KINGDOM OF THAILAND
MINISTRY OF AGRICULTURE AND COOPERATIVES
ROYAL IRRIGATION DEPARTMENT

MASTER PLAN STUDY
ON
THE WATER MANAGEMENT SYSTEM AND MONITORING PROGRAM
IN
THE CHAO PHRAYA RIVER BASIN

MAIN REPORT
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JUNE 1989

JAPAN INTERNATIONAL COOPERATION AGENCY

19790

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FINAL REPORT

ANNEX - 1 METEOROLOGY / HYDROLOGY

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ANNEX-1 METEOROLOGY / HYDROLOGY

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CHAPTER 1 METEOROLOGY

1.1 General Meteorology

Thailand belongs to monsoon weather in tropical area. Characteristics of this climate are high temperature and high humidity through the year and seasonal concentration of rainfall.

This monsoon climate, however, is affected by the southwest monsoon and the northeast monsoon. The former is characterized by the sea wind from the Gulf of Thailand to the inland between May and October, and the latter is the land wind caused by high pressure in the main land directed to the sea during the period between October or November and April.

Furthermore, rainfall occurs when the air becomes unstable by circuit wind from the Gulf of Thailand. This is called "Mango shower" by local people, which occurs in dry season.

Wet season in Thailand is usually between May and October in most of the country except the southern region. The rainfalls in this period amount to 60 - 90% of annual rainfall.

High temperature usually occurs in March - April, while low temperature in November - January. Difference of monthly mean temperature through the year is about 4 - 7°C. These climatological factors are considerably suitable for vegetation in Thailand. Annual rainfall, annual mean temperature and annual mean humidity are shown in Figure 1-1. Further details of annual rainfall distribution are shown in Figures 1-2 and 1-3.

1.2 Regional Meteorology

Thailand may be divided into four regions of the North, Northeast, Central and South regions by their specific features. Meteorological features of each region are presented in the followings.

1.2.1 Northern Region

Annual rainfall of this region shows 1,200 - 1,600 mm brought by the southeast monsoon blocked by mountains in the western border area. Its climatological features are that less rainfall occurs than in the central region because of far distance from the sea and complicated topographical undulation.

Climate in Chiang Mai which may be considered typical in this region indicates 1,184 mm of annual rainfall, 25.3°C of annual mean temperature and 72.9% of annual mean relative humidity. And 90% of annual rainfall is concentrated during May-October; i.e. wet season. Annual difference of monthly mean temperatures is about 8°C, a rather high due to its location at deep inland.

1.2.2 Northeastern Region

This region is separated by mountain ranges in the west and south and by Mekhon River in the north and east. The southwest monsoon is therefore blocked by the ranges to cause the driest climate in the country especially in the southwestern part. Annual rainfall in the region varies from 1,000-1,200 mm in the southwest to 1,800-2,000 in the northeastern part.

Climate in Khon Kaen which may be considered typical in this region shows 1,177 mm of annual rainfall, 26.8°C of annual mean temperature and 70.8% of annual mean relative humidity. About 90% of annual rainfall is concentrated in wet season. Difference of monthly mean temperatures through the year is 7°C.

1.2.3 Central Region

This region surrounded by the western and eastern mountain ranges shows 1,500-3,000 mm of annual rainfall brought by the southwest monsoon. Annual rainfall in the Chao Phraya plain, the most central part of this region, is less than 1,500 mm.

Climate of Bangkok which may be considered typical in this region shows 1,458 mm of annual rainfall, 27.7°C of annual mean temperature and 78.0% of annual mean relative humidity. About 90% of rainfall occurs in wet season. Difference of monthly mean temperature through the year is 4°C. This region is characterized by high temperature and high humidity through the year.

1.2.4 Southern Region

The Malay Peninsula area in Thailand is located in heavy rainfall area in the Southeast Continental Asia. Climatological features of this area are different from other 3 regions. Its annual rainfall is more than 2,000 mm, and in the highest area it amounts to more than 4,000 mm. Meanwhile, most rainfall in the eastern side of the peninsula occurs in October and November.

Climate in Nakhon-Si-Thamarat which may be considered typical for this region shows 2,382 mm of annual rainfall, 27.4°C of annual mean temperature and 80.5% of annual mean relative humidity. Dry season of this area is between January and April, two or three months shorter than the other regions. Rainfall of this region is concentrated during October-December; 60% of annual rainfall during this period. Difference of monthly mean temperature through the year is 2°C. High temperature and high humidity are observed through the year round.

1.3 Meteorology in The Study Area

1.3.1 Upper Basin

The upper area of Chao Phraya basin is located in the northern region. This area is very undulated with various water sources of rivers. Climate of this area shows an inland climate. Annual rainfall is 1,200 - 1,600 mm, annual mean temperature is 26°C and

annual mean relative humidity is 70 - 75%. Annual evaporation is about 1,600 mm, wind direction is mainly north and mean wind speed is 1.3 - 2.8 m/s.

Climate of Chiang Mai, which may be considered typical in this area, is shown in Table 1-1 (1).

1.3.2 Middle Basin

This area is located in the south of the northern region, the transitional part between the upper basin and the lower delta.

Annual rainfall varies from 1,200 mm to 1,400 mm, annual mean temperature is 27 - 28°C and annual mean relative humidity is about 70%. Other climatological factors in Phitsanulok which may be considered typical in this basin are 1,560 mm of annual evaporation, northern direction of annual wind and 0.9 m/s to 2.3 m/s of annual mean wind speed. Climate of Phitsanulok is shown is Table 1-1 (2).

1.3.3 Lower Basin

This area covers Chao Phraya delta which is center of the central region. Annual rainfall is about 1,200 mm, annual mean temperature is 28°C and annual mean relative humidity is 70 - 75%. Other climatical factors in Bangkok, which may be considered typical in this basin, are 1,780 mm for annual evaporation, north or northeast of wind direction and 2.3 - 5.0 m/s of annual mean wind speed. Climate of Bangkok is shown in Table 1-1 (3).

Climate factors and monthly/annual rainfall data at above 3 places, Chiang Mai, Phitsanulok and Bangkok are shown in Figures 1-4 and 1-5. From these comparison, monthly rainfalls are not much different in Chiang Mai and Phitsanulok in wet season. However, Bangkok has more rainfall in September and October than the other two stations.

CHAPTER 2 HYDROLOGY IN THE STUDY AREA

2.1 Hydrological Observation Network

As for hydrological observation in Thailand, rainfall observation is mainly carried out by Meteorology Department, while streamflow, groundwater and water quality observations are mainly by RID. Systems and networks of these observations are presented hereinafter.

2.1.1 Rainfall Observation

(1) Observation Station

Rainfall observations are carried out by Meteorology Department (MD), RID and other 15 related public agencies since 1952. Most of observation stations belong to Meteorological Department and RID. Among them, MD manages about 800 stations in key cities and key towns in the whole Thailand, while RID manages about 700 stations at field offices and at major water control structures.

The number of stations in Chao Phraya basin are 623 as of 1985, and their distribution is shown in the following table. Their distribution density is 400 - 500 sq.km/sta. in the upper basin and 120 sq.km/sta. in the lower basin. High density in the lower basin is because that quantification of precise irrigation water requirement from rainfall in the lower basin is more required for overall water management.

Distribution of Rainfall Station in Chao Phraya Basin

Basin	No. of Station M.D.	RID	Others	Total	Watershed Area (km^2)	Density (km^2/place)
Upper Basin (Regions 1&2)	94	39	13	146	56,700	390
Middle Basin (Region 3)	81	41	7	129	64,000	500
Lower Basin (Regions 7&8)	121	217	10	348	41,000	120
Total	296	297	30	623	161,700	260

Source : Hydrology Division, RID

Location map : Figure 2-1

(2) Observation method

Rainfall observations carried out by use of brass cylinder of 18-inch diameter at most stations. Observation is carried out at 7 A.M. in MD and 6 A.M. in RID.

(3) Data processing

Observed data are reported to the headquarters on daily and/or monthly basis by use of specific formats designed for the purpose and for data filing. As for RID, monthly reports of daily records are sent to Hydrology Division of the headquarters in written form thereon.

Hydrology Division compile the data into computer files. These data are stored in magnetic disk or magnetic tape of the IEC computer. Rainfall records collected for the study are listed in Tables 2-1 (1) and (2). Monthly rainfalls of key stations in the study area are shown in Tables 2-2 (1)-(6), while stochastic values of rainfall are shown in Tables 2-3 (1)-(4).

2.1.2 Water Level and Streamflow Observation

(1) Observation Station

Water level and streamflow observation are continuously carried out by Hydrology Division and O & M Division of RID. Hydrology division has long time been observing natural rivers; at some key stations observation periods exceed 70 years. Total number of station is 900 as of 1985, however 487 stations are now at work. Stations in Chao Phraya basin are 315 places in total, while working stations are 141. Details are shown in the following table.

Station Type	Number of Station	
	All Over Thailand	Chao Phraya Basin
(Working)	(487)	(141)
1. Staff Gauge & no rating	213	54
2. Recorder & no rating	24	8
3. Rating and Staff Gauge	174	51
4. Rating and Recorder	76	28
(Discont'd or suspended)	(413)	(174)
1. Staff Gauge & no rating	141	61
2. Recorder & no rating	12	4
3. Rating and Staff Gauge	189	92
4. Rating and Recorder	71	17
Total	900	315

Records of observed streamflows collected for the study are listed in Table 2-1 (3). Location map of streamgauging stations of Hydrology Division is shown in Figure 2-2. Distribution of water level gauge of Hydrology Division in the Chao Phraya basin is shown below.

Distribution of Water Level Gauge

Basin		Cont. Station	Dis. Cont. Station	Total	Watershed Area(km^2)	Density (km^2/place)
Upper and Middle	Ping	33	40	73	35,000	480
	Wang	12	12	24	11,000	460
	Yom	20	16	36	23,000	640
	Nan	29	38	67	33,000	490
Basin	Total	94	106	200	102,000	(510)
Lower Basin		42	50	92	41,000	450

Source: Hydrology Division, RID

On the other hand, O&M Division is observing water levels and flows at water control points along canal system of every project. These data are used for water distribution control after H-Q conversion. Total number of such stations are about 800 in the Chao Phraya basin. Density of the station is 30 sq.km/place in 14 projects in the delta as shown below.

Distribution of Water Level Gauging Stations of O&M Div.

Project	Number of Station	Irrigation Area(km^2)	Density (km^2/place)
Pasak Tai	17	435	26
Nakhon Luang	20	483	24
Rangsit Nua	32	713	23
Rangsit Tai	30	842	28
Khlong Dan	18	910	51
Phra Ong Chaiyanuchit	4	816	204
Maharaj	52	803	15
Manorom	15	423	28
Borommathat	4	591	148
Phonlathep	7	190	27
Thabote	11	350	32
Sam Chuk	43	595	14
Chanasutr	6	843	141
Yangmanee	6	374	62
Total	265	8,468	32

Source: O&M Division, RID

(2) Observation Method

Water level gauges under control of Hydrology Division are of two types; staff gauge and self- recording gauge, and those of staff gauge type is 80 % of the total number. Reading of water level is carried out 1 - 5 times daily only in daytime. Hourly reading for 24 hrs is carried out in some stations. Similarly for stations of O&M Div., water level reading is 2 - 5 times daily only in daytime, while 24-hr hourly reading at some stations.

(3) Data Processing

Water level records of Hydro. Division are sent to Data Processing Section of the headquarters. They are then converted into flows by H-Q calibrations. These water level and flow data at key stations are published in Water Year Book by Hydro. Div. and distributed among the concerned public agencies.

On the other hand, data of O&M Div. are used for water management purpose and sent to WOC (Water Operation Center) through the transmission network. They are then processed for data entry and filed in the computer system files for subsequent processing.

2.1.3 Groundwater Observation

(1) Observation Station

Groundwater observation is continued by RID in 60 projects since 1979. Contents of observation are measurement of groundwater table and examination of water quality. As of 1986, measurement of groundwater table is carried out in 25 projects and examination of water quality is 21 projects. Number of observation station in every region is shown as follows.

Region	As of 1979 (Beginning Year) (project)	As of 1986 Groundwater Table (project)	As of 1986 Water Quality (project)
1*	5	2	0
2*	1	0	0
3*	1	0	0
4	1	1	1
5	6	2	2
6	16	4	3
7*	11	8	7
8*	6	1	1
9	-	-	-
10	6	3	3
11	2	0	0
12	5	4	4
Total	60	25	21

* in Chao Phraya Basin

(2) Observation method

Observation is reading of water table of observation wells in each project. These data are send to RID headquarters.

(3) Data processing

Data recorded in specific formats are sent to the headquarters and compiled. Water quality data are processed as same as the groundwater data. These data are published in Groundwater Year Book.

2-1-4 Water Quality Observation

Water quality observation is carried out in two ways. One is of groundwater as already described. Another is salinity observation in sea-tide affected area in the lower Chao Phraya delta as presented hereinafter.

(1) Observation station

O&M Div. is observing salinity of irrigation water in river/canal network. Observed data are used to release water for salinity control. Observation stations at the Memorial Bridge in Chao Phraya River and at San Phran in Tachin River are stations to determine water release from Chao Phraya Dam and Pho Phya Regulator for salinity control, respectively. In addition, observation of salinity in the lower delta is also carried out in the following 3 projects in dry season on daily and/or weekly basis. Number of observation site in the above three projects is shown below.

Project	Number of Observation Site
Phasi Charoen	12
Khlong Dan	15
Phra Ong Chaiyanuchit	11

Location Map is shown in Fiure 2-3.

(2) Observation method

Salinity observation at Memorial Bridge and San Phran is continued through the year round, and observation at above sites in the 3 projects is carried out for a few month in dry season. For instance in case of Phasi Charoen Project, observation period is for three months from February to April at 9 A.M. every day. Measurement is at 50 cm under water surface and by using electric conductivity tester or saline tester. Thus observed data are sent to the headquarters.

(3) Data processing

Observed data sent from sites are compiled into files and used for judgement of water release for salinity control.

2.2 Hydrology by River System

The Chao Phraya River Basin covers an area of 162,600 sq.km, equivalent to 32% of the total national territory. Runoff from Chao Phraya River basin in 30,300 MCM in annual average. Fluctuation of annual runoff shows 14,500 MCM in drought year and 47,500 MCM in wet year.

Chao Phraya River system is composed of four large tributaries; Pin, Wang, Yom and Nan Rivers originated in the northern hilly area. Ping River joins with Wang River and Nan River joins with Yom River. The two join to form Chao Phraya River at Nakhon Sawan, which runs through Bangkok Metropolitan area and reaches to the Gulf of Thailand.

Total length of Chao Phraya River system in the basin is 980 km, and its length from Nakhon Sawan to the Gulf is about 250 km. The whole basin may be divided into 3 as upper, middle and lower basins as shown in Figure 2-4.

The Upper Basin may be said the basin area in RID-Regions No. 1 & 2 or the area upper than a line to connect Bhumibol and Sirikit Reservoirs. The Middle Basin may be said the basin area in RID-Region No. 3 or the basin area upper than Nakhon Sawan and lower than the Upper Basin. The Lower Basin may be said the area of RID-region No. 7 & 8 and a part of No. 9 in the Central Plain.

River flow is one of most important hydrological factors in the basin, and there are a large number of stations for streamflow observation. Among them, the following seven stations may be said some of the most important ones. Their hydrographs are shown in Figures 7-1 to 7-8 for reference.

Sta. Code	Name and Place
C2	Chao Phraya River flow at Nakhon Sawan
C13	Chao Phraya River flow at thru Chao Phraya Dam
P12	Ping River flow released from Bhumibol Dam
N12A	Nan River flow released from Sirikit Dam
W4A	Wang River flow at D/S end of the river
Y3A	Yom River flow thru Yom Weir
S9	Pasak River flow at Ban Muang Nua, Saraburi
K11	Meklong River flow thru Vajiralongkorn Dam

In the basin, a large number of storage facilities have been constructed, and their total storages by the 3 component basins are shown below, wherein storages of Bhumibol and Sirikit Reservoirs are counted in the Middle Basin.

