. 8	108 Oct.19	47 Jul.16	—
1984	95 Aug.16	118 Oct.10	37 Oct.16	—	83 Jul.10	28 Aug.12	27 Oct. 7	—
1985	119 Aug.23	74 Oct.24	10 May.19	—	186 Aug.21	19 Jul.23	72 Aug.21	—
1986	314 Oct. 4	184 Oct. 7	84 Aug.17	—	—	124 Sep.11	78 Sep.11	62 Sep. 3
1987	262 Sep.11	79 Oct. 6	29 Oct. 3	—	—	24 Sep.18	69 Sep.18	50 Aug.25
1988	115 Aug. 2	214 Oct.19	206 Oct.18	—	—	33 Oct.19	57 Sep.13	87 Oct.16
1989	233 Jun.27	54 Sep.13	45 Sep.16	—	—	19 Sep. 4	16 Oct.19	10 Oct.12
1990	558 Oct. 5	475 Oct. 5	358 Oct. 5	—	—	—	91 Oct. 5	94 Oct. 4

PEAK DISCHARGE (3)

(m³/S)

	Ny. 1 520 km²	Ny.1B 519 km²	Ny.1A 187 km²	Ny. 2 150 km²	Ny. 3 203 km²	Ny. 4 128 km²	Ny. 5 186 km²	Ny. 6 116 km²
1967	358 Aug.20	—	187 Sep.24	410 Aug.20	—	—	—	—
1968	270 Aug.16	—	—	—	—	—	—	—
1969	385 Jul.24	—	—	—	—	—	—	—
1970	222 Jul.14	—	—	—	—	—	—	—
1971	288 Jul. 9	—	—	—	—	—	—	—
1972	371 Sep.19	—	—	—	—	—	—	—
1973	—	488 Aug.19	—	—	—	—	—	—
1974	—	283 Aug.27	—	—	—	—	—	—
1975	—	340 Aug.21	—	—	—	—	—	—
1976	—	263 Jun. 2	—	—	—	—	—	—
1977	—	303 Jul.22	—	—	88 Aug.12	—	—	—
1978	—	369 Jul.27	—	—	81 Oct. 2	—	—	—
1979	—	337 Aug.18	—	—	111 Sep.25	—	—	—
1980	—	275 Aug.18	—	—	105 Sep.11	—	—	—
1981	—	—	—	—	—	—	—	—
1982	—	—	—	—	75 Sep.12	—	—	—
1983	—	—	—	—	95 Oct.11	—	—	—
1984	—	—	—	—	47 Jul.13	—	—	—
1985	—	—	—	—	85 Sep.21	—	—	—
1986	—	—	—	—	107 Aug.16	260 Sep. 6	616 Sep. 6	—
1987	—	—	—	—	51 Oct.13	300 Sep. 9	162 Aug.28	—
1988	—	—	—	—	70 Sep.21	374 Jul.19	247 Jul.20	61 Sep.20
1989	—	—	—	—	58 Sep.23	233 Aug.26	159 Aug.26	58 Aug.11
1990	—	—	—	—	115 Oct. 5	429 Oct. 5	300 Oct. 5	—

TABLE 3-5-3 PROBABILITY OF PEAK DISCHARGE

(m³/S)

	W=1/2	W=1/5	W=1/10	W=1/15	W=1/20	W=1/30	W=1/50	W=1/100	W=1/200	W=1/500	Remarks
Kgt.3	761.2	975.7	1,104.6	1,173.6	1,220.6	1,284.8	1,362.8	1,465.0	1,564.0	1,691.1	1941～1990
7,502km²	0.101	0.130	0.147	0.156	0.163	0.171	0.182	0.195	0.208	0.225	n=44
Kgt.10	268.8	475.6	672.8	807.4	912.3	1,074.7	1,304.7	1,667.8	2,095.4	2,771.8	1967～1990
2,523km²	0.107	0.189	0.267	0.320	0.362	0.426	0.517	0.661	0.831	1.099	n=24
Kgt.12	175.8	236.2	272.9	292.7	306.3	324.8	347.4	377.2	406.2	443.7	1967～1990
1,540km²	0.114	0.153	0.177	0.190	0.199	0.211	0.226	0.245	0.264	0.288	n=24
Kgt.13	480.9	735.0	941.3	1,070.8	1,167.1	1,309.6	1,500.7	1,783.5	2,094.2	2,550.9	1967～1990
5,347km²	0.090	0.137	0.182	0.200	0.218	0.245	0.281	0.334	0.392	0.477	n=22
Kgt.14	125.2	223.7	299.4	345.7	379.5	428.9	493.9	588.0	689.1	834.1	1967～1990
366km²	0.342	0.611	0.818	0.945	1.037	1.172	1.349	1.607	1.883	2.279	n=23
Kgt.15A	178.6	278.8	360.9	412.6	451.1	508.3	585.2	699.3	825.1	1,010.8	1968～1990
530km²	0.337	0.526	0.681	0.778	0.851	0.959	1.104	1.319	1.557	1.907	n=23
Kgt.18	158.0	271.2	360.6	415.8	456.6	516.4	595.8	712.0	838.1	1,021.2	1969～1990
951km²	0.166	0.285	0.379	0.437	0.480	0.543	0.626	0.749	0.881	1.074	n=22
Kgt.19	68.6	173.8	286.3	367.9	433.8	539.1	694.2	951.3	1,269.6	1,800.9	1967～1990
535km²	0.128	0.325	0.535	0.688	0.811	1.008	1.298	1.778	2.373	3.366	n=24
Kgt.25	30.8	55.1	80.8	99.2	114.0	137.5	172.0	228.8	298.6	414.1	1978～1989
243km²	0.127	0.227	0.333	0.408	0.469	0.566	0.708	0.942	1.229	1.704	n=12
Nyl,1B	350.1	438.5	496.2	528.5	551.1	582.5	621.8	675.0	728.3	799.3	1955～1980
520km²	0.673	0.843	0.954	1.016	1.060	1.120	1.196	1.298	1.401	1.537	n=24
Ny.3	83.5	102.8	112.9	118.0	121.3	125.7	130.7	137.1	142.9	150.0	1977～1990
203km²	0.411	0.506	0.556	0.581	0.598	0.619	0.644	0.675	0.704	0.739	n=13

Note;The lower : is specific discharge (m³/S・km²)

TABLE 3-5-4 TEN DAY MAXIMUM DISCHARGE AT KGT. 3 (1)

CA=7,502㎢

	Apr.			May.			Jun.			Jul.			Aug.			Sep.		
	1~10	11~20	21~30	1~10	11~20	21~31	1~10	11~20	21~30	1~10	11~20	21~31	1~10	11~20	21~31	1~10	11~20	21~30
1967	0.35	0.41	7.96	5.00	21	77	53	66	22	90	279	364	418	542	504	380	280	499
1968	0.35	0.14	29	22	88	11	45	28	20	64	33	75	280	391	222	74	324	269
1969	0.26	0.57	0.32	5.18	7.40	2.59	78	91	81	214	314	524	506	502	182	621	631	1,106
1970	2.50	2.60	2.70	11	5.70	10	11	59	259	273	341	225	226	463	577	557	405	268
1971	1.00	1.40	8.40	6.40	6.80	23	48	434	393	199	220	252	229	271	507	551	407	471
1972	28	29	11	8.00	2.40	2.80	24	51	15	53	124	186	391	397	221	729	962	973
1973	1.90	1.00	2.60	3.35	4.70	7.80	8.80	27	35	105	253	253	149	167	418	553	548	852
1974	10	112	50	35	52	123	165	172	103	58	50	118	215	254	529	526	242	255
1975	4.30	2.91	1.95	2.56	3.52	51	69	112	292	209	378	350	305	493	449	454	431	357
1976	3.10	4.20	2.10	4.25	4.25	13	172	76	37	467	207	453	384	300	485	474	641	648
1977	1.90	6.20	4.40	5.40	6.80	8.00	13	8.40	22	138	148	251	202	183	316	390	662	428
1978	2.6	6.5	3.8	2.0	65.6	113.6	88.5	132.0	237.9	306.4	305.6	464.4	524.6	519.9	406.9	315.6	487.8	819.9
1979	0.0	0.4	6.2	9.0	11.4	48.0	25.1	37.2	207.3	432.6	427.0	117.4	237.4	299.8	179.3	86.5	88.5	515.4
1980	2.5	1.9	4.4	2.3	4.9	10.0	13.0	58.0	240.5	232.8	110.8	356.2	329.8	149.2	414.7	509.2	493.0	383.4
1981	3.2	3.7	12.5	20.7	26.7	98.0	90.0	137.2	230.4	189.6	209.1	426.8	572.0	611.2	299.6	170.1	137.8	694.5
1982	2.3	22.5	18.6	1.8	11.6	18.6	16.5	79.0	46.4	145.6	238.2	143.8	280.6	299.0	605.0	540.0	593.0	460.0
1983	1.5	0.9	0.5	6.8	6.2	4.5	79.0	87.0	32.2	32.8	218.9	178.3	503.6	574.6	557.6	518.0	396.4	573.2
1984	3.80	1.80	6.90	7.30	4.85	48.80	70.47	94.00	126.74	75.66	210.75	72.82	166.80	503.00	463.35	352.40	348.40	229.04
1985	1.1	4.1	20.3	33.9	136.1	101.9	151.7	183.0	305.8	220.0	365.8	246.3	166.0	272.2	377.5	389.6	453.5	514.0
1986	1.6	5.3	3.4	24.1	266.0	127.0	36.3	122.8	143.8	77.7	158.8	275.1	256.2	439.4	391.7	553.2	716.0	378.4
1987	5.2	3.1	7.3	23.5	19.8	9.0	21.0	27.7	109.7	67.1	126.0	35.1	27.0	63.2	235.6	374.2	517.2	480.6
1988	2.5	2.8	16.7	35.3	51.8	34.6	243.3	388.4	330.8	76.8	255.7	340.1	388.4	299.6	218.6	163.0	380.3	447.4
1989	6.60	3.00	6.60	5.85	34.45	61.85	67.37	42.43	388.34	207.05	48.84	237.80	102.30	602.06	470.99	319.44	365.98	179.60
1990	5.8	5.4	7.6	29.3	16.1	24.8	18.2	54.6	13.8	47.4	39.8	98.5	95.5	147.8	199.1	224.3	419.0	327.0
Max.	28	112	50	35.3	266.0	127	243.3	434	393	467	427	524	524.6	602.06	657.6	729	962	1,106
Min.	0.0	0.14	0.32	1.8	2.40	2.59	8.80	27	13.8	32.8	33	35.1	27.0	63.2	179.3	74	88.5	179.60
Mean	4.016	9.243	9.801	12.916	35.753	42.91	66.968	106.989	153.862	165.896	210.929	253.318	289.8	364.332	392.914	409.356	455.054	505.351
S.D.	5.578	22.435	10.824	11.348	57.596	41.038	59.564	102.156	125.231	115.242	109.733	132.941	143.135	156.940	145.121	168.403	186.239	234.004
C.V.	1.389	2.427	1.104	0.879	1.611	0.956	0.889	0.955	0.001	0.695	0.520	0.525	0.494	0.431	0.369	0.411	0.409	0.463

TEN DAY MAXIMUM DISCHARGE AT KGT. 3 (2)

CA = 7,502 km²

	Oct.			Nov.			Dec.			Jan.			Feb.			Mar.		
	1~10	11~20	21~31	1~10	11~20	21~30	1~10	11~20	21~31	1~10	11~20	21~31	1~10	11~20	21~28	1~10	11~20	21~31
1967	722	559	139	45	65	26	16	13	11	6.17	3.60	2.60	2.30	2.10	2.50	1.90	1.09	2.70
1968	163	124	82	24	13	11	9.08	10	8.66	4.31	2.28	1.56	2.68	1.13	0.50	0.47	0.32	0.64
1969	692	241	120	82	52	30	19	17	15	11	6.08	4.40	3.11	3.11	2.59	1.90	1.40	1.06
1970	292	210	144	108	39	24	40	36	19	11	6.60	4.95	3.60	2.90	2.60	3.00	2.50	2.10
1971	468	341	171	243	57	29	20	22	14	18	6.60	4.80	4.20	3.40	3.55	2.95	3.85	2.95
1972	690	381	228	83	143	192	81	70	29	18	11	7.10	5.00	3.80	3.05	3.05	1.90	1.90
1973	713	580	104	52	221	250	30	25	18	10	7.60	6.60	6.80	5.60	5.60	4.55	12	50
1974	410	949	668	190	119	75	33	22	15	10	5.60	4.40	2.45	3.95	1.60	1.20	4.10	4.25
1975	557	574	176	94	51	31	21	20	14	9.00	6.69	5.35	4.45	4.45	3.88	3.16	2.92	3.28
1976	265	230	409	444	222	72	38	27	25	14	9.20	7.00	5.60	4.55	3.65	3.20	3.20	3.30
1977	338	234	226	174	45	29	25	17	18	8.40	5.80	3.80	3.20	3.20	1.80	1.60	1.60	2.80
1978	1,052.8	542.0	114.2	65.6	37.4	24.1	16.9	17.2	15.3	9.4	6.7	4.2	2.6	2.0	1.5	1.0	0.6	0.2
1979	535.2	177.9	44.8	27.2	14.3	10.2	11.0	11.0	8.2	5.2	2.4	1.5	1.2	1.0	0.8	0.8	0.6	0.8
1980	486.7	381.8	387.0	254.5	123.4	53.2	34.5	26.5	19.0	12.6	9.4	7.9	6.6	5.7	4.7	18.1	22.3	6.1
1981	685.5	264.2	187.0	197.5	142.6	103.0	67.4	31.2	25.5	14.0	9.6	7.4	5.8	7.4	5.0	3.8	3.5	3.4
1982	487.0	208.9	164.2	126.4	70.5	76.0	44.4	23.1	12.2	7.7	5.1	3.3	2.0	3.6	2.0	5.5	0.5	0.2
1983	825.7	874.3	806.8	274.0	162.0	79.0	29.4	14.2	11.6	8.0	3.4	1.3	0.3	0.0	0.0	0.0	0.0	0.0
1984	358.80	372.20	239.04	52.80	29.22	23.04	14.76	14.76	12.00	4.55	2.75	2.30	2.60	1.20	1.00	0.85	0.55	0.45
1985	382.6	183.6	289.8	156.4	101.3	52.6	48.9	28.0	15.6	7.9	5.4	4.5	3.1	2.8	4.1	2.5	1.1	0.6
1986	783.6	789.2	291.2	174.4	58.8	40.8	24.8	23.4	19.7	14.7	6.5	4.7	3.4	4.0	3.6	2.2	1.8	2.5
1987	285.6	207.5	117.5	130.3	94.1	70.1	41.1	27.4	20.1	13.6	8.6	6.5	6.1	10.3	9.7	7.6	7.4	2.8
1988	364.4	556.3	613.0	279.5	63.5	38.7	25.5	23.7	21.2	11.2	7.9	5.9	7.9	4.3	3.8	3.1	3.3	3.8
1989	173.36	224.30	255.29	57.69	39.35	26.10	18.60	19.20	16.80	9.00	6.60	6.00	4.35	3.30	3.15	2.80	59.30	17.40
1990	1,754.0	945.0	805.0	304.1	111.5	63.8	34.7	26.0	20.9	16.4	11.6	7.6	6.4	5.5	4.8	4.5	4.0	3.7
Max.	1,754.0	949	668	444	222	250	81	70	29	18	11.6	7.9	7.9	10.3	9.7	18.1	59.30	50
Min.	163	124	44.8	24	13	10.2	9.08	10	8.2	4.31	2.28	1.3	1.2	0.0	0.0	0.0	0.0	0.0
Mean	561.886	422.925	282.576	151.641	86.457	59.568	30.252	23.528	16.865	10.589	6.542	4.819	3.989	3.720	3.145	3.467	6.080	5.084
S.D.	331.144	251.065	217.827	103.790	57.610	54.846	17.664	11.573	5.126	3.853	2.505	1.960	1.897	2.155	2.003	3.515	12.289	10.159
C.V.	0.589	0.594	0.771	0.684	0.666	0.921	0.584	0.492	0.304	0.364	0.383	0.407	0.476	0.579	0.637	1.014	2.021	1.998

TEN DAY MAXIMUM DISCHARGE AT KGT. 18 (1)

CA = 951 km²

	Apr.			May.			Jun.			Jul.			Aug.			Sep.		
	1～10	11～20	21～30	1～10	11～20	21～31	1～10	11～20	21～30	1～10	11～20	21～31	1～10	11～20	21～31	1～10	11～20	21～30
1967	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1968	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1969	–	–	–	–	–	0.850	6.00	11	5.64	8.80	49	48	40	22	39	40	135	263
1970	0.12	0.070	0.030	0.070	0.050	0.070	6.00	8.78	63	57	25	18	23	26	93	13	45	129
1971	0.045	0.055	0.070	4.18	0.16	3.00	4.82	127	90	31	12	7.30	5.86	58	192	133	117	109
1972	2.06	1.34	2.81	0.97	0.079	0.053	7.34	2.14	1.44	1.66	0.39	0.39	6.48	35	2.10	101	107	107
1973	0.00	0.00	0.00	0.74	0.59	5.70	3.96	1.60	1.00	27	72	24	14	14	45	48	212	119
1974	0.18	7.34	4.20	1.84	19	18	30	7.67	3.10	12	16	26	78	9.32	32	15	24	28
1975	0.20	0.16	0.16	0.98	0.20	7.16	8.36	57	45	93	38	48	11	36	22	39	53	76
1976	0.16	0.10	0.09	0.13	0.34	0.32	1.39	0.40	0.15	0.34	5.40	36	51	16	42	102	275	30
1977	–	–	–	0.12	0.76	0.28	–	–	–	1.90	6.30	5.90	18	22	61	30	24	93
1978	0.00	0.00	0.00	0.00	5.80	14.65	4.90	39.50	11.54	42.75	188.50	85.70	29.30	12.19	83.95	42.50	273.90	191.80
1979	0.00	0.00	0.00	0.05	0.40	0.19	0.22	9.00	7.60	14.59	4.56	22.85	11.99	10.30	0.94	4.56	2.96	88.90
1980	0.00	0.00	0.00	0.00	0.19	0.10	19.16	64.63	80.60	18.10	3.98	27.36	37.00	19.96	70.56	34.22	49.08	112.11
1981	0.07	0.19	0.97	4.70	31.60	17.55	7.80	1.28	7.80	1.68	1.68	3.30	8.10	8.10	7.03	21.70	113.32	171.20
1982	0.11	0.26	0.52	0.18	0.10	1.18	0.70	2.91	0.61	0.22	0.30	1.90	1.10	5.64	23.80	31.13	49.42	47.86
1983	0.01	0.00	0.00	0.00	0.03	0.02	0.28	5.94	1.46	1.00	19.06	13.68	91.00	63.62	53.20	50.80	28.61	183.50
1984	0.18	0.12	0.06	0.05	0.40	0.55	0.74	0.82	6.15	2.60	11.55	1.38	0.18	34.88	67.20	83.28	29.30	50.29
1985	0.09	0.05	0.10	0.21	3.66	8.72	4.70	1.75	1.70	0.89	23.32	33.80	14.95	2.65	12.12	19.00	19.80	59.16
1986	0.00	0.00	0.42	35.66	84.64	3.54	3.36	28.07	29.02	6.70	21.00	81.11	23.88	142.60	38.88	34.40	87.00	16.96
1987	0.16	0.07	0.26	0.81	0.60	0.36	0.28	0.42	0.81	0.87	0.69	0.78	5.50	1.35	2.48	2.20	35.49	42.15
1988	0.00	0.00	1.92	2.80	8.08	2.87	51.72	96.66	7.87	5.63	14.67	44.14	51.98	57.52	51.45	13.18	62.24	81.15
1989	0.236	0.202	0.180	0.161	0.247	0.720	0.262	1.080	0.960	1.440	21.920	52.890	1.230	48.030	4.700	12.030	51.810	11.660
1990	1.06	0.21	0.04	0.46	2.46	1.63	0.53	8.67	0.50	4.20	4.52	60.12	23.96	12.56	10.54	84.82	89.56	53.12
Max.	2.06	7.34	4.20	35.66	84.64	18	51.72	127	90	57	188.50	85.70	91.00	142.60	192.0	133.0	275	263
Min.	0.00	0.00	0.00	0.00	0.03	0.02	0.22	0.40	0.15	0.22	0.30	0.39	0.18	1.35	0.94	2.20	2.96	11.660
Mean	0.234	0.508	0.592	2.577	7.590	3.978	7.739	22.682	17.426	12.821	24.534	29.209	24.887	30.449	43.407	43.401	85.659	93.812
S.D.	0.476	1.593	1.090	7.517	18.815	5.617	12.033	34.443	27.132	20.736	39.685	24.954	24.051	30.138	42.125	34.765	75.887	62.509
C.V.	2.034	3.136	1.841	2.917	2.479	1.412	1.555	1.519	1.557	1.617	1.618	0.854	0.966	0.990	0.970	0.801	0.886	0.666

TEN DAY MAXIMUM DISCHARGE AT KGT. 18 (2)

CA = 951 km²

	Oct.			Nov.			Dec.			Jan.			Feb.			Mar.		
	1~10	11~20	21~31	1~10	11~20	21~30	1~10	11~20	21~31	1~10	11~20	21~31	1~10	11~20	21~28	1~10	11~20	21~31
1967	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1968	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1969	68	7.10	9.60	5.82	1.40	0.54	0.27	0.18	0.12	0.072	0.15	0.096	0.024	0.024	0.024	0.00	–	0.00
1970	38	17	4.72	1.90	0.47	0.17	1.96	0.23	0.10	0.05	0.03	0.01	0.0	0.02	0.0	0.01	–	0.15
1971	92	121	206	71	7.20	2.52	1.12	0.51	0.24	0.12	0.095	0.090	0.075	0.065	0.065	0.050	0.055	0.45
1972	63	24	6.24	7.34	4.70	3.39	0.67	0.52	0.23	0.14	0.14	0.12	0.066	0.079	0.079	0.066	0.024	0.024
1973	81	43	5.70	2.46	64	2.84	0.71	0.41	0.18	0.060	0.040	0.040	0.10	0.080	0.00	0.00	0.56	0.14
1974	189	188	174	90	47	5.32	0.38	0.32	0.56	0.36	0.34	0.52	0.26	0.24	0.24	0.26	0.20	0.20
1975	149	89	13	6.70	3.89	1.34	0.67	0.36	0.22	0.20	0.17	0.15	0.17	0.16	0.12	0.11	0.13	1.22
1976	41	22	35	64	10	2.10	0.91	0.55	0.36	0.24	0.19	0.16	0.11	0.15	0.10	0.03	0.10	0.11
1977	28	4.64	5.30	1.35	0.68	0.39	0.22	0.16	0.10	0.12	0.08	0.08	0.10	0.05	0.05	0.04	0.008	0.03
1978	236.20	15.70	7.40	2.94	1.30	0.55	0.18	0.08	0.03	0.01	0.04	0.01	0.00	0.00	0.00	0.00	0.00	0.00
1979	81.28	3.60	0.70	0.25	0.08	0.05	0.04	0.03	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1980	61.22	13.86	45.48	9.00	4.66	1.40	0.52	0.26	0.17	0.15	0.08	0.04	0.10	0.05	0.26	0.17	0.07	0.02
1981	39.48	33.23	71.64	24.08	9.85	8.60	3.79	1.76	1.04	0.76	0.55	0.43	0.31	0.28	0.22	0.31	0.22	0.16
1982	41.50	9.20	18.85	5.56	13.38	4.56	3.17	0.74	0.36	0.20	0.19	0.17	0.18	0.13	0.18	0.10	0.13	0.10
1983	114.80	329.00	213.50	13.44	13.68	5.30	2.36	1.30	0.82	0.61	0.38	0.46	0.38	1.09	0.85	0.40	0.24	0.19
1984	111.66	87.65	12.65	3.16	1.80	1.14	0.38	0.22	0.17	0.03	0.03	0.32	0.03	0.03	0.03	0.03	0.03	0.01
1985	22.64	26.40	59.42	12.36	3.98	1.85	0.83	0.40	0.29	0.23	0.19	0.17	0.15	0.15	0.14	0.14	0.11	0.06
1986	177.90	29.78	22.60	9.10	4.14	2.40	0.85	0.50	0.30	0.25	0.21	0.19	0.18	0.16	0.16	0.15	0.11	0.19
1987	72.44	19.76	6.53	10.60	10.10	6.62	1.06	0.50	0.32	0.20	0.17	0.13	0.09	0.56	0.18	0.40	0.20	0.10
1988	103.06	206.00	151.94	14.39	4.66	2.14	1.23	0.64	0.46	0.40	0.22	0.22	0.28	0.12	0.13	0.25	0.06	0.10
1989	12.940	13.850	4.500	1.950	0.760	0.360	0.255	0.236	0.221	0.218	0.214	0.206	0.195	0.188	0.180	0.580	1.600	0.500
1990	340.25	89.56	199.00	11.48	4.04	2.05	1.19	0.65	0.36	0.27	0.20	0.20	0.13	0.12	0.09	0.11	0.11	0.08
Max.	340.25	329.00	213.50	90	64	8.60	3.79	1.76	1.04	0.76	0.55	0.52	0.38	1.09	0.85	0.580	1.600	1.22
Min.	12.940	3.60	0.70	0.25	0.08	0.05	0.22	0.03	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mean	98.335	63.333	57.899	17.019	9.626	2.529	1.035	0.480	0.303	0.214	0.169	0.173	0.133	0.170	0.141	0.148	0.198	0.174
S.D.	77.348	80.656	74.075	24.369	15.258	2.221	0.953	0.386	0.239	0.182	0.126	0.141	0.102	0.234	0.174	0.154	0.344	0.262
C.V.	0.787	1.274	1.279	1.448	1.585	0.878	0.921	0.804	0.789	0.850	0.746	0.815	0.767	1.376	1.234	1.041	1.737	1.506

TEN DAY MAXIMUM DISCHRGE AT NY1, 1B (1) NY 1, CA=520㎢

NY1B, CA=519 〃

	Apr.			May.			Jun.			Jul.			Aug.			Sep.		
	1~10	11~20	21~30	1~10	11~20	21~31	1~10	11~20	21~30	1~10	11~20	21~31	1~10	11~20	21~31	1~10	11~20	21~30
1967	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1968	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1969	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1970	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1971	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1972	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1973	0.46	0.37	0.45	0.90	5.35	4.00	4.15	56	25	61	112	121	36	388	159	101	92	278
1974	0.60	1.10	4.00	2.40	4.45	7.60	59	42	75	32	97	153	30	90	187	81	43	54
1975	1.90	0.70	0.70	1.40	6.30	6.10	131	159	270	66	190	90	79	90	252	96	155	67
1976	0.50	0.70	0.30	5.12	8.34	65	190	81	56	149	97	119	91	146	171	145	170	103
1977	0.10	0.15	0.050	0.40	1.20	26	16	28	120	59	27	195	123	187	104	154	160	56
1978	0.00	0.00	0.00	0.00	2.50	20.10	48.00	56.75	102.00	103.80	54.05	291.60	270.70	158.10	77.50	40.00	86.40	184.70
1979	0.14	0.00	0.98	0.84	5.61	17.76	18.32	17.76	167.30	120.76	52.40	132.36	164.96	237.23	76.86	56.90	27.72	198.34
1980	0.78	0.83	0.82	0.75	0.77	2.34	8.70	35.65	116.40	159.30	41.50	139.80	77.80	196.90	146.30	73.40	78.90	95.40
1981	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1982	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1983	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1984	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1985	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1986	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1987	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1988	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1989	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1990	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Max.	1.90	1.10	4.00	5.12	8.34	65	131	159	270	159.30	190	291.60	270.70	388	252	154	170	278
Min.	0.00	0.00	0.00	0.00	0.77	2.34	4.15	17.76	25	32	27	90	30	90	76.86	40.00	27.72	54
Mean	0.64	0.64	1.04	1.69	4.32	18.61	59.40	59.52	116.46	93.86	83.87	155.2	109.05	186.65	146.71	93.41	101.63	129.56
S.D.	0.56	0.31	1.24	1.52	2.46	19.25	62.76	41.82	70.82	43.36	49.13	58.83	73.52	89.69	55.84	37.31	50.83	76.41
C.V.	0.875	0.484	1.192	0.899	0.569	1.034	1.057	0.703	0.608	0.462	0.586	0.379	0.674	0.481	0.381	0.399	0.500	0.590

TEN DAY MAXIMUM DISCHRGE AT NY1, 1B (2) NY1, CA=520㎢

NY1B, CA=519″

	Oct.			Nov.			Dec.			Jan.			Feb.			Mar.		
	1~10	11~20	21~31	1~10	11~20	21~30	1~10	11~20	21~31	1~10	11~20	21~31	1~10	11~20	21~28	1~10	11~20	21~31
1967	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1968	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1969	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1970	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1971	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1972	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1973	66	29	19	15	12	9.25	7.00	4.75	1.80	1.40	1.20	1.00	1.40	0.60	0.70	0.40	0.35	0.40
1974	68	123	29	39	26	13	12	11	6.40	4.60	4.75	4.30	2.40	4.30	2.00	3.85	1.40	1.00
1975	92	57	23	20	25	13	11	7.50	4.70	2.70	2.20	1.91	4.70	2.10	1.30	0.90	0.70	0.63
1976	44	99	64	36	23	18	16	17	11	8.55	3.28	1.50	1.30	0.90	0.70	0.70	0.30	0.50
1977	41	27	23	15	13	17	9.00	5.40	2.30	1.50	0.65	0.50	0.40	0.30	0.25	0.20	0.10	0.15
1978	297.90	27.00	18.90	15.00	14.40	10.20	2.95	1.00	0.70	0.35	0.50	0.30	0.20	0.05	0.00	0.00	0.00	0.00
1979	51.50	16.08	18.04	8.40	4.05	2.20	1.70	1.33	1.12	1.60	0.91	0.84	0.77	0.63	0.56	0.56	0.42	0.49
1980	106.80	35.65	32.50	22.84	17.50	16.50	12.00	3.50	2.02	1.49	0.98	0.92	0.90	0.87	0.92	0.92	0.83	0.80
1981	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1982	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1983	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1984	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1985	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1986	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1987	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1988	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1989	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1990	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Max.	297.90	123	64	39	26	18	16	17	11	8.55	4.75	4.30	4.70	4.30	2.00	3.85	1.40	1.00
Min.	41	16.08	18.04	8.40	4.05	2.20	1.70	1.33	0.70	0.35	0.50	0.30	0.20	0.05	0.00	0.00	0.00	0.00
Mean	95.9	73.81	28.43	17.66	16.87	12.39	8.96	6.44	3.76	2.77	1.81	1.41	1.51	1.22	0.92	1.08	0.59	0.57
S.D.	79.29	65.53	14.27	8.30	7.04	4.86	4.54	5.02	3.27	2.48	1.41	1.19	1.36	1.30	0.53	1.16	0.40	0.26
C.V.	0.827	0.888	0.502	0.470	0.417	0.392	0.507	0.780	0.870	0.895	0.779	0.844	0.901	1.066	0.576	1.074	0.678	0.456

TEN DAY MAXIMUM DISCHARGE AT NY3 (1)

CA = 203km²

	Apr.			May.			Jun.			Jul.			Aug.			Sep.		
	1~10	11~20	21~30	1~10	11~20	21~31	1~10	11~20	21~30	1~10	11~20	21~31	1~10	11~20	21~31	1~10	11~20	21~30
1967	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1968	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1969	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1970	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1971	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1972	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1973	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1974	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1975	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1976	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1977	1.20	0.34	0.35	0.25	0.56	0.37	1.16	9.67	7.18	6.30	2.20	16	29	69	19	39	29	45
1978	0.13	0.16	0.10	0.08	0.22	7.40	5.31	5.00	16.10	32.40	14.45	32.00	26.64	24.86	17.80	8.76	32.40	55.50
1979	0.13	0.19	0.19	0.13	1.44	2.68	1.08	0.72	14.00	15.95	13.16	18.12	27.20	57.25	29.80	18.76	10.36	108.26
1980	0.15	0.14	0.12	0.08	0.04	0.02	0.71	11.29	3.94	10.45	17.04	40.14	14.38	66.10	31.08	23.38	77.43	43.08
1981	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1982	0.30	0.30	0.44	0.38	0.40	0.44	0.68	1.21	1.60	4.01	6.40	9.05	5.77	5.77	26.32	45.32	71.08	30.40
1983	0.23	0.19	0.05	0.12	0.29	0.28	1.60	1.21	0.64	0.44	4.45	22.00	47.79	44.56	56.45	43.99	9.05	11.96
1984	0.64	0.26	0.32	0.50	0.23	0.26	0.32	4.35	2.06	14.98	35.07	5.15	6.40	31.59	19.44	7.48	32.45	34.90
1985	0.18	0.17	0.21	0.20	0.28	0.64	0.48	0.74	3.42	1.21	57.65	16.94	17.25	21.52	21.04	69.32	53.85	82.61
1986	0.50	2.12	2.60	3.24	4.40	4.90	2.20	7.18	8.89	5.00	13.58	46.92	48.99	98.55	14.30	30.80	42.26	17.16
1987	0.00	0.04	0.02	0.10	0.10	0.04	0.28	0.22	0.13	1.44	1.20	0.96	1.12	1.38	3.56	–	–	–
1988	0.00	1.35	0.24	1.85	1.50	5.92	12.08	33.08	13.16	8.00	8.70	34.70	17.26	45.10	6.10	7.18	41.20	66.86
1989	0.035	0.040	0.000	0.000	0.015	0.000	0.000	0.055	0.075	0.060	0.360	1.060	3.110	36.755	43.560	34.770	13.960	46.790
1990	0.00	0.00	0.00	0.00	0.00	2.00	2.20	4.08	0.70	3.87	3.52	2.80	8.25	6.27	3.80	17.18	34.45	10.91
Max.	1.20	2.12	2.60	3.24	4.40	7.40	12.08	33.08	16.10	32.40	57.65	46.92	48.99	98.55	56.45	69.32	77.43	108.26
Min.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.055	0.13	0.060	0.360	0.96	1.12	1.38	3.56	7.18	9.05	10.91
Mean	0.269	0.408	0.357	0.569	0.729	1.919	2.162	6.062	5.530	8.008	13.675	18.911	19.474	39.131	22.481	28.828	37.291	46.119
S.D.	0.327	0.593	0.661	0.939	1.161	2.450	3.156	8.565	5.521	8.627	15.527	14.846	15.191	27.369	14.749	17.977	20.933	27.900
C.V.	1.216	1.453	1.852	1.650	1.593	1.277	1.460	1.413	0.998	1.077	1.135	0.785	0.780	0.699	0.656	0.624	0.561	0.605

TEN DAY. MAXIMUM DISCHARGE AT NY3 (2)

CA = 203km²

	Oct.			Nov.			Dec.			Jan.			Feb.			Mar.		
	1~10	11~20	21~31	1~10	11~20	21~30	1~10	11~20	21~31	1~10	11~20	21~31	1~10	11~20	21~28	1~10	11~20	21~31
1967	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1968	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1969	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1970	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1971	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1972	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1973	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1974	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1975	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1976	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1977	18	12	12	7.73	2.60	1.44	1.04	0.80	0.60	0.48	0.40	0.31	0.31	0.25	0.56	0.31	0.25	0.16
1978	73.30	7.73	4.40	2.36	1.88	1.50	1.12	0.88	0.96	0.40	0.37	0.28	0.22	0.22	0.19	0.16	0.08	0.04
1979	39.84	4.12	12.32	1.26	0.80	0.48	0.72	0.52	0.37	0.52	0.34	0.13	0.10	0.10	0.06	0.05	0.09	0.05
1980	63.64	26.23	13.97	10.23	5.08	2.50	1.49	1.05	0.75	0.75	0.60	0.57	0.64	0.57	1.15	0.90	0.71	0.15
1981	–	–	–	–	–	–	–	–	–	–	–	–		–	–	–	–	–
1982	43.23	11.96	21.84	5.77	2.78	1.60	6.76	1.21	0.98	0.94	0.64	0.61	0.53	0.34	0.36	0.28	0.26	0.25
1983	34.90	87.01	57.85	9.80	7.72	2.94	1.42	1.03	0.98	0.98	1.12	2.06	1.90	1.84	1.54	1.60	1.17	0.85
1984	29.55	27.34	19.76	3.50	3.76	2.06	1.90	1.36	1.30	1.30	1.21	1.30	1.03	0.30	0.27	0.36	0.26	0.21
1985	20.56	11.96	52.85	34.37	8.32	4.65	3.10	2.30	2.22	2.54	2.94	3.18	3.02	2.54	2.46	2.78	2.38	1.90
1986	88.90	16.40	12.32	7.73	4.40	3.88	2.84	2.44	2.68	2.60	1.68	1.38	1.26	1.12	0.22	0.07	0.00	0.00
1987	20.36	47.38	16.40	10.36	6.30	3.32	3.08	2.60	2.60	2.52	2.20	1.80	1.96	1.88	1.26	0.80	0.40	0.34
1988	26.80	20.56	19.05	6.28	2.00	1.65	2.00	1.30	0.84	0.60	0.33	0.24	0.28	0.06	0.01	0.03	0.00	0.00
1989	19.360	18.940	24.740	4.230	2.480	1.260	2.360	0.460	0.400	0.460	0.320	0.360	0.140	0.060	0.045	0.005	0.260	0.080
1990	110.75	26.54	26.20	11.90	9.00	2.30	1.10	0.94	0.94	0.61	0.36	0.26	0.12	0.20	0.00	0.00	0.12	0.20
Max.	110.75	87.01	57.85	34.37	9.00	4.65	6.76	2.44	2.68	2.60	2.94	3.18	3.02	2.54	2.46	2.78	2.38	1.90
Min.	18	4.12	4.40	1.26	0.80	0.48	0.72	0.37	0.37	0.40	0.33	0.24	0.10	0.06	0.00	0.00	0.00	0.00
Mean	45.32	24.47	22.59	8.89	4.39	2.27	2.23	1.30	1.20	1.13	0.96	0.96	0.89	0.73	0.68	0.61	0.54	0.38
S.D.	28.68	20.99	15.10	8.01	2.58	1.12	1.52	0.68	0.76	0.82	0.81	0.89	0.88	0.80	0.73	0.79	0.66	0.52
C.V.	0.633	0.858	0.668	0.901	0.588	0.493	0.682	0.523	0.633	0.726	0.844	0.927	0.989	1.096	1.074	1.295	1.222	1.368

3.5.3 Flood Runoff Method

The mechanism of surface runoff may fall generally into two parts; namely (1) the behaviour of rain water which flows down a sloping surface and pours directly into river channel and (2) the behaviour of lateral inflow which pours into such a stream. As a simplified stream condition, the behaviour of unsteady flow in an open channel with distributed lateral inflow along a channel is studied hydraulically to establish the basic relationship between the rate of inflow and runoff in a stream or on a sloping surface. Hydrographs under this simplified condition are easily computed for both laminar and turbulent flows, and the hydraulic character of hydrographs resulting from simulated inflow at a given rate are investigated. The method of characteristics was employed to express this phenomenon. Breif explanation is as below:

If the law of resistance of Manning's type is used, unsteady flow in an open channel with a given rate of lateral inflow would be expressed for the practical purposes by the equations;

$$A = n \times I^{-1/2} \times R^{2/3} \times Q = kQ^{p} \quad \text{and}$$

$$\frac{\partial A}{\partial t} + \frac{\partial Q}{\partial X} = q$$

The method of characteristics is applied in order to solve the above equations and the characteristic curves are given as follows:

$$\frac{dX}{1} = \frac{dt}{dA/dQ} = \frac{dt}{pkQ^{p-1}} = \frac{dQ}{q}$$

where, A : cross-sectional area of flow (sq.m)

n : Manning's roughness coefficient

I : water surface slope of flow

R : hydraulic radius (m)

Q : discharge (cu.m/sec)

k, p : constants

t : time

X : distance along channel (m)

q : lateral inflow per unit length of channel (cu.m/sec/m)

This means that to solve the former equations is to solve the following two equations on a characteristic curve, which is expressed as $dX/dt = Q^{1-p}/pk$. Thus;

$qdt = pkQ^{p-1}$ or $qt = kQ^p$ + constant, and

$qdX = dQ$ or $qX = Q$ + constant

Taking that constant = 0, the flow condition is expressed for a given magnitude of lateral inflow q, as;

$t = kQ^p/q$ and

$t = kXQ^{p-1}$

When q=0, it is expressed on a characteristic curve given above that A = constant and Q = constant $= (A/k)^{1/p}$. The flow condition is so given as follows:

$X = (Q^{1-p}/pk)t.$

Some Consideration on Effect of Storage on a Paddy Plot

The time lag of concentration of runoff is generally recognized to be remarkable for drainage area mainly composed of low flat paddy because of storage capacity on a paddy plot. A paddy plot surrounded by levees with certain depth of flooding water can be regarded as a small reservoir and, therefore, the conception of simplified reservoir operation could be introduced to take into account the effect of rain water deposit on a paddy plot.

A storage function is introduced to calculate the specific runoff capacity from a paddy plot by the following equation:

$$\frac{dV}{dt} = I - O$$

where V denotes storage on a paddy plot, I and O, inflow into and outflow from a paddy plot respectively, and t time. The above equation can be divided by the water surface area on a plot, A, and then transformed:

$$\frac{dH}{dt} = i - o$$

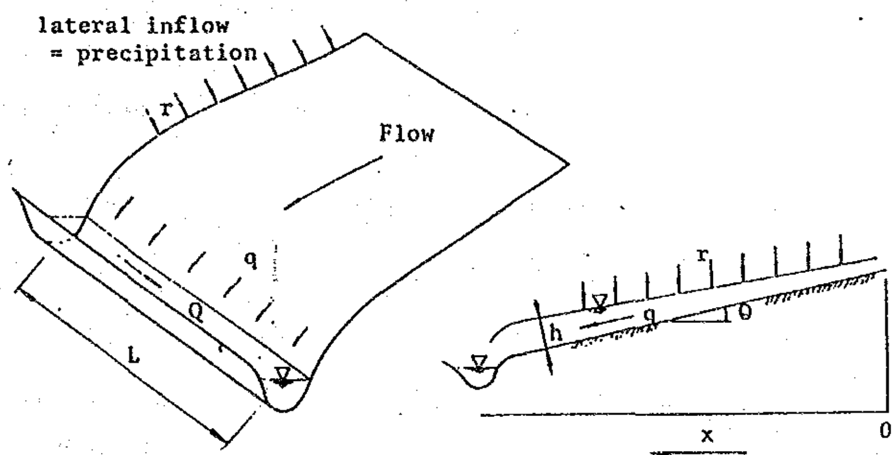
where H shows ponding depth on a plot, i specific inflow corresponding to effective rainfall on a plot, and o specific outflow corresponding to the specific runoff capacity from a paddy plot. A differencial equation is constructed to solve the above equation by a computer as;

$$H_{t+1} = H_t + (RE_{t,t+1} - \frac{O_t - O_{t+1}}{2})\Delta t$$

where $RE_{t,t+1}$ represents effective rainfall between time t and t+1 and Δt is a time interval given for computation. The specific runoff capacity from paddy fields is thus computed at corresponding time t, and then this is considered as a lateral inflow of drainade canal or stream.

Application of the Characteristic Method to a Real Problem

(1) For a Slope



- In the case when $r \neq 0$

$t = kq^p/\delta r$

$t = kXq^{p-1}$

- When $r = 0$

$$t = pkX/q^{1-p} = 0.6q^{-0.4}(N/I^{1/2})^{0.6}X$$

where, δ : conversion rate from mm/hr to m^3/sec = 0.2778×10^{-6}

r : effective rainfall (mm/hr)

q : discharge per unit width of slope (m^3/sec/m)

N : equivalent roughness coefficient of slope

I : slope = $\sin\theta$

X : flow distance

(2) For River or Channel : As stated previously with theoretical conception.

(3) For Paddy Field

- for ditch

$$A_m = kQ_m^p$$

$$\frac{\partial A_m}{\partial t} + \frac{\partial Q_m}{\partial X} = (2b0)\alpha, \text{ and}$$

- for lateral drainage canal

$$A_b = kQ_b^p$$

$$\frac{\partial A_b}{\partial t} + \frac{\partial Q_b}{\partial X} = \frac{Q_m}{2b}$$

where, A_m, Q_m : flow area and discharge in a ditch

A_b, Q_b : flow area and discharge in a laretal canal

k, p : constants

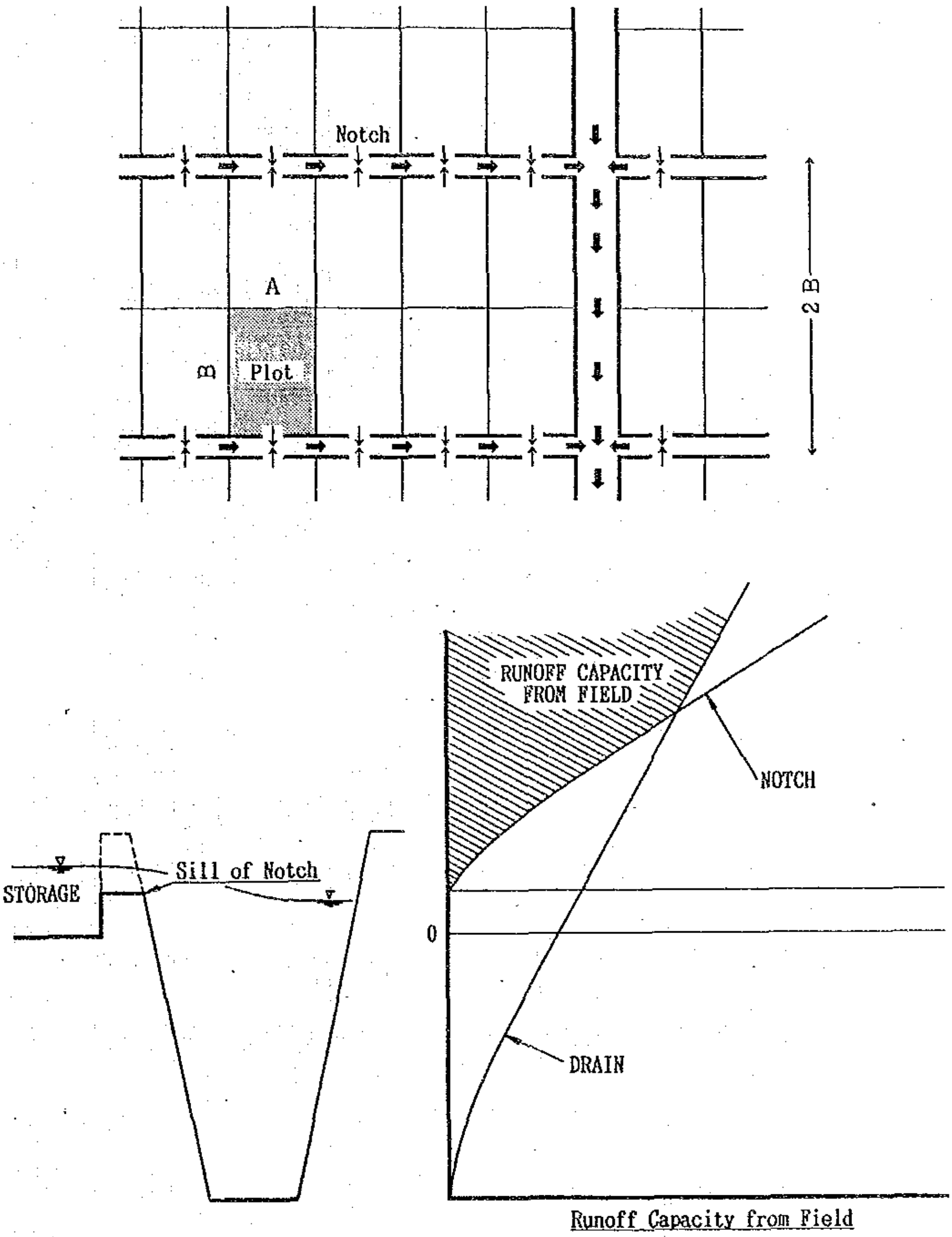
α : = 0.2778×10^{-6}

b : see Figure

0 : runoff capacity per unit area (mm/hr)

Table 3-5-5 presents basin characteristics given for flood runoff analysis, and Figure(p.__)shows the concept of runoff capacity from the paddy field.

RUNOFF CAPACITY FROM PADDY FIELD



3. 5. 4 Blocking of Watershed and Runoff Model Constants

TABLE 3-5-5 BASIN CHARACTERISTICS GIVEN FOR FLOOD RUNOFF ANALYSIS

Sub Basin	Site No	Watershed Area (sq. km)				Slope Gradient			River Chan.	
		Paddy	Upland	Others	Total	Pad.	Upld	Othr	Lngt	Slope
UPP-3	803	0.0	0.0	266.0	266.0	300	200	30	30	90
-2	802	215.2	103.0	455.6	774.0	200	170	10	58	1450
-1	801	250.4	272.1	65.5	588.0	200	160	10	58	2900
KPS-4	704	19.7	231.2	363.1	614.0	200	150	40	48	170
-3	703	26.2	304.2	507.6	838.0	200	120	80	45	1100
-2	702	92.4	103.3	605.3	801.0	200	150	120	38	1900
-1	701	161.3	163.2	65.5	390.0	300	200	100	50	5000
MPP-1	601	195.2	218.2	556.6	970.0	500	450	200	63	6300
MHM-5	505	0.0	0.0	68.0	68.0	400	300	25	8	90
-6	506	0.0	56.5	39.5	96.0	500	400	15	7	35
-4	504	38.8	3.9	131.3	174.0	800	500	60	18	450
-8	508	0.0	0.0	64.0	64.0	200	100	60	10	250
-9	509	0.0	0.0	147.0	147.0	1000	500	50	20	80
-7	507	0.0	0.0	232.0	232.0	1000	800	100	28	350
-3	503	0.0	0.0	273.0	273.0	200	150	110	37	300
-2	502	0.0	0.0	159.0	159.0	500	300	170	28	40
-1	501	206.4	340.6	370.0	917.0	2000	800	80	53	1300
UBP-3	403	346.9	374.5	28.6	750.0	1000	400	300	40	8000
-5	405	0.0	0.0	107.0	107.0	300	200	130	15	35
-4	404	230.3	103.6	60.1	394.0	500	250	110	35	1200
-2	402	177.2	262.8	6.0	446.0	1000	250	60	38	8000
-1	401	919.4	134.8	5.8	1060.0	5000	3000	400	43	8000
MNN-6	306	0.0	0.0	151.0	151.0	200	100	10	18	450
-5	305	34.3	82.1	339.6	456.0	3000	500	300	40	110
-4	304	0.0	0.0	114.0	114.0	200	100	10	8	60
-3	303	179.4	44.1	121.5	345.0	1000	300	60	25	1700
-2	302	260.3	46.2	62.5	369.0	5000	5000	400	15	1900
-1	301	342.8	8.0	147.2	498.0	5000	5000	400	35	3500
KTL-9	209	1.3	24.5	559.2	585.0	200	100	70	38	420
-8	208	3.8	36.4	350.8	391.0	200	100	20	38	380
-7	207	2.5	98.7	293.8	395.0	200	140	70	33	1700
-4	204	7.9	100.8	28.3	137.0	200	100	100	25	2500
-6	206	1.8	82.3	96.9	181.0	200	180	100	18	1800
-5	205	7.6	121.2	488.2	617.0	200	200	100	43	1100
-3	203	0.0	62.7	6.3	69.0	5000	3000	200	18	1000
-2	202	1.3	77.3	7.4	86.0	5000	3000	200	15	7500
-1	201	13.7	15.2	3.1	32.0	5000	3000	400	22	9000
LBP-17	117	11.9	3.6	4.5	20.0	5000	500	400	7	3500
-16	116	22.0	160.8	16.2	199.0	5000	400	400	30	1250
-15	115	18.5	41.8	4.7	65.0	5000	300	300	12	500
-14	114	12.5	171.3	17.2	201.0	5000	250	300	25	830
-13	113	27.8	12.7	15.5	56.0	5000	400	400	8	800
-12	112	1.4	250.0	92.6	344.0	2000	100	70	15	500
-11	111	6.4	137.9	39.7	184.0	2000	200	70	15	1000
-10	110	25.3	53.9	5.8	85.0	2000	200	300	13	1300
-9	109	26.2	54.6	7.2	88.0	2000	200	70	15	300
-8	108	99.5	77.8	4.7	182.0	5000	500	300	28	2800
-7	107	39.7	415.5	45.8	501.0	2000	100	70	25	190
-6	106	59.6	13.0	7.4	80.0	2000	200	200	25	1050
-3	103	438.9	82.2	4.9	526.0	5000	3000	400	45	15000
-2	102	48.4	12.6	58.0	119.0	5000	3000	400	8	15000
-5	105	104.8	172.2	2.0	279.0	2000	100	70	20	670
-4	104	83.9	41.6	16.5	142.0	5000	800	400	15	5000
-1	101	0.0	1.6	33.4	35.0	5000	500	400	10	1700

FIGURE 3-5-2 BLOCKING OF WATERSHED IN BANG PAKONG RIVER

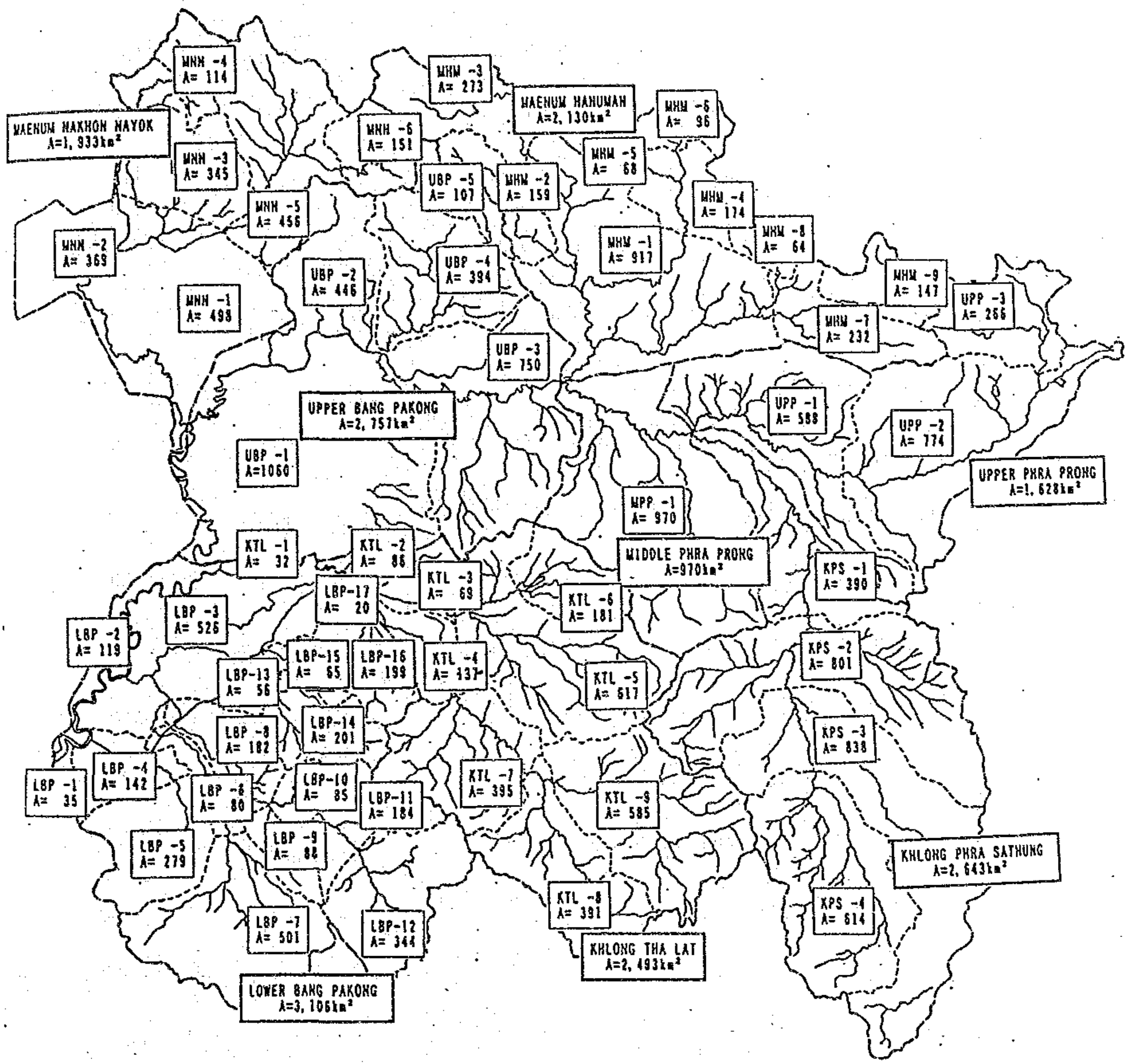
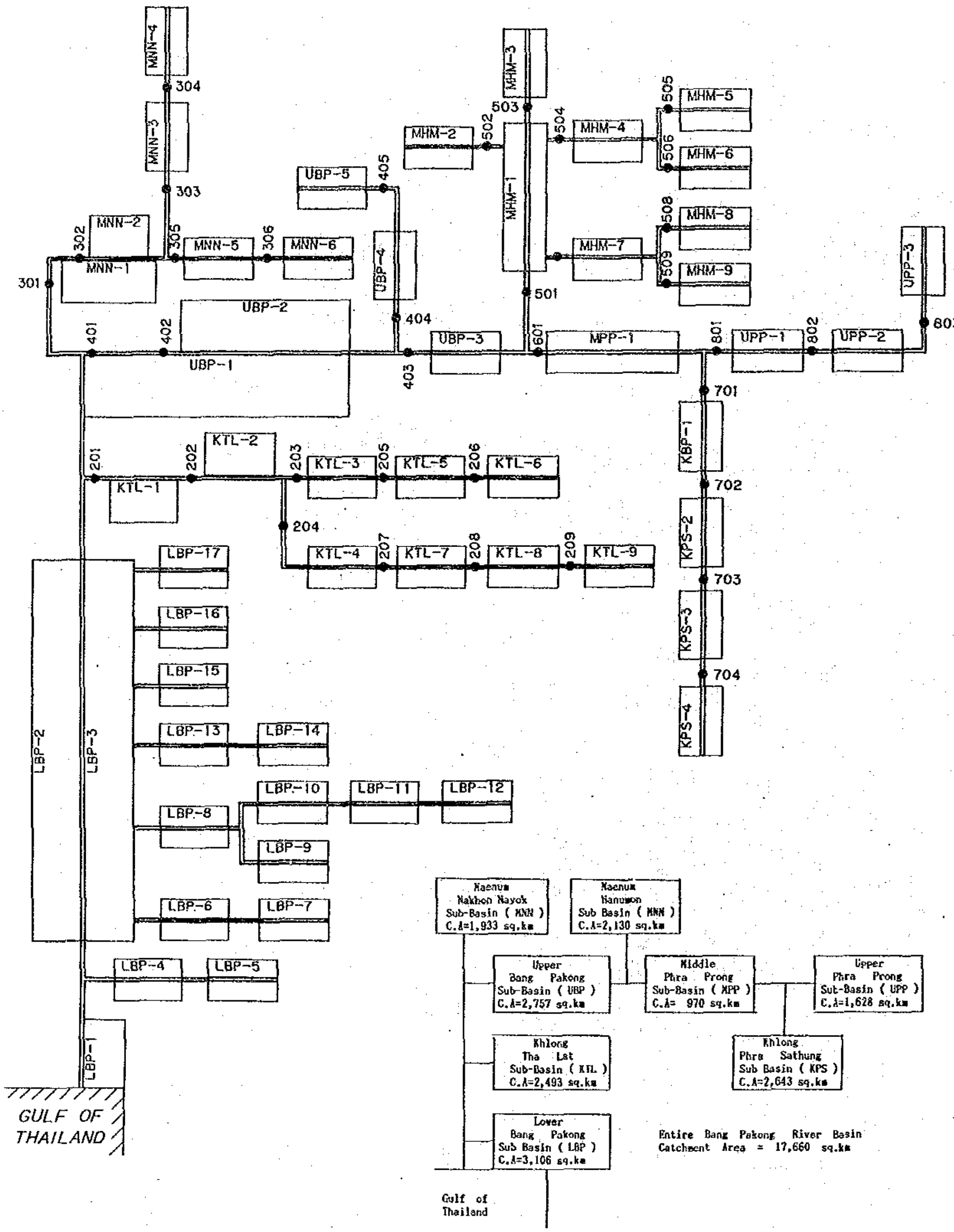


FIGURE 3-5-3 BANG PAKONG RIVER SYSTEM



3.5.5 Study of Runoff Analysis

TABLE 3-5-6 FLOOD HYDROGRAPH IN OCTOBER 1983

(m³)