Basin	Area (km^2)	Storage (MCM)
Upper Basin	56,700	786.7
Middle Basin	64,000	22,549.7
Lower Basin	41,900	445.4
Total	162,000	23,738.1

2.2.1 Upper Basin

Runoff pattern and characteristic features of four tributaries in the upper basin of the study area are shown as below.

(1) Ping River

Areas of upper Ping basin is left rather undeveloped except some area around Chiang Mai, and their annual runoff coefficients are 0.18 - 0.25. Streamflow gauging stations of P.1, P.19 and P.12 may be said representing the area. However, P.12 is not suitable for identification of runoff pattern because of its location in downstream of Bhumibol Dam. Mean

annual runoffs at P.1, P.19 and P.12 are 2,150 MCM, 3,280 MCM and 5,560 MCM (average of 1967 - 1986) respectively. Their hydrographs at P.1, P.12 and P.19 are shown in Figure 2-5.

(2) Wang River

Annual runoff coefficient of this river is as low as 0.16 at W.1 (in the upper stream of Phrae) and 0.10 at W.4A (at the downstream end) This is because that annual rainfall is slightly lower than the adjacent areas, irrigated agriculture is carried out around Lampang, and Kiu Lom Dam is located in the upstream to control 570 MCM of annual runoff. Mean annual runoffs are 600 MCM at W.1 and 1,130 MCM at W.4A. Both hydrographs are shown in Figure 2-7.

(3) Yom River

In this river basin, irrigated agriculture is carried out around Phrae. Annual runoff coefficients are 0.22 at Y.20 and 0.17 at Y.3. Furthermore, annual runoffs are 13.8 MCM at Y.20 and 26.9 MCM at Y.3. Hydrographs of the two are shown in Figure 2-8. There is no substantial storage facilities therein.

(4) Nan River

Annual runoff coefficient is high at N.35 though it is located in upstream of Sirikit Dam. This is because that this upper area is not developed yet and located in heavy rain area. Meanwhile, annual runoff coefficient at No.12 at direct downstream of Sirikit Dam is 0.30. Both annual mean runoffs are 55.5 MCM at N.35 and 58.6 MCM at N.12. Both hydrographs are shown in Figure 2-9.

(5) Bhumibol and Sirikit Dams

Bhumibol Dam and Sirikit Dam in are located at the RID-regional boundary of Region No. 3 across the Ping and Nan. These storage dams are very important for water management in the whole Chao Phraya Basin. Inflows to both reservoirs are as follows.

Annual Runoff (unit: MCM)

Reservoir	(Average)	(Drought Year)	(Wet Year)	(Maximum)
Bhumibol Res.	6,600	3,300	9,100	9,700
Sirikit Res.	6,000	2,800	10,000	6,000
Total	12,000	6,100	19,100	15,700

Inflows to both reservoirs are as much as 40% of total runoff in the Chao Phraya basin. This runoff volume can be fully controlled by these two reservoirs due to their huge storage capacity. Both dams have their own operation rule curve for control of water release. These curves and behavior of both dam storages are shown in Figures 2-14 (1)-(3).

Water release from the both reservoirs is determined from hydropower generation requirement and water use requirements in the downstream. RID's requests for water release and records of release from the reservoirs for the last 8-years period are shown in Table 2-4 and Figure 2-15. This requested water for release is that derived from irrigation, navigation, salinity control, industry and domestic water and other water requirements.

2.2.2 Middle Basin

In the middle basin, major tributaries of the Chao Phraya River flows down to Nakhon Sawan to form Chao Phraya River joining with a number of small tributaries originated in the eastern and western

mountainous areas. Annual runoff from these areas is about 15,000 MCM; as much as 50% of the total runoff from the whole Chao Phraya River Basin.

Meanwhile, watersheds of tributaries along the Ping and Nan are so small that no large reservoirs such as Bhumibol or Sirikit Reservoirs is found. Therefore, their runoffs cannot be stored and regulated.

Runoff volume in wet season is quite substantial and it often causes floods in the lower reaches of the Middle Basin. and the Lower basin as well. Floods in Bangkok Metropolitan area are often caused by runoffs from the Middle Basin.

(1) Ping and Wang Rivers

Ping River flows down to Nakhon Sawan, after joined with Wang River at the downstream of Bhumibol Dam. Annual runoff coefficients along the course are 0.16 at P.7 and 0.17 at P.17 streamflow gauging station. Annual runoffs are 7,940 MCM at P.7 and 9,130 MCM at P.17. Their hydrographs are shown in Figure 2-6.

(2) Yom and Nam Rivers

Nan River flows down to Nakhon Sawan after joined with Yom River at 30 km upstream of Nakhon Sawan and then joins with Ping River.

Phitsanulok irrigation project has developed areas along Nan River by diverting irrigation water by Naresuan Dam. Annual runoff coefficient in Yom River is as low as 0.12 at Y.17 station. The same in Nan River is as high as 0.28 at N.10 station, while it decreases to 0.17 at N.37 station after joining with Yom River. Their annual runoffs are 3,150 MCM at Y.17, 11,060 MCM at N.10 and 12,370 MCM at N.37 station. These hydrographs are shown in Figures 2-8 and 2-9.

2.2.3 Lower Basin

The Lower Basin is as large as 41,900 sq.km, and Chao Phraya River joins with two major tributaries of Sakae Krang River and Pasak River along the course. Annual runoff at Chao Phraya Dam is that from the Upper and Middle Basins as much as 18,000 MCM.

There occurs some floods in the lower reaches of the Basin and Bangkok Metropolitan areas caused by flood runoffs from the Middle Basin and/or from Pasak River and/or heavy rainfall in the area and/or high tide and their combinations.

(1) Chao Phraya River

Ping River and Nan River join at Nakhon Sawan and change the name into Chao Phraya River. A 30 km length between Nakhon Sawan and Chainat is the only one length where joins no major tributaries. Chao Phraya River diverts Suphan and Noi Rivers at Chainat, and joins Pasak River at Ayutthaya and Noi River at Bang Sai, then flow out to the Gulf of Thailand.

Annual runoff and annual runoff coefficient are 23,260 MCM and 0.18 at Nakhon Sawan respectively. After Suphan and Noi Rivers diverted, annual runoff discharge of Chao Phraya River at station C.13 of Chao Phraya Dam site is 13,000 MCM, and 11,840 MCM at station C.7 respectively. Hydrograph of C.2, C.13 and C.7 are shown in Figure 2-11.

Chao Phraya River causes floods in some years in the lower parts of the delta. Hydrographs in severe flood years of 1975, 1978, 1980 and 1983 at Chao Phraya Dam (Chainat Dam), Rama VI Barrage and Bang Sai are shown in Figure 2-12 for reference.

Tidal effect on Chao Phraya River water level reaches to near Ayuttaya, and water released from Chao Phraya Dam is determined based on the requirements for irrigation in the delta, navigation, industry and domestic water demands as well as for salinity control.

(2) Pasak River

Pasak River located in the eastern part of Chao Phraya basin joins with Chao Phraya River at Ayutthaya. Annual runoff and annual runoff coefficient are 2,570 MCM and 0.15 at station S.9 respectively. Hydrograph at S.9 is shown in Figure 2-10.

(3) Suphan River and Noi River

Flow patterns of Suphan River and Noi river are mostly controlled artificially by operation of regulators installed across and along the courses. Lower reaches of the Suphan River (or Tachin River) are affected by sea water intrusion that water release for salinity control from Pho Phraya Regulator is carried out.

(4) Mae Klong River

Mae Klong River system is originated from the western border area with Burma. Upstream of Mae Klong River system is composed of Khwae Noi and Khwae Yai Rivers. These two rivers meets at Kanchanaburi to form Mae Klong River and flows to the Gulf of Thailand. There are Khao Lean Dam in the upstream of Khwae Noi River and Sri Nakarindra Dam in the upstream of Khwae Yai River. Both dams are multi-purpose and mainly used for hydro-power generating and irrigation.

Annual runoff and runoff coefficient at station K.10 in Khwae Noi River are 5,910 MCM and 0.54 respectively. Such high runoff coefficient is due to hilly and undevelopment watershed and heavy rainfall. On the other hand, as for Khwae Yai River, annual runoff and runoff coefficient at K.26 are 2,790 MCM and 0.17. The runoff coefficient is low due to less annual rainfall. Annual runoff and runoff coefficient at station K.11 (after confluence of the two rivers) are 8,810 MCM and 0.26. Hydrographs at stations K.10, K.11 are shown in Figure 2-12.

(5) Bang Pakong River

Runoff patterns in the middle and lower basins of Bang Pakong River cannot be well identified due to tidal influence in flow calibration and insufficient observation facilities. Tidal effects on water level reaches to Nakhon Nayok, however water release from upstream for salinity control as practiced in Chao Phraya River and Suphan River is not employed. A large number of tidal gates to prevent sea water intrusion into farmlands is installed along the course.

Location Map of key streamgauging stations in Chao Phraya Basin is shown in Fig. 1.2.2, while monthly runoffs at key streamgauging stations are shown in Table 2-5, and the stochastic values of annual runoffs are shown in Table 2-6. And, runoff patterns in the upper, the middle and the lower basins are shown in Figure 2-16 and Figure 2-17.

CHAPTER 3 HYDROLOGICAL OBSERVATION FOR THE STUDY

3.1 Purpose

Hydrological observation equipment have been brought by the Study Team in order to reinforce the present observation network, to supplement data and to improve data quality required for examination of water management performances and identification of water behavior in the delta. The component study items of the observation and correspondent activities are as follows.

(1) Study on water behavior in river/canal system
..... Water level and stream gauging
(2) Study on tidal influence.. Tide level observation
(3) Water quality study ..... Water quality measurement
(4) H-Q rating ..... Examination of H-Q curve
(5) Rainfall data examination. Installation of recording raingauge
(6) Examination of canal capacity
..... Canal cross-section survey

These activities may be categorized into those at fixed station and at mobile station. The former aims to collect long term data like as water level, flow and rainfall records, whole the latter aims to collect occasional or periodical short-term data such as water quality and canal cross-section survey data.

3.2 Selection of Equipment and Observation Site

3.2.1 Equipment

For the above observation for the Study, following equipment have been selected.

Observation Item	Equipment
1. Water level and flow	Water Level recorder, current meter
2. Tidal water effects	Water level recorder, flow direction and velocity meter
3. Water quality	Water quality checker Water sampler
4. Examination of H-Q curve	Current meter, survey equipment and vehicle
5. Rainfall examination	Recording raingauge
6. Canal section survey	Survey equipment, vehicle

The Study Team selected the following equipment consequently.

Items	Q'ty
(For mobile observation)	
- Vehicle: 4-WD Diesel (TOYOTA)	3
- Water quality checker (WQC-2A)	3
- Current meter; ordinary current (UC-2)	3
slow current (UC-3)	3
- Saline tester (STC-2S)	3
- Water sampler (KITAHARA)	2
- Levelling compass (TS-3A)	2
- Theodolite (TL-60DP)	2
(For fixed stations)	
- Water level recorder (W-021)	30
- Recording raingauge (BR-12)	6
- Current direction and speed meter (CM-2D)	2
- Saline tester (UC-77)	6
- Water sampler (KITAHARA)	6

3.2.2 Observation Site

(1) Water Level Recorder

Installation sites of water level recorder have been selected at major water control point in the study area with considerations on the following priority.

Priority	Recording Site
1	Barrage/dam/regulator across main rivers
2	Water control point along major irrigation canals - at intake regulator - at site to release water for salinity control - at sites evenly located along the course
3	Water control points along major drainage/river - at site to release water for salinity control - at sites evenly located along the course
4	Water quality check points in the Chao Phraya and Suphan Rivers
5	Key points for hydraulic study in the intensive study area

N.B. Priority is given to the sites in accordance with necessity for data collection

From the above criteria, 30 stations have been selected as shown in Table 3-1.

(2) Recording Raingauge

For reinforcement and examination of the present rainfall observation, recording raingauge has been selected. Following 6 stations have been selected for installation in the Study area.

No.	Recording Site
1	Upper Krasiew Reservoir
2	Koke Kathiem Regulator
3	Pak Hai Regulator
4	Amphoe Nong Kae
5	Jadeebucha Regulator
6	Cholahan Pichit Regulator

Location map of installation sites of water level recorders and recording raingauges is shown in Figure 3-1.

3.3 Equipment Installation

3.3.1 Water Level Recorder

After selection of gauging sites and field investigations, layout of gauging structures and cost estimation were carried out. Among the 30 stations, the Study Team constructed 24 stations while RID did 6 stations.

The installation works by the Study Team have been made by contract with a local contractor in 3 contracts as soon as completion of preparatory works for contract awarding.

(1) The First Group Stations Installed

The first contract was awarded in July 1987 to construct 12 station by the end of August 1987. Gauge installation was followed as soon as construction of each station was over. Recording at all 12 stations started from September 1987. Places of the 12 stations are as follows.

No.	Station Name	Station Code
1.	Phra Sri Saowaphak Reg. U/S Sta.	PSSR-U
2.	" D/S Sta.	PSSR-D
3.	Phra Sri Sil Reg D/S Sta.	PSRR-D
4.	Rama VI Barrage U/S Sta.	RM6-U
5.	D/S Sta.	RM6-D
6.	Phra Narai Reg. D/S Sta.	PNS-D
7.	Chao Phraya Dam U/S Sta.	CPYA-U
8.	" D/S Sta.	CPYA-D
9.	Pho Phraya Reg. U/S Sta.	PHOR-U
10.	" D/S Sta.	PHOR-D
11.	Pathum Thani Sta.	PTMT
12.	Bang Len Sta.	BLEN

(2) The Second Group Stations Installed

The second contract was for 8 stations started in the end of August 1987 to completed by the early October 1987. Gauge installation was followed subsequently, and the recording began in the middle of October. Location of the 8 stations is as follows.

No.	Station Name	Station Code
13	2E Reg. U/S Sta.	2ER-U
14	" D/S Sta.	2ER-D
15	Phra Thamaracha Reg. D/S Sta.	PTMR-D
16	Hok Wa Reg. U/S Sta.	HKWR-U
17	" D/S Sta.	HKWR-D
18	Chachoengsao Boat House Sta.	CSBH
19	Chorahan Phichit Reg. U/S Sta.	CPIR-U
20	Ban Soi Nung Sta.	BSN

(3) The Third Group Stations Installed

The third contract was for 4 started in October 1987, and the recording started from early November. As for the 6 stations by RID's construction, it started in December 1987 after confirmation of budget allocation. Names of the 4 stations and RID's 6 stations are as follows.

No.	Station Name	Station Code
21	Reong Rang Reg. U/S Sta.	RUNR-U
22	" D/S Sta.	RUNR-D
23	Koke Kathiem Reg. U/S Sta.	KKAR-U
24	" D/S Sta.	KKAR-D
25	Maharaj Reg. D/S Sta.	MHAR-D
26	Manorom Reg. U/S Sta.	MNOR-U
27	" D/S Sta.	MNOR-D
28	Makamthao-Uthong Reg. D/S Sta.	MKMR-D
29	Pak Hai Reg. U/S Sta.	PAKR-U
30	" D/S Sta.	PAKR-D

(4) Recording Raingauge

Installation of all 6 recording raingauges was carried out by the Hydrology Division of RID. Installation works were completed by the end of October and recording started subsequently.

3.4 Observation

3.4.1 Automatic Gauge

(1) Water Level Recorder

Recording by water level recorders is started from the gauge installation. These data are periodically sent to the headquarters of RID for filing and further processing.

(2) Recording Raingauge

Recording by the new raingauge also started from the gauge installation. The records are sent to the headquarters of RID for filing and further processing.