	201 2,493 (km²)	301 1,933 (km²)	401 10,128 (km²)	501 2,130 (km²)	601 5,241 (km²)	701 2,643 (km²)	801 1,628 (km²)	kgt.3 7,502 (km²)
50hr	97.1	203.0	11.1	222.0	33.0	101.9	290.2	249.8
55	165.8	237.3	12.2	249.9	137.7	153.4	339.7	355.2
60	240.6	262.6	13.4	275.2	449.6	177.9	360.3	640.2
65	286.4	282.9	14.5	300.4	579.6	186.3	349.1	863.7
70	314.7	301.3	29.2	320.4	622.7	201.8	316.5	945.6
75	353.6	318.5	36.8	331.9	615.5	236.8	275.1	957.6
80	376.3	331.1	45.0	371.5	602.6	226.9	233.8	971.7
85	385.7	329.4	1,097.9	380.8	584.5	222.9	204.0	985.9
90	365.0	318.2	1,148.4	375.2	534.0	226.0	184.2	931.7
95	330.2	312.1	1,156.6	364.7	498.7	239.5	175.2	884.2
100	309.3	310.7	1,188.9	366.6	478.5	274.5	173.1	859.3
105	304.2	311.4	1,151.1	378.1	481.2	313.9	176.9	866.1
110	314.1	319.7	1,103.2	381.8	522.3	349.7	186.3	905.2
115	353.2	332.5	1,067.2	379.7	583.2	370.9	203.8	961.4
120	393.7	341.3	1,054.3	377.5	646.8	381.4	232.2	1,023.9
125	416.3	347.5	1,074.6	377.9	700.3	391.4	260.7	1,079.8
130	435.8	347.3	1,126.1	379.4	744.2	396.7	278.2	1,126.7
135	442.5	325.5	1,191.1	381.1	776.9	391.6	273.4	1,163.2
140	433.3	305.7	1,251.7	383.6	787.4	376.6	249.0	1,181.5
145	421.7	282.8	1,300.4	386.8	763.7	359.0	219.5	1,166.6
150	412.6	261.6	1,338.5	391.4	716.1	345.3	189.6	1,126.4
155	401.1	244.5	1,359.9	399.7	668.4	332.5	165.4	1,084.7
160	379.9	237.4	1,350.4	409.0	625.5	320.5	146.9	1,050.4
165	348.4	235.5	1,314.8	418.1	588.9	305.1	133.9	1,021.3
170	315.2	234.2	1,270.8	427.8	558.3	288.3	125.6	999.1
175	287.0	233.8	1,234.6	433.0	529.4	271.8	119.2	977.5
180	262.5	231.0	1,202.6	405.6	503.2	256.3	113.9	930.4
185	242.3	220.3	1,176.6	371.0	478.6	242.0	108.9	870.4
190	227.6	208.4	1,154.2	339.6	456.1	228.9	103.4	815.4
195	214.0	197.3	1,119.7	311.1	435.4	217.0	97.3	765.4
200	201.6	187.4	1,061.2	291.2	417.9	207.8	93.8	723.6
205	189.0	180.1	1,004.2	304.2	405.9	205.7	101.0	714.6
210	176.3	179.6	952.1	328.8	400.7	221.4	125.7	731.8
215	163.9	182.0	904.6	352.9	410.1	263.2	183.8	761.2
220	152.0	185.0	867.6	375.2	453.3	324.6	295.4	817.0
225	142.0	188.2	864.2	387.9	574.9	381.5	405.7	932.6
230	136.3	196.7	882.5	379.1	800.5	421.5	466.5	1,146.5
235	144.1	214.5	918.7	369.9	982.0	432.9	440.0	1,335.6
240	171.7	234.5	1,006.2	362.5	1,041.8	426.2	383.7	1,414.7
245	224.0	254.6	1,239.2	358.9	1,007.4	419.7	332.5	1,387.7
250	274.1	269.7	1,502.8	352.8	947.3	414.6	286.2	1,324.3
255	323.2	263.9	1,609.7	342.5	893.3	409.5	242.1	1,259.6
260	372.6	249.4	1,596.1	330.8	842.0	403.9	203.4	1,197.5
265	423.2	234.6	1,545.2	319.6	794.8	397.8	171.7	1,138.3
270	471.0	220.2	1,491.5	308.2	752.2	392.2	146.5	1,084.6
275	505.4	207.5	1,440.5	292.8	716.0	384.5	127.8	1,032.9
280	491.7	198.6	1,390.2	276.1	685.4	372.4	115.0	984.3
285	450.2	192.2	1,341.5	261.7	658.0	360.9	107.6	942.0
290	414.3	186.9	1,290.1	249.3	631.6	350.5	105.3	902.2
295	384.9	182.4	1,239.8	249.3	609.9	341.0	105.8	868.5
300	358.8	177.9	1,194.8	224.8	592.0	330.4	106.1	837.0
305	333.0	171.0	1,152.4	208.0	576.2	315.3	105.2	803.5
310	306.5	163.4	1,112.0	192.7	558.5	295.1	102.4	770.4
315	283.2	156.4	1,073.5	179.3	535.3	273.1	97.1	734.2
320	263.1	150.2	1,033.6	168.3	508.9	253.4	92.2	696.1
325	244.5	145.2	993.4	163.1	483.5	236.5	90.5	662.3
330	226.0	141.5	953.3	163.6	463.3	223.6	94.8	640.3
335	205.8	138.8	910.4	164.8	448.3	213.7	104.9	624.4
Qmax	507.2	349.7	1,612.2	433.3	1,041.8	433.2	466.5	1,414.7

TABLE 3-5-7 DESIGN FLOOD HYDROGRAPH (W=1/50)

(m³/S)

	201 2,493 (km²)	301 1,933 (km²)	401 10,128 (km²)	501 2,130 (km²)	601 5,241 (km²)	701 2,643 (km²)	801 1,628 (km²)
5hr	0.5	1.0	2.1	13.1	10.3	4.8	10.1
10	1.1	2.3	4.7	29.6	23.3	10.8	22.6
15	1.7	3.5	7.3	46.0	36.2	16.8	35.2
20	2.3	4.8	9.9	374.2	49.1	22.7	47.8
25	2.9	6.1	12.5	555.4	62.0	28.7	60.3
30	3.5	7.3	15.1	728.1	74.9	34.7	127.7
35	97.6	8.6	17.7	901.6	87.9	62.1	421.4
40	340.4	538.9	20.4	1,066.8	270.1	297.6	621.3
45	666.4	716.1	23.0	1,229.4	1,109.7	433.9	814.2
50	875.4	851.2	71.6	1,397.8	1,654.1	561.1	1,039.5
55	1,005.2	933.7	131.0	1,674.8	1,998.5	896.7	1,200.7
60	1,156.2	824.0	3,372.5	1,784.0	2,486.3	946.0	1,092.1
65	1,206.2	688.8	4,150.9	1,553.6	2,421.9	880.2	850.7
70	1,275.6	620.7	4,971.0	1,320.1	2,130.1	814.7	645.3
75	1,328.5	579.3	4,773.4	1,131.9	1,888.3	763.9	494.2
80	1,366.5	556.4	4,327.7	961.7	1,713.6	742.9	388.6
85	1,257.5	534.8	3,910.3	806.7	1,593.0	792.7	325.3
90	1,122.7	509.8	3,540.5	680.6	1,523.8	891.9	301.6
95	1,050.8	475.8	3,220.5	580.8	1,538.7	988.8	303.1
100	944.2	434.5	2,958.8	502.7	1,595.7	1,060.4	319.7
105	833.6	406.8	2,782.1	466.4	1,669.9	1,099.7	354.3
110	809.7	375.7	2,701.1	481.2	1,725.9	1,109.3	418.5
115	857.2	352.1	2,685.4	509.3	1,786.6	1,097.6	496.1
120	905.2	332.8	2,734.8	544.6	1,842.0	1,088.6	560.3
125	954.5	318.0	2,816.5	581.5	1,891.6	1,082.7	604.2
130	988.2	312.1	2,913.6	573.5	1,918.4	1,061.6	603.3
135	966.2	320.0	3,004.5	531.0	1,905.9	994.4	535.6
140	929.0	335.4	3,037.6	494.8	1,791.5	912.8	442.4
145	900.4	351.7	2,988.2	462.3	1,616.1	840.5	360.1
150	862.9	363.6	2,867.2	437.3	1,455.1	780.6	295.1
155	814.5	377.0	2,672.0	457.9	1,325.7	731.3	249.8
160	737.2	394.3	2,468.3	505.0	1,227.8	685.2	221.9
165	659.6	409.6	2,310.7	541.7	1,152.9	642.0	212.0
170	590.4	423.0	2,232.0	572.5	1,096.0	603.2	212.0
175	527.7	435.0	2,198.0	590.5	1,052.4	567.4	217.4
180	474.5	421.6	2,172.9	541.6	1,007.9	528.6	219.9
185	429.1	384.5	2,147.4	486.0	963.4	482.0	215.3
190	385.9	350.8	2,091.1	438.0	909.3	434.5	204.7
195	342.5	321.3	1,973.3	396.8	844.6	391.8	189.4
200	304.3	296.0	1,852.1	361.2	778.9	354.1	171.6
205	271.1	274.4	1,733.8	328.5	714.1	320.9	156.0
210	242.3	256.0	1,615.6	299.5	653.3	291.9	140.3
215	217.2	240.1	1,502.3	273.2	598.9	266.9	125.5
220	195.4	226.0	1,396.5	246.5	548.8	244.9	113.0
225	176.3	213.2	1,296.6	220.7	503.5	225.4	102.8
230	159.7	201.7	1,206.2	198.2	463.7	207.9	94.1
235	145.3	191.3	1,123.4	179.0	428.6	192.3	86.1
240	133.1	181.8	1,044.8	162.7	397.4	178.3	79.5
245	121.7	173.1	972.4	148.8	369.1	165.8	73.9
250	111.4	165.2	907.9	136.4	343.8	154.5	69.2
255	102.3	158.1	850.5	124.7	321.3	144.3	65.3
260	94.1	151.5	799.3	113.9	301.3	135.1	62.0
265	86.7	145.3	753.3	104.4	283.3	126.7	59.1
270	80.2	139.8	711.5	96.2	267.2	119.1	56.7
275	74.3	134.8	673.7	89.0	252.5	112.1	54.6
280	68.9	130.2	639.0	82.6	239.3	105.8	52.8
285	64.1	126.0	607.4	77.0	227.3	100.1	51.2
290	59.8	122.1	578.9	72.0	216.3	94.8	49.8
Qmax	1,367.9	933.7	4,971.0	1,876.2	2,517.9	1,110.2	1,204.5

TABLE 3-5-B DESIGN FLOOD HYDROGRAPH (W=1/2)

	201 2,493 (km²)	301 1,933 (km²)	401 10,128 (km²)	501 2,130 (km²)	601 5,241 (km²)	701 2,643 (km²)	801 1,628 (km²)
5hr	0.1	0.2	0.5	0.8	1.4	1.6	2.0
10	0.2	0.3	1.0	1.9	3.1	3.6	4.5
15	0.3	0.5	1.6	3.0	4.8	5.6	7.0
20	0.4	0.7	2.1	4.0	6.6	7.6	9.5
25	0.6	0.9	2.7	5.1	8.3	9.7	12.1
30	0.7	1.1	3.3	6.1	10.0	11.7	14.6
35	0.8	1.3	3.8	7.2	11.8	13.7	17.1
40	0.9	1.5	4.4	47.7	13.5	15.7	52.1
45	1.0	1.7	5.0	58.9	15.2	26.6	63.6
50	1.1	1.9	5.5	69.5	17.0	75.3	123.9
55	1.4	61.3	6.1	79.9	18.7	102.6	152.5
60	2.0	73.2	6.7	90.0	48.6	126.4	173.8
65	138.6	79.2	7.2	99.5	130.0	137.7	182.7
70	140.2	79.9	7.8	109.2	313.5	141.2	181.0
75	140.2	79.7	8.4	118.4	346.7	163.6	172.7
80	141.9	79.7	8.9	126.5	351.2	163.9	161.0
85	142.2	79.0	16.4	131.3	355.0	153.2	148.5
90	142.5	75.2	18.8	131.5	354.8	141.2	133.1
95	136.7	68.8	21.2	137.8	332.8	129.8	116.1
100	126.0	62.8	22.9	143.3	306.8	117.9	100.8
105	115.9	57.3	565.3	136.2	279.5	109.5	87.4
110	108.3	52.5	578.9	126.3	253.2	103.2	75.8
115	104.0	48.4	568.5	117.2	229.5	98.7	66.1
120	101.9	45.1	555.1	110.0	210.4	96.8	58.0
125	101.1	42.9	531.5	104.2	194.1	92.3	51.2
130	100.8	41.1	499.8	98.9	181.5	87.5	45.4
135	98.6	39.6	465.7	94.2	172.7	83.0	40.6
140	95.4	38.4	432.9	88.8	163.4	79.2	36.4
145	92.6	37.5	404.7	82.2	154.5	77.1	32.9
150	90.2	36.8	380.4	75.7	146.7	75.9	29.9
155	88.1	36.2	358.9	69.8	139.9	75.0	27.3
160	86.6	35.8	341.0	64.4	134.8	74.5	25.0
165	85.0	35.5	325.8	59.5	131.4	74.4	23.0
170	81.7	35.3	309.7	55.1	128.8	74.5	21.3
175	76.5	35.2	293.5	51.1	126.8	73.4	19.7
180	71.5	35.2	278.4	47.4	124.8	70.8	18.3
185	66.8	35.3	264.7	44.1	122.5	68.1	17.1
190	62.3	35.0	252.6	41.0	119.7	65.6	16.0
195	58.1	34.0	242.4	38.3	115.1	63.4	15.0
200	54.3	32.7	233.7	35.7	110.0	61.3	14.1
205	50.8	31.4	225.8	33.4	105.2	59.5	13.3
210	47.5	30.0	218.5	31.3	100.8	57.4	12.6
215	44.6	28.8	211.5	29.4	96.8	54.5	11.9
220	41.9	27.6	204.7	27.6	93.1	51.5	11.3
225	39.4	26.5	197.8	26.0	89.7	48.7	10.8
230	37.1	25.4	189.9	24.5	86.1	46.1	10.3
235	35.0	24.5	181.7	23.1	82.0	43.6	9.8
240	33.1	23.6	174.1	21.8	77.9	41.3	9.4
245	31.3	22.7	166.9	20.6	74.1	39.2	9.0
250	29.7	21.8	160.3	19.5	70.6	37.2	8.6
255	28.2	21.0	154.1	18.5	67.2	35.3	8.3
260	26.8	20.2	148.3	17.6	64.1	33.6	8.0
265	25.5	19.4	142.9	16.7	61.1	31.9	7.7
270	24.5	18.7	137.5	15.9	58.4	30.4	7.4
275	23.4	18.0	132.0	15.1	55.7	29.0	7.2
280	22.2	17.4	126.5	14.4	53.3	27.6	6.9
285	21.1	16.8	121.3	13.8	51.0	26.1	6.7
290	20.1	16.2	117.3	13.1	48.4	25.2	6.5
Qmax	142.7	79.9	579.1	144.1	362.1	166.3	182.9

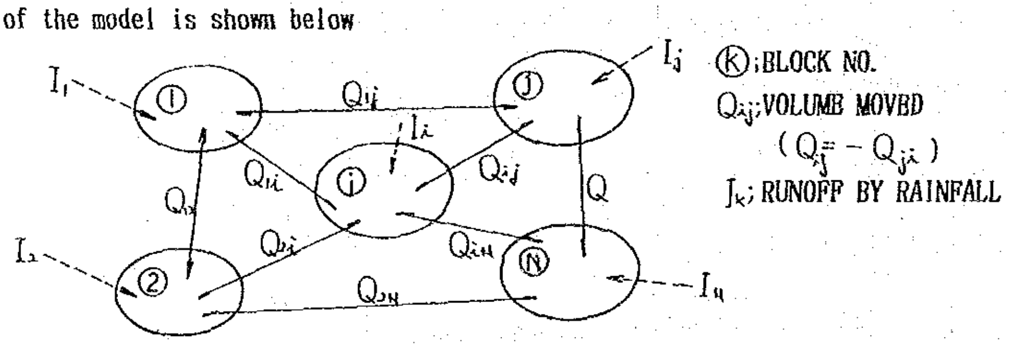
3.6 HYDRAULIC ANALYSIS

3.6.1 Method of Analysis

In a watershed, runoff caused by rainfall therein is governed by the topographical characteristics and appears in the river or artificial channel with some delay in time. And the runoff in the channel is then governed by the hydraulics of the channel. In case flow capacity of the channel does not meet the runoff or in case the flow in the channel is restricted due to backwater from the downstream, the runoff remained from the discharge causes innundation at the place. Such phenomenon emerges not only in channels but also in culverts across roads, siphones, gateways, drainage puming stations, etc. Such situations are commonly observed in the low flat areas. In order to precisely simulate the sphenomenon, so-called continuous reservoir model method is availab e. The water balance study is therefore made thereby.

Continuous Reservoir Model

The continuous reservoir model assumes that each of a number of blocks divided into from a watershed is an reservoir with storage functions characterized by H-V and H-A curves. What connect two reservoirs are drainage facilities such as channels, culverts, siphones, gateways, pumps, weirs, etc. The move of water between the two is generated by difference in water levels and governed by the hydraulic functions and dimensions of the facilities, and causes difference in stored volumes in the component reservoirs. Differences in the storages are then calibrated into differences in the water levels to pursue the further changes in the storages and water levels. Conceptual image of the model is shown below



CONCBPTUAL IMAGB: CONTINUOUS RBSERVOIR MODEL

A continuity equation for an arbitrary i'th block is given as,

$$\frac{dV_i}{dt} = I_i - \sum_{j=1}^{N} Q_{ij} \quad (i \neq j) \quad \text{-------------------} \quad (1)$$

where V_i = storage volume in i'th block,
I_i = flow into I'th block; i.e. direct runoff within the block,
Q_{ij}= flow from i'th block to j'th block (reverse is negative), and
t = time.

For application of the model to the blocks in a watershed, the change of water level in a unit time of calculation interval Δt is generally anticipated infinitesimal. Accordingly, an approximate equation below may be justified.

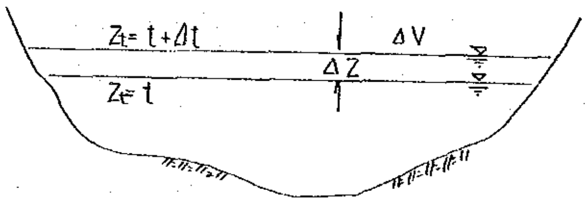


IMAGE OF CROSS-SECTION OF BLOCK RESERVOIR

$$\Delta V = A \cdot (Z_{t-t}) \cdot \Delta Z \quad \text{-------------------} \quad (2)$$

where ΔV = incremental storage volume,
A = innundated areas (given by a function of Z),
ΔZ = incremental innundated water level, and
Z = innundated water level.

Subsituting the equation (2) for the equation (1), then

$$\frac{dZ_i}{dt} = \frac{1}{A(Z_i)} \left(I_i - \sum_{j=1}^{N} Q_{ij} \right) \quad \text{-------------------} \quad (3)$$

Changes in water levels may thus be calculated. In the above equation, $A(Z_i)$ and I_i are derived from the water level- storage curve and runoff analysis in each block respectively, while Q_{ij} are from water level differences between the reservoirs and functions and dimensions of the hydraulic facilities.

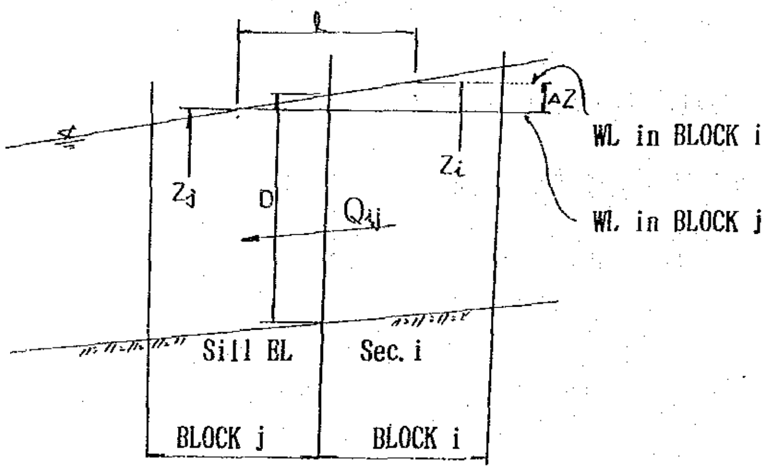
The equation (3) is formed simultaneously in each of whole N blocks, and therefore the study in changes of innundated water levels is to solve N numbers of simultaneous differetial equations. Some of numerical analysis methods such as Runge-Kutter-Gill method for instance, can accordingly be employed.

Flow Contition Equation

Each reservoir block is mutually connected by an arbitral number of drainage facilities and the flows through them are governed by water level differences. Flow condition equations are equations to calculalte the flows through the various drainage facilities, and are expressed in terms of water level difference by substituting hydraulic functions and dimensions of the facilities.

The flow condition equations for various drainage facilities are given below.

i) River channel



Flow between i'th and J'th blocks is assumed to run by gravity by the water level difference ΔZ and by Manning's Formula, then

$$Q_{ij} = \frac{A_{ij}}{n} \cdot R_{ij}^{2/3} \cdot I_{ij}^{1/2}$$
$$= \frac{1}{n} \cdot A_{ij} \cdot R_{ij}^{2/3} \cdot \left(\frac{\Delta Z_{ij}}{\ell_{ij}}\right)^{1/2}$$
$$= \frac{1}{n\sqrt{\ell_{ij}}} (A_{ij} \cdot R_{ij}^{2/3}) \cdot \sqrt{\Delta Z_{ij}} \quad \text{------------ (1)}$$

Generally in the flow channels, $AR^{2/3}$ equals aD^b (a and b are the constants while D is the water depth) and substituting this for the equation (1), then

$$Q_{ij} = \frac{1}{n\sqrt{\ell_{ij}}} \times a_{ij} \times D_{ij}^{b_{ij}} \times \sqrt{\Delta Z_{ij}}$$
$$= \frac{1}{n\sqrt{\ell_{ij}}} \times a_{ij} \times \left(\frac{Z_i + Z_j}{2} - SILL_{ij}\right)^{b_{ij}} \times \sqrt{Z_i - Z_j} \quad \text{---- (2)}$$

In the equation (2), l_{ij}, a_{ij} b_{ij} and Sill-EL_{ij} are identical in each block so that Q_{ij} can directly be calculated from water levels in the blocks by giving those identical figures in the equation in advance.

In the equations (1) and (2), Z_i nd Z_j are the water levels in i'th and j'th blocks respectively, a_{ij} and b_{ij} are the constants, n is the Manning's coefficient of roughness, ΔZ is the water level difference, l is the distance between the two blocks, and D_{ij} is the water depth.

3. 6. 2 Hydraulic Model Constants

TABLE 3 - 6 - 1 FLOWING CAPACITY OF RIVER CHANNEL

Section No.	Distance L (km)	Sill Elevation (El.m)	Flowing Capacity	
			a	b
1	5.0	− 9.20	39.801	1.945
2	5.0	− 9.00	50.654	1.870
3	5.0	−15.30	16.624	2.023
4	4.0	− 7.10	29.378	2.178
5	4.0	−10.10	45.388	1.895
6	4.0	− 8.60	52.468	1.831
7	5.0	−10.60	31.042	2.034
8	8.0	− 7.10	58.522	1.996
9	6.0	− 7.60	113.171	1.688
10	2.0	− 8.20	68.763	1.874
11	2.0	−10.00	163.234	1.381
12	3.0	− 9.10	119.077	1.536
13	4.0	− 8.80	165.521	1.450
14	4.0	− 8.60	152.124	1.524
15	4.0	−11.90	121.985	1.506
16	4.0	−11.60	69.057	1.841
17	4.0	− 9.70	54.049	2.027
18	5.0	− 6.90	66.430	1.974
19	5.0	−12.60	55.722	1.891
20	5.0	− 9.20	74.820	1.947
21	6.0	− 6.70	134.509	1.902
22	5.0	−11.50	79.058	1.802
23	4.0	− 7.10	120.470	2.023
24	4.0	−11.30	78.469	1.893
25	5.0	− 8.70	118.659	1.960
26	6.0	−10.00	52.092	2.196
27	5.0	−12.40	20.109	2.456
28	4.0	− 6.20	184.639	2.276
29	4.0	− 6.20	184.639	2.276

Remarks : $AR^{2/3} = a\,D^{b}$, D = water depth (m).

TABLE 3－6－2 WATER STAGE

H (EL. m)	No.1 (MCM)	No.2 (MCM)	No.3 (MCM)	No.4 (MCM)	No.5 (MCM)	No.6 (MCM)	No.7 (MCM)	No.8 (MCM)	No.9 (MCM)	No.10 (MCM)	No.11 (MCM)	No.12 (MCM)	No.13 (MCM)	No.14 (MCM)	No.15 (MCM)
3.0			36.92	37.52	33.86	21.30	32.89	25.54	30.16	28.25	26.54	29.02	16.47	15.64	18.73
2.0		45.44	26.82	25.52	22.76	13.60	16.39	13.54	17.96	16.95	13.34	16.12	9.77	9.04	11.03
1.8														7.72	
1.7	GULF						11.44	9.94	14.30	13.56			7.76		
1.6				20.72	18.32	10.52					8.06	10.96			
1.5	OF						11.24	9.86	14.08	13.28				7.58	7.18
1.4		34.34	20.76												
1.1	THAILAND		20.10												
1.0		32.36	19.78	19.02	16.98	9.94	10.74	9.28	13.14	12.42	7.48	10.14	6.92	7.10	6.86
0.0		27.46	16.56	16.46	14.84	8.72	9.54	8.16	11.42	10.76	6.52	8.82	5.76	6.18	6.10
-1.0		22.72	13.50	14.14	12.80	7.56	8.40	7.10	9.78	9.20	5.64	7.58	4.66	5.30	5.38
-2.0		19.68	10.76	12.10	10.86	6.48	7.30	6.08	8.26	7.72	4.62	6.48	3.80	4.48	4.76

H (EL. m)	No.16 (MCM)	No.17 (MCM)	No.18 (MCM)	No.19 (MCM)	No.20 (MCM)	No.21 (MCM)	No.22 (MCM)	No.23 (MCM)	No.24 (MCM)	No.25 (MCM)	No.26 (MCM)	No.27 (MCM)	No.28 (MCM)	No.29 (MCM)	No.30 (MCM)
3.0	42.50	32.45	23.98	15.30	17.16	33.44	77.91	27.52	18.32	27.78	46.78	68.12	61.64	33.26	1101.08
2.0	24.80	12.55	11.38	5.00	6.16	13.04	21.47	11.20	8.00	12.26	18.46	28.16	19.12	13.66	371.80
1.8				2.94			10.18	7.94							
1.7		6.58		2.92	2.86				4.90				6.36		
1.6			6.34												
1.5		6.54			2.82	2.84				4.50	4.30			3.86	7.16
1.4							9.60					4.18	6.32		
1.1															
1.0	7.10	6.24	5.78	2.64	2.62	2.64	8.74	7.04	4.44	4.22	3.98	4.08	6.14	3.68	6.80
0.0	6.32	5.38	4.90	2.26	2.22	2.22	6.90	5.98	3.82	3.68	3.46	3.66	5.42	3.20	5.88
-1.0	5.54	4.64	4.06	1.90	1.88	1.86	5.34	5.00	3.26	3.16	2.96	3.24	4.74	2.78	5.00
-2.0	4.82	3.96	3.32	1.60	1.58	1.50	3.96	4.06	2.74	2.68	2.48	2.84	4.08	2.34	4.16

FIGURE 3-6-1 BLOCKING DIAGRAM OF BANG PAKONG RIVER

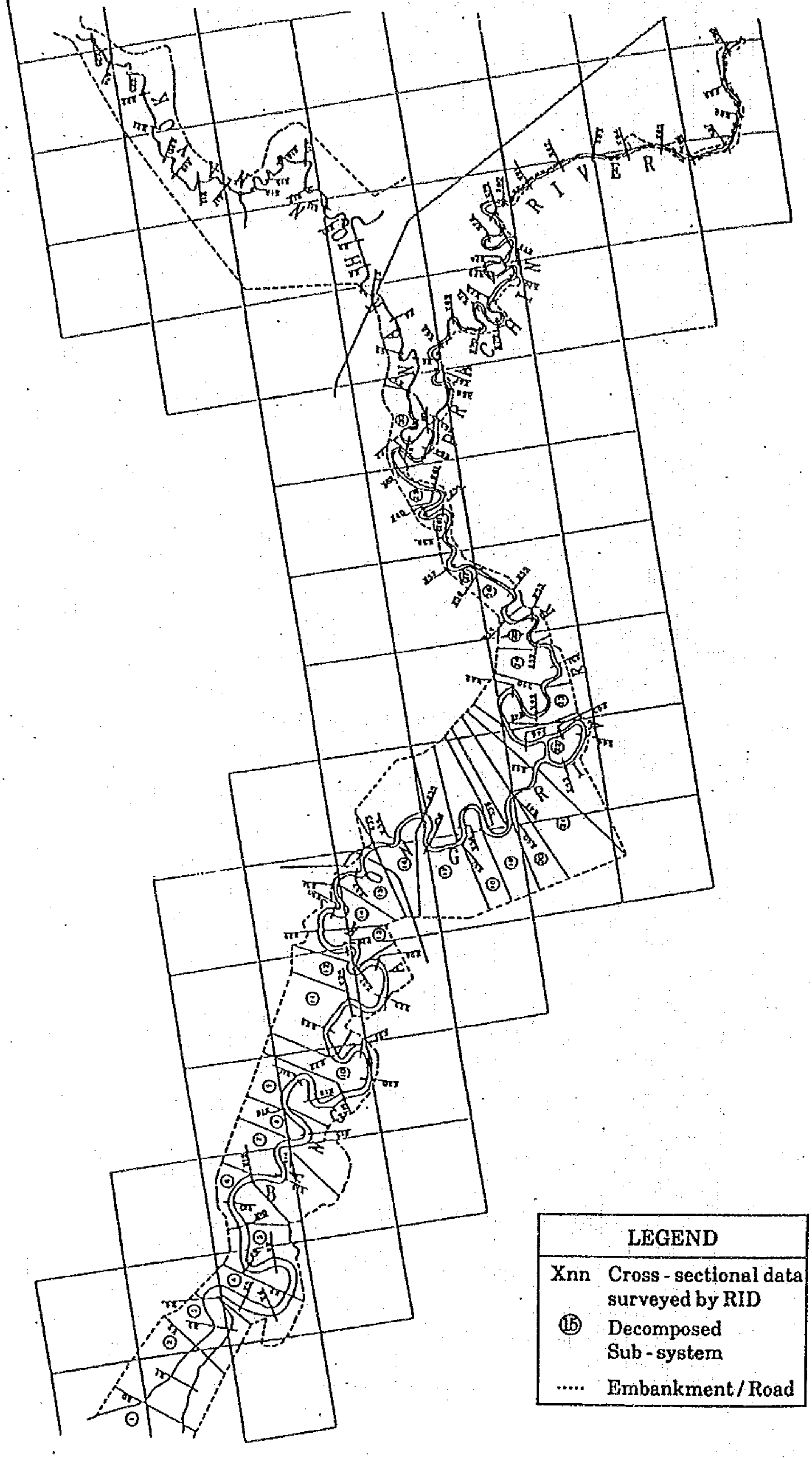
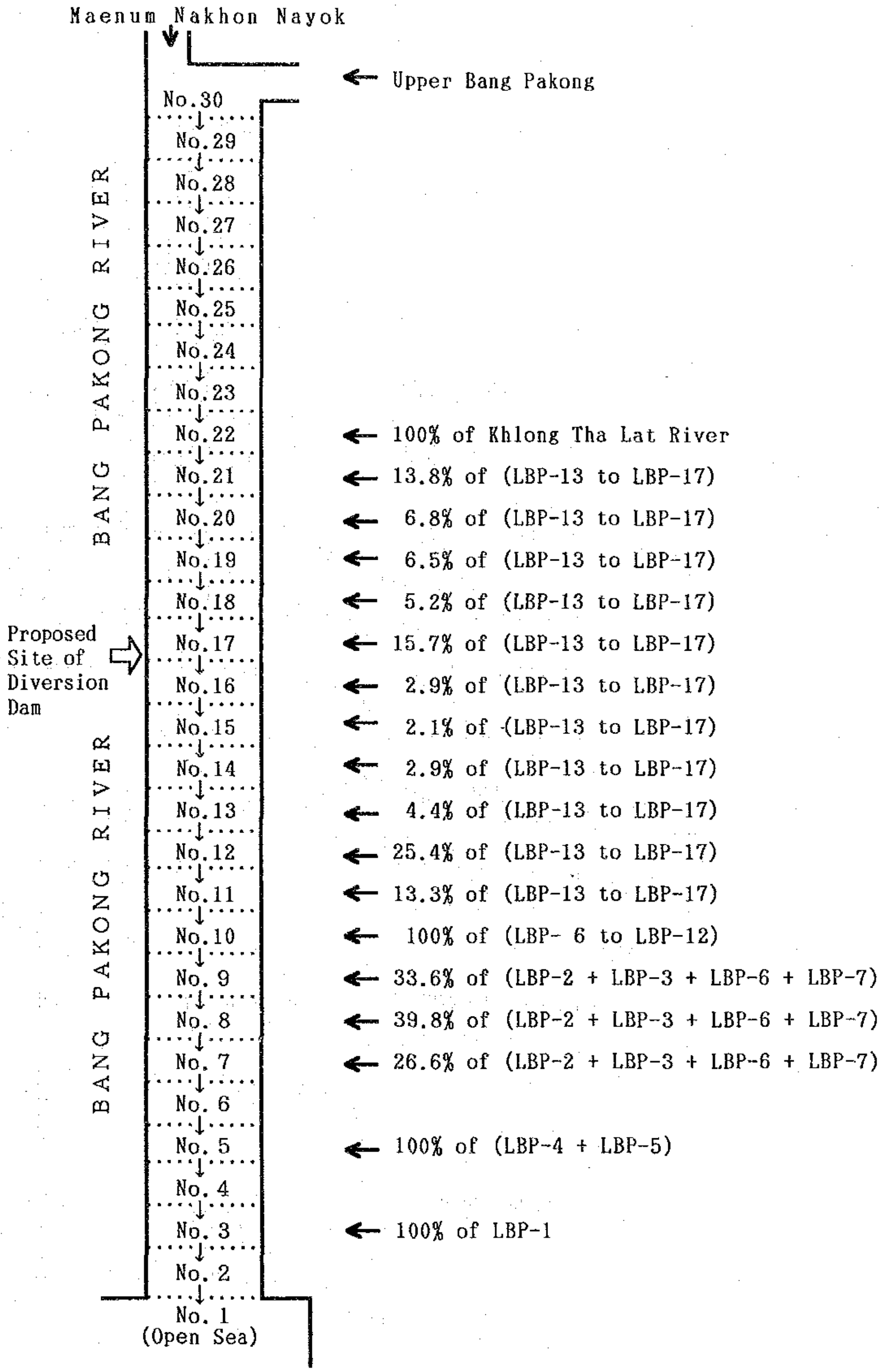