3.4.2 Flow Measurement

(1) Observation Method

Await for arrival of measuring equipments, the Study Team started flow measurement jointly with O&M staff of RID. The Study Team mainly measured flows in the left bank of Chao Phraya River, while O&M Div. in right bank and Hydrology Div. along Main River. The Study Team started the measurement from Chainat-Pasak Canal and Raphiphatana Canal. Cross-sectional survey at every measuring site along the canals has been accompanied by the flow measurement.

(2) Flow Measurement Site

Flow measurement sites were selected at 25 places in total; 12 along Raphiphatana Canal and 12 along Chainat-Pasak Canal and 1 along Chainat-Ayutthaya Canal. List of selected flow measurement sites is shown in Table 3-2, and its location map is shown in Figure 3-2.

(3) Observation Period and Frequency

The flow measurement has been carried during October - December in cooperation with RID staff.

3.4.3 Water Quality Measurement

(1) Purpose

Salinity measurement in areas near coast and along tidal affected canals and rivers has been conducted in dry season for examination of salt intrusion.

(2) Measurement Method

Measurement has been carried out in canals and rivers by use of saline tester in cooperation with RID field staff.

(3) Measurement Sites

Measurement sites were selected at 25 places. List of sites and location map are shown in Table 3-3 and Figure 3-3.

(4) Measurement Period and Frequency

Measurement has been made from February to May 1988 at time of high tide on bi-monthly basis.

CHAPTER 4 WATER BEHAVIOR IN THE DELTA

4.1 Runoff by Sub-basin of the Study Area

In order to evaluate potential availability of water resources in the Study area, the basin has been divided into 19 sub-basins including Mae Klong Basin. Division has been made at major dams, barrages and conjunctions of major tributaries as shown in Figure 4-1.

Stream flow records and rainfall records have been collected and analyzed to yield annual runoffs and annual rainfalls in each sub-basin. Results of the analysis are also presented in the same Figure 4-1 and Tables 4-1 (1)-(2).

In the sub-basins of the upper Chao Phraya River basin (Nos. 1, 2, 5 & 7) annual runoff coefficients vary 0.18 - 0.47, while those in the middle basin (Nos. 4, 6, 8, 9 & 10) are 0.12 - 0.23. Considerable difference in annual runoff by sub-basin has thus been found.

4.2 Bi-monthly Flow and Water Level

4.2.1 Objective and Outline of Analysis

In order to identify characteristics of water behavior in the delta, a preliminary statistical approach to discover some relations between water levels and river/canal flows at key points for water distribution has been made as presented hereinafter.

Records of daily water level and calibrated flow at 30 places in the delta during 36 months of Apr.'84 - Mar.'86 have been compiled into a computer data file. Among general basic statistical analyses, Ranges of fluctuation of water levels and flows on bi-monthly basis for the 3 years have been worked out. Location of the 30 places are shown in Figure 4-2.

4.2.2 Results of Analysis

After eliminating 10 % of both high-valued and low-valued daily records in each bi-month period for the 3 years, maxima and minima of the remained record in each bi-month of the year were derived at the 30 places. Results thus worked out are illustrated in Figure 4-3 (1)-(5).

Fluctuation of flow and water level at upstream/downstream of regulator is one of parameters to judge natures or goodness in water water control such as stable flow or water level control.

Fluctuation of water level at upstream of Manorom, Borommathat and Phonlathep Regulators are caused by Chao Phraya Dam and has nothing to do with their operation. It must be noted that their major function is to maintain stable water diversion as programed and not to maintain water water level.

Major functions of regulators except those at the beginning of canals is to maintain stable flow diversion or stable water level, either upstream or downstream, or their combination to some extent by control of gate opening. Therefore, small fluctuation of either flow or water level means good control of regulator.

For instance along Chainat-Pasak Canal, Roeng Rang Regulator is best operated for stable upstream water level control as seen from small water level fluctuation as compared with those at the other regulators in spite of rather same magnitude of flow fluctuation.

Along Noi River, Chanasutr Regulator is best operated for upstream water level control despite of considerable flow fluctuation. Along Suphan River, it is seen that Sam Chuk Regulator is best operated in the same manners.

4.3 Half-monthly Flow and Water Level

4.3.1 Objectives and Outlines of Analysis

In order to discover characteristics of water flow and water level by river/canal system, to find constraints which restrict improved water control and distribution and to find some indices to judge operational complexity and performance in water control and operation, subsequent analysis has been made.

Daily records of water levels and flows at 30 key places in the delta and 2 other places (Naresuan Dam and Yom Weir) have been collected and employed for analysis of this study. The 32 places are at key dam, barrage, regulators, weir and siphon. Data for the analysis are those measured and calibrated by the concerned project offices during the period of April 1984 - March 1987 (36 months). Hydrographs at key control stations along Chainat-Pasak Canal, Noi River and Suphan River are presented in Figures 4-4 (1)-(3). Statistical analyses made on the above-mentioned data are as follows.

- Calculation of means and standard deviations in every half-month for 3 years.

- Calculation of means of daily fluctuation of water levels and flows at each place on half-monthly basis.

- Correlations between water levels of stations in the lower reaches of the Chao Phraya Delta (water conservation areas.)

At the key places, water control has to be made to maintain either stable water level or stable flow diversion during a specific time (1 week in the delta). Therefore, an assumption has been set-up for quantification of operational complexity or performance at the water control structures.

If mean daily fluctuation of water level is less than 10 cm, it assumes "good water level control", while if that of water flow is less than 10% of mean plow or less than 5 CMS, then assume "good flow control".

Thus, number of half-month periods which is under "good control" either in water level or flow in the 3-year period has been counted as an index to represent operational performance.

4.3.2 Results of Analysis

Results of calculations have been presented in Figures 4-5 (1)-(3) and Tables 4-2 (1)-(15) to indicate magnitudes of daily fluctuation of both water levels and flows. The Results are condensed into Table 4-3 to indicate degrees of both "good water level control" and "good flow control" at key stations in the canal/river systems. Findings and considerations on them are as follows.

(1) Chao Phraya Dam

It has been found that the dam is carefully and intensively operated for water level and flow control. As indicated in the table, a share of 64% of annual time under "good control" is very high by taking account of arrivals of uncontrolled floods and unstable discharges released from remote two reservoirs for hydro-power generation.

(2) Chainat-Phasak Canal

Manorom regulator can maintain "good flow control" during 46% of annual time; i.e. flow deviation is more than 10% or 5 CMS in the rest of annual time.

At the three regulators after Manorom, flows are neatly regulated that daily flow fluctuation is less than 10 CMS in most of periods except those of flood time and beginning/ending of cropping. Such neat control of flow, on the contrary, causes fluctuation of water levels. Degree of water level fluctuation at Chong Kae and Roeng Rang Regulators is more than that at Roeng Rang Regulator. This is due to side flows from left-bank area of the canal caused by rainfall run-off and/or drainage from fields.

(3) Noi River

Noi River system is surrounded by Chao Phraya River and Suphan River that water behavior therein is very stable because influences from outer areas are absorbed by the two rivers and reach thereto a little extent.

Borommathat Reg. is located at 4 km upstream of Chao Phraya Dam and divert water into Noi River to supply water to 1,400,000 rai in 4 project areas. As upstream water level is controlled by Chao Phraya River, this regulator functions only for flow control.

It is obvious that control of the 3 regulators after Borommathat are mostly performed water level control to secure stable water diversion. It is clearly said that water level at Chanasutr and Phak Hai is well controlled with fluctuation not more than 10 cm.

Attention has to be paid on Chanasutr Reg. that during the period of large water level fluctuation, flow fluctuation is well controlled or at low level and vise versa. This implies that water behavior at this regulator is much complicated requiring complicated operation, and that the regulator is thus operated.

(4) Suphan River

Phonlathep Reg. located at 16 km upstream of Chao Phraya River functions, as a head regulator for intake, for only flow control since upstream water levels are controlled by Chao Phraya River.

It is obvious that the 3 regulators after Phonlathep are mostly operated for water level control for stable diversion. This control adversely causes high fluctuations of flows. However, it may be considered that the flow fluctuations at regulator can be quickly neutralized by large channel storage distribution in the downstream reaches.

(5) Rama VI Barrage

Function of this barrage is to maintain water level for diversion. However, it found that only 36% of annual time is under "good water level control". Water flow fluctuation is very arbitrary through year round. Considering a fact that the barrage is a very large and old structure with large slide gates of manual operation, frequent and precise control of gate opening may be technically complicated and physically hard work, however it may be said that operation of gates requires improvement measures.

(6) Raphiphatana Main Canal

Phra Narai Reg. located left bank of Rama VI Barrage, divert water into the canal and shall function to control only water flow as required regardless of water level fluctuation caused by inflow from Pasak river or Chainat-Pasak Canal or by gate operation of the barrage.

It is found that "good flow control" of the regulator is only 23% of annual time, much lower than those of other regulators solely for flow control. In combination with Rama VI Barrage, some

examination of mechanical difficulties in gate operation and review of operation practices and method shall be required. And some improvement measures shall be taken since the flow fluctuation is causing much difficulties in water control in downstream reaches.

4.4 Drainage Flow in Early Dry Season

4.4.1 Purpose

Prior to harvest of wet season paddy, water in paddy fields is drained out in early dry season from late November till mid-January. Among major drainage regulators which drain water directly to Chao Phraya River, following 10 regulators have been selected for production of flow calibration and quantification. Flow measurement has accordingly been carried out jointly with RID personnel. Figure 4-6 shows location of the 10 regulators, while Table 4-4 shows their detailed information.

Water levels and gate openings of the regulators are continuously recorded 3 - 5 times/day, and by application of the calibration curve, potentiality of iterative use of drain water for irrigation can be quantified.

Drainage Regulators for Flow Measurement

No.	Regulator Name	Project Name
1.	Bang Chom Sri Regulator	Maharaj Project
2.	Wat Manee Regulator	Koke Kathiem Project
3.	Wat U-Rom Regulator	Maharaj Project
4.	Kao Mao Regulator	Nakhon Luang Project
5.	Ban Pho Regulator	Nakhon Luang Project
6.	Bang Khum Regulator	Reong Rang Project
7.	Lum Chuad Regulator	Yangmanee Project
8.	Nong Sa Rai Regulator	Yangmanee Project
9.	Phasi Charoen Regulator	Phasi Charoen Project
10.	Chularongkorn Regulator	Rangsit Tai Project

4.4.2 Measurement Method

Flow measurement team visits the sites to meet timings of gate opening/re-adjustment. As for the data collection for quantification of drainage flows into volume, records at only five regulators have been analyzed because of some incompleteness of records at other regulators.

4.4.3 Result

Thus quantified drainage discharge in every 10-day period between November and January from the five regulator is shown in Table 4-5. It was found that a considerable volume of drainage water is discharged to Chao Phraya River without re-use in the downstream reaches.

4.5 Flow in Chao Phraya River at Phathum Thani

4.5.1 Outline

Flow in the Chao Phraya River can be quantified at Chao Phraya Dam and Angthong by H-Q calibration, however, it cannot below Angthong because of tidal water level influence up to Ayutthaya. Quantification of flow near Bangkok is one of most important theme for water management around the Metropolis.

Direct flow measurement at Phathum Thani was conducted by use of equipment brought be the Study Team. The results have been processed and compiled by Hydrology Div. together with water level records at related gauging stations, among which Phathum Thani Station is one of gauging stations installed by the Study Team.

In order to estimate/quantify flow in the Chao Phraya River from water level records, a correlation analysis has been carried out as presented hereinafter.

4.5.2 Records Observed and Variables Employed

Observed records for analyses are:-

- 2-hourly flow data measured on hourly basis at Phathum Thani (C.31) during 16:00 Sep. 16 - 8:00 Sep. 27, 1987.
- 2-hourly water level records at Fort Chula, Phathum Thani (C.31) and Bang Sai during the same period.

Following 8 variables have been employed for correlation analysis form the original 4 variables.

① = Chao Phraya River flow at Phathum Thani (C.31)
② = Water level at Fort Chula in MSL-m + 2.50
③ = Water level at Phathum Thani (C.31) in MSL-m
④ = Water level at Bang Sai in MSL-m.
⑤ = ④ - ③ + 0.60
⑥ = SQRT(⑤)
⑦ = (③ + 12.0) ** 1.7
⑧ = ⑥ * ⑦

4.5.3 Correlation Analysis

Means, correlation coefficients and linear regression equations have been calculated. Correlation of the Variable ① to each of other variables by delay time of ① to them is shown in the following table.

Correlation Coeff. of ① to Other Variables by Delay Time

Variable	0 hr	2 hr	4 hr	6 hr	8 hr	10 hr
②	-.385	-.506	-.448	-.201	.128	.380
③	.203	.383	.605	.775	.832	.787
④	.451	.607	.744	.812	.802	.736
⑤	.759	.741	.557	.307	.129	.061
⑥	.774	.772	.578	.324	.129	.026
⑦	.204	.383	.605	.774	.831	.786
⑧	.783	.792	.615	.377	.191	.088

Among variables of ② to ⑧, key ones with good correlation have been found ③, ⑤ and ⑧ to show correlation coefficient values of 0.832, 0.759 and 0.792 respectively.

In order to off-take some random factors involved while observation, moving averages of variables of ①, ③, ⑤ and ⑧ on 6- , 12- and 24-hr basis have been calculated and again analyzed on their correlation. Maximum correlation coefficients among those of various delay time have been worked out to show significantly improved correlation as presented in the following table together with regression equations and statistical values. Their scattergrams are also shown in Figures 4-7 (1)-(12).

Maximum Correlation of ① to Key Variables

Basis	Variable Y	Max. Corr.	Time Delay	Regression Equation	No. of Sample	Mean Value X= 1	Mean Value Y	Fig. No.
Instan-	③	.832	8 hrs	1,469 Y - 399	124	1,364	1.20	(1)
taneous	⑤	.759	0	3,515 Y + 639	128	1,335	.20	(2)
Basis	⑧	.783	0	25 Y + 552	127	1,344	32.5	(3)
6-hr	③	.861	8	1,507 Y - 448	122	1,358	1.20	(4)
Average	⑤	.819	0	4,146 Y + 514	126	1,337	.20	(5)
Basis	⑧	.846	0	30 Y + 344	126	1,337	32.8	(6)
12-hr	③	.896	8	1,493 Y - 436	119	1,351	1.20	(7)
Average	⑤	.884	0	4,878 Y + 368	123	1,340	.20	(8)
Basis	⑧	.884	0	33 Y + 249	123	1,340	32.8	(9)
24-hr	③	.935	6	1,421 Y - 360	114	1,344	1.20	(10)
Average	⑤	.958	6	5,239 Y + 315	114	1,344	.20	(11)
Basis	⑧	.947	0	35 Y + 183	117	1,335	32.8	(12)

N.B. Data of zero-value eliminated from calculation.

4.5.4 Conclusion

- Instantaneous flow is best correlated to and calibrated from water level of 8-hr-before at Phathum Thani (corr. coeff.= 0.832)

- 6-hr and 12-hr average flows are also best correlated to and calibrated from 6-hr and 12-hr averaged water levels at 8-hr-before at Phathum Thani (corr. coeff.= 0.861 and 0.896 respectively)

- 24-hr average flow is best correlated to and calibrated from 24-hr averaged water level differences of 6-hr-before between Bang Sai and Phathum Thani (corr. coeff.= 0.958)

CHAPTER 5 WATER QUALITY IN THE DELTA

5.1 General Outline

Water quality observation is conducted mainly for salinity control in the delta caused by sea water intrusion into river channels and inland along the channels and coast. As aforementioned in the Section 2.1.4 of this report, salinity at Memorial Bridge in Chao Phraya River and San Phran in Suphan (Tachin) River exceeds 2,000 ppm, 40 CMS and 20 CMS of water is exclusively allocated only for salinity control and released from Chao Phraya Dam and Pho Phraya Regulator respectively.

There emerges such occasion every year in the end of dry season. It also emerges in the early wet season or even in the mid-wet season in some years when no rainfall continues for a month or more.

On the other hand, salinity of inland along the 3 rivers and the sea coast is controlled not by water release from upstream but by occasional drainage to the sea or rivers through regulators only when salinity becomes concentrated and outer water level is lower.

Aside from salinity, deterioration of water quality in Bangkok Metropolis and its urban areas has currently emerged. Some of possible causes of the deterioration are concentration of population and industries, insufficient sewage system and water treatment facilities, new drainage system to protect Bangkok Metropolis from floods, deteriorated drainage capacity caused by land subsidence, etc.

In addition to observation by RID, the Study Team conducted observation of water quality in salinity and other chemical/physical consistencies in the lower delta.

5.2 Observation by the Study Team

In order to find irrigation water quality in dry season, water quality survey and examination have been conducted at 21 sites. Water sampling sites have been selected from tidal-effected reaches in the 3 rivers and from canals in the water conservation area. Breakdowns of the sites are as follows. List and location map of the sites are shown in Table 5-1 and Figures 5-1 (1)-(2).

- Chao Phraya River 2 sites
- Suphan River 4
- Bang Pakong River 3
- Phasi Charoen Project 4
- Khlong Dan Project 4
- Phra ong Chaiyanuchit Project 3

Sampling has been made 3 times in February, 1988 to examine water quality deterioration. Examination are both environmental and heavy metal items as follows.

Environmental items :

- PH, EC
- Ca, Mg, Na, K, CO_3, Cl, SO_4
- SSP, SAR, RSC (meq/l), TDS (ppt.), Irr (class)

Heavy Metal items :

- Zn, Cu

5.3 Results of Water Quality Examination

Judging from results of the analysis in EC (electric conductivity) and SAR (sodium absorption ratio), water quality at 12 sites where have been classified into C_2S_1, or C_3S_1 has no substantial problem for irrigation.

On the other hand, downstream reaches of Kratum Baeng in Suphan River and of Chachoengsao in Bang Pakong River are anticipated to cause considerable damages by salinity so that much attention shall be paid on intake of water therefrom.

In Bang Pakong River, high SAR is observed at Bang Kanak (100 km from estuary) that intake of river water shall also be carefully operated. Meanwhile, intake of river water at the 2 sites in Chao Phraya River and at Sam Phran and upper reaches in Suphan (Tachin) River has no problem in water quality.

As for analysis of heavy metal, only nominal concentration has been quantified to results no problem. Their results are presented in Figure 5-2 and Figures 5-3 (1) - (7).

CHAPTER 6 Groundwater

6.1 General Outline

In most part of Thailand, geological structures for groundwater are relatively favorable. The two best water-bearing strata (the Recent and Terrace alluvial aquifers) are widely distributed in all regions except the Northeast. Chao Phraya River basin may be geologically divided into the northern highland, upper plain (flood plain in the Middle Basin) and lower plain (Chao Phraya delta). Features of groundwater in the 3 areas are presented in the followings.

6.1.1 Northern Highland

The most important groundwater resources of this area are contained in the Recent alluvium and Terrace alluvium systems which occur in river valleys and intermontane basins. The major alluvium systems are found in Ciang Mai, Lampang, Chiang Rai, Mae Chan and Phrae basins; elsewhere alluvial deposits are of limited lateral extent and depth. Within the major basins, Thickness of alluvium in excess of 200 m occur. Depths to water level range from near land surface in the central parts of the basin to more than 30 m at the peripheries. Well yields for shallow and deep tubewells are relatively high and the chemical quality is good.

6.1.2 Upper Plain

The entire area is underlain by the Terrace aquifer system and locally by the Recent alluvium aquifers. These offer an immense groundwater resource which can be exploited by both deep and shallow tubewells. The Recent alluvium is present at depths of up to 60 m beneath the flood plains of the Ping, Yom and Nan Rivers and their tributaries, occurring as elongated strips up to 20 km wide on each side of the rivers.

The thickness of the Terrace alluvium ranges up to 300 m. Water levels are generally at shallow depth and a local flowing artesian condition occurs in Khanuworalak District. Well yields are moderate to high and the water is of good chemical quality.

6.1.3 Lower Plain

Groundwater conditions in the northern part of this area (north from Sing Buri) are similar to those of the Upper Plain, with Recent alluvium and Terrace alluvium aquifers forming the groundwater resource. In this part of the plain, phreatic aquifers near the surface give way to confined aquifers at depth and yield good quality water which can be exploited for irrigation by both deep and shallow wells.

In the southern part of this area, a thick surface clay blanket is generally present to a depth of about 20 m. Below this, eight aquifer layers have been recognized to a depth of 650 m and are separated by layers of clay or sandy clay. The upper two layers are attributed to the Recent alluvium while the lower six layers are believed to be Lower Terrace alluvium.

These aquifers provide an important part of the water supply of Bangkok and the system is vastly overdrawn in the city area, where water level decline of more than 50 m has led to increasing severe problem of land subsidence and sea water intrusion. Thus, these aquifers do not offer development potential for irrigation. Present abstraction for Bangkok by private and public wells is presently estimated at 1.3 million cu.m/day. Bangkok and the five adjoining provinces have been designated the 'Bangkok Groundwater Area' and groundwater development and abstraction in this area is now subject to legal control.

6.2 Behavior of Groundwater in the Delta

In the Study area, 11 projects are observing groundwater in RID-Regions No. 1, 7 and 8. List of projects of observation is shown in Table 6-1 and their location map is shown in Figure 6-1. Furthermore, hydrogeological profile of Chao Phraya River is shown in Figure 6-2.

Behavior of groundwater level in the 11 projects (12 areas) is shown in Figures 6-3 (1) - (4). It is seen that groundwater table is at low level during February to March due to drying of paddy field during and after harvesting, while it is at high level during September to October in wet season.

However like in Don Chedi Project, fluctuation of groundwater level is as little as -0.6 to -0.8 m through year round. On the other hand, there is project in which groundwater level is as deep as -1.4 to -2.2 m like in Phonlathep Project. Furthermore, there is project in which water level becomes above the ground level like in Sam Chuk (Interception Drain) Project in wet season.

Table 1-1 (1) CLIMATOLOGICAL DATA AT CHIANG MAI (1956 - 1985)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
Pressure (+1000 or 900 mbs.)													
Mean	13.90	11.26	09.07	07.02	05.66	04.56	04.62	04.84	07.10	10.66	13.25	14.50	08.87
Ext. Max.	26.20	24.30	21.40	18.10	14.30	12.10	13.10	13.10	15.40	19.70	24.30	24.70	26.20
Ext. Min.	03.70	00.90	99.40	96.70	96.90	95.30	94.90	95.10	96.90	01.30	04.50	03.90	94.90
Mean daily range	6.56	7.02	7.13	6.80	5.76	4.65	4.43	4.57	5.16	5.39	5.56	6.07	5.76
Temperature (℃)													
Mean	20.3	22.7	26.2	28.7	28.1	27.3	26.9	26.4	26.3	25.6	23.6	21.0	25.3
Mean Max.	28.9	32.1	35.1	36.3	34.2	32.3	31.7	30.9	31.2	31.0	29.8	28.5	31.8
Mean Min.	13.5	14.5	18.0	21.8	23.6	23.7	23.5	23.4	22.9	21.7	18.8	15.0	20.0
Ext. Max.	34.7	37.3	39.6	41.5	41.4	37.9	37.5	35.4	36.1	35.3	34.5	33.5	41.5
Ext. Min.	3.7	7.3	10.0	15.5	19.6	20.0	20.5	20.7	16.8	13.3	6.0	5.0	3.7
Relative Humidity (%)													
Mean	72.2	62.8	55.7	58.6	71.4	78.0	79.3	81.8	81.8	79.9	77.5	75.3	72.9
Mean Max.	92.6	87.9	80.8	81.2	88.3	91.8	92.4	93.2	93.6	93.4	93.3	93.2	90.1
Mean Min.	41.7	32.8	30.4	36.1	50.6	59.4	61.5	65.0	63.4	58.9	53.2	47.6	50.1
Ext. Min.	17.0	12.0	9.0	15.0	22.0	40.0	40.0	44.0	38.0	29.0	30.0	30.0	9.0
Dew Point (℃)													
Mean	14.4	14.0	15.4	18.8	21.8	22.8	22.7	22.8	22.7	21.6	19.0	15.8	19.3
Evaporation (mm)													
Mean - Pan	105.4	134.5	177.5	196.2	172.9	136.6	125.9	117.0	125.3	126.3	104.1	100.2	1621.9
Cloudiness (0 - 10)													
Mean	2.9	2.4	2.4	4.0	6.8	8.1	8.5	8.7	7.8	6.3	4.7	3.8	5.5
Sunshine Duration (hr.)													
Mean	281.6	276.3	282.3	272.5	241.9	175.1	146.6	140.4	173.1	224.1	243.1	265.2	2722.2
Visibility (km)													
0700 L.T.S.	6.0	5.8	4.5	6.4	10.6	12.0	11.9	11.5	10.7	8.9	7.5	6.3	8.5
Mean	8.6	7.4	6.3	7.9	11.4	12.4	12.1	11.8	11.8	11.5	10.9	9.9	10.2
Wind (knots)													
Prevailing wind	S	S	S	S	S	S	S	S	S	S	N	N	-
Mean wind speed	1.3	1.8	2.2	3.0	2.8	2.3	2.2	2.0	1.9	1.8	1.4	1.3	-
Max. wind speed	45 N	54 W	55 N	63 SE	64 N, NNE	43 W, WSW	50 W	56 N	52 N	40 S	43 N	42 E	64 N, NNE
Rainfall (mm)													
Mean	9.7	3.5	13.3	47.1	154.5	134.2	171.8	232.9	240.8	114.2	41.5	20.1	1183.6
Mean rainy days	1.3	0.8	1.7	5.8	15.4	16.9	19.3	21.7	17.8	10.7	4.9	2.0	118.3
Greatest in 24 hr.	27.1	30.3	69.8	78.0	113.3	68.7	105.6	166.5	131.6	74.9	59.5	92.9	166.5
Day/Year	10/75	14/61	23/70	29/57	20/70	7/57	8/78	14/68	23/67	26/76	7/27	12/80	14/68
Number of days with													
Haze	26.5	27.5	30.6	24.0	4.8	0.2	0.1	0.0	0.5	2.8	7.9	18.1	143.0
Fog	1.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.4	1.2	2.0	3.3	8.0
Hail	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
Thunderstorm	0.3	0.4	2.9	9.6	16.6	9.1	8.4	10.3	12.2	7.8	1.1	0.3	79.0
Squall	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2

Remarks : Evaporation 1965 - 1985

Table 1-1 (2) CLIMATOLOGICAL DATA AT PHITSANULOK (1956 - 1985)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
Pressure (+1000 or 900 mbs.)													
Mean	13.55	11.27	09.69	07.97	06.58	05.80	05.92	06.00	07.66	10.69	13.06	14.12	09.36
Ext. Max.	25.35	23.09	22.95	20.00	14.86	12.80	13.03	13.60	15.39	19.94	23.32	23.66	25.35
Ext. Min.	04.22	01.81	00.94	98.22	98.22	96.60	96.74	97.70	99.02	01.77	05.38	04.34	96.60
Mean daily range	5.39	5.74	6.07	6.11	5.31	4.24	4.00	4.15	4.65	4.82	4.80	5.05	5.03
Temperature (℃)													
Mean	23.9	26.4	28.9	30.6	29.6	28.5	27.9	27.7	27.7	27.5	26.0	24.1	27.4
Mean Max.	31.5	33.8	36.0	37.4	35.7	33.7	32.8	32.2	32.2	32.4	31.8	31.0	33.4
Mean Min.	17.7	20.4	23.3	25.2	25.2	24.7	24.5	24.4	24.5	23.9	21.5	18.4	22.8
Ext. Max.	36.7	38.0	40.5	42.8	42.0	38.7	38.4	36.3	36.6	35.3	36.0	35.6	42.8
Ext. Min.	8.9	13.1	13.5	19.1	21.6	21.8	21.6	22.2	21.5	17.6	12.1	9.4	8.9
Relative Humidity (%)													
Mean	66.5	64.4	62.2	62.4	71.6	77.8	79.5	81.3	81.9	79.0	73.7	68.8	72.4
Mean Max.	85.9	83.2	80.5	80.6	86.8	90.6	91.7	92.6	92.8	91.7	89.6	87.6	87.8
Mean Min.	41.7	40.8	40.2	41.5	51.3	60.1	62.8	65.2	65.4	60.4	52.1	44.7	52.2
Ext. Min.	22.0	17.0	15.0	20.0	27.0	38.0	46.0	46.0	45.0	32.0	31.0	21.0	15.0
Dew Point (℃)													
Mean	16.6	18.6	20.4	22.0	23.5	24.0	23.9	24.0	24.1	23.3	20.6	17.5	21.5
Evaporation (mm)													
Mean - Pan	103.6	111.8	154.2	180.0	171.8	140.4	131.2	120.7	111.3	119.8	110.7	104.8	1560.3
Cloudiness (0 - 10)													
Mean	4.0	4.4	4.4	5.4	7.3	8.3	8.5	8.8	8.2	6.4	4.8	4.1	6.2
Sunshine Duration (hr.)													
Mean	265.7	251.0	268.0	276.7	255.1	187.0	177.1	160.1	162.7	227.1	250.9	264.8	2746.2
Visibility (km)													
0700 L.T.S.	4.4	4.1	5.3	7.3	9.5	10.1	9.8	9.5	9.3	8.8	7.7	6.2	7.7
Mean	7.1	6.0	6.4	8.0	10.3	10.8	10.7	10.4	10.6	10.9	10.5	9.5	9.3
Wind (knots)													
Prevailing wind	S	S	S	S	S	S	S	S	S	N	N	N	-
Mean wind speed	0.9	1.4	2.0	2.3	2.0	1.7	1.6	1.5	1.3	1.1	1.0	1.0	-
Max. wind speed	26 WSW	29 S	50 NE	52 N	40 SW	39 SW	35 S	35 WSW	34 E, NNW	35 NE	23 SE	25 S	50 NE
Rainfall (mm)													
Mean	6.8	14.1	33.7	51.5	194.7	177.7	209.1	242.7	262.5	140.1	29.7	5.5	1368.1
Mean rainy days	1.6	2.2	3.4	5.4	14.5	16.8	19.0	21.7	19.6	12.6	3.9	1.2	121.9
Greatest in 24 hr.	26.1	41.5	69.5	81.9	141.5	105.0	126.6	113.4	265.7	184.8	81.8	23.7	265.7
Day/Year	10/75	10/56	7/63	21/59	5/76	23/83	12/70	23/80	5/77	16/85	13/85	1/64	5/77
Number of days with													
Haze	24.5	26.3	28.8	20.3	2.0	0.0	0.0	0.0	0.0	1.4	3.7	12.6	119.6
Fog	1.9	0.5	0.1	0.0	0.0	0.0	0.1	0.1	0.2	0.7	0.6	0.9	5.0
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	1.1	3.2	6.6	14.0	11.1	9.5	9.8	12.1	9.8	1.2	0.2	78.9
Squall	0.0	0.0	0.3	0.5	0.5	0.4	0.5	0.1	0.1	0.0	0.0	0.0	2.4