FIGURE 3-6-2 DIAGRAM FOR SIMULATION STUDY



3.6.3 Study of Hydraulic Analysis

FIGURE 3-6-3 RESULT OF HYDRAULIC ANALYSIS IN OCTOBER 1983
(HYDRAULIC PROFILE)

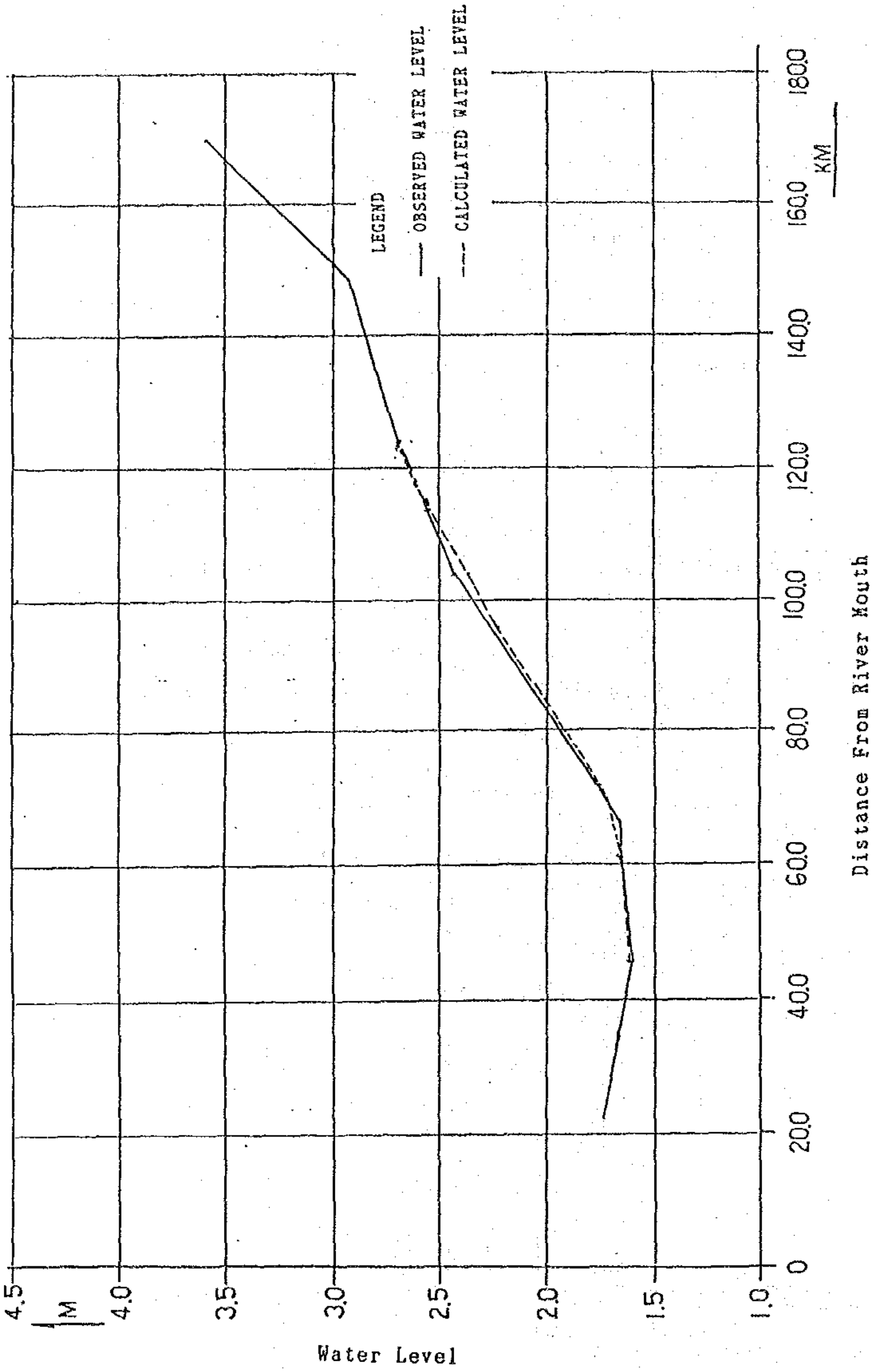


FIGURE 3-6-4 RESULT OF HYDRAULIC ANALYSIS IN OCTOBER 1983

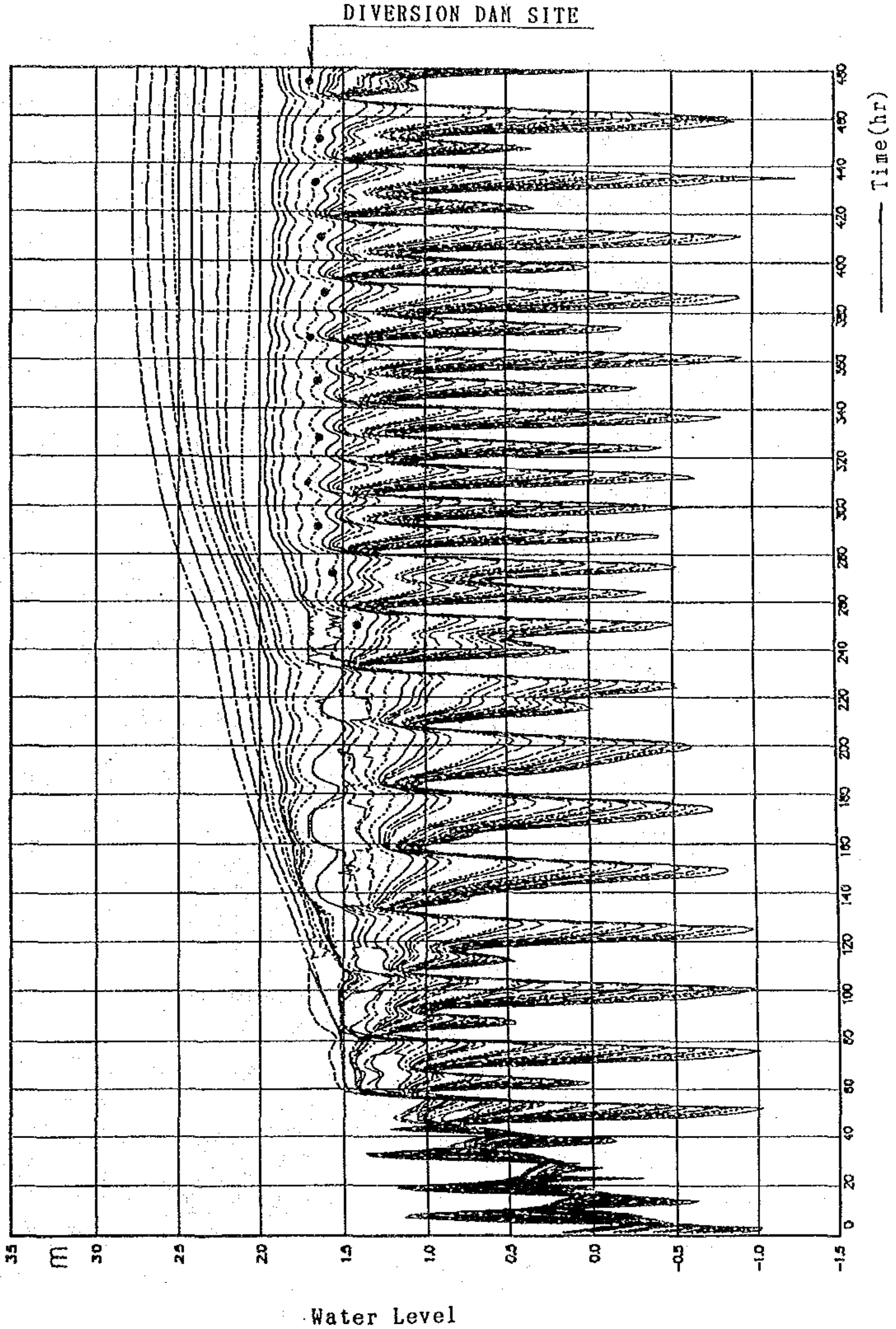


FIGURE 3-6-5 FLOOD WATER LEVEL OF 50 YEARS PROBABILITY
(BEFOR FLOOD DIKE CONSTRUCTION)

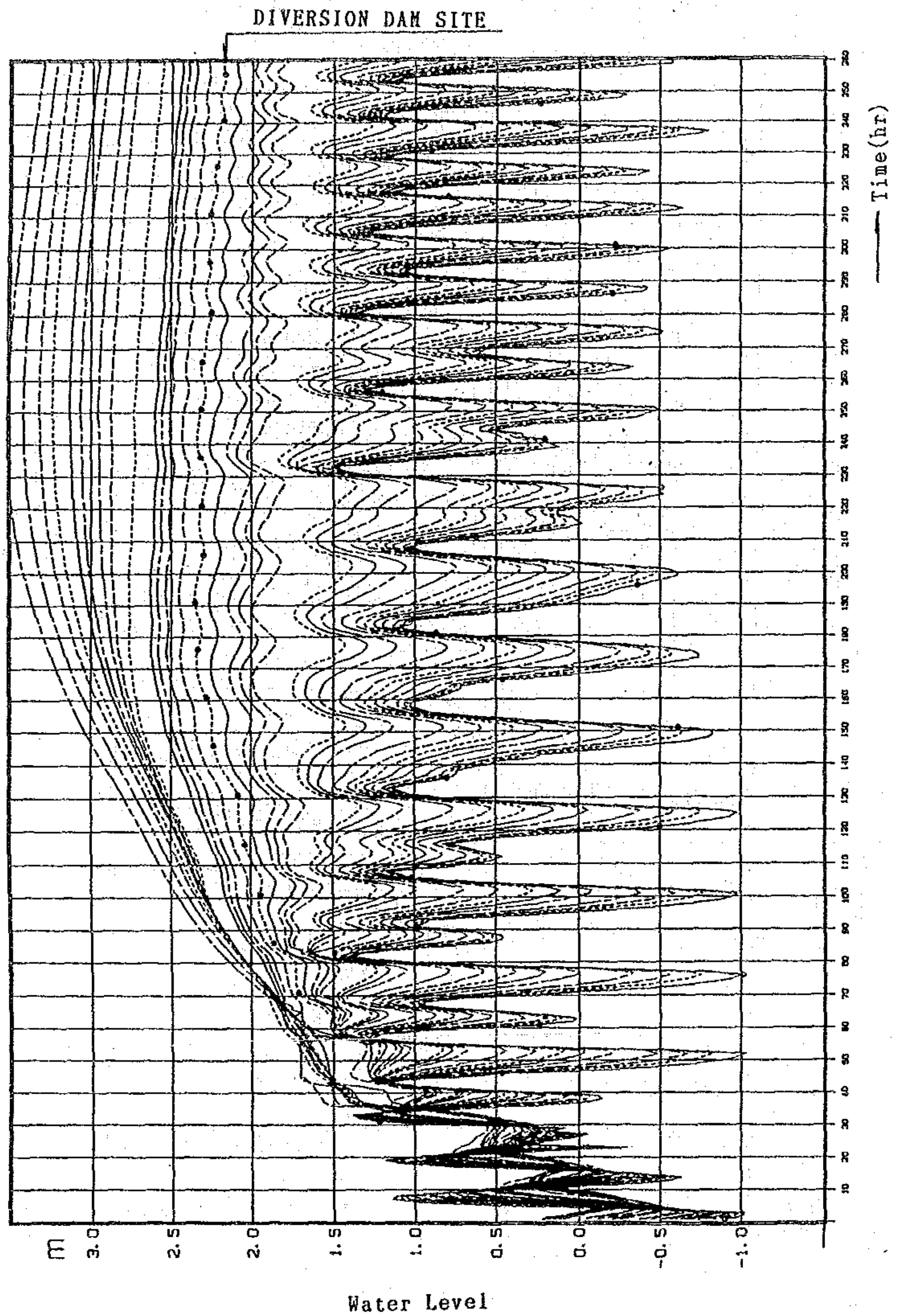


FIGURE 3-6-6 FLOOD WATER LEVEL OF 50 YEARS PROBABILITY
(AFTER FLOOD DIKE CONSTRUCTION)

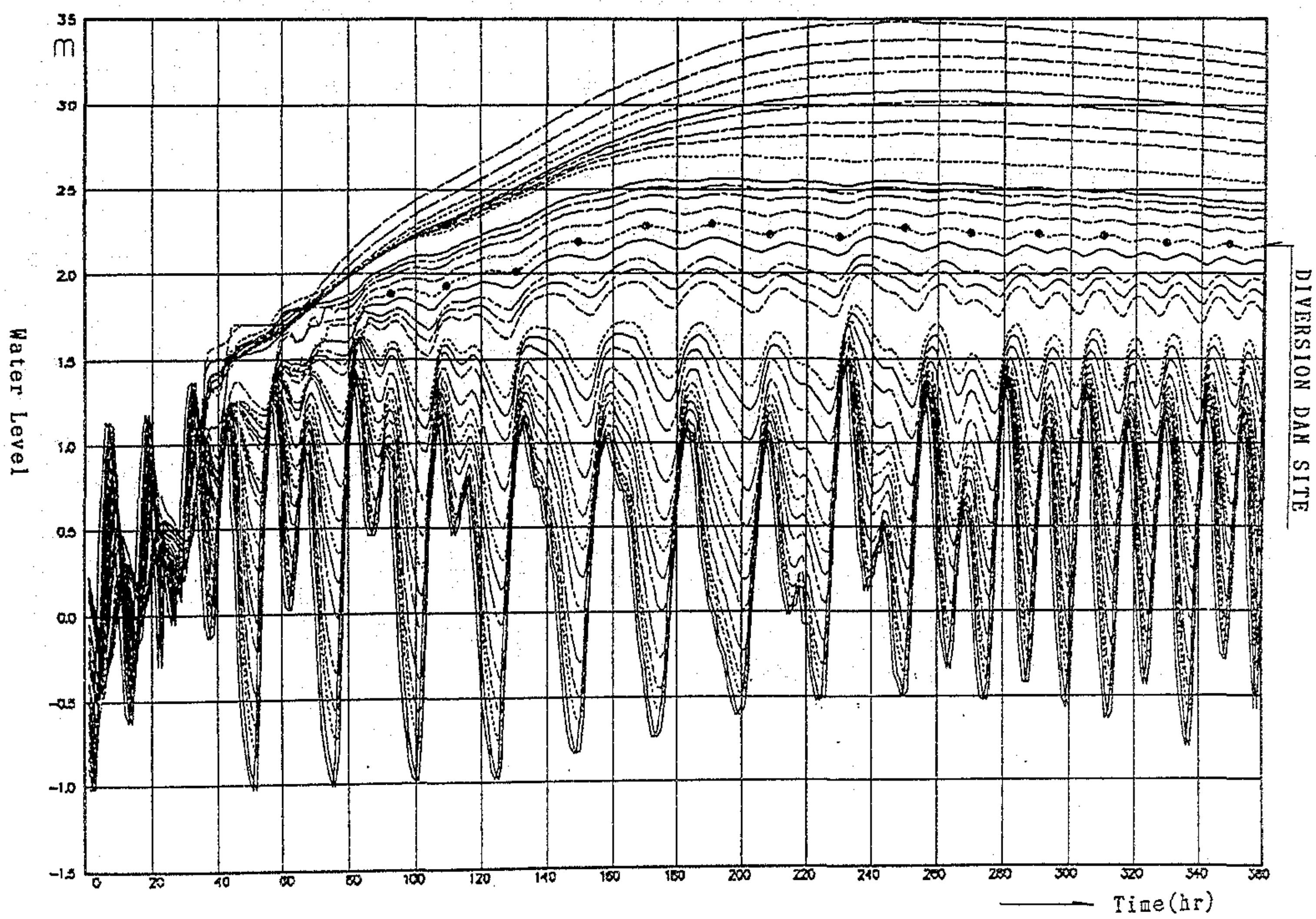


FIGURE 3-6-7 FLUCTION OF WATER LEVEL WITH AND WITHOUT DIVERSION IN DROUGHT PERIOD

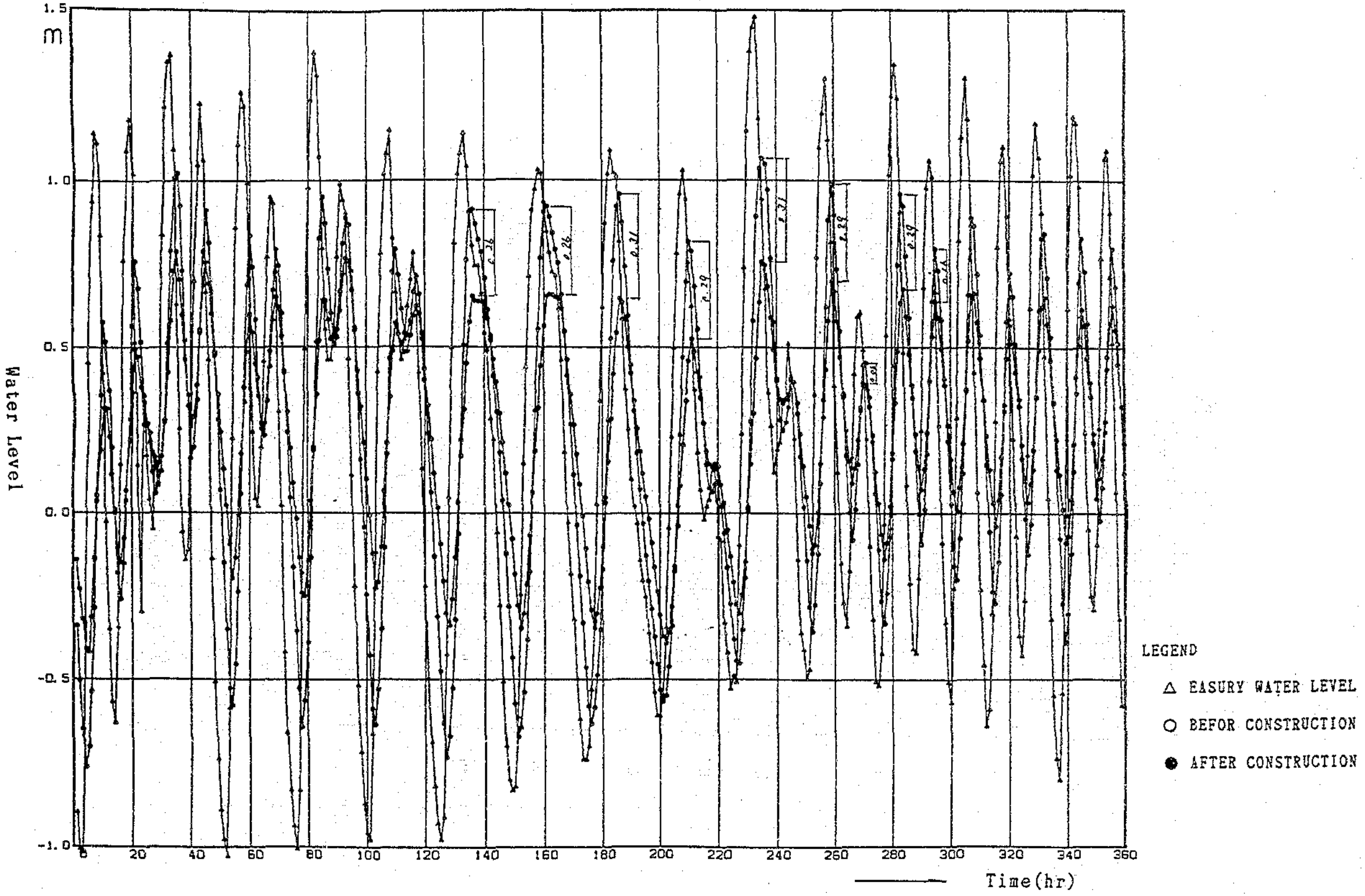
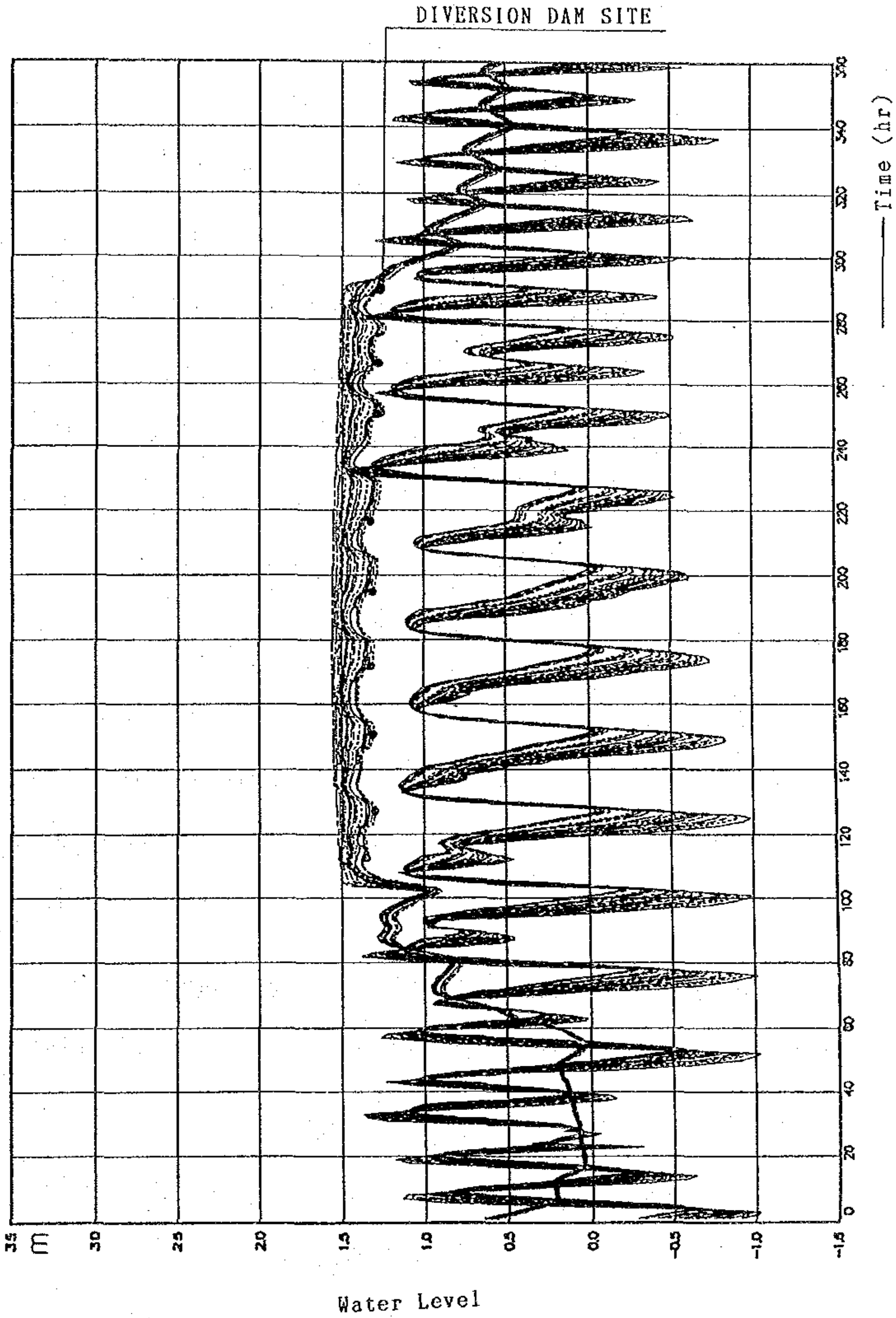


FIGURE 3-6-8 WATER LEVEL OF 2 YEARS PROBABILITY



3.7 Operatio OF Tidal Protection Gate

3.7.1 Water Demand and Water Supply

Annual discharge at diversion dam site is 7,931MCM in Bang Pakong river. This details are as follows.

Wet season;May to Oct.	6,827 MCM (86%)
Dry season;Nov. to Apr. ...	1,104 MCM (14%)
Total	7,931 MCM

On the other side, annual total of water demands is 323.8 MCM and its details are as follows.

Irrigation ;	151.2 MCM	(46.6%)
Industry ;	129.7 MCM	(40.1%)
Water Supply;	19.0 MCM	(6.9%)
Fishery ;	16.7 MCM	(5.2%)
Maintenace ;	7.2 MCM	(2.2%)
total	323.8	(100.0%)

That is to say, 86.7% of water demand of Bang Pakong river consists of irrigation and industry water. Another 13.3% of water demand is used for water supply ,fishery and maintenance.

Monthly runoff and demands are shown on Table 3-7-1.

TABLE. 3-7-1 MONTHLY PUMPING WATER OPERATION

MONTH	Available Water MCM	m3/s	Water Demands Irrigation MCM	Fish MCM	Industry MCM	W. Supply MCM	Maintenanc MCM	Total MCM	Surplus MCM
APR	398	150	7.4	1.8	10.7	1.6	0.6	22.1	375.9
MAY	745	280	4.6	0	11	1.7	0.6	17.9	727.1
JUN	1061	410	0.2	1.4	10.7	1.6	0.6	14.5	1046.5
JUL	1185	440	2.8	1.1	11	1.6	0.6	17.1	1167.9
AUG	1386	520	16.6	0.3	11	1.7	0.6	30.2	1355.8
SEP	1460	560	15.3	0.1	10.7	1.5	0.6	28.2	1431.8
OCT	990	370	16.9	0.1	11	1.5	0.6	30.1	959.9
NOV	332	130	6.9	1.5	10.7	1.5	0.6	21.2	310.8
DEC	81	30	18.2	1.2	11	1.5	0.6	32.5	48.5
JAN	32	12	23.1	2.2	11	1.5	0.6	38.4	-6.4
FEB	87	36	21.3	3.3	9.9	1.5	0.6	36.6	50.4
MAR	174	65	17.9	3.7	11	1.8	0.6	35	139
TOTAL	7931		151.2	16.7	129.7	19	7.2	323.8	7607.2
RATIO %			46.6	5.2	40.1	6.9	2.2	100	

notes;
(1)Water utilization ratio in total;323.8/7931=0.041
(2)Monthly mean runoff water in wet season(May to Oct.);
6827MCM/6=1140MCM/Month
(3)Monthly mean runoff water in dry season(Nov. to Apr.);
1104MCM/6=180MCM/Month

3.7.2 Gate and Water operation

The peak of discharge at diversion dam in Sep. is 1,460MCM (560m3/s). As the total gate span of diversion dam is 150m, the unit discarge per one meter is 3.7 m3/s. On the other side, the minimum discharge in Jan. is 32 MCM (12.0 m3/s). Monthly water shortage occurs only in Feb..

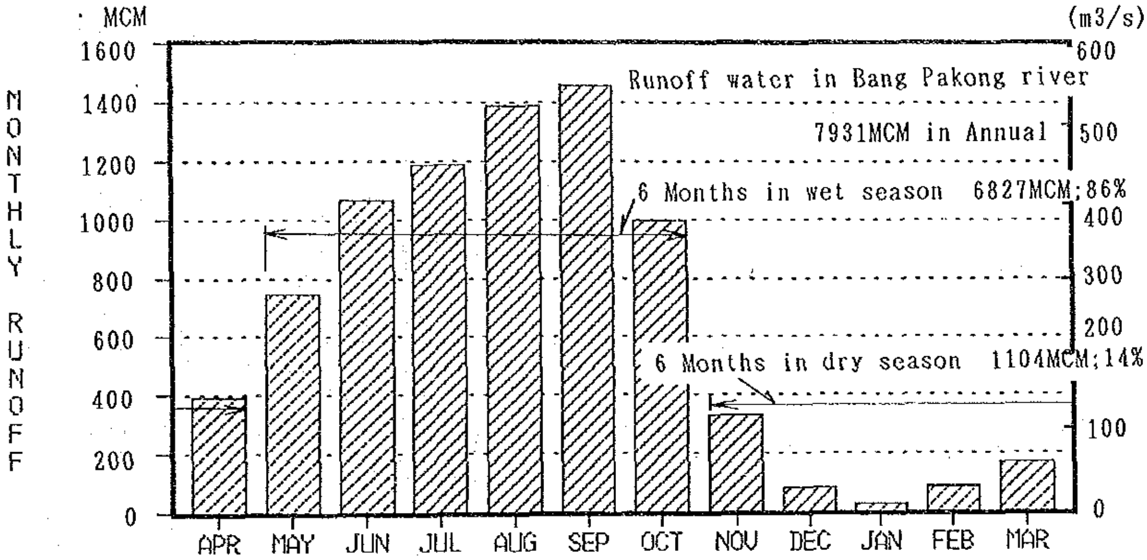
Taking into consideration of the condition of runoff and run-up of salinity, the gates operation will be decided as follows.

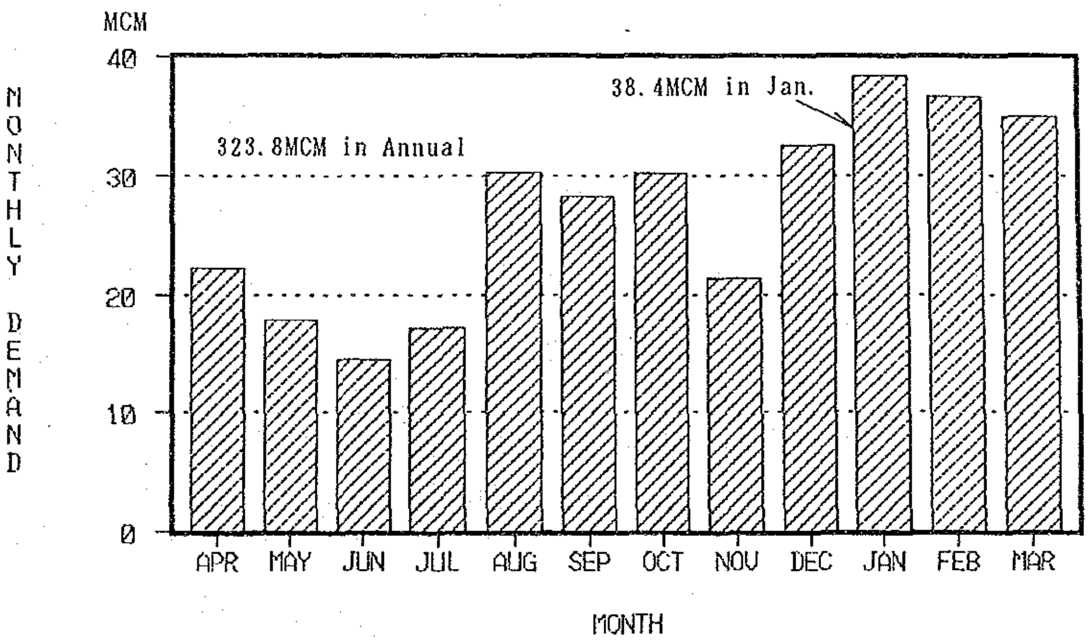
Wet season; Jun. to middle of Nov. .... All gates are opened

Dry season; Middle of Nov. to May .... All gates are closed, and water level will be controled by two regurating gates.

Outline of this opration is shown on Figure 3-7-1.

FIGURE 3-7-1 MONTHLY RUNOFF WATER IN BANG PAKONG RIVER
AND WATER SUPPLY PLAN





Notes;
(1)All tidal gates will be opened fully for 6 months from Jun to middle of Nov.
(2)As for dry season 6 Months, all gates will be closed and two regulating gates will be operated for runoff water control.

APPENDIX - 4 : BASIC DESIGN OF FACILITIES

APPENDIX - 4. BASIC DESIGN OF FACILITIES

LIST OF CONTENTS

4.1 DIVERSION CANAL

4.1.1 FIGURE

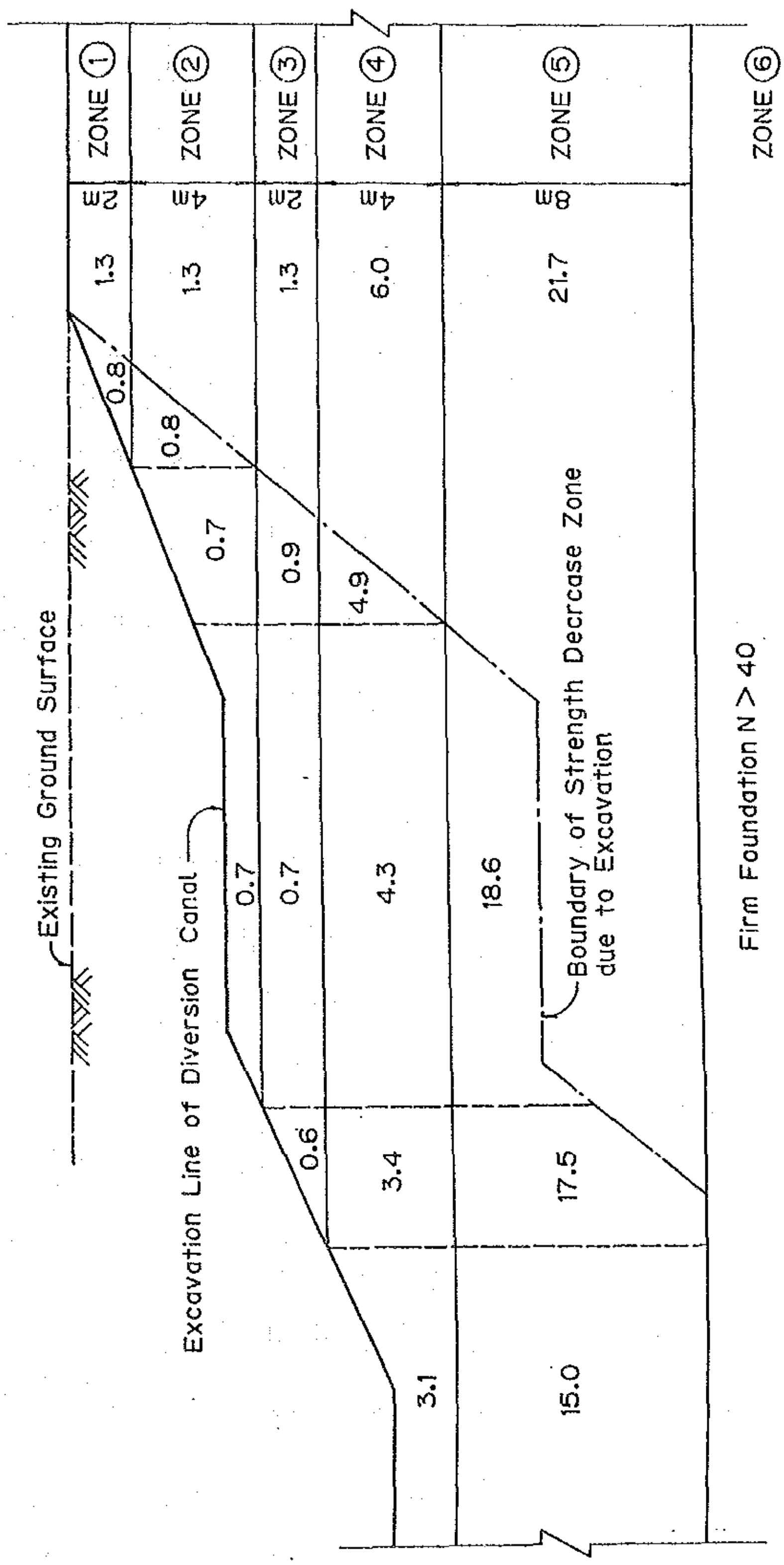


FIGURE 4-1-1 CALCULATION MODE FOR STABILITY ANALYSIS (FIGURES IN THE MODEL SHOW THE COHESION M tf/m^2)

FIGURE 4-1-2 RESULT OF STABILITY ANALYSIS (1 : 7.0)

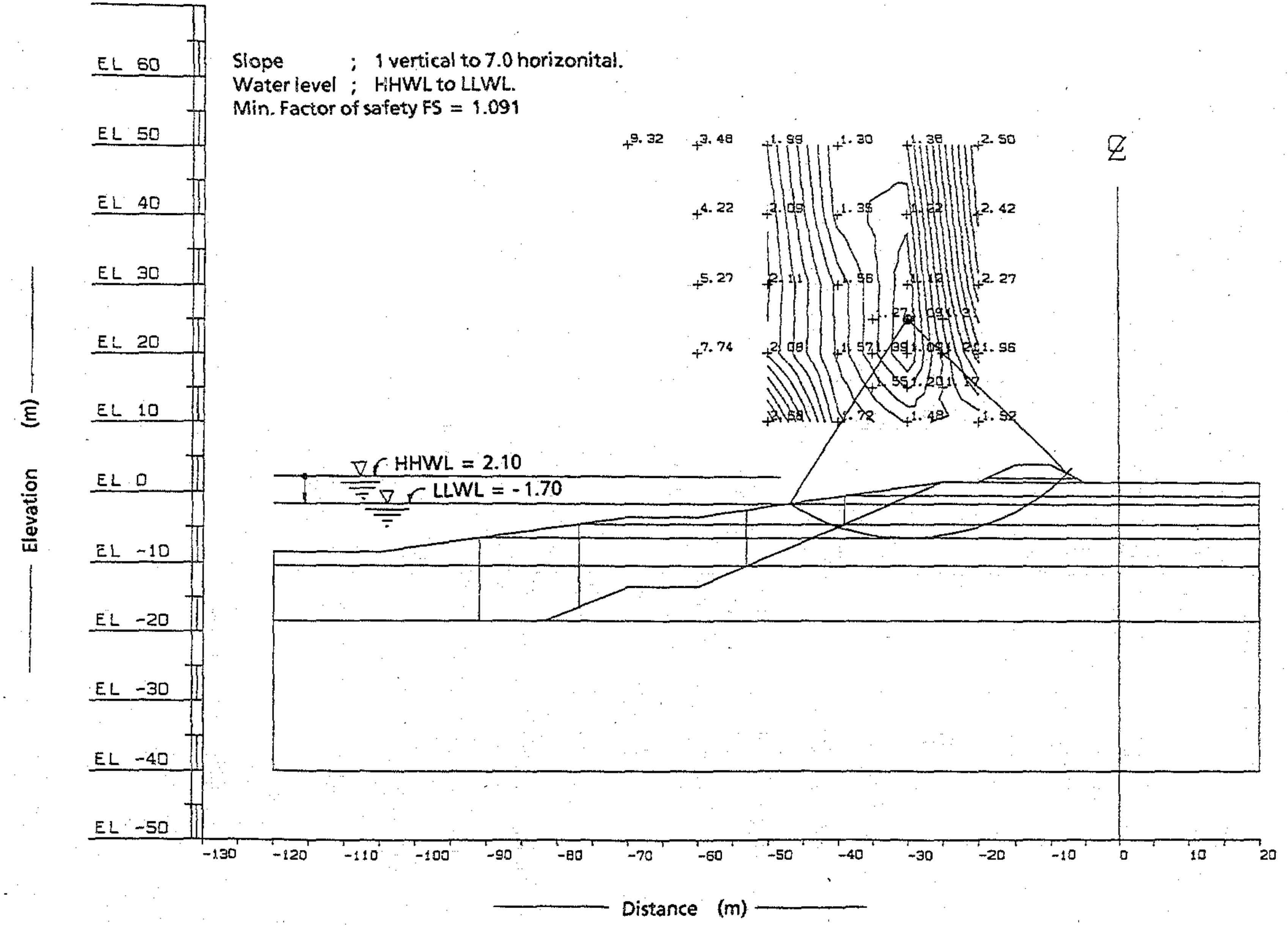
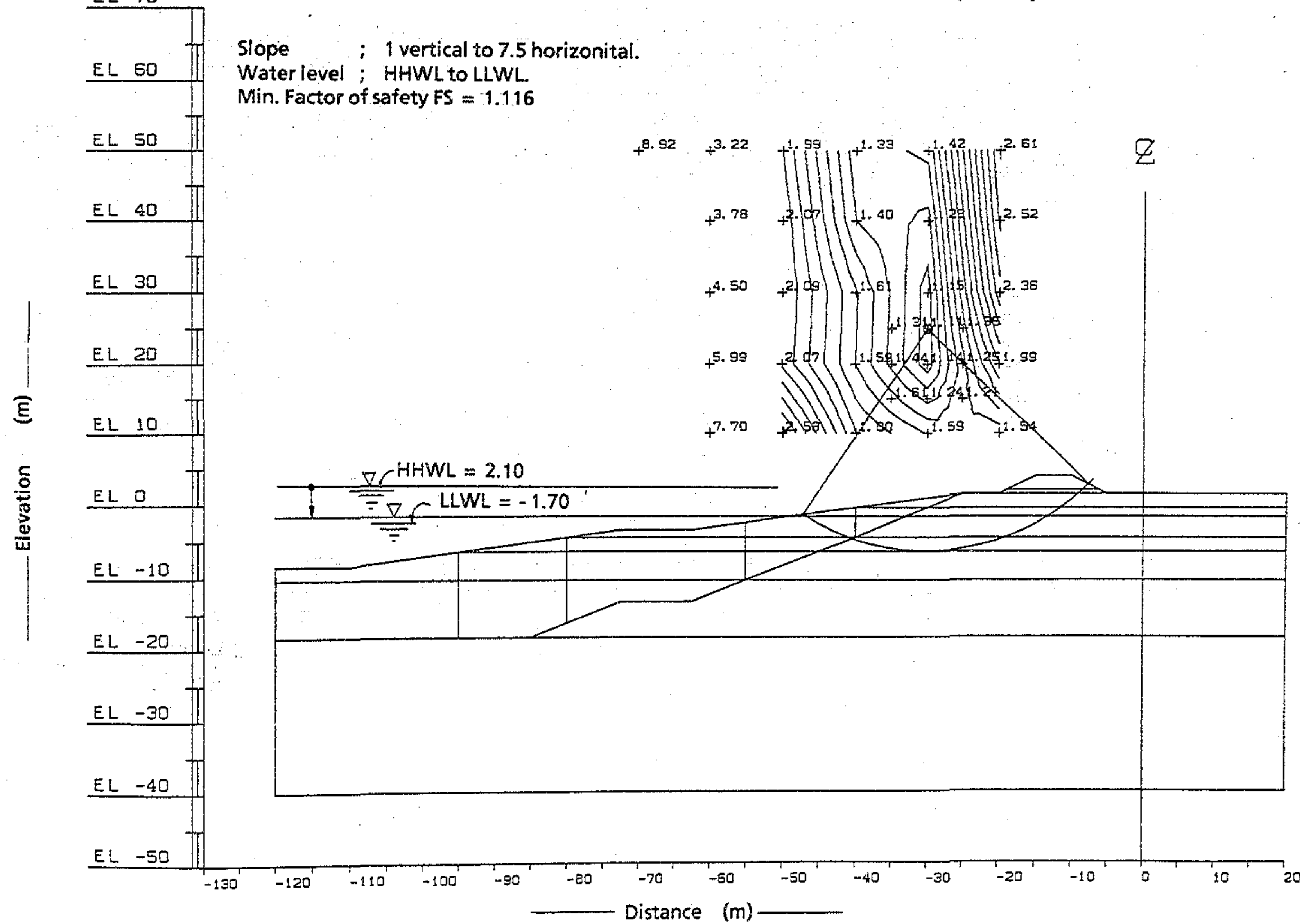


FIGURE 4-1-3 RESULT OF STABILITY ANALYSIS (1 : 7.5)

Slope ; 1 vertical to 7.5 horizonital.
Water level ; HHWL to LLWL.
Min. Factor of safety FS = 1.116



4.2 CLOSURE DAM

4.2.1 FIGURE

FIGURE 4-2-1 COMPARATIVE STUDY MODELS

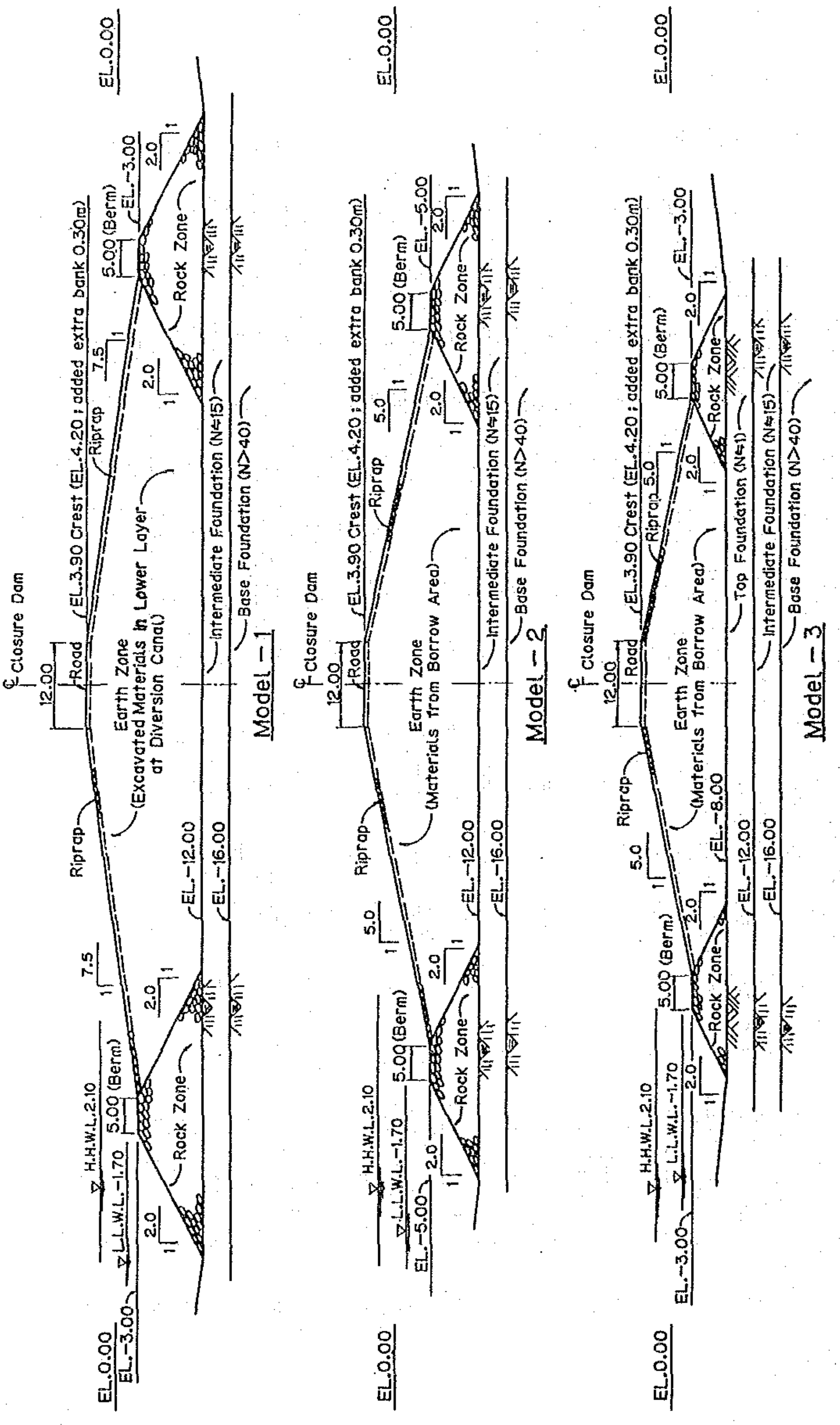


FIGURE 4-2-2 RESULT OF STABILITY ANALYSIS (MODEL-1)

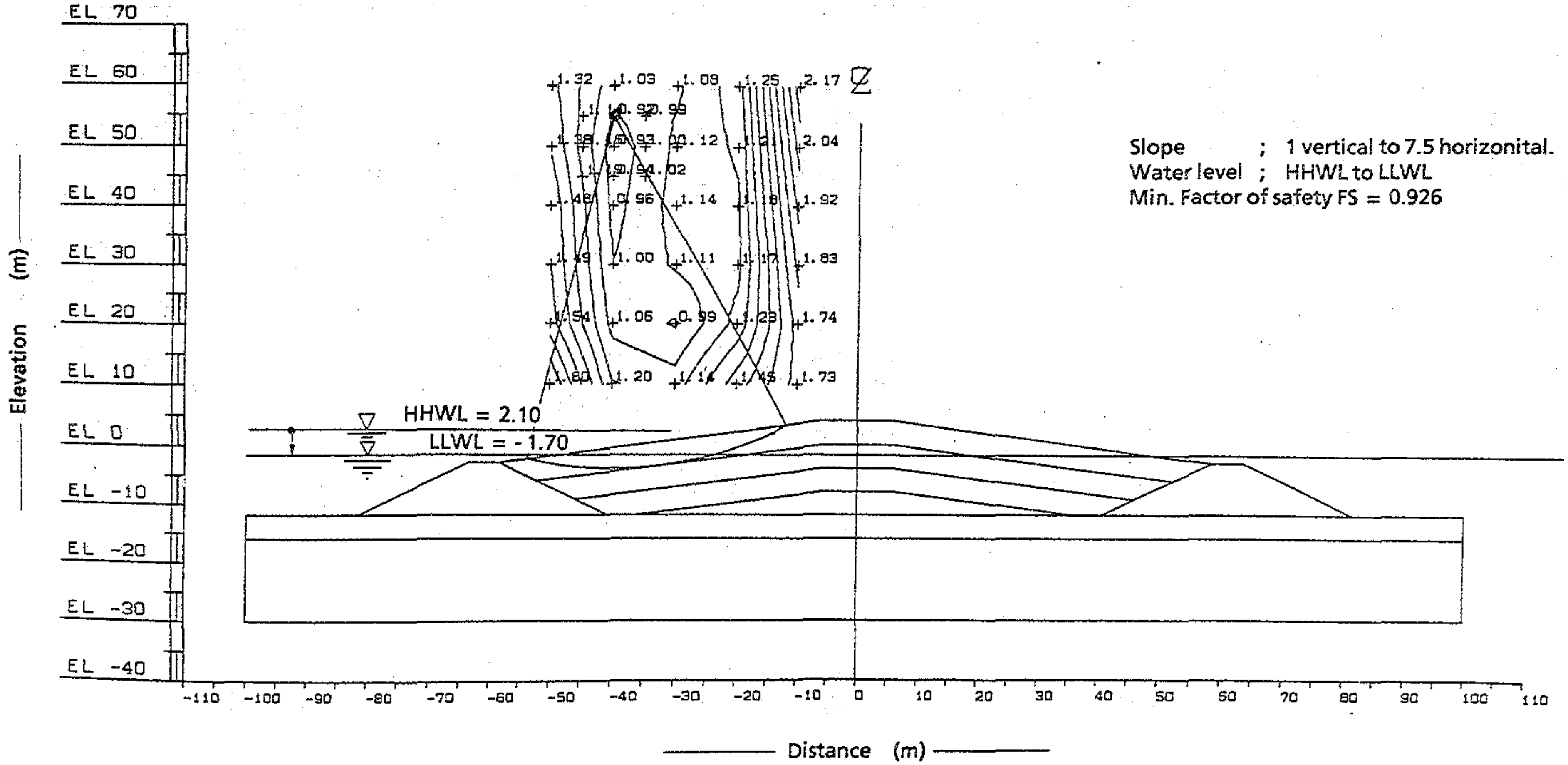


FIGURE 4-2-3 RESULT OF STABILITY ANALYSIS (MODEL-2)

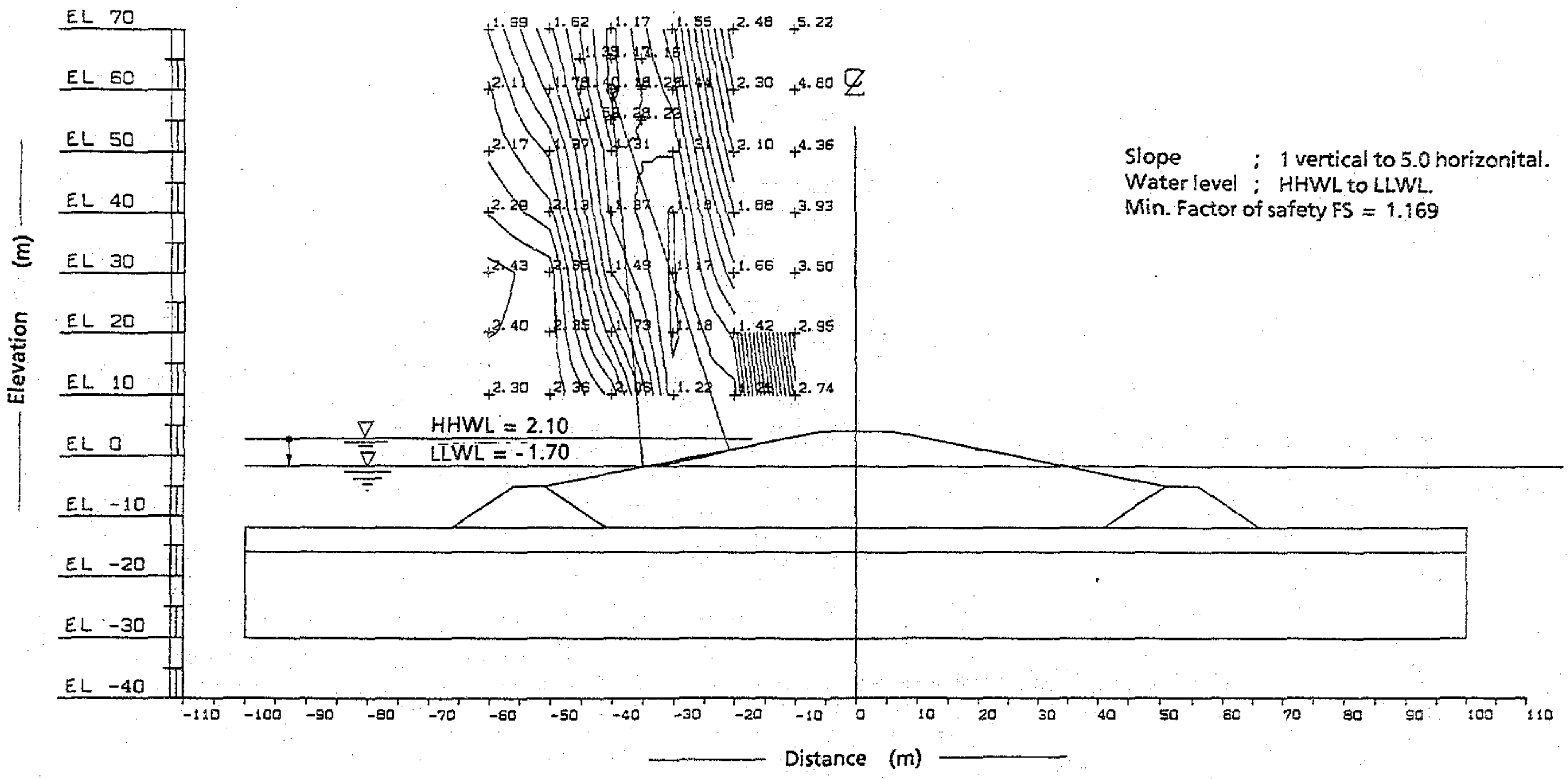
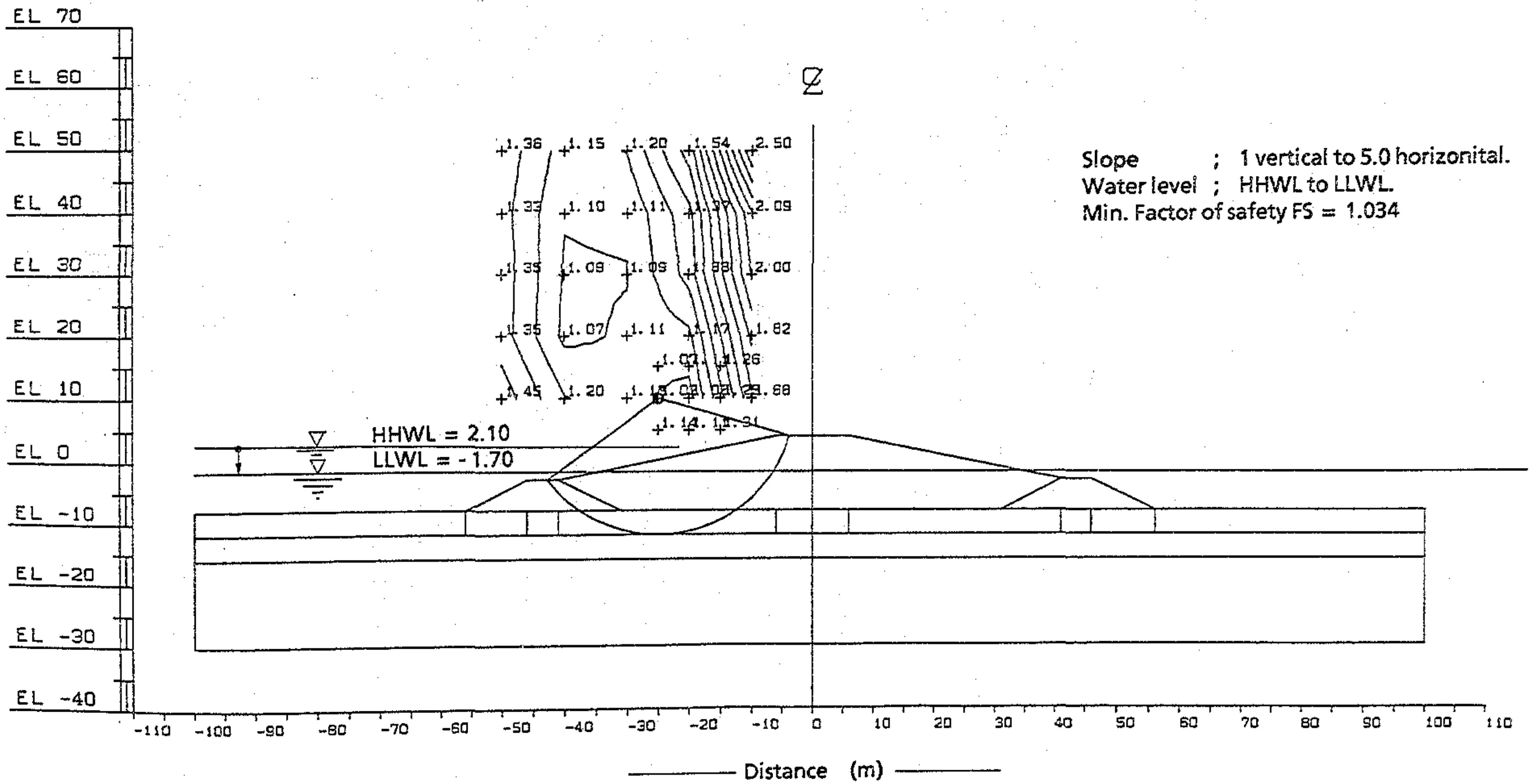


FIGURE 4-2-4 RESULT OF STABILITY ANALYSIS (MODEL-3)



4.3 Pumping Station

4.3.1 Study on Sedimentation Basin

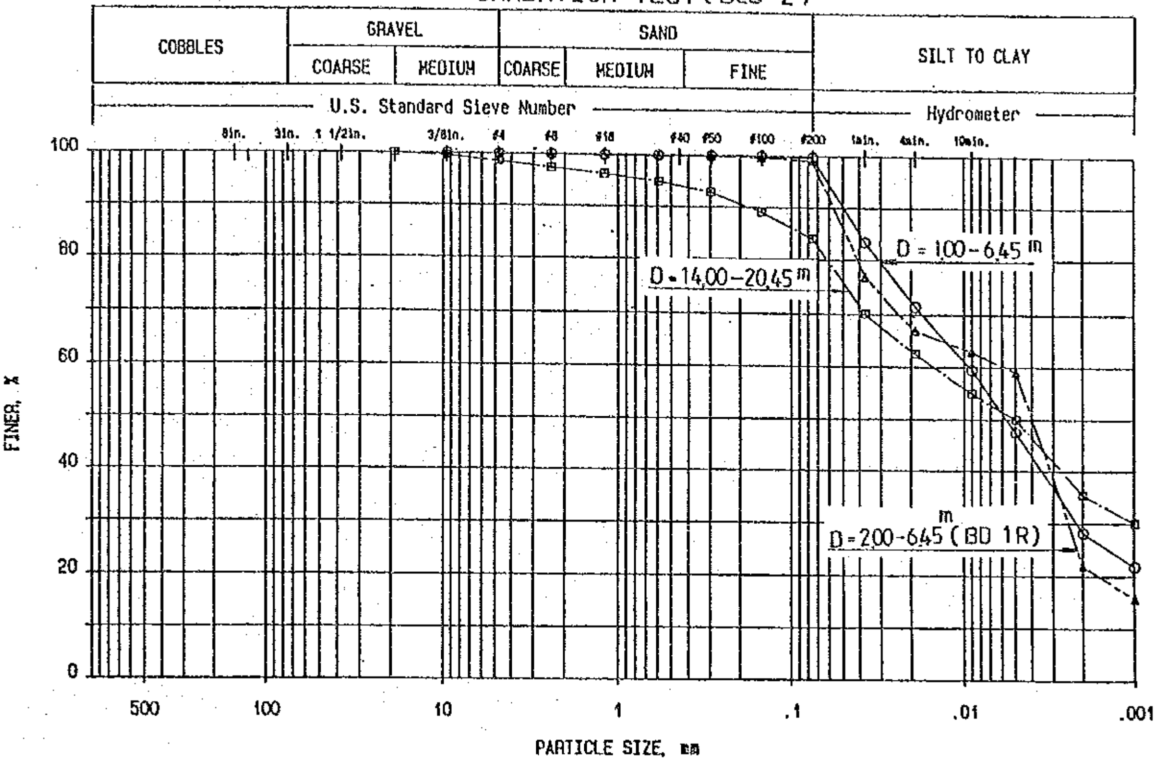
The minimum size of sand particles to be trapped in sedimentation basins for irrigation water is generally 0.3 mm in diameter, although depending those conditions of gradation curve of inflow sediments, amount of sediments in canals, etc.