Remarks : 1. Evaporation 1962 - 1985
2. Shunshine Duration 1957 - 1985

Table 1-1 (3) CLIMATOLOGICAL DATA AT BANGKOK (1956 - 1985)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
Pressure (+1000 or 900 mbs.)													
Mean	12.47	10.99	09.96	08.40	06.85	06.34	06.46	06.51	07.56	09.75	11.60	12.63	09.13
Ext. Max.	26.50	20.96	20.97	17.74	14.06	13.00	13.34	13.50	14.38	18.02	20.38	21.32	26.50
Ext. Min.	04.42	02.27	02.08	99.66	99.40	97.76	98.78	99.36	98.20	01.22	04.60	03.87	97.76
Mean daily range	4.81	4.80	4.85	4.83	4.46	3.80	3.75	3.93	4.39	4.43	4.28	4.51	4.40
Temperature (℃)													
Mean	25.6	27.2	28.6	29.6	29.3	28.7	28.1	27.9	27.6	27.5	26.7	25.5	27.7
Mean Max.	31.9	32.8	33.9	34.9	34.2	33.1	32.6	32.4	32.0	31.8	31.5	31.4	32.7
Mean Min.	20.6	23.1	24.8	25.9	25.6	25.3	24.9	24.8	24.5	24.3	23.0	20.9	24.0
Ext. Max.	35.7	36.6	39.8	40.0	39.5	37.7	37.8	36.3	36.0	35.3	35.1	35.2	40.0
Ext. Min.	11.5	14.9	16.5	19.9	21.1	21.7	22.2	21.2	21.6	18.3	14.2	10.5	10.5
Relative Humidity (%)													
Mean	72.1	75.7	76.0	76.0	78.4	78.5	79.3	80.2	82.8	82.2	77.5	72.5	77.6
Mean Max.	90.6	92.2	91.6	90.7	92.2	91.5	91.8	93.2	94.8	94.3	92.5	90.0	92.1
Mean Min.	48.6	53.4	55.2	55.8	60.1	62.3	63.5	63.9	66.0	65.6	59.4	52.1	58.8
Ext. Min.	27.0	17.0	23.0	28.0	30.0	38.0	43.0	47.0	49.0	36.0	36.0	31.0	17.0
Dew Point (℃)													
Mean	19.6	22.1	23.6	24.5	24.8	24.2	23.9	23.9	24.2	23.9	22.1	19.7	23.0
Evaporation (mm)													
Mean - Pan	135.9	141.1	182.1	187.5	171.4	150.1	147.9	147.1	130.4	127.9	125.8	133.3	1780.5
Cloudiness (0 - 10)													
Mean	5.9	6.5	6.8	7.0	8.2	8.5	8.6	8.9	9.0	8.2	6.8	5.9	7.5
Sunshine Duration (hr.)													
Mean	276.6	252.5	270.0	256.0	222.4	178.5	169.1	159.4	152.6	202.0	242.6	266.1	2647.8
Visibility (km)													
0700 L.T.S.	5.2	4.9	5.9	7.5	8.6	8.7	8.4	8.1	8.0	8.0	8.1	7.5	7.4
Mean	9.6	9.2	9.4	10.7	11.9	12.1	11.9	11.6	8.6	11.4	11.7	11.2	10.8
Wind (knots)													
Prevailing wind	NE	S	S	S	S	S	SW	SW	SW	SW	NE	NE	-
Mean wind speed	2.6	4.1	5.0	4.6	3.8	3.8	3.5	3.6	2.7	2.3	2.3	2.4	-
Max. wind speed	31 NNW	37 N	48 ENE	52 E, ESE	41 SSW	41 W	41 W,S NW,WNW	43 E	44 SSW	40 NE	37 SE ESE	31 SE NNE	52 E, ESE
Rainfall (mm)													
Mean	9.3	29.1	26.2	66.4	189.9	156.1	158.7	204.6	339.4	239.3	48.3	9.7	1477.0
Mean rainy days	1.3	2.9	3.0	6.4	15.7	16.7	18.1	20.6	21.5	17.0	5.9	1.3	130.4
Greatest in 24 hr.	39.3	73.0	88.4	89.7	124.2	167.3	108.6	97.8	153.7	123.2	81.2	32.0	167.3
Day/Year	31/61	11/64	30/82	29/57	15/66	13/79	28/76	26/71	23/68	5/60	2/69	8/72	13/79
Number of days with													
Haze	19.1	15.9	16.3	9.3	2.9	1.3	0.8	0.8	1.0	2.2	6.3	11.8	87.7
Fog	3.5	1.2	0.4	0.0	0.1	0.0	0.1	0.0	0.0	0.1	0.3	0.7	6.4
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	0.5	0.8	2.4	8.1	15.8	9.7	10.3	11.0	16.3	14.7	3.7	0.7	94.0
Squall	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.2

Remarks : Evaporation 1965 - 1985

Table 2-1 (1) LIST OF COLLECTED RAINFALL DATA

Station of Observation			Duration of Observation	
Province	Code	Location	50 55 60 65 70 75 80 85	Annual Rainfall
Ang Thong	01012	A. Muang		1,243.6 mm
Chainat	04361	Chao Phraya Dam		939.3
Chiang Mai	07013	A. Muang		1,187.4
	07182	A. Chom Thong		966.3
	07252	Doi Chiang Dao, Watershed Research		1,571.6
Kamphaeng Phet	12061	Khlong Suanmak (P.26) A. Muang		1,257.8
	12091	Ban Pang Wai (P.35) A. Khlong Khlung		1,183.0
Kanchanaburi	13132	Hin Lap, A. Bo Phloi		1,035.6
	13171	Vachiralongkoru Dam (K.11)		1,039.5
	13211	Ban Lum Sum (K.10), A Sai Yok		1,213.9
	13342	Ban Khao Lek, A. Si Sawat		1,177.3
	13352	Ban Rai School, A. Thong Pha Phum		1,893.1
Lampang	16013	A. Muang		1,047.6
	16180	Mae Suk (W.16), A. Chae Hom		1,082.0
Lamphun	17062	Ban Ko, A. Li		974.5
Lop Buri	19360	Ban Tha Ruak (S.14), A. Chai Badan		1,134.8
Nakhon Pathom	23012	A. Muang		1,107.1
Nakhon Sawan	26013	A. Muang		1,100.8
	26102	A. Nong Bua		1,204.9
NAN	26102	A. Chiang Klang		1,267.5
	28131	Yan Sarang (N.35), A. Sa		1,064.0
Phetchabun	36013	A. Muang		1,107.8
	36141	Ban Wang Thadi (S.12), A. Nong Phai		1,313.8
Phichit	38012	A. Muang		1,427.0
Phitsanulok	39142	A. Chattrakan		1,510.1
Phrae	40111	Yom River (Y.20), A. Song		1,246.4
Bangkok	41013	Meteorological Department		1,473.7
Ayutthaya	42012	A. Muang		1,123.0
Samut Sakhon	52012	A. Muang		1,281.3
Saraburi	54192	A. Muak Lek		1,463.3

Table 2-1 (2) LIST OF COLLECTED RAINFALL DATA

Station of Observation: Province	Code	Location	Duration of Observation 50 55 60 65 70 75 80 85	Annual Rainfall		
Sukhothai	59121	Kaeng Luang (Y.6)		1,141.0		
Suphan Buri	60022	A. U. Thong		937.8		
TAK	63042	A. Um Phang		1,376.8		
	63073	Phumiphon Dam		1,052.9		
Uthai Thani	69121	Ban Bung Ai Chiam (Ct.9)		1,302.4		
Uttaradit	70013	A. Muang		1,407.3		
	70151	Nat Phai (N.12A), A. The Pla		1,253.6		
Phayao	73082	A. Chiang Kuan		1,119.8		

Table 2-1 (3) LIST OF COLLECTED DISCHARGE DATA

Station of Observation			Duration of Observation	Catchment Area	Runoff Discharge	Specific Runoff Discharge	
River	Code	Location	50 55 60 65 70 75 80 85				
Ping River	P1	Chiang Mai, Mae Nam Ping		6,355 ㎢	2,151.3 MCM	0.34 MCM/㎢	(0.011㎥/S/㎢)
	7	Kampaeng Phet, Mae Nam Ping		42,704	7,934.6	0.19	(0.006)
	12	Wan Krа Chao, Mae Nam Ping		26,396	5,557.3	0.21	(0.007)
	19	Ban Tha Sala, Mae Nam Ping		14,023	3,282.5	0.23	(0.007)
	20	Chiang Dao, Mae Nam Ping		1,355	388.5	0.29	(0.009)
	35	Ban Pang Wai, Khlong Khlung		730	336.6	0.46	(0.015)
Wang River	W1A	Lampang, Mae Nam Wang		3,481	598.1	0.17	(0.005)
	4A	Ban Wang Nan, Mae Nam Wang		10,507	1,131.3	0.11	(0.003)
	16	Ban Hai, Mae Nam Wang		1,284	262.3	0.20	(0.006)
Yom River	Y3A	Sawankhalok, Mae Nam Yom		13,583	2,691.9	0.20	(0.006)
	20	Ban Ngao Sak, Mae Nam Yom		5,410	1,386.7	0.26	(0.008)
Nan River	N7	Phichit, Mae Nam Nan		29,153	9,822.6	0.34	(0.011)
	12A	Ban Hat Phai, Mae Nam Nan		15,718	5,854.7	0.37	(0.012)
	35	Kaeng Sarang, Mae Nam Nan		10,335	5,546.1	0.54	(0.017)
	36	Ban Nong Krathao, Mae Nam Khwae Noi		1,651	646.3	0.39	(0.012)
	51	Ban Wang Hit, Huai Nam Yao		774	435.1	0.56	(0.018)
Chao Phraya River	C 2	Nakhon Sawan, Mae Nam Chao Phraya		110,569	23,258.1	0.21	(0.007)
	7	Ban Bang Kaeo, Mae Nam Chao Phraya		—	11,842.8	—	—
	13	Ban Ro Rai, Mae Nam Chao Phraya		120,693	13,000.6	0.11	(0.003)
Pasak River	S 9	Ban Muang Nua, Mae Nam Pasak		14,374	2,566.2	0.18	(0.006)
	10	Ban Hin Hao, Huai Nam Phung		268	68.7	0.26	(0.008)
	14	Ban Na Som, Lam Sonthi		1,247	183.1	0.15	(0.005)
Mae Klong River	K10	Ban Lum Sum, Mae Nam Khwae Noi		7,008	5,908.9	0.84	(0.027)
	11	Ban Wang Khanai, Mae Nam Mae Klong		26,449	8,806.9	0.33	(0.010)
	13	Ban Tha Khaun, Mae Nam Khwae Noi		4,047	4,757.9	1.18	(0.037)
	26	Ban Lat Ya, Mae Nam Khwae Yai		14,479	2,789.7	0.19	(0.006)

Runoff Discharge is calculated by the records of 1967 - 1986 yr.

ROYAL IRRIGATION DEPARTMENT
STATION - A. MUANG, CHIANG
AREA -

Table 2-2 (1) MONTHLY RAINFALL AT CHAIANG MAI (07013)

COMPUTER CENTER
RAINFALL - 2.06

MONTHLY RAINFALL IN MILLIMETER

WATER YEAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	ANNUAL
1952	0.0	175.9	200.0	107.0	229.7	225.5	123.4	39.8	0.0	20.0	74.2	0.0	1195.5
1953	152.1	156.6	338.1	196.4	181.9	386.2	291.2	77.3	0.6	0.0	0.0	0.0	1780.4
1954	33.4	273.8	32.5	54.0	300.2	288.4	153.9	16.5	4.9	0.0	8.5	51.2	1217.3
1955	119.2	139.7	198.2	157.0	166.6	223.8	81.7	50.0	0.0	0.0	11.6	0.0	1147.8
1956	39.2	311.2	136.3	223.3	206.0	341.0	50.0	4.6	0.5	0.0	0.6	0.0	1312.7
1957	101.2	54.9	204.0	157.6	246.9	208.7	85.2	0.0	0.1	32.3	0.0	32.9	1123.8
1958	20.4	149.5	144.1	164.4	214.7	211.8	159.3	0.5	0.0	15.4	0.0	16.9	1097.0
1959	35.8	127.1	94.7	164.8	188.7	290.5	19.7	0.0	0.0	15.4	0.0	7.9	944.6
1960	6.1	256.1	142.2	233.9	219.1	281.9	126.3	25.0	84.9	1.8	33.3	22.5	1433.1
1961	56.0	254.0	108.4	102.8	286.9	473.1	137.9	15.2	60.6	0.0	0.0	7.5	1502.4
1962	28.0	8.6	57.2	211.9	136.4	265.0	248.7	8.9	0.0	0.0	1.6	0.0	966.3
1963	35.6	17.5	140.3	125.8	280.4	127.0	188.6	123.2	1.9	1.9	0.0	11.9	1054.1
1964	62.8	133.5	88.7	225.8	124.1	292.2	134.1	19.5	1.5	0.0	0.0	0.0	1082.2
1965	20.2	71.1	72.9	68.6	284.1	148.3	195.6	48.1	75.8	3.6	0.3	0.0	988.6
1966	7.5	140.8	56.4	202.2	236.7	131.4	77.7	5.8	0.5	6.2	0.0	2.1	867.3
1967	32.2	108.8	173.6	200.5	144.7	529.6	54.9	97.8	3.7	3.8	0.0	7.7	1357.3
1968	122.4	123.2	245.6	150.8	301.5	184.1	110.4	9.1	0.0	5.5	0.0	0.0	1252.6
1969	22.4	228.5	91.9	156.6	340.5	163.8	92.3	18.9	0.0	0.4	1.8	91.6	1208.7
1970	69.9	352.0	244.9	179.4	348.7	194.7	37.8	7.1	35.1	0.0	0.0	17.2	1486.8
1971	33.1	245.0	173.0	299.6	324.8	194.8	130.4	24.1	11.0	0.0	6.3	5.2	1447.3
1972	156.1	65.0	91.2	70.0	264.3	193.2	46.4	164.7	17.4	0.0	0.0	86.5	1154.8
1973	4.4	163.0	128.7	233.5	330.1	295.3	30.2	25.0	0.0	0.0	0.0	11.2	1221.4
1974	51.6	88.4	106.6	159.9	203.2	278.6	171.3	90.8	5.0	74.9	4.5	3.5	1238.3
1975	7.8	171.6	185.8	190.9	378.4	243.2	168.9	77.7	53.2	0.0	5.4	6.5	1489.4
1976	20.8	173.7	88.9	97.3	209.7	198.1	223.8	3.1	8.1	63.2	2.2	35.0	1123.9
1977	90.2	121.0	98.3	120.1	222.5	303.6	164.2	3.0	49.2	34.6	16.3	0.0	1223.0
1978	13.9	198.2	61.9	445.7	279.4	211.5	70.0	2.1	6.3	0.0	0.7	1.7	1291.4
1979	63.1	194.3	178.1	89.9	145.0	200.0	95.0	0.0	0.0	0.0	0.0	20.0	985.4
1980	29.0	209.9	142.2	182.9	132.8	172.9	146.1	37.1	97.6	0.0	0.0	1.9	1152.4
1981	******	******	******	******	******	******	******	******	******	******	******	******	******
1982	53.4	130.4	74.0	122.9	66.7	337.6	45.6	8.9	0.0	0.0	0.0	0.0	839.5
1983	7.5	106.9	80.3	80.5	192.5	203.0	207.9	133.7	11.6	0.0	7.8	0.0	1031.7
1984	25.9	77.0	138.4	100.4	163.4	143.0	127.2	0.7	0.0	1.4	0.0	0.2	777.6
1985	******	******	******	******	******	******	******	******	******	******	******	******	******
AVERAGE	47.5	157.1	134.9	164.9	229.7	248.2	124.9	35.6	16.5	8.8	5.5	13.8	1187.4

Table 2-2 (2) MONTHLY RAINFALL AT LAMPANG (16013)