The particle size of the sediment sand in the Bang Pakong River of the Project, will include less than 5 percent by over 0.3 mm diameter and found most by silt and clay with diameter by 0.074 mm, judging from the gradation tests of the sand along the surface of the riverside. In consequence, the suspended particles included in the surface of the river flow are deemed most as silty and clayey materials, and there will be little adverse effects expected to pump impeller as will as to sedimentation on the canal bed.

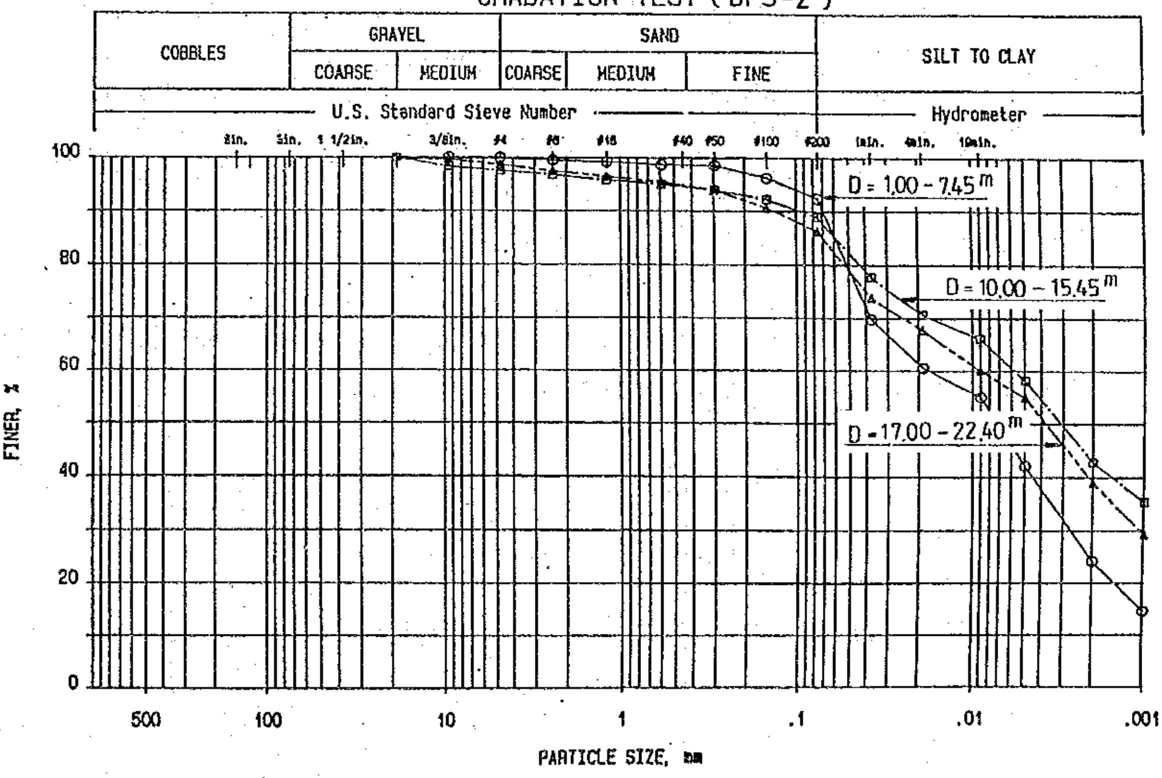
In other respect, since the whisky factory near the Tha Lat River has been taking the river water by about 240 thousand cubic meters to use after storing in the reservoir where very little sediments can be found, it is considered unnecessary to provide a total sedimentation basin for the pumping station. It is, therefore, the proposed pumping station shall not provide a total sedimentation basin, but a intake canal with the under - mentioned dimensions at the upstream of the pumping site so as to prevent inflow of sediment material from flowing into the pumps.

Mean velocity ; 0.15 ~ 0.30 m/s
Flowing duration ; 30 ~ 60 sec

GRADATION TEST (BCD-2)



GRADATION TEST (BPS-2)



4. 3. 2 Study on Cavitation

1) Study Conditions

Design discharge / unit	Q = 240 m^3/min
Design actual pump head	ha = 5.40 m
Lowest discharge water level	Min. D. W. L. 1.39 m
Operatable minimum suction water level	Min. S. W. L. (-) 1.90 m
Suction water level at minimum actual head	S. W. L. 1.39 m
Finished floor elevation of pump room	EL. 4.30 m

Total pump head

Horizontal shaft type $ht = ha + hl = 5.40 + 0.80 = 6.20$ m

Vertical shaft type $ht = ha + hl = 5.40 + 0.70 = 6.10$ m

2) Conditions for Planning

	Axial flow pump	Mixed flow pump
Specific speed (Ns)	1,500	900
Rounding Speed (N)	375 rpm	225 rpm
Suction specific speed (S)	1,200	1,300
Pipe loss head		
Horizontal shaft type (hls)	0.30 m	0.30 m
Vertical shaft type (hls)	0 m	0 m
Atmospheric pressure (Pa)	10.33 m	10.33 m
Saturated vapor pressure (Pv)	0.33 m	0.33 m
Allowable suction head (β)	0.50 m	0.50 m

3) Study Result

The vertical shaft type mixed flow pumps will not cause cavitation in every range of operation, but other types of pumps will.

(1) STUDY ON CAVITATION BY HORIZON TAL SHAFT PUMP

Pump Type		Axial Flow Pump		Mixed Flow Pump		Remarks
Bore		φ 1,350 mm		φ 1,350 mm		
Study Conditions		Lowest S.W.L	Min. ha	Lowest S.W.L	Min. ha	
Discharge Water Level (D.W.L)	m	1.39	1.39	1.39	1.39	
Suction Water Level (S.W.L)	m	(-) 1.90	1.39	(-) 1.90	1.39	
Total Head (ht)	m	6.20	6.20	6.20	6.20	
Minimum Actual Head (hamin)	m	3.29	0	3.29	0	
Actual Head Ratio (hamin/ht)	—	0.53	0	0.53	0	
Loss Head of Pipe (h_s)	m	0.80	0.80	0.80	0.80	
Loss Head Ratio (h_s/ht)	—	0.13	0.13	0.13	0.13	
Capacity Ratio (q)	—	1.15	1.28	1.19	1.38	
Coefficient (α)	—	1.50	2.55	1.40	2.70	
Re. NPSH at the Design Point (Hsvo)	m	8.19	8.19	3.73	3.73	
Re. NPSH at the Max. Capacity (Hsv)	m	12.29	20.88	5.22	10.07	
Allowable Actual Suction Head (Hs_2)	m	(-) 3.09	(-)11.68	3.98	(-) 0.87	9.20-Hsv
Basic Elevation (EL)	m	6.13	6.13	6.13	6.13	
Actual Suction Head (H'_{s2})	m	8.03	4.74	8.03	4.74	
Judgement $Hs_2 \geqq 0$ $Hs_2 \geqq H'_{s2}$		NO	NO	NO	NO	
		×		×		

(2) STUDY ON CAVITATION BY VERTICAL SHAFT PUMP

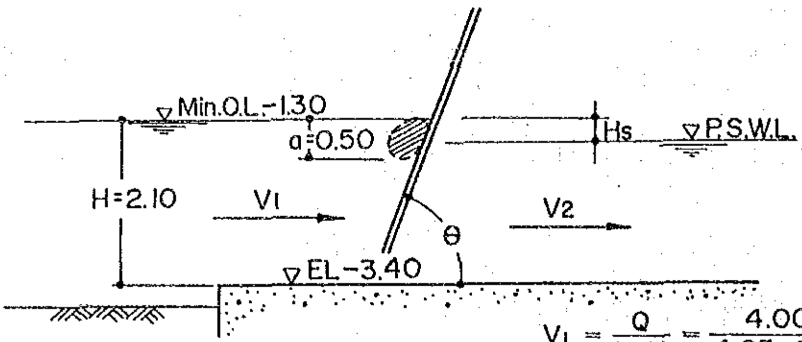
Pump Type		Axial Flow Pump		Mixed Flow Pump		Remarks
Bore		ϕ 1,350 mm		ϕ 1,350 mm		
Study Conditions		Lowest S.W.L	Min. ha	Lowest S.W.L	Min. ha	
Discharge Water Level (D.W.L)	m	1.39	1.39	1.39	1.39	
Suction Water Level (S.W.L)	m	(-) 1.90	1.39	(-) 1.90	1.39	
Total Head (ht)	m	6.10	6.10	6.10	6.10	
Minimum Actual Head (hamin)	m	3.29	0	3.29	0	
Actual Head Ratio (hamin/ht)	–	0.54	0	0.54	0	
Loss Head of Pipe (h_ℓ)	m	0.70	0.70	0.70	0.70	
Loss Head Ratio (h_ℓ/ht)	–	0.11	0.11	0.11	0.11	
Capacity Ratio (q)	–	1.16	1.29	1.20	1.39	
Coefficient (α)	–	1.50	2.65	1.40	2.80	
Re. NPSH at the Design Point (Hsvo)	m	8.19	8.19	3.73	3.73	
Re. NPSH at the Max. Capacity (Hsv)	m	12.29	21.70	5.22	10.44	
Allowable Actual Suction Head (Hs_2)	m	2.79	12.20	(-) 4.28	0.94	−(9.50-Hsv)
Basic Elevation (EL)	m	(-) 3.53	(-) 3.53	(-) 3.53	(-) 3.53	
Actual Suction Head ($H's_2$)	m	1.63	4.92	1.63	4.92	
Judgement $H's_2 \geqq Hs_2$		NO	NO	OK	OK	
		×		○		

4.3.3 Table and Figure

1) Table 4-3-1 Ten-day Water Requirements (Without Rainfall)

Season	Mon		W.Paddy (Trans.)		W.Paddy (Broad.)		W.Paddy (Broad.)		Soybean		Groundnuts		Mungbean		Orchard		Vegetable		F.Pond		S.Pond		W.Supply	TOTAL
			Req.	A=8910ha	Req.	A= 990ha	Req.	A=1980ha	Req.	A= 280ha	Req.	A= 920ha	Req.	A=1780ha	Req.	A=4150ha	Req.	A=(1420)ha	Req.	A= 400ha	q	A= 981ha	V=2.2 MCM/Year	
				m^3/S		m^3/S		m^3/S		m^3/S		m^3/S		m^3/S		m^3/S		m^3/S		m^3/S		m^3/S	m^3/S	m^3/S
Dry	4	1	—		—		4.35	1.675	0.63	0.042	3.08	0.669	0.44	0.185	2.69	2.643	3.37	720 0.573	—		0.6319	0.689	0.073	6.550
		2	—		—		2.48	0.955	—		1.77	0.385	1.69	0.711	2.69	2.643	3.37	0.573	—		0.6319	0.689	0.073	6.029
		3	—		—		0.79	0.304	—		0.56	0.122	3.41	1.434	2.69	2.643	3.37	0.573	—		0.6319	0.689	0.073	5.838
Wet	5	1	—		—		—		—		—		4.93	2.073	1.99	1.955	2.90	0.493	—		—		0.073	4.595
		2	—		—		—		—		—		5.04	2.119	1.99	1.955	2.90	0.493	—		—		0.073	4.640
		3	—		—		—		—		—		4.06	1.707	1.99	1.955	2.90	0.493	—		—		0.073	4.229
	6	1	—		—		—		—		—		1.73	0.727	—		1.14	240 0.065	16.30	0.545	—		0.070	1.407
		2	—		—		—		—		—		0.66	0.277	—		1.14	0.065	17.80	0.595	—		0.070	1.007
		3	—		—		—		—		—		0.11	0.046	—		1.14	0.065	19.31	0.646	—		0.070	0.827
	7	1	—		5.11	0.984	—		—		—		—		—		—		20.72	0.693	—		0.070	1.747
		2	—		6.54	1.259	—		—		—		—		—		—		14.25	0.476	—		0.070	1.806
		3	2.78	4.818	8.06	1.552	—		—		—		—		—		—		6.65	0.222	—		0.070	6.663
	8	1	5.16	8.943	9.46	1.822	—		—		—		—		—		2.10	0.119	6.39	0.214	—		0.073	11.171
		2	6.64	11.508	8.67	1.670	—		—		—		—		—		2.10	0.119	6.39	0.214	—		0.073	13.584
		3	8.27	14.334	6.89	1.327	—		—		—		—		—		2.10	0.119	6.39	0.214	—		0.073	16.067
	9	1	8.84	15.321	6.89	1.327	—		—		—		—		—		2.70	0.153	6.00	0.201	—		0.066	17.068
		2	7.24	12.548	7.01	1.350	—		—		—		—		—		2.70	0.153	5.83	0.195	—		0.066	14.312
		3	6.97	12.080	6.97	1.342	—		—		—		—		—		2.70	0.153	4.67	0.156	—		0.065	13.797
	10	1	7.21	12.496	7.21	1.388	—		—		—		—		—		2.94	0.167	3.42	0.114	—		0.056	14.231
		2	6.72	11.647	6.72	1.294	—		—		—		—		—		2.94	0.167	2.05	0.069	—		0.066	13.243
		3	5.25	9.099	5.25	1.011	—		—		—		—		—		2.94	0.167	0.68	0.023	—		0.066	10.366
Dry	11	1	3.86	6.690	3.86	0.743	—		—		—		—		—		0.82	0.046	16.29	0.545	—		0.066	8.091
		2	2.21	3.830	2.21	0.426	—		—		—		—		—		0.82	0.046	17.76	0.594	—		0.066	4.963
		3	0.70	1.213	0.70	0.136	—		—		—		—		—		0.82	0.046	19.24	0.643	—		0.066	2.104
	12	1	—		—		5.18	1.995	—		—		—		3.80	3.734	1.69	1,420 0.567	20.92	0.699	—		0.066	7.062
		2	—		—		6.75	2.600	0.07	0.005	0.08	0.017	—		3.80	3.734	1.69	0.567	14.49	0.484	—		0.066	7.473
		3	—		—		8.42	3.243	0.70	0.046	0.76	0.165	—		3.80	3.734	1.69	0.567	6.90	0.231	—		0.066	8.052
	1	1	—		—		10.14	3.905	1.63	0.108	1.72	0.374	—		3.65	3.587	3.36	1.127	6.86	0.229	0.5417	0.590	0.066	9.987
		2	—		—		9.55	3.678	2.73	0.181	2.86	0.622	—		3.65	3.587	3.36	1.127	6.86	0.229	0.5417	0.590	0.066	10.080
		3	—		—		7.86	3.027	3.74	0.247	3.69	0.802	—		3.65	3.587	3.36	1.127	6.86	0.229	0.5417	0.590	0.066	9.676
	2	1	—				8.52	3.282	4.70	0.311	4.51	0.980	—		3.59	3.528	3.59	1.204	7.25	0.242	1.0833	1.181	0.070	10.797
		2	—		—		8.67	3.339	5.12	0.339	4.79	1.041	—		3.59	3.528	3.59	1.204	7.05	0.236	1.0832	1.181	0.070	10.937
		3	—		—		8.62	3.320	5.17	0.342	4.75	1.032	—		3.59	3.528	3.59	1.204	5.64	0.189	1.0833	1.181	0.070	10.865
	3	1	—		—		8.87	3.416	5.56	0.368	5.17	1.123	—		3.32	3.262	2.42	720 0.412	4.33	0.145	1.1736	1.279	0.077	10.032
		2	—		—		8.24	3.174	3.99	0.264	4.62	1.004	—		3.32	3.262	2.42	0.412	2.60	0.087	1.1736	1.279	0.077	9.558
		3	—		—		6.42	2.473	2.07	0.137	4.13	0.897	—		3.32	3.262	2.42	0.412	0.87	0.029	1.1736	1.279	0.077	8.566
TOTAL			(E=0.595)	110.03 MCM	(E=0.595)	15.57 MCM	(E=0.595)	35.08 MCM	(E=0.490)	2.04 MCM	(E=0.490)	7.96 MCM	(E=0.490)	8.16 MCM	(E=0.490)	48.97 MCM	(E=0.490)	12.81 MCM	(E=0.900, A=0.650)	8.16 MCM	(E=0.900)	9.65 MCM	2.20 MCM	260.63 MCM

TABLE 4-3-2 LOSS HEAD OF TRASHRACK



$$V_1 = \frac{Q}{B \cdot H} = \frac{4.00}{4.05 \times 2.10} = 0.470\,m/s$$

The trashrack loss head can be estimated by the following equation.

$$Hs = 6.69 \times \sin\theta \cdot (t/b)^{4/3} \cdot \exp(0.074 \times \gamma a \times \frac{a}{H}) \cdot \frac{V^2}{2g}$$

where

- Hs ; Loss head by trashrack (m)
- a ; Height of trashes adsorbed (=0.50m)
- γa ; Trash weight by unit volume (=200km/m³)
- θ ; Sloping angle of trashrack (=70°)
- H ; Water depth at the upstream of the trashrack (=2.10m)
- t ; Thickness of trashrack bars (=0.009m)
- b ; Mesh size of trashrack (=0.050m)
- g ; Gravity added (=9.8m/s²)

$$Hs = 6.69 \times \sin 70 \times (\frac{0.009^{4/3}}{0.050}) \times \exp(0.074 \times 200 \times \frac{0.50}{2.10}) \times \frac{0.470^2}{2 \times 9.8} = 0.244\,m$$

The intake losses and some allowance shall be added to the above result to get the trashrack loss head by Hs=0.30m as design value.

TABLE4−3−3 LOSS HEAD OF DISCHARGE PIPE IN EEACH CASE

Item \ No. of Pumps			3 − Pumps		4 − Pumps		5 − Pumps	
Pump Bore		(mm)	ϕ 1,500		ϕ 1,350		ϕ 1,200	
Discharge/Unit		(m^3/s)	5.333		4.000		3.200	
Discharge Pipe Bore		(m)	1.50	1.80	1.35	1.65	1.20	1.50
Area		(m^2)	1.767	2.545	1.431	2.138	1.131	1.767
Velocity		(m/s)	3.018	2.095	2.795	1.871	2.829	1.811
Velocity Head		(m)	0.465	0.224	0.399	0.179	0.408	0.167
Friction Loss Coefficient		(λ)	0.0305	0.0304	0.0306	0.0305	0.0306	0.0305
Water Conveyrance Slope $I=\lambda \cdot \frac{1}{D} \cdot \frac{V^2}{2g}$		($\times 10^{-3}$)	9.455	3.783	9.044	3.309	10.404	3.396
Loss Heads (m)	Butterfly Valve	$f_v=0.30$		0.140		0.120		0.122
	Bend (30° × 2)	$f_B=0.07$		0.065		0.056		0.057
	Enlarge of Area	$f_E=0.46$		0.020		0.020		0.024
	Flap Valve		($f_v=0.57$)	0.128	($f_v=0.62$)	0.111	($f_v=0.68$)	0.114
	Water Release	$f_O=1.0$		0.224		0.179		0.167
	Friction ($\ell \fallingdotseq 13.5$ m)			0.128		0.122		0.141
	In-Pipe Cooler (Only for Engine)	$f_C=0.35$		0.163		0.140		0.143
Total Loss Head	For Motor	(m)	0.705 ≒ 0.80		0.608 ≒ 0.70		0.625 ≒ 0.70	
	For Engine	(m)	0.868 ≒ 0.90		0.748 ≒ 0.80		0.768 ≒ 0.80	

TABLE4-3-4 PRIME MOVER OUTPUT IN EACH CASE

Item \ No. of Pumps		3 - Pumps		4 - Pumps		5 - Pumps	
Pump Bore	(mm)	φ1,500		φ1,350		φ1,200	
Discharge/Unit (Q)	(m³/min)	320		240		192	
Actual Head (ha)	(m)	5.40		5.40		5.40	
Type of Prime Mover		Motor	Engine	Motor	Engine	Motor	Engine
Loss Head (h_e)	(m)	0.80	0.90	0.70	0.80	0.70	0.80
Total Head (H)	(m)	6.20	6.30	6.10	6.20	6.10	6.20
Pump Efficiency (η_p)		0.84		0.835		0.83	
Transmission Efficiency (η_G)		0.96		0.96		0.96	
Extra Coefficient (R)		0.15	0.20	0.15	0.20	0.15	0.20
Prime Mover Output (P)		(461.2) 470KW	(666.0) 670PS	(342.3) 350KW	(494.5) 500PS	(275.6) 280KW	(398.0) 400PS

$$P = K \cdot \frac{r \cdot Q \cdot H}{\eta_p \cdot \eta_G} \cdot (1 + R)$$

Where K ; coefficient (0.163 in KW, 0.222 in Ps)

r ; specific gravity of water (1.0)

TABLE4-3-5 PUMP OPERATION COST IN EACH CASE

No. of Pumps / Item	3-Pumps		4-Pumps (1)	4-Pumps (2)		4-Pumps (3)		5-Pumps	
Type of Prime Mover	Motor	Engine	Engine	Motor	Engine	Motor	Engine	Motor	Engine
Prime Mover output	470kw	670PS	350kw	350kw	500ps	350kw	500ps	280kw	400ps
Required Input	461.2kw		342.3kw	342.3kw		342.3kw		275.6kw	
No. of Prime Mover	2	1	4	3	1	2	2	4	1
Total Annual Operation Hours	10,988hr	69hr	13,303hr	13,279hr	24hr	12,427kw	876hr	15,686hr	15hr
1) Electric Charge	B		B	B		B		B	
a) Demand Charge	(470X2X167X12)		(350X4X167X12)	(350X3X167X12)		(350X2X167X12)		(280X4X167X12)	
(1.67 B/kw·Month)	1,883,760		2,805,600	2,104,200		1,402,800		2,244,480	
b) Energy Charge	(461.2X10,988X1.23)		(342.3X13,303X1.23)	(342.3X13,279X1.23)		(342.3X12,427X1.23)		(275.6X15,686X1.23)	
(1.23 B/kw·hr)	6,233,228		5,600,948	5,590,844		5,232,127		5,317,365	
Sub-Total	8,116,988		8,406,548	7,695,044		6,634,927		7,561,845	
2) Fuel Cost <*>									
300~ 500PS···1.41 B/Ps·hr	(670X69X1.27)			(500X24X1.27)		(500X876X1.27)		(400X15X1.41)	
500~1,000PS···1.27 B/Ps·hr	58,712		–	15,240		556,260		8,460	
3) Annual Operation Cost (Total)	8,175,700		8,406,548	7,710,284		7,191,187		7,570,305	
	'000 B		'000 B	'000 B		'000 B		'000 B	
Twenty Years Operation Cost	163,514		168,131	154,206		143,824		151,406	

<*> ; 300~ 500 PS ····· 0.20 kg/Ps·hr × 1/0.85 kg/ℓ × (1+0.5) = 1.41 B/Ps·hr

500~1,000 PS ····· 0.18 kg/Ps·hr × 1/0.85 kg/ℓ × (1+0.5) = 1.27 B/Ps·hr

TABLE4-3-6 PUMP OPERATION HOURS IN EACH CASE (1968—1987)

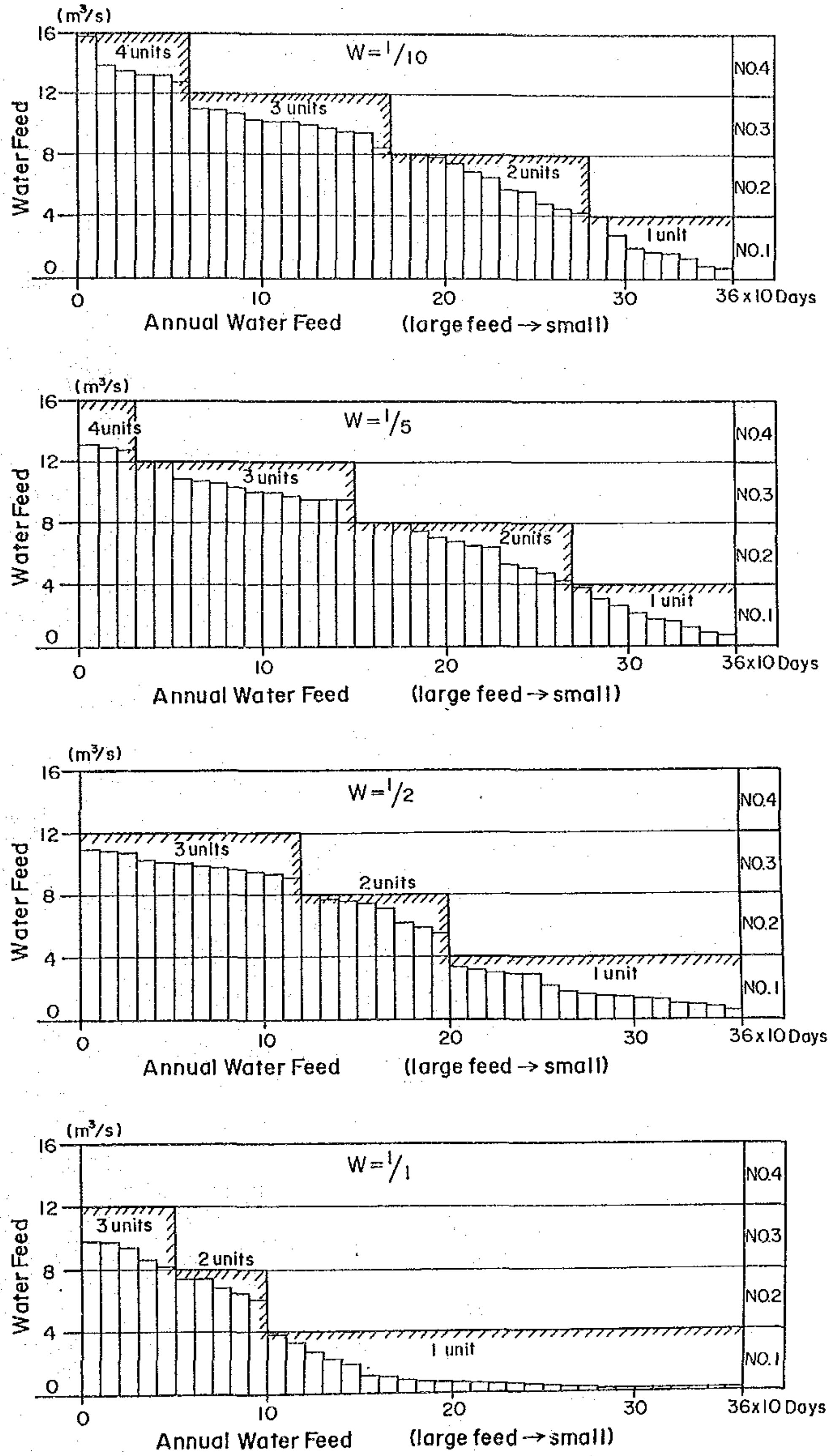
(Hour/Year)

No. of Pumps / Year	3 - Pumps			4 - Pumps				5 - Pumps				
	No. 1	No. 2	No. 3	No. 1	No. 2	No. 3	No. 4	No. 1	No. 2	No. 3	No. 4	No. 5
1968	8,784.0	2,316.7	171.5	8,784.0	3,750.5	871.4	146.5	8,784.0	4,532.4	2,257.7	380.9	123.1
1969	8,760.0	1,751.3	25.2	8,760.0	3,263.2	621.0	0	8,760.0	4,303.8	1,752.5	154.8	0
1970	〃	2,258.0	134.9	〃	3,594.2	954.1	99.7	〃	4,239.0	2,387.4	351.1	64.6
1971	〃	2,186.1	0	〃	3,833.5	626.4	0	〃	4,659.8	2,194.1	33.6	0
1972	8,784.0	2,156.3	56.1	8,784.0	3,342.3	972.4	0	8,784.0	4,161.5	2,217.1	303.8	0
1973	8,760.0	2,219.9	127.3	8,760.0	3,607.2	943.0	9.6	8,760.0	4,245.7	2,224.2	393.9	0
1974	〃	1,953.4	0	〃	3,576.9	460.1	0	〃	4,157.5	1,956.9	32.8	0
1975	〃	1,916.3	0	〃	3,422.5	619.7	0	〃	4,537.3	1,893.3	86.7	0
1976	8,784.0	2,076.9	0	8,784.0	3,612.5	642.8	0	8,784.0	4,526.8	2,120.5	46.2	0
1977	8,760.0	2,130.9	71.1	8,760.0	3,676.9	784.6	14.8	8,760.0	4,446.2	2,235.6	224.8	0
1978	〃	2,252.1	60.3	〃	3,820.0	839.0	0.3	〃	4,633.4	2,269.6	199.0	0
1979	〃	3,001.2	275.0	〃	4,284.1	1,644.6	62.3	〃	4,826.8	3,071.0	825.3	0
1980	8,784.0	2,002.4	52.9	8,784.0	3,581.7	585.6	0	8,784.0	4,338.1	1,942.6	193.8	0
1981	8,760.0	2,574.7	235.5	8,760.0	3,625.6	1,314.2	145.8	8,760.0	4,096.4	2,738.9	531.2	116.2
1982	〃	2,271.4	24.5	〃	3,688.2	790.2	0	〃	4,176.2	2,430.2	179.2	0
1983	〃	1,806.5	23.9	〃	3,081.1	700.9	0	〃	3,963.6	1,805.2	151.1	0
1984	8,784.0	2,288.0	47.9	8,784.0	3,843.6	851.8	0	8,784.0	4,666.9	2,325.0	218.8	0
1985	8,760.0	2,357.4	12.7	8,760.0	3,474.0	919.9	0	8,760.0	4,414.0	2,471.9	159.6	0
1986	〃	2,390.0	42.1	〃	3,912.7	928.7	0	〃	4,628.6	2,494.6	208.5	0
1987	〃	2,535.2	20.0	〃	3,946.6	962.7	0	〃	4,566.7	2,598.5	220.2	0
Max.	8,784.0	3,001.2	275.0	8,784.0	4,284.1	1,644.6	146.5	8,784.0	4,826.8	3,071.0	825.3	123.1
Min.	8,760.0	1,751.3	0	8,760.0	3,081.8	460.1	0	8,760.0	3,963.6	1,752.5	32.8	0
Mean	8,766.0	2,222.2	69.0	8,766.0	3,660.5	851.6	23.9	8,766.0	4,405.5	2,269.3	244.8	15.2

Note ; 1) No.1 pump operation hour is calculated in case of value control.