ROYAL IRRIGATION DEPARTMENT, THAILAND
STATION - A. MUANG, LAMPANG (16013)
AREA -

COMPUTER CENTER
RAINFALL - 2.06

MONTHLY RAINFALL IN MILLIMETER

WATER YEAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	ANNUAL
1952	48.8	58.0	103.0	108.8	193.2	174.6	85.6	15.9	0.0	24.5	2.1	0.0	814.5
1953	27.0	65.0	165.6	162.8	228.5	281.7	55.8	20.9	31.5	0.0	8.1	57.0	1103.9
1954	10.4	123.7	60.7	28.6	229.3	194.0	229.3	10.3	0.0	0.0	18.6	0.0	904.9
1955	43.0	147.7	288.9	83.7	292.5	116.9	43.9	14.7	25.0	0.0	0.0	0.9	1057.2
1956	113.2	161.4	66.5	156.1	211.1	224.0	63.4	14.7	0.0	0.0	3.8	22.7	1036.9
1957	48.8	80.0	119.7	94.0	106.4	183.6	88.2	0.9	0.0	36.8	0.0	95.8	854.2
1958	32.4	69.1	193.3	67.4	160.5	138.4	92.7	13.0	0.0	0.1	0.0	3.4	770.3
1959	108.9	318.6	121.8	155.1	235.2	219.5	85.1	0.0	0.0	16.3	0.0	16.3	1276.8
1960	0.6	115.4	131.4	194.8	274.2	258.1	101.7	46.7	1.9	0.4	2.4	36.6	1164.2
1961	58.6	239.1	103.8	56.1	317.7	201.9	179.7	24.5	2.4	4.3	0.0	0.9	1189.0
1962	19.2	89.1	70.7	144.3	246.3	238.2	120.1	0.0	1.4	0.0	2.0	6.1	937.4
1963	58.8	24.1	196.8	140.2	192.4	183.1	170.2	55.2	1.2	0.0	1.4	0.0	1023.4
1964	42.3	184.5	79.5	148.4	126.9	272.9	152.5	1.5	1.2	0.0	56.5	35.3	1101.5
1965	55.6	98.7	142.5	59.4	222.2	119.5	140.5	23.1	1.8	12.6	0.2	7.8	883.9
1966	1.0	288.1	123.5	130.7	235.9	170.6	115.0	26.8	9.7	0.2	0.0	0.4	1101.9
1967	48.2	114.9	103.9	104.7	189.8	242.6	49.0	47.2	1.4	0.0	1.5	6.4	909.6
1968	136.1	151.3	203.9	77.9	131.4	125.1	85.8	13.9	0.0	3.8	0.0	12.2	941.4
1969	126.4	168.5	129.2	82.2	193.7	305.0	52.3	0.0	2.5	0.0	11.6	51.0	1122.4
1970	75.0	250.2	230.4	109.2	316.6	323.4	100.1	10.7	28.2	0.0	8.8	25.2	1477.8
1971	40.7	224.1	102.6	332.2	204.9	216.1	154.5	2.0	20.0	3.2	0.0	31.9	1332.2
1972	111.4	81.2	108.9	107.9	215.9	139.5	196.0	93.5	14.9	0.0	0.1	56.5	1125.8
1973	24.3	151.7	90.8	241.5	212.3	306.2	92.2	49.2	0.0	0.0	0.0	37.6	1205.8
1974	236.5	154.4	136.1	135.5	180.9	326.2	62.8	134.4	5.9	59.7	6.1	24.2	1462.7
1975	23.2	142.6	119.6	207.7	413.4	179.9	257.1	25.4	7.9	0.0	13.8	0.0	1390.6
1976	19.9	120.2	40.3	62.0	169.3	193.1	92.6	14.7	2.1	69.0	0.0	12.3	795.5
1977	119.4	127.7	11.3	131.4	323.8	282.8	175.6	3.4	29.7	17.9	15.7	0.0	1238.7
1978	15.0	202.3	66.7	213.0	130.5	206.7	86.4	0.0	0.0	0.0	7.0	0.0	927.6
1979	110.3	100.4	157.3	59.3	101.2	92.9	44.1	0.0	0.0	0.0	0.0	36.9	702.4
1980	20.2	153.3	175.7	159.1	78.5	150.3	74.8	48.7	11.0	0.0	0.0	24.2	895.8
1981	******	******	******	******	******	******	******	******	******	******	******	******	******
1982	35.3	131.0	106.6	50.5	113.6	376.8	108.9	0.3	0.0	4.4	0.0	0.0	927.4
1983	4.7	204.8	39.0	196.3	161.0	335.3	148.6	61.0	4.2	0.2	8.8	0.5	1164.4
1984	89.3	125.5	106.2	90.7	191.9	146.9	92.1	19.1	0.0	0.0	0.0	3.1	864.8
1985	95.4	144.9	45.8	61.6	66.1	212.7	157.4	80.1	0.0	0.0	0.2	0.0	864.2
AVERAGE	60.6	145.8	119.5	125.9	202.0	216.3	113.8	26.4	6.2	7.7	5.1	18.3	1047.6

ROYAL IRRIGATION DEPAR
STATION - A. HUANG, NAI
AREA -

Table 2-2 (3) MONTHLY RAINFALL AT NAKHON SAWAN (26013)

COMPUTER CENTER
RAINFALL - 2.06

MONTHLY RAINFALL IN MILLIMETER

WATER YEAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	ANNUAL
1952	19.8	222.6	198.3	70.5	112.2	232.5	346.7	15.7	0.0	0.0	38.6	0.0	1256.9
1953	70.0	81.3	59.1	193.0	187.4	362.8	151.5	0.0	0.0	4.4	0.0	0.0	1109.5
1954	8.3	211.9	179.1	44.0	166.5	332.1	39.6	2.8	1.4	0.0	0.0	30.3	916.0
1955	22.5	284.4	140.7	240.5	180.3	191.2	28.3	28.6	0.0	0.0	6.2	9.2	1131.9
1956	220.4	167.9	179.1	176.7	128.5	275.1	169.5	2.4	0.0	28.6	26.4	73.0	1447.6
1957	72.3	69.1	135.7	74.0	208.3	271.8	135.0	0.0	0.0	0.0	0.0	0.0	966.2
1958	85.7	46.6	91.4	94.9	145.9	294.2	43.2	0.0	0.0	0.0	71.1	99.9	972.9
1959	64.9	111.1	76.3	261.6	163.1	290.9	18.2	0.2	0.0	1.4	0.4	0.0	988.1
1960	44.6	60.8	145.9	179.7	105.2	174.6	141.5	21.4	0.0	0.0	31.1	7.4	912.2
1961	52.8	189.2	137.6	152.4	92.1	157.8	186.1	0.0	12.8	0.0	0.3	4.2	985.3
1962	75.5	65.6	101.7	102.2	203.9	330.1	87.3	1.6	0.0	0.0	0.0	2.8	970.7
1963	26.8	12.6	158.7	149.6	209.0	247.1	296.7	60.1	2.0	1.6	4.2	51.2	1219.6
1964	215.7	162.3	93.3	249.0	176.3	405.2	155.4	5.3	6.1	0.0	23.8	85.0	1577.4
1965	49.9	111.1	145.3	37.7	242.7	222.0	121.8	16.0	0.0	51.4	6.0	0.0	1003.9
1966	50.7	132.4	121.2	90.8	225.1	156.5	319.2	132.2	60.6	0.0	1.6	4.4	1294.7
1967	109.7	99.6	71.5	73.0	157.1	347.1	114.0	90.9	0.0	26.2	13.4	18.2	1120.7
1968	51.3	95.5	118.2	201.2	156.8	94.6	73.8	0.7	0.0	53.9	0.0	35.2	881.2
1969	91.0	104.0	229.8	135.8	73.8	302.9	98.3	2.8	0.0	0.0	20.9	110.9	1170.2
1970	80.8	297.0	289.1	122.1	200.5	163.4	158.9	10.6	23.9	4.6	109.1	63.5	1523.5
1971	12.8	163.4	43.1	42.9	411.2	80.9	51.6	2.9	9.2	0.0	3.2	14.1	835.3
1972	117.2	34.9	108.9	44.1	238.3	246.1	188.6	63.2	42.7	0.0	0.0	108.6	1192.6
1973	27.4	148.3	131.5	188.6	219.2	193.2	60.1	9.3	0.0	0.2	0.2	12.7	990.7
1974	22.1	139.0	119.7	178.3	121.6	218.3	269.4	33.9	0.0	103.3	26.6	36.8	1269.0
1975	14.9	118.4	45.5	141.1	232.0	262.2	191.7	55.3	1.8	0.0	0.7	37.6	1101.2
1976	89.7	314.5	43.2	110.6	224.2	175.5	110.6	4.5	0.0	0.2	0.0	16.7	1089.7
1977	39.2	218.9	32.7	56.1	175.7	84.5	40.9	0.0	33.7	0.5	55.5	10.6	748.3
1978	20.8	86.0	162.6	253.9	142.6	334.9	139.9	2.8	0.0	0.3	3.4	0.0	1147.2
1979	56.1	79.9	49.6	69.0	140.4	279.1	0.4	0.0	0.0	0.0	22.1	14.0	710.6
1980	22.7	154.3	129.4	181.4	123.2	299.5	221.6	49.6	0.0	0.0	7.8	37.3	1226.8
1981	130.8	141.8	331.4	206.7	204.4	186.5	85.4	114.1	0.0	0.0	0.0	2.3	1403.4
1982	91.1	89.0	57.9	97.7	255.8	248.4	96.9	47.6	11.3	44.8	0.0	0.0	1040.5
1983	0.0	107.2	73.6	233.2	244.6	221.1	201.3	61.1	13.4	0.0	22.0	4.4	1181.9
1984	48.1	106.0	94.7	212.8	119.7	191.0	58.8	8.5	0.0	2.2	0.2	25.0	867.0
1985	41.0	198.8	90.2	97.8	217.5	281.4	207.9	44.1	0.0	0.0	2.2	0.0	1180.9
AVERAGE	63.1	136.0	120.2	140.1	182.5	239.8	135.6	26.1	6.4	9.5	14.6	26.9	1100.8

ROYAL IRRIGATION DEPARTMENT, THAILAND
STATION - CHAO PHRAYA DAM, CHAI NAT (04361)
AREA -

COMPUTER CENTER
RAINFALL - 2.06

Table 2-2 (4) MONTHLY RAINFALL AT CHAO PHRAYA DAM (04361)

WATER YEAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	ANNUAL
1952	******	******	******	******	******	******	******	******	******	******	******	******	******
1953	******	******	******	******	******	******	******	******	******	******	******	******	******
1954	******	******	******	******	******	******	******	******	******	******	******	******	******
1955	44.8	110.9	107.0	113.8	113.9	182.3	58.0	33.9	0.0	0.0	7.7	44.5	816.8
1956	65.0	146.4	54.4	99.1	68.9	185.9	88.3	0.0	0.0	0.0	1.1	18.3	727.4
1957	51.9	54.5	128.3	162.8	145.4	220.2	242.8	19.2	0.0	3.0	4.6	156.4	1189.1
1958	7.1	******	******	16.3	101.6	201.6	36.6	0.6	0.0	3.0	4.0	32.8	******
1959	0.8	67.1	26.4	79.7	47.4	285.5	172.0	1.5	0.4	0.0	0.0	7.8	688.6
1960	5.3	120.3	135.8	111.2	92.3	138.7	138.5	72.6	0.0	0.0	1.6	2.8	819.1
1961	37.9	205.4	45.8	92.9	95.7	84.4	60.6	0.0	0.0	0.0	0.0	7.3	630.0
1962	77.4	142.6	39.3	72.9	127.6	333.4	140.2	4.7	0.0	0.0	0.0	1.6	939.7
1963	18.0	83.5	39.7	78.6	170.9	231.5	186.4	44.0	0.0	12.5	0.0	20.0	885.1
1964	29.5	103.4	66.2	123.8	88.9	330.0	191.5	5.9	0.0	0.0	22.0	5.1	966.3
1965	0.0	125.4	93.7	33.3	102.7	336.4	124.0	19.2	0.0	15.4	36.4	0.0	886.5
1966	3.3	226.1	70.9	84.8	91.8	151.5	346.2	56.7	18.0	0.0	0.0	0.0	1049.3
1967	73.6	116.0	70.2	136.9	102.2	173.9	65.5	52.0	0.0	0.0	42.2	38.7	871.2
1968	54.2	122.8	133.7	104.8	89.5	162.8	99.9	48.0	0.0	8.5	0.0	68.7	892.9
1969	19.6	60.5	130.2	66.7	69.5	297.6	106.3	41.3	0.0	3.3	3.0	18.4	816.4
1970	79.2	78.3	218.5	91.1	163.7	202.8	157.1	19.2	25.5	0.0	26.0	7.8	1069.2
1971	32.3	145.4	79.0	36.9	346.8	141.5	93.9	0.0	1.4	0.0	0.0	28.1	905.3
1972	73.2	0.0	80.6	93.8	111.2	320.0	143.9	114.7	3.8	0.0	0.0	0.0	941.2
1973	28.1	192.2	120.2	68.2	153.5	228.3	76.7	28.2	0.4	0.0	41.8	56.4	994.0
1974	73.9	140.4	90.8	211.4	130.4	274.7	321.5	30.6	5.1	64.7	22.2	47.4	1413.1
1975	0.8	103.6	51.5	132.3	204.2	168.2	173.3	53.6	15.8	0.0	2.8	40.7	946.8
1976	2.6	378.9	75.2	51.4	193.8	******	111.1	7.1	0.0	******	******	******	******
1977	9.4	110.7	43.0	77.7	153.8	141.1	96.7	0.0	31.5	0.9	31.7	0.0	696.5
1978	100.2	194.4	164.1	345.6	59.7	343.1	99.0	6.6	0.0	0.0	0.2	0.0	1312.9
1979	63.4	34.1	73.3	53.5	119.3	396.1	2.1	0.0	0.0	0.0	6.8	15.6	764.2
1980	24.5	79.0	144.1	134.4	118.6	304.6	148.5	17.0	0.0	0.0	18.0	26.0	1014.7
1981	63.5	117.7	63.4	283.3	129.2	215.0	35.2	194.9	1.2	0.0	53.0	0.0	1156.4
1982	73.6	76.5	18.4	156.0	140.7	218.3	173.6	16.0	30.8	4.8	0.0	5.3	914.0
1983	0.0	136.6	69.8	145.9	199.3	270.9	241.8	101.0	40.2	7.0	2.3	16.6	1231.4
1984	18.7	165.0	52.8	235.2	164.9	229.4	69.2	0.5	0.0	20.0	4.1	7.7	967.5
1985	15.4	60.0	29.1	134.5	142.0	337.6	141.9	43.2	0.0	0.0	0.0	0.0	903.7
AVERAGE	37.0	123.3	83.8	117.1	130.3	236.9	133.6	33.3	5.6	4.8	11.1	22.5	939.3

Table 2-2 (5) MONTHLY RAINFALL AT AYUTTHAYA (42012)

ROYAL IRRIGATION DEPAR — COMPUTER CENTER
STATION - A. MUANG, PHRA NAKHON SI AYUTTHAYA (42012) — RAINFALL - 2.06
AREA -

MONTHLY RAINFALL IN MILLIMETER

WATER YEAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	ANNUAL
1952	23.1	27.5	113.7	218.2	185.2	215.8	385.7	11.8	0.0	9.0	97.8	35.5	1323.3
1953	9.5	159.6	227.8	176.9	83.2	188.4	129.8	78.7	0.0	0.0	0.0	11.0	1066.9
1954	30.9	181.9	220.6	250.9	171.9	202.8	53.6	0.0	0.0	0.0	0.0	25.3	1137.8
1955	52.1	101.3	262.4	204.2	96.4	164.7	98.8	81.4	15.1	4.5	0.0	15.2	1096.1
1956	199.5	344.6	217.9	182.5	313.0	530.3	173.9	26.8	0.0	0.0	0.0	36.1	2024.6
1957	31.4	76.8	107.0	142.9	64.4	352.6	297.2	30.2	0.0	0.0	3.5	8.8	1114.8
1958	50.3	123.4	228.4	130.6	207.1	296.7	118.5	0.0	0.0	0.0	0.0	0.0	1155.0
1959	35.4	133.0	78.6	269.3	84.2	291.7	219.9	0.0	0.0	0.0	0.0	6.5	1118.6
1960	0.0	97.2	159.0	80.7	13.8	354.6	187.8	38.2	20.3	0.0	0.0	0.0	951.6
1961	140.1	186.9	106.5	120.9	65.3	148.2	103.2	18.4	0.0	0.0	0.0	0.0	889.5
1962	42.6	76.4	151.1	182.4	93.9	160.8	129.7	0.0	4.8	0.0	0.0	6.9	848.6
1963	0.0	46.4	155.1	98.8	135.7	182.9	99.4	17.4	2.8	0.0	1.5	8.4	748.4
1964	40.8	236.4	100.3	120.7	59.7	251.8	30.6	1.2	0.0	0.0	5.7	21.5	868.7
1965	17.6	276.9	316.8	142.3	182.2	379.4	121.6	17.2	8.6	2.7	0.1	9.6	1475.0
1966	11.0	215.7	298.0	217.5	265.4	226.4	184.8	32.3	0.1	34.5	0.0	0.6	1486.3
1967	89.6	133.2	90.4	121.0	57.4	178.8	120.0	40.2	0.0	0.0	8.2	3.2	842.0
1968	72.7	134.7	182.8	97.8	150.6	224.3	77.3	42.7	0.0	0.0	0.0	0.0	982.9
1969	18.7	63.4	215.7	255.2	327.7	284.9	100.2	30.8	5.2	1.8	5.8	32.2	1341.6
1970	37.8	133.6	353.5	134.1	195.9	246.6	119.9	14.0	8.7	0.0	0.8	19.3	1264.2
1971	46.3	39.3	38.9	27.5	257.8	159.6	151.7	0.0	0.0	0.0	6.5	45.4	773.0
1972	76.8	63.2	186.7	41.5	135.6	507.0	138.5	241.4	28.6	0.0	0.0	71.8	1491.1
1973	22.9	76.1	157.1	165.9	220.0	312.2	149.3	29.5	0.0	0.0	0.0	38.3	1171.3
1974	209.2	81.3	178.1	226.7	107.6	297.9	366.5	33.5	0.0	108.6	0.0	0.0	1609.4
1975	58.2	123.0	189.3	168.1	207.2	200.5	68.7	0.0	0.0	0.0	30.5	0.0	1045.5
1976	75.4	257.5	86.3	322.2	180.0	371.9	91.1	38.6	0.0	0.0	0.0	25.4	1448.4
1977	71.7	40.9	109.3	76.3	133.0	216.1	28.6	0.0	0.0	8.4	31.2	0.0	715.5
1978	0.0	171.6	9.6	191.8	43.7	153.7	137.8	0.0	0.0	0.0	0.0	0.0	708.2
1979	98.7	134.9	90.9	254.2	65.2	180.5	0.0	0.0	0.0	0.0	0.0	3.4	827.8
1980	133.2	139.0	182.0	95.1	112.7	228.4	118.2	0.0	0.0	0.0	0.0	0.0	1008.6
1981	******	161.8	******	******	******	114.0	******	******	******	0.0	0.0	0.0	******
1982	2.1	59.4	138.0	96.7	168.3	240.5	35.8	46.4	0.0	0.0	0.0	0.0	787.2
1983	0.0	97.6	190.3	241.8	265.7	393.9	331.4	53.5	1.5	2.5	32.7	14.7	1625.6
1984	******	******	******	******	******	******	******	******	******	******	******	******	******
1985	******	******	******	******	******	******	******	******	******	******	******	******	******
AVERAGE	54.8	131.1	165.9	163.1	150.0	258.1	141.0	29.8	3.1	5.4	7.0	13.7	1123.0

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Table 2-2 (6) MONTHLY RAINFALL AT BANGKOK (41013)

COMPUTER CENTER
RAINFALL - 2.06

MONTHLY RAINFALL IN MILLIMETER

WATER YEAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	ANNUAL
1952	64.1	125.9	128.7	179.0	223.1	298.3	403.4	20.5	0.0	35.5	51.0	36.1	1565.6
1953	24.3	213.8	144.2	365.6	158.0	316.3	113.6	114.7	2.3	0.9	15.1	91.7	1560.5
1954	97.6	169.2	199.8	314.2	206.7	295.6	107.2	0.1	2.5	0.1	15.5	5.7	1414.2
1955	51.2	207.2	102.6	244.6	189.0	487.3	164.8	43.1	3.8	2.2	0.4	0.0	1496.2
1956	83.7	121.0	162.0	130.3	193.8	365.2	189.0	115.0	0.0	1.0	2.2	47.5	1410.7
1957	150.7	36.1	244.3	165.0	302.0	448.4	490.1	68.8	0.0	35.5	39.6	3.2	1983.7
1958	2.7	36.9	175.3	168.0	316.9	278.7	228.7	12.3	0.0	0.0	38.6	20.8	1278.9
1959	60.6	218.7	136.5	240.2	102.5	210.3	224.6	20.9	0.0	0.0	0.0	34.4	1250.7
1960	1.8	112.0	79.4	127.4	243.9	499.7	443.2	94.4	10.1	39.3	88.1	60.0	1799.3
1961	86.2	194.3	208.6	119.1	180.0	219.6	226.0	31.4	1.7	0.0	20.0	43.5	1330.4
1962	36.4	179.3	117.9	125.5	223.5	464.6	164.6	1.5	0.0	0.0	10.0	40.5	1363.8
1963	55.5	83.8	122.0	132.4	318.3	386.3	333.4	56.0	2.3	4.6	107.4	15.0	1617.0
1964	45.9	554.1	100.2	279.6	243.9	403.2	100.2	10.0	2.7	0.4	125.4	2.6	1868.2
1965	66.2	264.7	96.0	83.1	185.1	543.4	277.5	26.3	18.3	0.0	35.2	1.3	1597.1
1966	72.0	380.8	214.6	314.7	157.4	257.4	191.3	4.2	39.2	6.3	0.0	4.2	1642.1
1967	67.6	235.9	28.0	104.7	121.0	165.1	96.6	36.2	0.0	4.6	51.2	0.4	911.3
1968	124.7	124.4	180.1	114.7	269.7	293.7	166.4	31.5	0.0	38.5	0.1	0.4	1344.2
1969	12.0	68.5	280.0	78.0	95.6	292.8	159.0	93.6	1.6	1.2	68.2	44.6	1195.1
1970	157.5	283.0	307.7	152.8	144.3	355.2	187.3	50.4	103.2	0.0	28.1	11.0	1780.5
1971	31.1	236.3	82.2	178.9	352.1	383.2	177.4	2.8	0.8	0.0	19.9	18.8	1483.5
1972	146.9	55.1	127.8	69.5	157.0	676.3	237.9	88.4	54.7	0.0	0.0	102.6	1716.2
1973	5.6	157.5	131.4	78.5	97.3	368.3	113.8	36.8	11.2	0.7	0.0	10.2	1011.3
1974	130.2	179.2	82.3	130.5	160.9	219.7	470.2	134.8	0.0	38.1	1.0	32.4	1579.3
1975	3.9	186.2	100.7	174.8	323.7	211.5	261.5	35.0	9.0	0.0	52.2	1.7	1360.2
1976	55.1	409.6	72.5	183.0	247.6	297.3	98.8	16.8	0.0	27.1	25.7	4.2	1437.7
1977	28.4	101.3	61.3	113.3	120.7	358.3	135.9	59.8	3.9	23.5	46.3	1.0	1053.7
1978	13.0	245.3	255.2	135.1	81.9	274.7	102.5	0.6	0.0	36.7	6.8	0.0	1151.8
1979	10.7	141.6	373.8	101.7	130.4	295.9	22.3	13.3	0.2	0.0	0.3	4.0	1094.2
1980	52.5	29.9	267.5	205.5	201.1	352.3	324.5	33.9	0.0	0.0	10.6	16.7	1494.5
1981	153.5	437.2	101.1	157.1	131.1	178.5	257.2	156.3	0.0	0.0	19.7	176.0	1767.7
1982	223.2	235.5	187.8	229.2	220.7	254.8	248.8	44.3	19.6	0.0	0.0	0.0	1663.9
1983	0.0	53.7	161.4	230.2	574.5	453.3	487.2	131.8	13.6	0.6	12.9	33.9	2153.1
1984	52.9	184.0	130.9	239.8	93.2	330.8	292.8	25.8	0.0	18.7	5.5	11.3	1385.7
1985	60.6	174.0	90.5	143.0	134.6	337.6	375.8	17.1	0.0	0.0	5.9	0.0	1339.1
AVERAGE	65.5	189.3	154.6	170.9	203.0	340.4	231.6	47.9	8.8	9.3	26.6	25.8	1473.7

Table 2-3 (1) STOCHASTIC CONSECUTIVE MAXIMUM RAINFALL

STATION : CHAO PHRAYA DAM, CAHI NAT (04361)

RETURN PERIOD (YR) / RAINFALL	1/5	1/10	1/20	1/50	1/100
MAX. 1-DAY	94.9 mm	110.9	126.3	146.4	161.6
MAX. 2-DAY	116.5 mm	137.2	157.7	185.1	206.5
MAX. 3-DAY	126.1 mm	148.4	171.2	202.6	227.6
MAX. 4-DAY	136.4 mm	161.2	186.9	223.0	252.3
MAX. 5-DAY	152.5 mm	177.3	201.5	233.5	258.2
MAX. 6-DAY	164.1 mm	193.1	221.8	260.1	290.0
MAX. 7-DAY	176.3 mm	205.3	233.3	270.2	298.3
DRIED DAYS	101 DAYS	114	125	139	149
MAX. MONTH	322.1 mm	354.1	380.8	411.3	431.9
YEAR	1089.3 mm	1187.6	1276.2	1384.7	1462.9

STATION : CHIANG MAI (07013)

RETURN PERIOD (YR) / RAINFALL	1/5	1/10	1/20	1/50	1/100
MAX. 1-DAY	95.0 mm	110.3	124.9	143.7	157.8
MAX. 2-DAY	122.8 mm	142.1	160.8	185.2	203.8
MAX. 3-DAY	141.9 mm	165.9	189.9	222.5	248.1
MAX. 4-DAY	153.8 mm	179.2	204.7	239.6	267.2
MAX. 5-DAY	168.0 mm	192.7	216.5	247.6	271.3
MAX. 6-DAY	180.6 mm	203.8	224.8	250.9	269.8
MAX. 7-DAY	194.8 mm	222.5	248.4	281.4	305.9
DRIED DAYS	95 DAYS	113	132	158	179
MAX. MONTH	358.5 mm	408.8	457.4	521.0	569.5
YEAR	1368.8 mm	1466.8	1548.5	1641.3	1703.9

Table 2-3 (2) STOCHASTIC CONSECUTIVE MAXIMUM RAINFALL

STATION : LAMPANG (16013)

RETURN PERIOD (YR) / RAINFALL	1/5	1/10	1/20	1/50	1/100
MAX. 1-DAY	87.9 mm	99.4	110.1	123.6	133.5
MAX. 2-DAY	112.2 mm	126.0	138.6	154.3	165.3
MAX. 3-DAY	124.8 mm	137.3	148.2	161.3	170.4
MAX. 4-DAY	136.0 mm	150.4	162.9	178.0	188.6
MAX. 5-DAY	147.5 mm	163.3	177.2	193.7	205.3
MAX. 6-DAY	160.0 mm	179.3	196.9	219.0	235.1
MAX. 7-DAY	174.1 mm	193.0	209.5	229.1	242.7
DRIED DAYS	96 DAYS	114	130	151	167
MAX. MONTH	312.0 mm	345.3	374.5	409.5	434.1
YEAR	1203.8 mm	1314.3	1414.7	1538.9	1628.8

STATION : NAKHON SAWAN (26013)

RETURN PERIOD (YR) / RAINFALL	1/5	1/10	1/20	1/50	1/100
MAX. 1-DAY	94.7 mm	106.6	117.4	130.8	140.5
MAX. 2-DAY	120.9 mm	138.1	154.2	174.8	190.1
MAX. 3-DAY	132.9 mm	150.9	168.5	191.9	209.9
MAX. 4-DAY	146.5 mm	166.4	185.3	209.7	228.0
MAX. 5-DAY	159.1 mm	179.6	199.0	223.9	242.5
MAX. 6-DAY	173.6 mm	195.5	215.9	241.9	261.1
MAX. 7-DAY	183.5 mm	205.1	225.3	251.0	270.0
DRIED DAYS	102 DAYS	120	136	157	173
MAX. MONTH	333.2 mm	358.5	379.5	403.5	419.7
YEAR	1267.5 mm	1373.8	1467.6	1580.2	1659.8

Table 2-3 (3) STOCHASTIC CONSECUTIVE MAXIMUM RAINFALL

STATION : PHITSANULOK (39013)

RETURN PERIOD (YR) / RAINFALL	1/5	1/10	1/20	1/50	1/100
MAX. 1-DAY	122.4 mm	145.2	168.1	198.9	223.2
MAX. 2-DAY	152.3 mm	181.2	210.8	252.0	285.0
MAX. 3-DAY	164.0 mm	191.7	219.9	258.9	290.1
MAX. 4-DAY	175.0 mm	203.0	232.1	272.9	305.9
MAX. 5-DAY	192.7 mm	228.3	266.5	321.9	368.1
MAX. 6-DAY	213.8 mm	252.4	292.4	348.8	394.6
MAX. 7-DAY	233.5 mm	271.2	308.4	358.3	397.2
DRIED DAYS	83 DAYS	95	107	121.5	132.5
MAX. MONTH	400.6 mm	439.3	473.7	515.3	545.0
YEAR	1540.3 mm	1653.5	1752.2	1869.2	1951.1

STATION : BANGKOK (41013)

RETURN PERIOD (YR) / RAINFALL	1/5	1/10	1/20	1/50	1/100
MAX. 1-DAY	114.6 mm	129.6	143.4	160.5	173.1
MAX. 2-DAY	148.1 mm	170.9	193.1	222.3	244.8
MAX. 3-DAY	184.9 mm	214.5	242.8	279.6	307.4
MAX. 4-DAY	201.9 mm	230.4	257.2	291.3	316.7
MAX. 5-DAY	221.1 mm	251.8	280.3	316.2	342.7
MAX. 6-DAY	239.0 mm	272.3	303.3	342.2	371.0
MAX. 7-DAY	246.6 mm	279.4	309.8	347.7	375.6
DRIED DAYS	77 DAYS	90	103	119	131
MAX. MONTH	460.8 mm	514.5	563.2	623.2	666.5
YEAR	1704.9 mm	1837.7	1950.8	2081.9	2171.8

Table 2-3 (4) STOCHASTIC CONSECUTIVE MAXIMUM RAINFALL

STATION : AYUTTHAYA (42012)

RETURN PERIOD (YR) / RAINFALL	1/5	1/10	1/20	1/50	1/100
MAX. 1-DAY	104.1 mm	117.9	130.0	144.3	154.3
MAX. 2-DAY	130.2 mm	151.5	171.3	196.0	214.3
MAX. 3-DAY	151.4 mm	175.1	196.4	222.4	241.0
MAX. 4-DAY	164.2 mm	184.8	202.0	221.4	234.5
MAX. 5-DAY	174.0 mm	197.3	217.3	240.7	256.9
MAX. 6-DAY	180.9 mm	209.7	235.8	268.1	291.6
MAX. 7-DAY	190.3 mm	218.9	244.7	276.3	299.0
DRIED DAYS	140 DAYS	159	176	195	208
MAX. MONTH	355.0 mm	410.4	461.0	523.9	569.6
YEAR	1352.5 mm	1551.7	1734.3	1961.5	2127.4

Table 2-4 RID'S DEMAND AND ACTUAL RELEASED WATER VOLUME FROM BHUMIBOL AND SIRIKIT DAMS (1979 - 1986)