2) Operation hour except No.1 pump is calculated in case of on-off control.

FIGURE 4-3-1 PUMP OPERATION UNITS FOR ANNUAL WATER FEED
(In each return period)



4.4 Control System

4.4.1 Figure

FIGURE 4-4-1 Location of Gauging Station(Prachin Riv.)

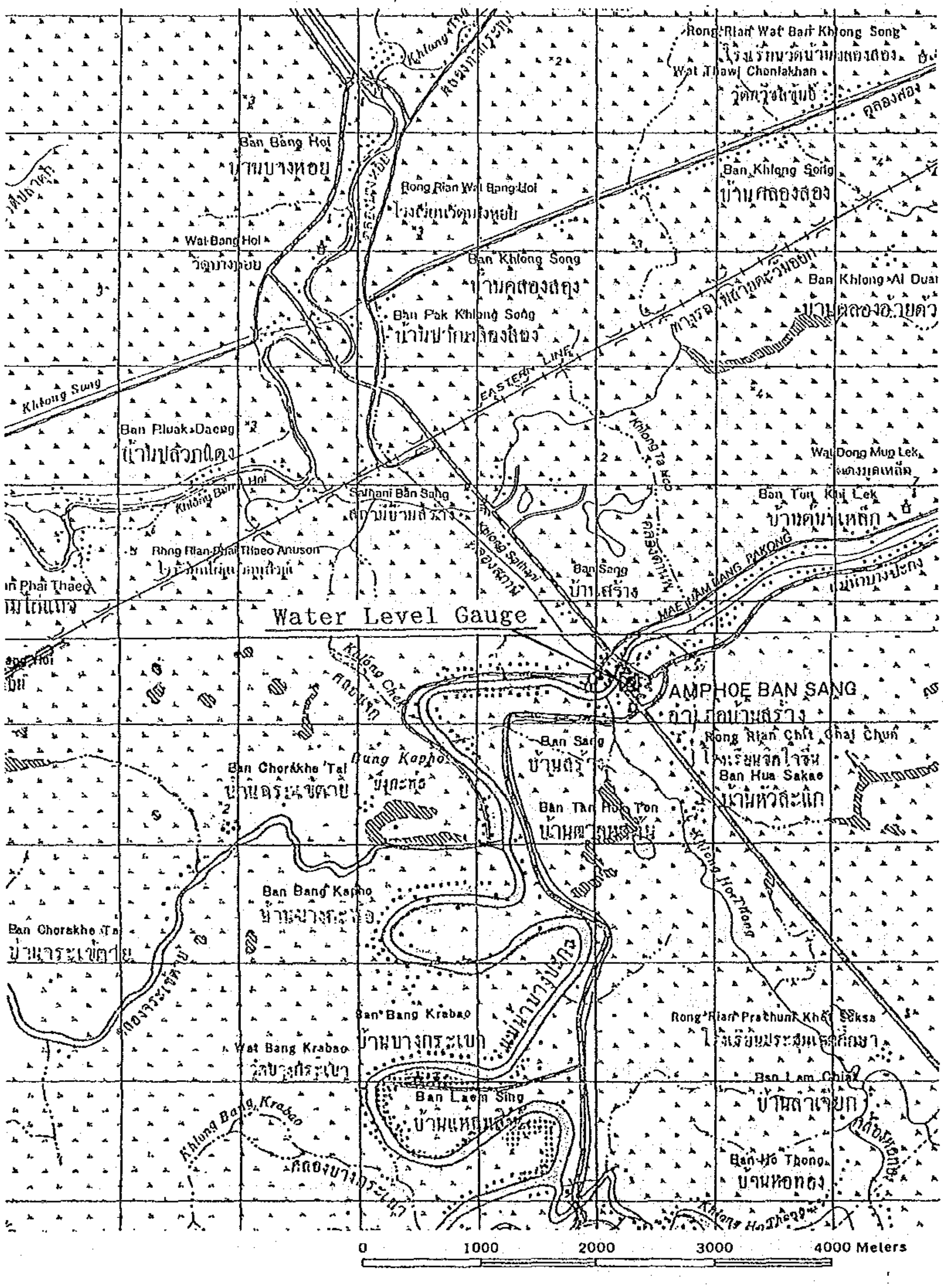


FIGURE 4-4-2 Location of Gauging Station(Nakhong Nayok Riv.)

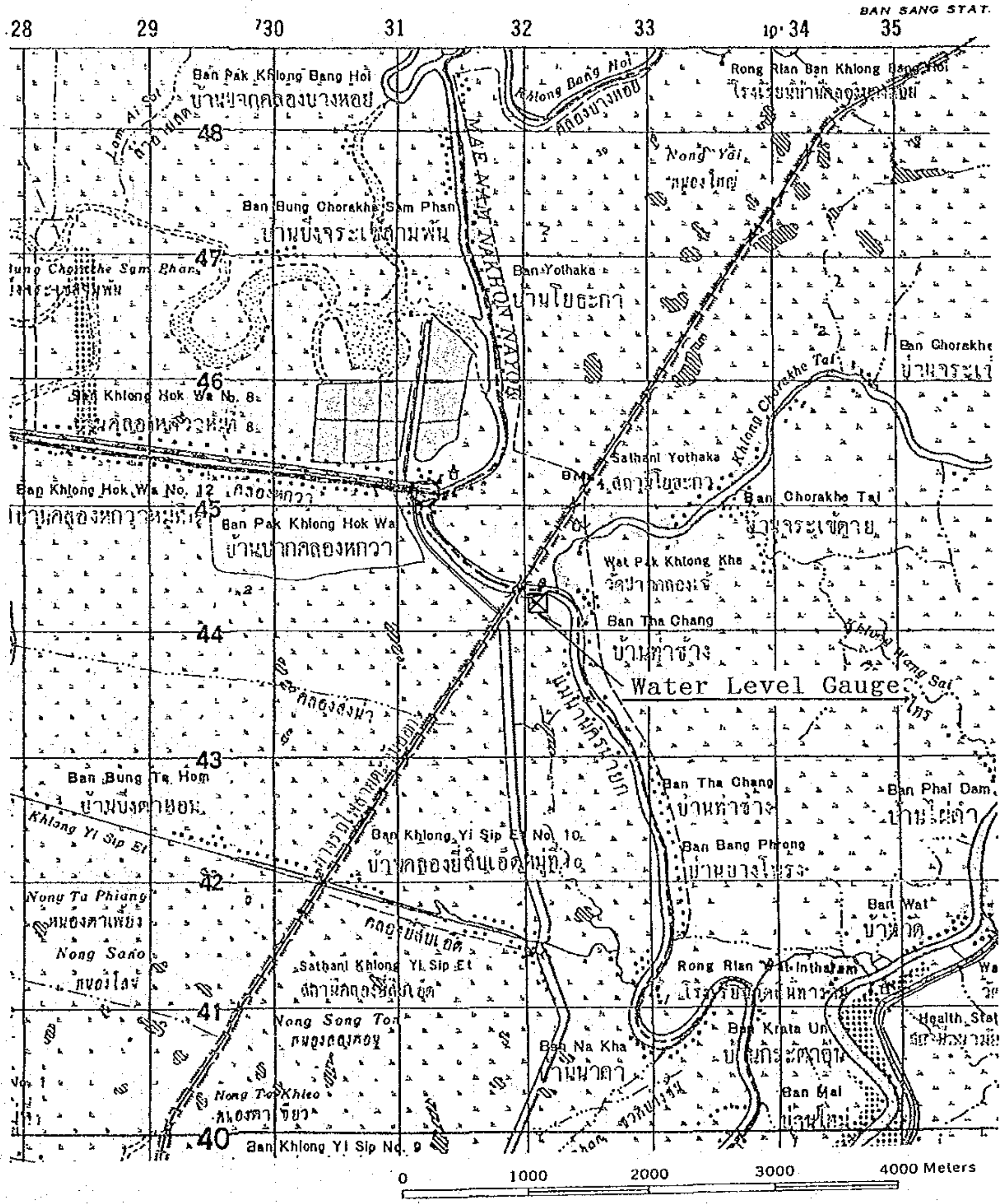


FIGURE 4-4-3 Location of Gauging Station(Diversion Dam)

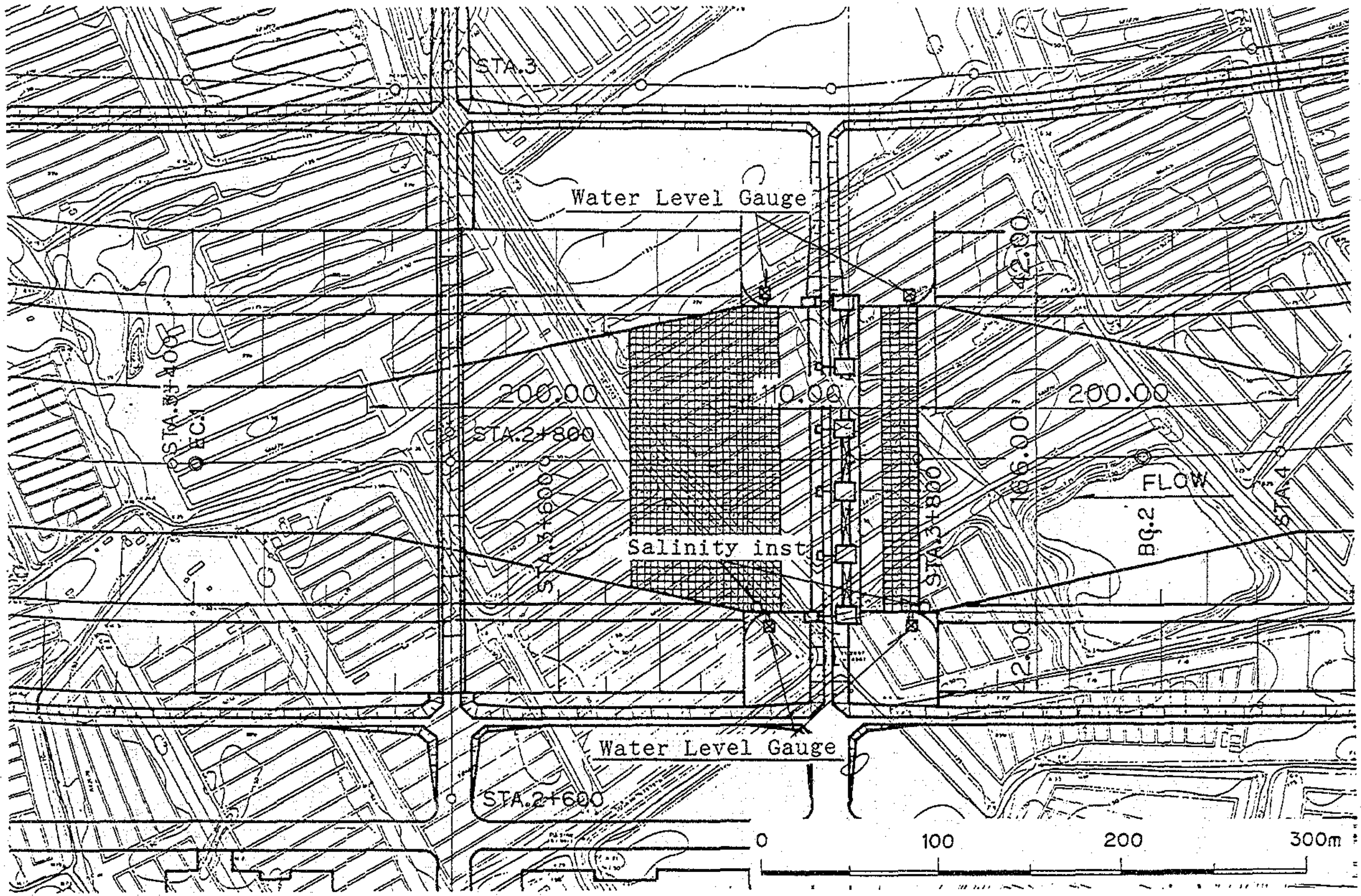


FIGURE 4-4-4 Location of Gauging Station(Pumping Station)

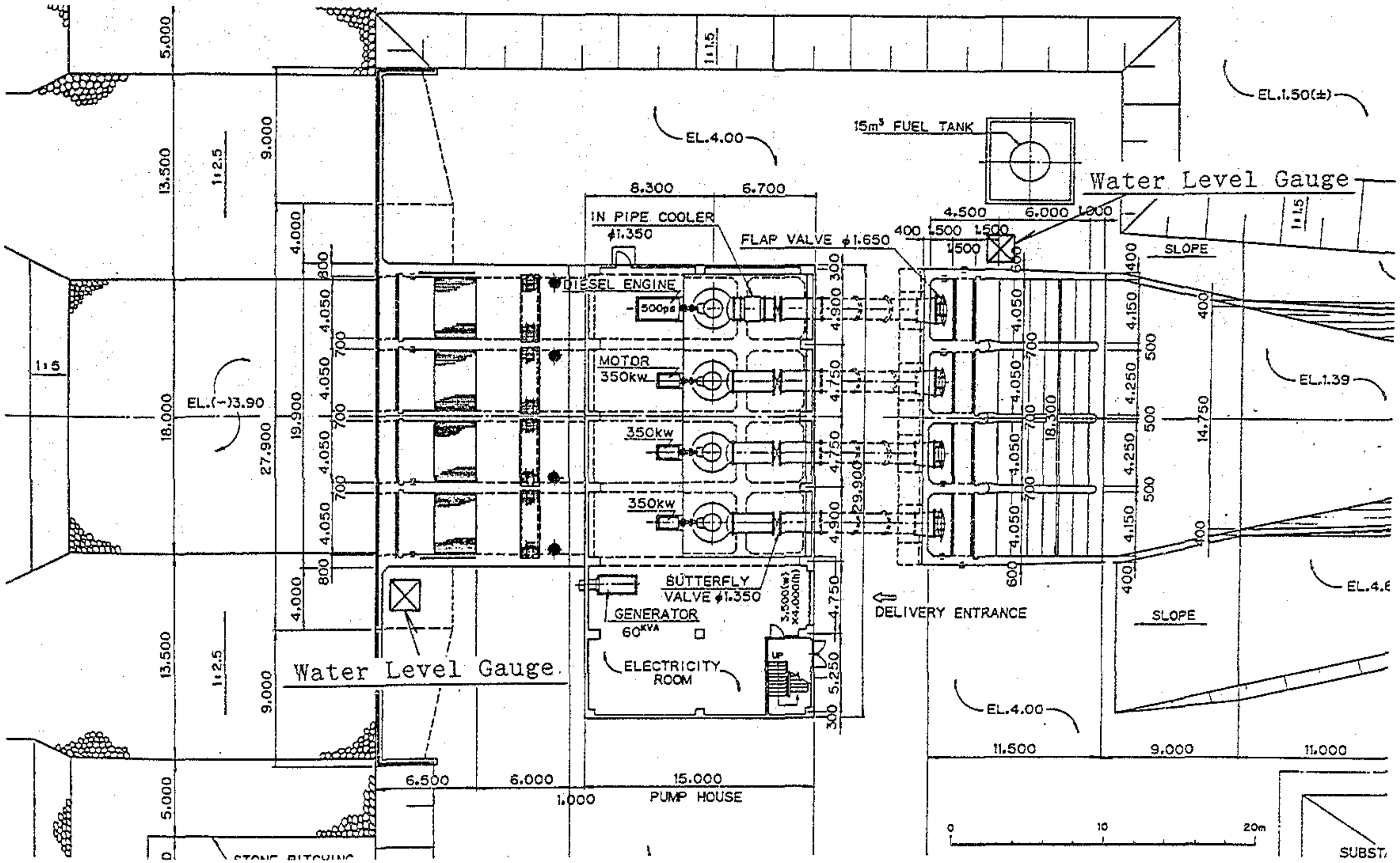


FIGURE 4-4-5 Antenna Tower

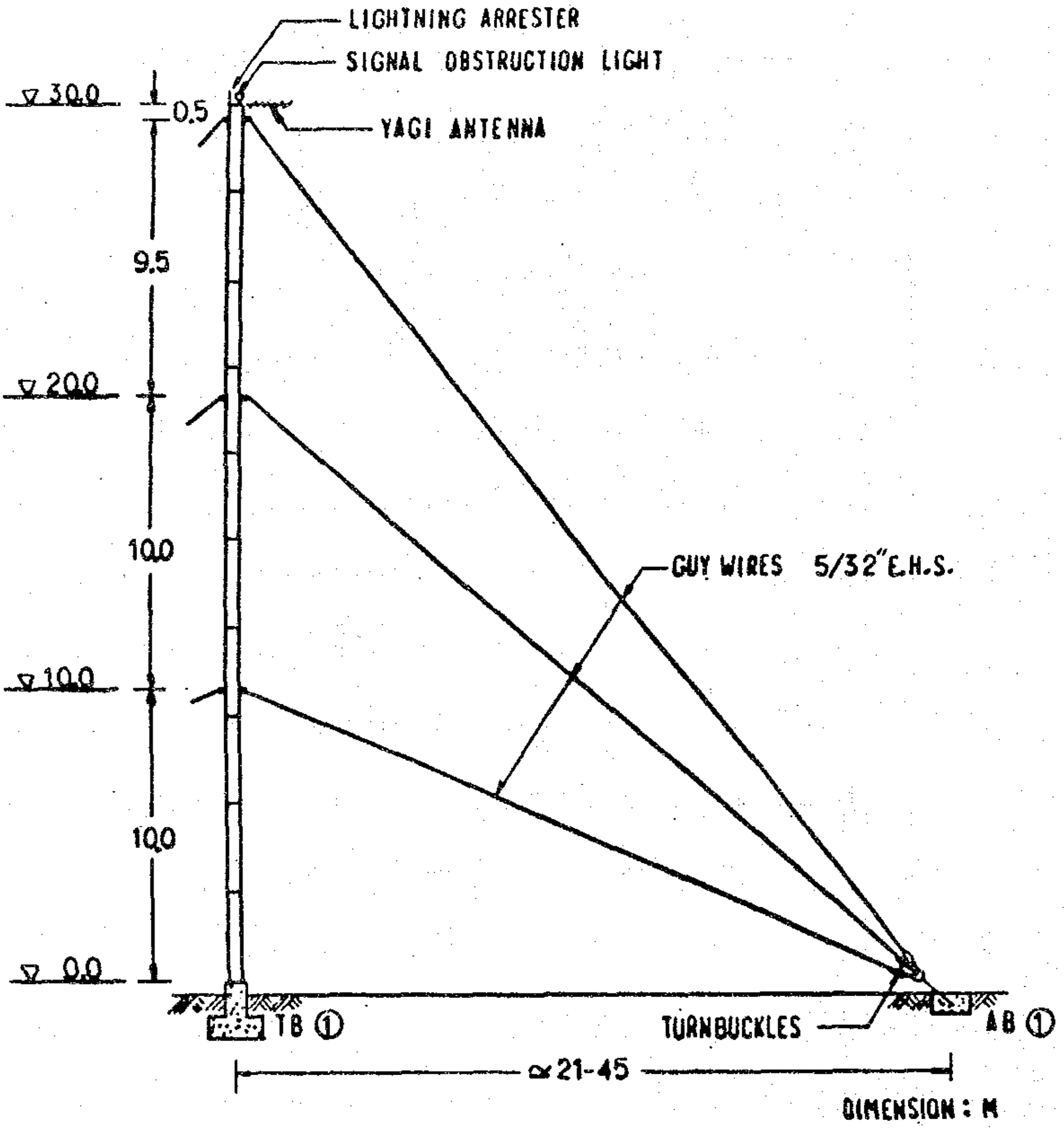


FIGURE 4-4-6 Perspective(Control Center to Prachin Riv.)

PROFILE

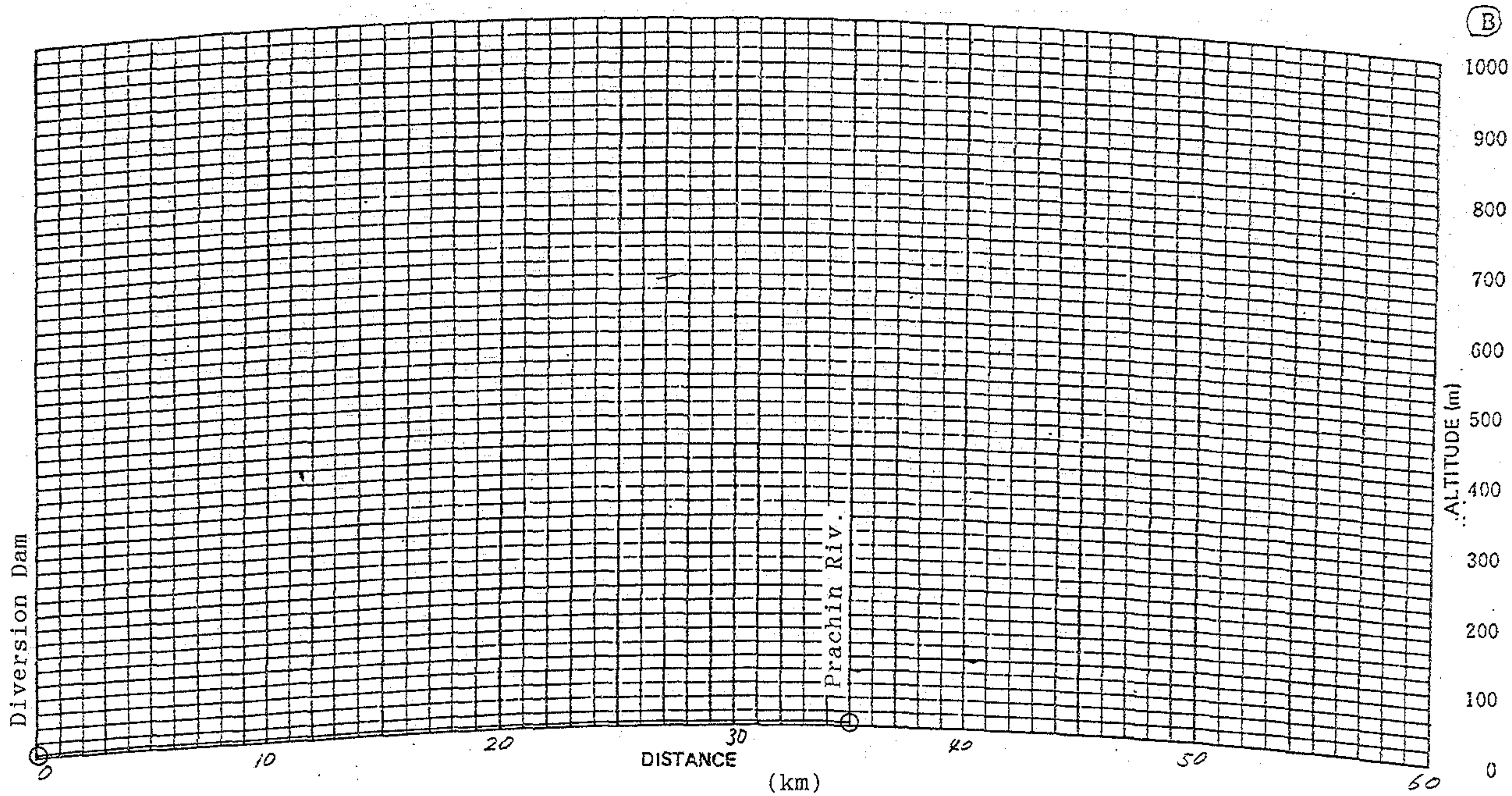
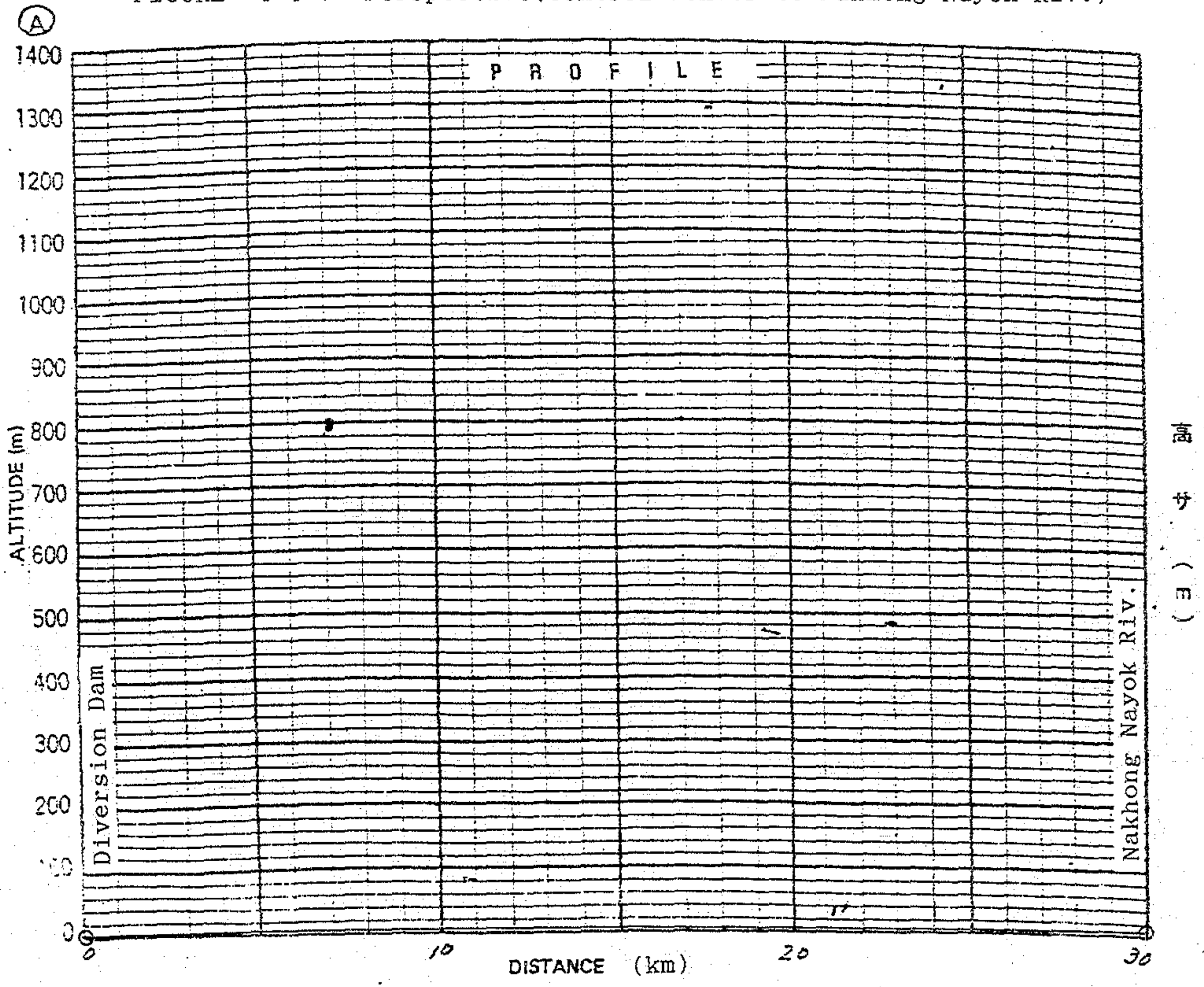


FIGURE 4-4-7 Perspective(Control Center to Nakhong Nayok Riv.)



4.5 Electrical Facilities

4.5.1 Computation of Transformer Capacity

1) No. 1 Substation (At the Site of Diversion Dam)

a) Gate Motor

Regulating Gate	: 380v · 22kw × 2 sets, 11kw × 2 sets
Flood Gate	: 380v · 18.5kw × 2 sets

$$L = \frac{\Sigma(KW + KW \times N)}{q \times pf} \times \beta$$

L	=	Load	KVA
ΣKw	=	Total Motor KW	KW
N	=	Ratio to Rating Current	5.4
q	=	Motor Efficiency	0.85
Pf	=	Motor Power Factor	0.8
β	=	Demand Factor	1.0

$$L = \frac{59 + 22 \times 2 \times 5.4}{0.85 \times 0.8} = \frac{59 + 238}{0.68} = \underline{\underline{437}} \text{ KVA}$$

b) Road Lighting

$400w \times 130 = 52kw$ $\qquad 52kw \times \frac{1}{0.68} = \underline{\underline{65}}KVA$

c) Control House & Training Center Building

Total floor area : m^2

Control House .... $3,720\ m^2$

Training Center Building .... $3,556\ m^2$

Effective Floor Area ≃ $3,720 \times 0.7 = 2,640\ m^2$

 〃 ≃ $3,556 \times 0.7 = 2,490\ m^2$

Applicable kw/m^2 .... $109\ w/m^2$ For office building in Japan (by Tokyo Electric Power Co., LTD.)

Control House $= 2604 \times 109 \times \frac{1}{0.8} \simeq 355$KVA

Training Center Building $= 2490 \times 109 \times \frac{1}{0.8} \times 0.7 \simeq 238$KVA

d) Transformer Capacity KVA

$Tr^{KVA} = \Sigma^{KVA} \times 1.2 = (437 + 65 + 355 + 238) \times 1.2 = 1{,}095 \times 1.2 = \underline{\underline{1{,}314}}$KVA

Transformer Capacity 1,500KVA

2) No.2 Substation (At the Site of Pumping Station)

a) Main Motor : Cage Rotor with Reactor Type Starter

350kw × 3 = 1050kw
Operation Rule : 350kw × 2 + 350kw × 3.9

$$L_{KVA} = \frac{350 \times 2 + 350 \times 3.9}{0.9 \times 0.9} = 2{,}550\text{KVA}$$

Where : N = 3.9
q = 0.9
Pf = 0.9
β = 1.0

b) Auxiliary Equipment

100KVA (assumed)

c) Transformer Capacity KVA

$Tr^{KVA} = (2{,}550 + 100) \times 1.2 = 2{,}650 \times 1.2 = \underline{\underline{3{,}180}}$KVA For starting

Transformer Capacity = 3,000KVA

3) Substation at Residential Area

a) Actual Example at Chachoengsao City

Watt Hour Meter Rating	5A	→	20%
	10A	→	60%
	20A	→	20%

No of Sampling → 15 Houses

b) Nos. of Families

High Class	17	Families
Middle Class	48	〃
Low Class	396	〃
Total	461	〃

c) Application

17	Families	$\times$ 20A $\times$ 220v $\times \frac{1}{0.8}$ =	94KVA
48	Families	$\times$ 10A $\times$ 220v $\times \frac{1}{0.8}$ =	132KVA
396	Families	$\times$ 5A $\times$ 220v $\times \frac{1}{0.8}$ =	545KVA
		Total =	771KVA

Transformer Capacity KVA $= 771 \times \beta$

β = Demand Factor 0.6

$Tr^{KVA} = 771 \times 0.6 \times 1.2 = 463 \times 1.2 = 556$KVA

Transformer Capacity : 300KVA $\times$ 2 sets = 600KVA

4.5.2 COMPUTATION OF EMERGENCY GENERATOR CAPACITY

1) Emergency Generator for Diversion Dam

Calculation Basis

Motor Load .. 3ø - 50Hz - 380V - 22kw, 2 sets operation at one time

Lighting & Air Conditioner 34KVA

$$Q = (\beta + \beta m \times N) \times \frac{1}{K}$$

$$Q = (34 + 64 \times \frac{484}{92}) \times \frac{1}{1.5}$$

$$\doteqdot 250\text{KVA} \rightarrow 270\text{KVA}$$

Q	:	Generator Capacity	KVA
β	:	Base Load	34KVA
βm	:	Motor Capacity	64KVA
N	:	Ratio for Starting/Rating	
K	:	Coefficient	

2) Emergency Generator for Pumping Station

Calculation Basis

Cooling Water Pump 8KVA

Magnetic Valve 5.5KVA

Lubrication Oil Pump 2.2KVA

Drain Pump 0.6KVA

Compressor .... 5.5 KVA

Fuel Oil Pump 0.6KVA

Ventilator 5.9KVA

Lighting & Other 10KVA

$$Q = (30.3 + 8 \times 5) \times \frac{1}{1.5} = 47\text{KVA} \doteqdot 50\text{KVA}$$

APPENDIX - 5 : PART IV. ENVIRONMENTAL CONSIDERATION

APPENDIX - 5. PART IV. ENVIRONMENTAL CONSIDERATION

LIST OF CONTENTS

5.1 New Organization of Ministry of Science, Technology and Environment (MOSTE)

The office of National Environment Board (ONEB) presided by the vice prime minister was upgraded to the National Environment Board (NEB) to be presided by the prime minister, and the Ministry of Science, Technology and Environment (MOSTE) of which organization was expanded on April 4, 1992. The new organization, offices and duties are shown on Figure 5-1 to 5-4.

The personnel training in the Environmental Research and Training Center with grant-in-aid by the Japanese Government started at the same time, is the NEB's main subject. Although their organization and rights are enlarged and expanded, they cannot be expected so much for the time being, because they have not yet equipped with personal and material conditions. Especially, the present situation of the water quality laboratory is far weak as compared with RID's laboratory.

5.2 Designating Procedure of Specific Environmental Conservation Area (Pollution Control Area)

The concerned area upstream of the diversion damsite in this project will be designated as pollution control area for water quality conservation after the diversion dam completion. The designating procedure for it is shown on Figure 5-5, in accordance with the national ordinance for environment and environmental conservation.

5.3 Results of Pollution Source Survey

The pollution source survey, water sampling and water quality analysis were carried out twice in dry and wet season. (Table 5-1 and 5-2)

1) Noodle Factory (S-1, -2 and -3)

The water for the noodle factory is being taken from an irrigation canal constructed by RID.

Almost all the discharges are the water with which noodle was washed. In the factory, three settling tanks are set for precipitating suspended matters. Due to no draining of sludge, the water quality of the discharge after passing through the tanks was rather worse than that of the water with which noodle has just been washed, before passing. The water quality of course, further over the water quality standard values of the Ministry of Industry (MOI). It will certainly be improved by draining the sludge from the tanks.

2) Old Paper Reproducing Factory (S-4)

Since this factory cannot take water from the river in a dry season, a chemical condensation and floating by pressure equipment was being operated as water treating facilities aiming at also re-cycle. SS of the treated water was pretty low indicating 153 mg/l, probably due to re-cycling, but BOD was far over the standard value.

3) Whisky Factory (S-5 and -6)

The factory is classified as one of the semi-governmental firms with complete discharge treatment, particularly with an oxidation pond with aerators for the treatment of the water with which bottles are washed and miscellaneous drainages such as toilet soil water.

The treated water was so clean as usable water for miscellaneous purposes. Since this factory cannot take water from Bang Pakong river in a dry season owing to high salinity, it possesses a large reservoir. When the factory stores the water taken from the river, pH of the water gradually becomes extremely low, unusable as it is. The cause was not known at the surveying time.

4) Shrimp and Fish Ponds (S-7, -8 and -9)

As found out on the tables, the water in the ponds are qualitatively with no problem as a whole. There, however, are a little high values of nitrogen and phosphorus in the fish pond. Because the fish pond, over which 4,000 laying hens were being kept in a pen, could treat mostly well hen droppings.

5) Pig Farm (S-10 and -11)

In case of S-10, urine and dung and water with which pigs were washed, from piggeries, were not directly sampled form there but taken from the canal just after passing a temporary storing tank. (not regarded as an oxidation pond.) The canal is situated 100 m inside of the river bank upstream of Bang Pakong diversion damsite, and the water quality has no problem, because a pig farmer said that even if water is taken form the irrigation canal it was hardly drained to it. As water was sampled form surface layer in the canal, it does not indicate water quality of piggery discharge, even though it is contaminated. It was expected, however, at the canal bottom layer, plenty of pig dung was deposited.

6) Fish Pond Supplied with Dung as Feed (S-12)

Some pig farmers are using or selling dung as feed for fish for /to themselves or independent fish breeders.

Although BOD and SS values were somewhat high because of water sampling near the feeding spot, it does not seem that it contributes to a pollution of Bang Pakong river.

7) Ground Water On Left Bank Upstream of Diversion Damsite (S-13)

The survey was carried out so as to know whether the ground water in the area where many pig farms lie scattered, has been polluted or not.

It is said that shallow wells cannot be used at all owing to high salinity, with no necessity of the survey on pollution with pig urine and dung.

A sample of S-10 was taken from a deep well 70 m in depth. However, there are some items over the water quality standard values in drinking water supply ordinance. That is,

C1	:	1,079 mg/l over	200 mg/l	of standard value
TDS	:	2,543 mg/l over	500 mg/l	ditto
Mn	:	2,346 mg/l over	0.3 mg/l	ditto

5. 4 Results of Water Quality Survey On Irrigation Canal Water Taken From Bang Pakong River

5. 5 Survey on River Water

Since water sampling and water quality analysis are being performed at the sites shown on Figure 5-6 for 5-4 and 5-5. They will be summarized after completion of them.

5. 6 Table and Figure

TABLE 5-1 PROPERTIES OF WATER SAMPLES FROM FACTORIES AND PONDS AT CHACHOENGSAO IN OCTOBER, 1992

mg/l

Sample	Noodle Factory			Paper Mill	Whisky Factory		Shrimp/Fish Pond		
	Tap. W	Wash.W	Disch W	Disch. W	Tap. W	Disch. W	Shrimp A	Shrimp B	Fish
(Time)	Oct. 27	Oct. 27	Oct. 27	Oct. 27	Oct. 26	Oct. 26	Oct. 27	Oct. 27	Oct. 20
	S-1	S-2	S-3	S-4	S-5	S-6	S-7	S-8	S-9
Temp. °C									
pH	6.2	4.2	3.1	6.4	6.2	7.5	7.9	7.8	8.3
TDS	548	1907	781	2303	113	499	2099	1658	767
SS	17.5	393.3	262.0	153.3	17.5	20.0	23.5	45	99
TS	565.5	2200.3	1043.0	2456.3	130.5	519	2122.5	1703	866
COD	3.55	105	370	458	4.3	11.9	6.9	9.8	9.0
BOD	6.50	>140	>350	>350	2.2	9.9	8.3	15.0	11.3
EC	857	2980	1220	3600	176	780	3280	2590	1199
Cl	127.4	736.8	232.7	393.4	27.7	38.8	952.9	637.1	282.5
Salinity	0.26	1.36	0.45	0.74	0.08	0.10	1.75	1.18	0.54
T-P	0.01	4.00	N.D.	0.10	0.02	0.10	0.03	0.10	0.06
T-N	0.833	17.54	2.75	3.60	0.434	1.269	0.587	1.157	2.52
NH_4-N	N.D.	7.84	0.21	N.D.	N.D.	N.D.	N.D.	0.56	1.15
NO_2-N	0.003	0.010	0.004	N.D.	0.004	0.069	0.007	0.007	0.08
NO_3-N	0.130	0.940	0.02	1.01	0.15	0.01	0.02	0.03	0.11
Org-N	0.76	8.75	2.52	2.59	0.28	1.19	0.56	0.56	1.17

Table 5-2 PROPERTIES OF WATER SAMPLES FORM PIG RAISING FARM, FISH POND AND GROUND WATER AT CHACHOENGSAO IN NOV. 1992

mg/l

	Pig Raising Farm. Discharge (Pond)	Pig Raising Farm. Discharge (Canal)	Fish Pond (Pig Feces Feed)	Ground Water (Deep Well)
	S-10	S-11	S-12	S-13
Temp. °C				
pH	6.9	6.6	6.3	6.4
TDS	770.0	316	181.5	2543
SS	18.0	66.0	76.5	9.0
TS	788	382	258	2552
COD	31	197	55	6.4
BOD	23.18	87.7	36.6	0.97
EC	1400	606	265	3910
Salinity	0.64	0.16	0.07	1.98
Cl	340.0	70.6	21.3	1079.4
T-N	14.571	27.476	1.515	1.068
NH4-N	11.800	24.150	0.500	0.50
N02-N	1.030	0.003	0.008	0.003
N03-N	0.171	0.003	0.117	0.065
Org-N	1.570	3.320	0.890	0.500

(Note) All these samples were analysed three days after sampling.
In S-13, Heavy metals such as Cd, Pb, As Cu,Cr : N.D.
Dissoved Fe = 0.01
Mn = 2.346
Zn = 0.026

FIGURE 5-1 ORGANIZATION STRUCTURE OF MINISTRY OF SCIENCE, TECHONOLOGY AND ENVIRONMENT (MOSTE)

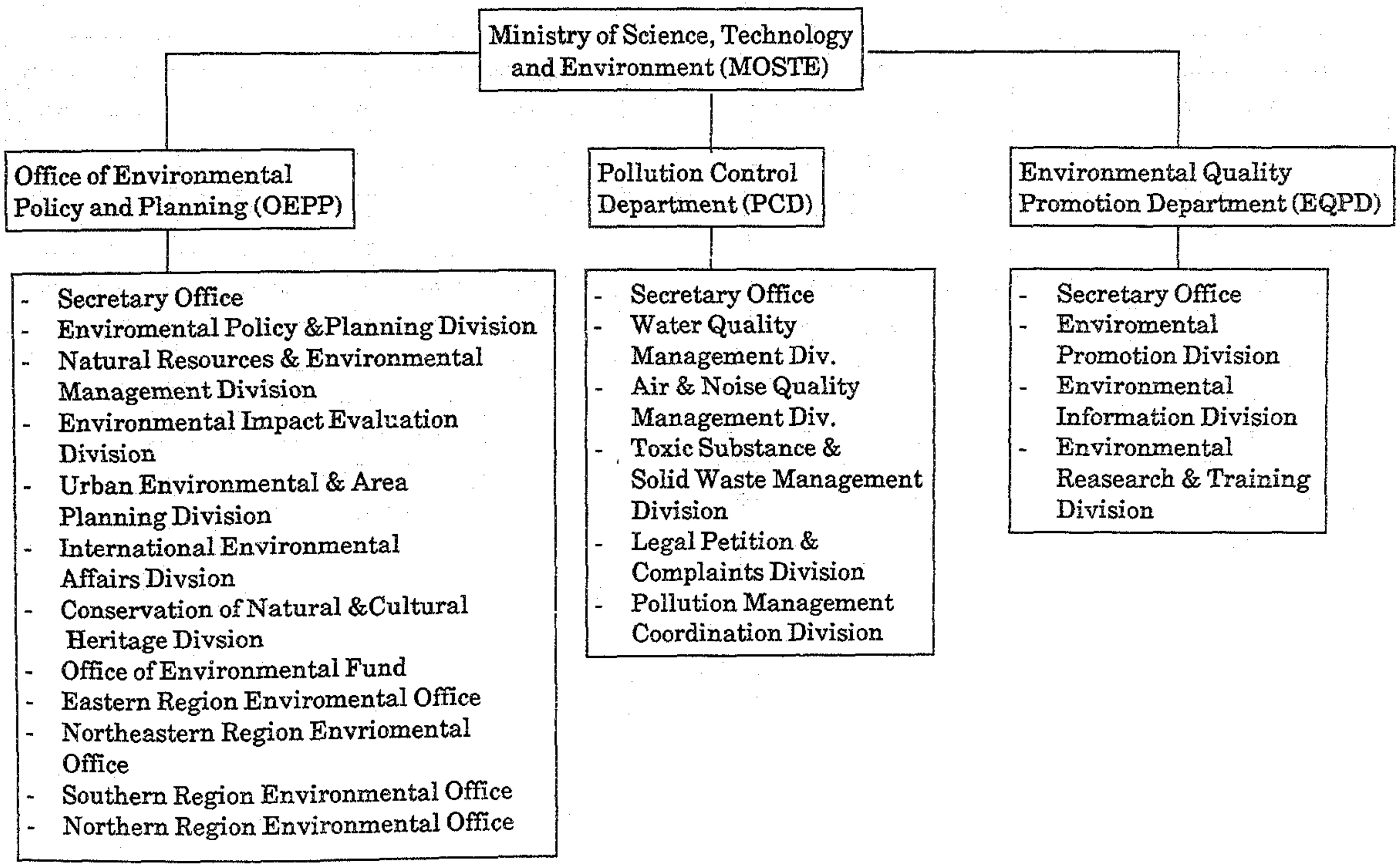


FIGURE 5-2 STRUCTURE OF OEPD

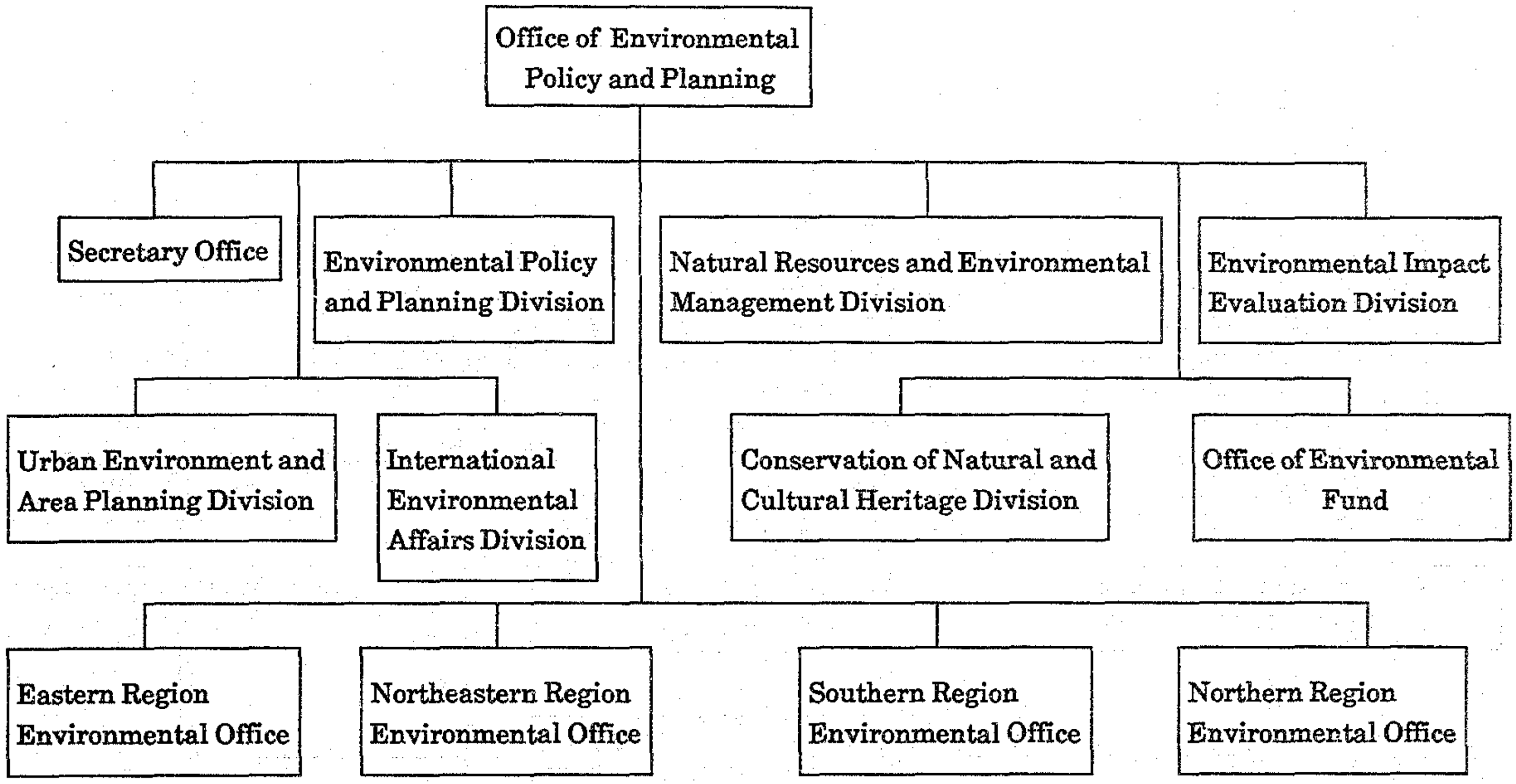


FIGURE 5-3 STRUCTURE OF PCD

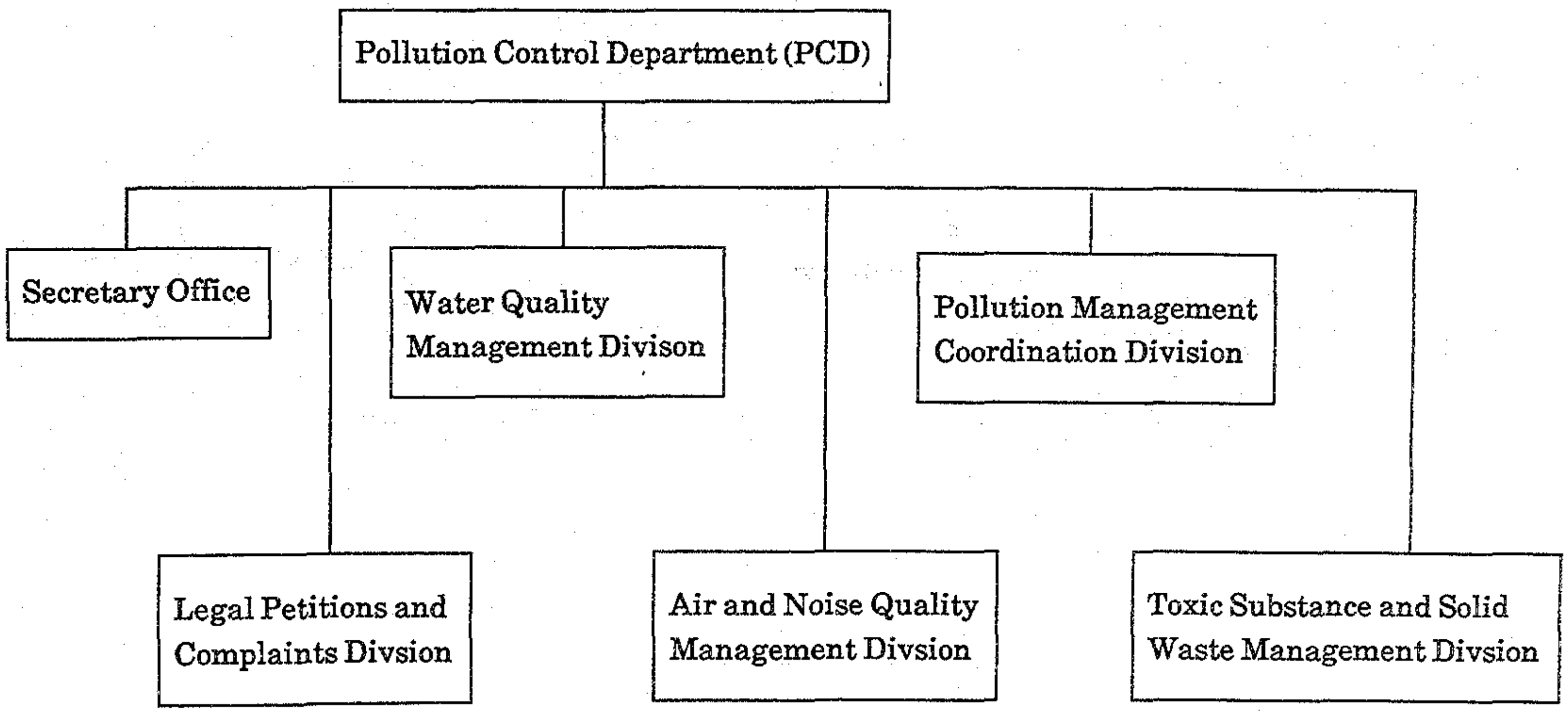


FIGURE 5-4 STRUCTURE OF EQPD

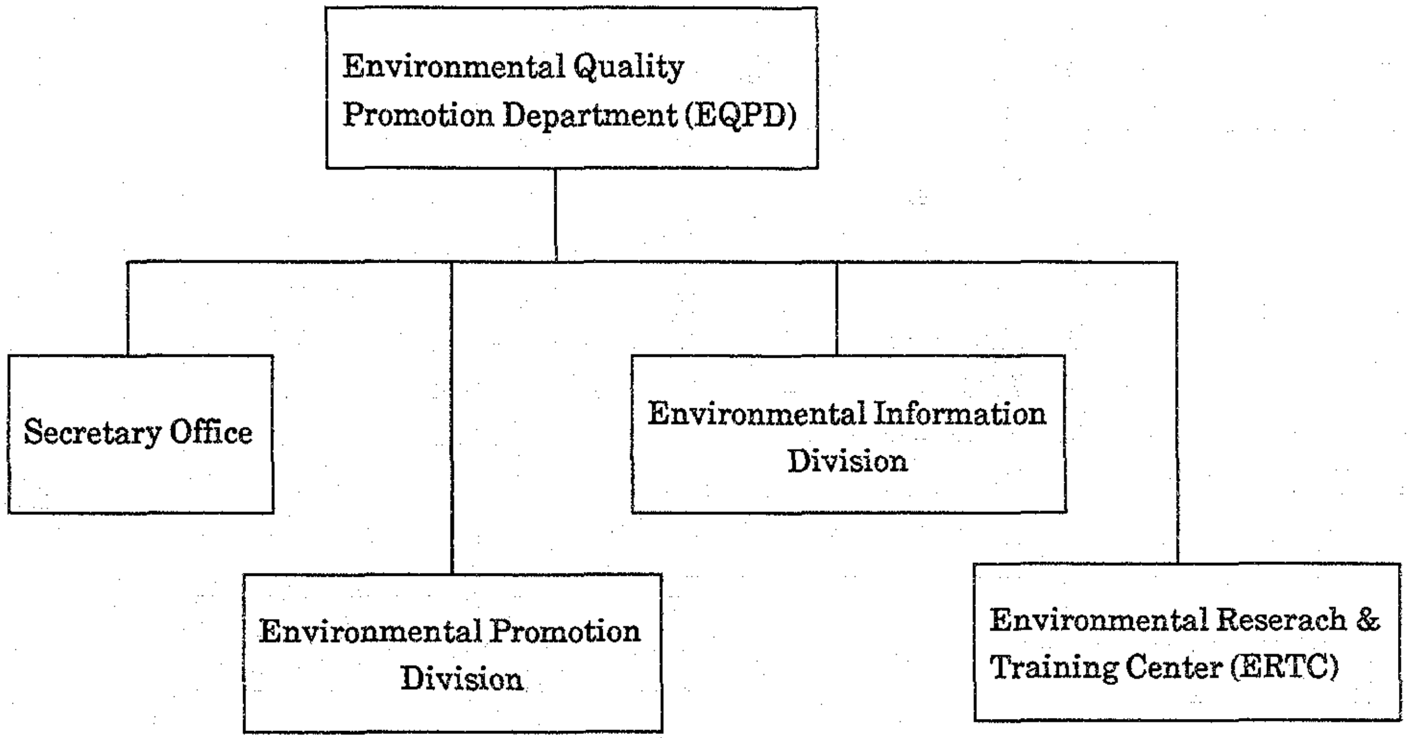


FIGURE 5-5 FLOW CHART OF ACTIONS WHICH WILL BE DONE AFTER THE DESIGNATING SUCH AREA AS THE POLLUTION CONTROL AREA

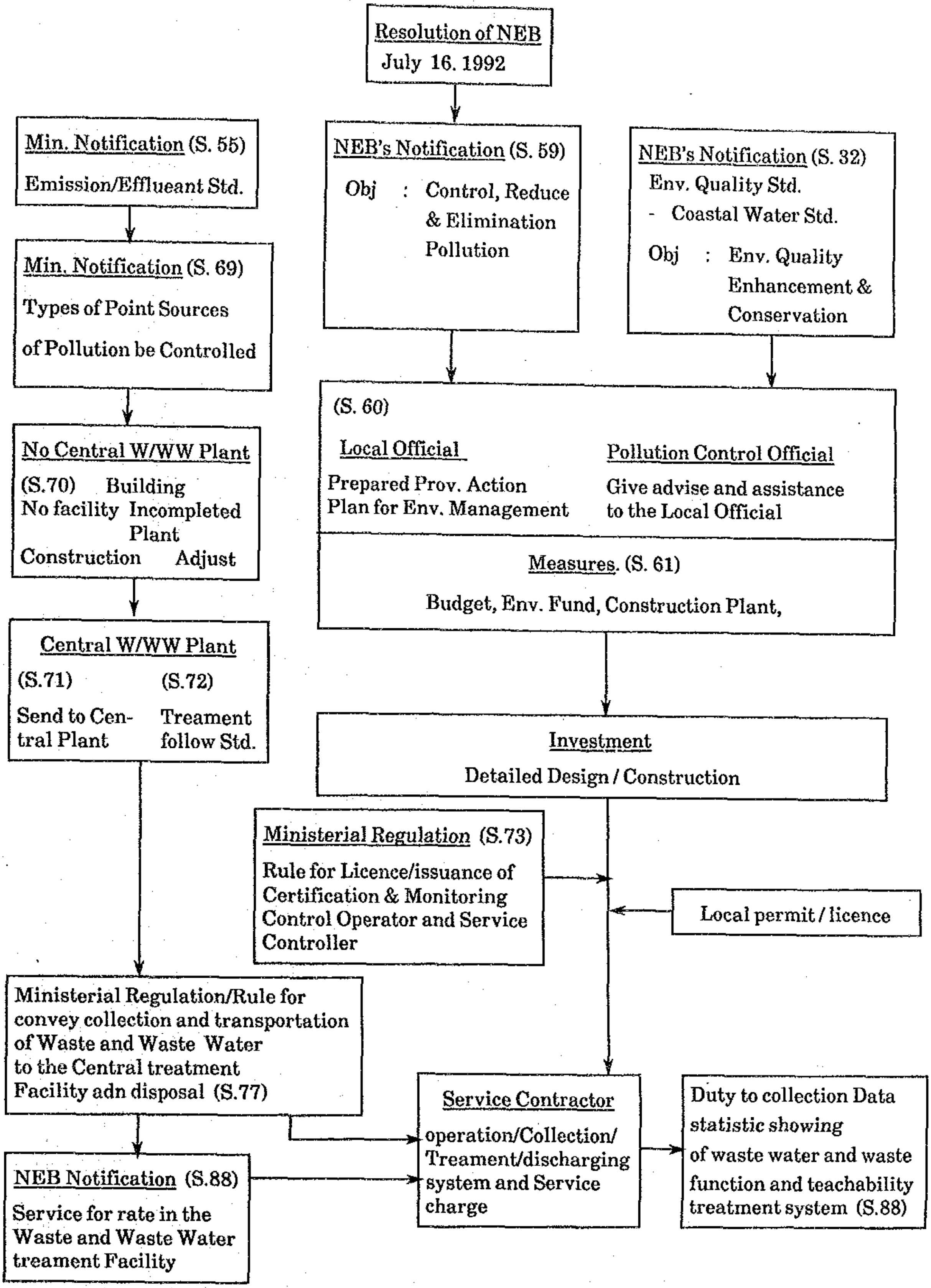
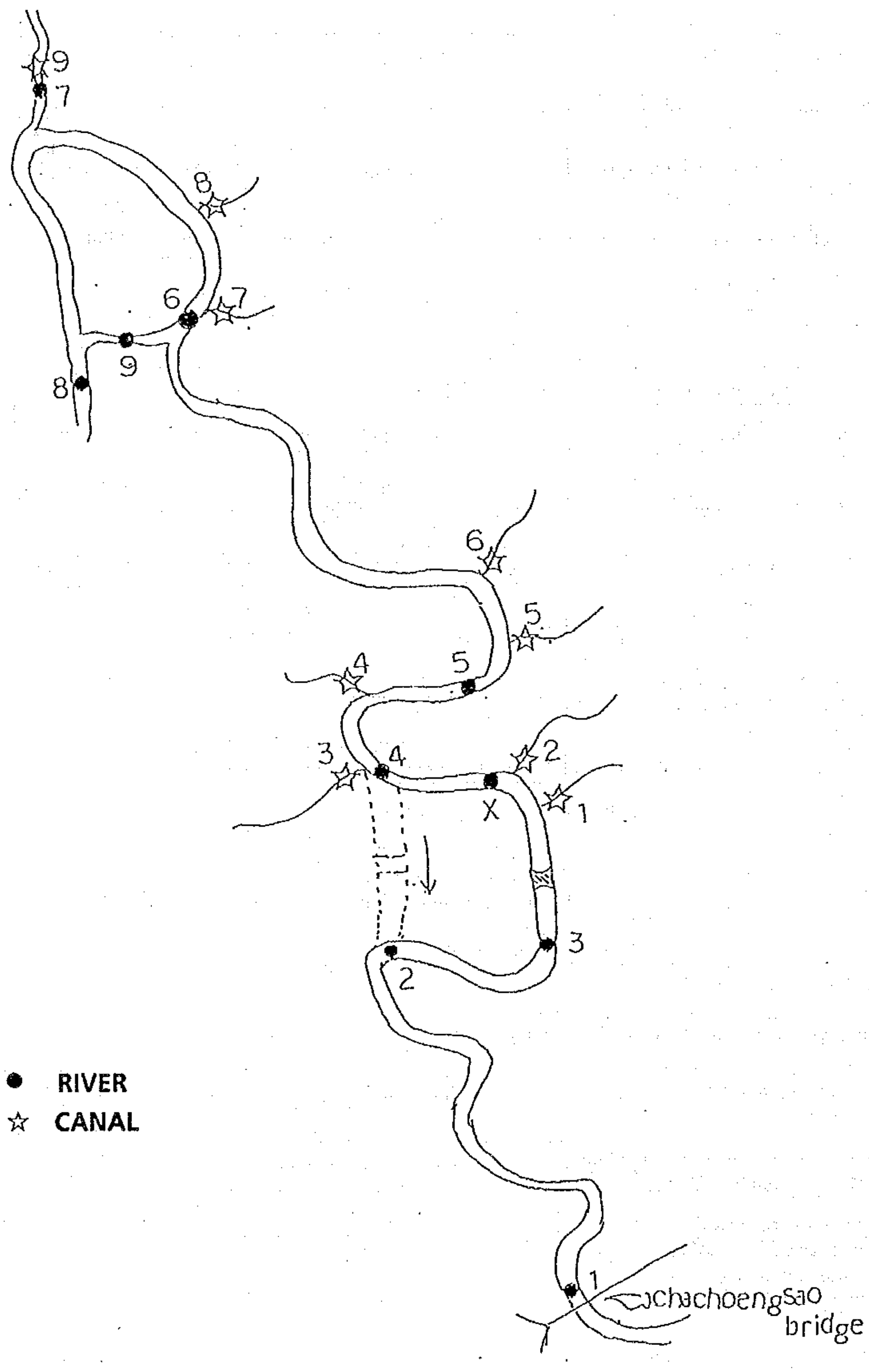


FIGURE 5-6 WATER SAMPLING POINT



JICA