UNIT : MCM

YEAR	1979		1980		1981		1982		1983		1984		1985		1986	
MONTH	DEMAND	SUPPLY	DEMAND	SUPPLY	DEMAND	SUPPLY	DEMAND	SUPPLY	DEMAND	SUPPLY	DEMAND	SUPPLY	DEMAND	SUPPLY	DEMAND	SUPPLY
JAN.	295	794	0	535	156	639	469	713	813	858	276	325	786	737	333	[illegible]
FEB.	921	956	466	461	879	921	1,300	1,209	1,301	1,251	1,192	1,142	1,178	1,169	1,175	1,1[illegible]
MAR.	1,590	1,660	683	616	1,343	1,287	1,747	1,663	1,671	1,658	1,668	1,609	1,690	1,6[illegible]	1,680	1,647
APR.	1,723	1,618	604	588	1,438	1,480	1,496	1,428	1,615	1,673	1,698	1,501	1,547	1,510	1,540	1,433
MAY	1,180	1,447	447	545	782	1,332	1,074	1,129	1,312	1,260	968	1,001	989	962	783	1,196
JUNE	503	1,011	433	353	0	1,333	736	759	458	645	259	456	579	489	229	1,221
JULY	734	1,234	670	366	0	548	1,331	1,251	1,050	969	778	648	613	469	1,172	1,078
AUG.	1,464	1,337	0	265	60	1,187	1,702	1,428	631	506	1,166	1,053	448	487	704	732
SEP.	828	847	0	329	0	719	674	434	34	165	873	913	441	350	514	537
OCT.	884	938	0	342	542	649	0	357	0	59	389	272	60	108	1,063	908
NOV.	1,683	1,409	0	320	700	861	206	607	0	73	726	731	36	147	1,447	1,280
DEC.	896	853	0	417	161	515	200	495	0	79	233	273	0	200	339	445
TOTAL	12,691	14,104	3,303	5,137	6,061	11,471	10,935	11,473	8,885	9,196	10,226	9,922	8,407	8,285	11,039	12,061

Table 2-5 RUNOFF DISCHARGE AT MAIN STATIONS IN CHAO PHRAYA BASIN (UNIT : MCM)

	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	TOTAL
PING RIVER													
P. 1	21.5	84.9	141.3	184.5	407.4	506.2	326.2	218.0	144.1	89.2	28.6	19.6	2,171.5
19	24.6	82.5	162.8	214.5	583.1	882.6	617.6	391.1	179.5	82.2	25.1	19.0	3,264.6
12	620.8	569.2	500.0	534.1	467.1	321.4	349.5	426.9	333.2	328.6	497.4	658.4	5,606.6
7	685.3	702.0	675.0	731.7	788.5	1,015.3	1,034.1	765.9	476.2	418.4	540.1	696.6	8,529.1
17	679.9	732.2	743.5	795.0	846.4	1,287.4	1,287.2	912.3	633.8	498.0	535.5	681.3	9,632.5
WANG RIVER													
W. 1	8.0	15.3	23.6	42.1	122.4	151.4	96.2	44.1	18.2	12.1	5.1	6.2	544.7
4	9.6	31.3	50.5	62.1	166.3	354.1	251.5	121.8	39.9	19.3	9.3	8.8	1,124.5
YOM RIVER													
Y.20	16.1	51.7	59.9	151.1	365.6	387.2	186.7	74.1	32.1	20.9	11.2	9.1	1,365.7
3	15.6	80.9	121.8	231.9	629.2	892.9	446.0	158.9	60.5	29.5	13.4	9.4	2,690.9
17	8.9	50.8	134.7	190.9	415.6	827.8	934.2	413.1	108.4	33.2	10.4	5.9	3,133.8
NAN RIVER													
N.35	68.4	155.1	312.3	889.2	1,569.2	1,299.4	538.4	236.1	147.0	105.0	71.5	61.9	5,453.3
12	526.4	471.4	426.9	627.8	883.6	802.7	427.2	347.3	233.8	260.6	361.7	517.2	5,886.6
10	435.3	520.3	646.1	998.4	1,731.8	2,273.6	1,747.4	910.5	536.4	347.0	327.1	430.4	10,904.3
37	450.8	575.9	704.8	1,015.2	1,652.0	2,205.0	2,276.3	1,301.9	587.1	260.8	210.6	357.6	11,598.0
CHAO PHRAYA RIVER													
C. 2	1,084.2	1,242.2	1,399.2	1,664.1	2,403.1	3,775.8	4,818.7	2,809.2	1,393.8	765.5	822.3	1,081.0	23,259.1
13	253.2	500.6	655.3	745.7	1,116.4	2,282.5	3,745.5	1,755.8	967.2	401.2	271.7	262.5	12,957.6
7	331.8	557.9	656.3	662.4	849.1	1,765.9	2,847.4	1,662.0	1,210.6	477.6	321.9	322.7	11,665.6
SUPHAN RIVER													
S. 9	20.0	46.9	57.8	137.9	255.3	667.4	974.9	183.8	61.1	31.6	17.8	17.7	2,472.2
MAE KHLONG RIVER													
K.10	71.8	114.4	427.7	903.2	1,692.2	1,179.6	730.4	302.5	181.3	124.8	90.6	84.4	5,902.9
26	361.3	329.7	276.3	208.1	176.0	287.7	236.5	237.2	145.7	144.6	276.1	360.8	3,040.0
11	190.5	253.9	579.8	1,063.9	2,015.5	1,663.0	1,370.3	669.0	374.2	254.7	179.4	191.5	8,805.7

Table 2-6 STOCHASTIC ANNUAL RUNOFF AT KEY STATIONS FOR STREAM FLOW GAUGING

(UNIT : MCM)

STATION	1/5	1/10	1/20	1/50	1/100	1/200
P.1	2,7[illegible].6	3,392.6	4,009.5	4,855.7	5,527.8	6,230.4
P.7A	10,303.7	11,401.7	12,364.0	13,511.3	14,317.4	15,084.0
P.12	6,936.4	7,684.9	8,310.2	9,022.3	9,502.7	9,945.7
P.19	4,148.4	5,011.7	5,897.3	7,126.8	8,113.7	9,153.6
P.20	448.8	490.0	527.4	573.5	606.9	639.4
P.35	504.0	662.4	823.4	1,045.2	1,221.9	1,407.1
W.1A	819.2	1,126.2	1,476.2	2,014.9	2,487.5	3,021.2
W.4A	1,539.7	1,903.0	2,264.1	2,750.1	3,129.8	3,521.8
W.16	346.1	421.5	496.3	597.0	675.6	756.7
Y.3A	3,574.8	4,223.9	4,825.1	5,581.2	6,138.0	6,686.8
Y.20	1,789.2	2,063.6	2,311.6	2,616.1	2,835.8	3,048.9
N.7	12,025.9	13,388.3	14,578.3	15,992.4	16,983.1	17,923.1
N.12A	7,409.9	8,464.6	9,415.7	10,581.3	11,420.3	12,233.1
N.35	6,666.0	7,461.7	8,191.1	9,098.9	9,761.5	10,410.1
N.36	822.1	957.6	1,086.1	1,251.5	1,375.7	1,500.1
N.51	533.1	594.5	648.5	713.2	758.9	802.4
C.2	29,119.0	32,866.9	36,178.0	40,155.8	42,969.7	45,659.4
C.7A	15,823.2	19,099.2	22,286.5	26,490.3	29,717.1	33,001.9
C.13	18,295.7	23,683.9	29,288.4	37,175.0	43,579.8	50,390.4
S.9	3,652.5	4,519.2	5,372.6	6,511.4	7,394.5	8,300.6
S.10	94.8	110.8	124.7	141.3	153.0	164.0
S.14	237.9	284.5	330.3	391.3	438.5	486.9
K.10	7,656.4	8,691.0	9,640.2	10,823.1	11,687.1	12,533.6
K.11	12,039.6	14,492.8	16,809.0	19,776.3	21,997.0	24,213.7
K.13	6,305.3	7,111.9	7,785.5	8,552.0	9,069.0	9,545.4
K.26	4,079.2	4,900.2	5,701.1	6,760.1	7,574.6	8,405.2

Table 3-1 LIST OF NEW WATER LEVEL GAUGING STATION

No.	Name of Station	Station Code
1	Phra Sri Saowaphak Reg. U/S	PSSR-U
2	-do- D/S	PSSR-D
3	Phra Sri Sril Reg. D/S	PSRR-D
4	Rama VI Barrage U/S	RM6-U
5	-do- D/S	RM6-D
6	Phra Narai Reg. D/S	PNS-D
7	Chao Phraya Dam U/S	CPYA-U
8	-do- D/S	CPYA-D
9	Pho Phraya Reg. U/S	PHOR-U
10	-do- D/S	PHOR-D
11	Pathum Thani	PTMT
12	Bang Len	BLEN
13	2E Reg. U/S	2ER-U
14	-do- D/S	2ER-D
15	Phra Thammaracha Reg. D/S	PTMR-D
16	Hok Wa Reg. U/S	HKWR-U
17	-do- D/S	HKWR-D
18	Chachaengsao Bout House	CSBH
19	Cholahan Pichit Reg. U/S	CPIR-U
20	-do-	CPIR-D
21	Roeng Rang Reg. U/S	RUNR-U
22	-do- D/S	RUNR-D
23	Koke Kathiem Reg. U/S	KKAR-U
24	-do- D/S	KKAR-D
25	Maharaj Reg. D/S	MHAR-D
26	Manorom Reg. U/S	MNOR-U
27	-do- D/S	MNOR-D
28	Makamthao-Uthong Head Reg. D/S	MKMR-D
29	Pak Hai Reg. U/S	PAKR-U
30	-do- D/S	PAKR-D

Table 1-2 LOCATION OF FLOW MEASUREMENT SITES

Site No.	Location	Note
(Chainat-Pasak Canal)		
1	D/S of Manorom Regulator	at bridge
2	9 km D/S of Manorom Reg.	-do-
3	35 km D/S of Manorom Reg.	-do-
4	1 km D/S of Chong Kae Reg.	
5	20 km D/S of Chong Kae Reg.	at bridge
6	28 km D/S of Chong Kae Reg.	-do-
7	D/S of Koke Kathiem Reg.	-do-
8	9 km D/S of Koke Kathiem Reg.	-do-
8-1	15 km D/S of Koke Kathiem Reg.	-do-
9	31 km D/S of Koke Kathiem Reg.	-do-
10	2 km D/S of Roeng Rang Reg.	-do-
11	8 km D/S of Roeng Rang Reg.	-do-
(Chainat-Ayutthaya Canal)		
12	1 km D/S of Maharaj Reg.	-do-
(Raphiphatana Main Canal and Branch Canals)		
A	D/S of Phra Narai Reg.	at bridge
B	4 km D/S of Phra Narai Reg.	-do-
C	12 km D/S of Phra Narai Reg.	-do-
D	22 km D/S of Phra Narai Reg.	-do-
E	D/S of Phra Sri Saowaphak Reg.	-do-
F	13 km D/S of Phra Sri Saowaphak Reg.	-do-
G	23 km D/S of Phra Sri Saowaphak Reg.	-do-
H	D/S of Phra Thammaracha Reg.	
I	D/S of Hok Wa Reg.	at bridge
J	6 km D/S of Hok Wa Reg.	-do-
K	D/S of Khlong 13 Tail Reg.	
L	D/S of Phra Sri Sril Reg	

Table 3-3 LOCATION OF SALINITY MEASUREMENT SITES

River / Project	Measurement Site	Code
Chao Phraya River	- Memorial Bridge	MEMB
	- RID, Samsen	RIDS
	- RID, Nonthaburi	RIDN
	- Pathum Thani	PATT
Suphan River	- Kratum Baen	KRAT
	- San Phran	SAMP
	- Nakhon Chaisri	NKCS
	- Bang Len	BANL
Bang Pakong River	- Bang Pakong	BANP
	- Chachaengsao	CHAC
	- Bang Kanak	BANK
Phasi Charoen Proj.	(along Maha Sawad Canal)	
	- Maha Sawad Reg. 2 plcs	MASR
	- Chimplee Reg. 2 plcs	CIPR
	- Junc. with Thawewatana C.	JTMS
	(along Phasi Charoen Canal)	
	- Phasi Charoen Reg. 2 plcs	PACR
	- Kratum Baen Reg. 2 plcs	KRBR
	- Junc. with Thawiwatana C.	JTPC
Khlong Dan Project	- Cholahan pichit Reg. 2 plcs	CHPR
	- Bang Thamru Reg. 2 plcs	BATR
	- Bang Bo	BANB
	- Bang Plee	BANP
	- Lat Krabang Reg. 2 plcs	LTKR
Pra Ong Chaiyanuchit	- Bang Nam Priew	Bann
Project	- Junc. of Nakhon Neong Ket	
	Canal with Preng Canal	JNPC
	- Junc. of Pravadee Burirom	
	Canal with Preng Canal	JPCC

Table 4-1 (1) ANNUAL RUNOFF COEFFICIENT BY SUB-BASIN

Sub Basin	Catchment Area	Rainfall			Runoff Discharge			Runoff Percentage	Note
		Code	Annual Raintall(mm)	Total Raintall(MCM)	Code	Specific Discharge (MCM/km²)	Total Discharge(MCM)		
<Chao Phraya Basin>									
Ping Basin									
1	26,400		1,175.0	31,020		0.26	6,864	0.22	Upstream of Bhumibol
		07013	1,187.4		P1	0.34			
		07182	966.3		12	0.21			
		07252	1,571.6		19	0.23			
		17062	974.5						
4	13,120		1,220.4	16,012		0.29	3,805	0.24	Downstream of Bhumibol
		12061	1,257.8		P7	0.19			
		12091	1,183.0		35	0.46			
					C2	0.21			
Wang Basin									
2	2,700		1,082.0	2,921		0.20	540	0.18	Upstream of Kiu Lon
		16180	1,082.0		W16	0.20			
3	7,810		1,047.6	8,182		0.14	1,093	0.13	Downstream of Kiu Lon
		16013	1,047.6		W1A	0.17			
					4A	0.11			
Yom Basin									
5	9,190		1,183.0	10,873		0.26	2,389	0.22	
		40111	1,246.4		Y20	0.26			Upstream Basin
		73082	1,119.8						
6	11,920		1,141.0	13,601		0.21	2,503	0.18	
		59121	1,141.0		Y3A	0.20			Downstream Basin
					C2	0.21			
Nan Basin									
7	13,200		1,165.8	15,389		0.55	7,260	0.47	U/S of Sirikit Dam
		28102	1,267.5		N35	0.54			
		28131	1,064.0		51	0.56			
8	26,230		1,411.7	37,029		0.33	8,656	0.23	D/S of Sirikit Dam
		38012	1,427.0		N7	0.34			
		39142	1,510.1		12A	0.37			
		70013	1,302.4		36	0.39			
		70151	1,407.3		C2	0.21			

Table 4-1 (2) ANNUAL RUNOFF COEFFICIENT BY SUB-BASIN

Sub Basin	Catchment Area	Rainfall			Runoff Discharge			Runoff Percentage	Note
		Code	Annual Raintall(mm)	Total Raintall(MCM)	Code	Specific Discharge (MCM/km)	Total Discharge(MCM)		
Pasak Basin									
1 0	13,780		1,185.5	16,336		0.20	2,756	0.17	
		19360	1,134.8		S 9	0.18			
		36013	1,107.8		10	0.26			
		36141	1,313.8		14	0.15			
Chao Phraya Basin									
9	6,860		939.3	6,444		0.11	755	0.12	Nakhon Sawan
		04361	939.3		C13	0.11			
					C 2	0.21	1,441	0.22	
1 1	8,060		939.3	7,571		—			Upper East
		04361	939.3		C 7	—			
1 2	6,840		1,296.4	8,881		—			Lower East
		41013	1,473.7		—	—			
		42012	1,123.0						
1 3	6,290		1,201.3	7,556		—			Upper West
		04361	939.3		—	—			
		54192	1,463.3						
1 4	4,280		1,108.7	4,745		—			Lower West
		23012	1,107.1		—	—			
		52012	1,281.3						
		60022	937.8						
<Mae Klong Basin>									
Khwae Yai Basin									
1 5	10,880		1,177.3	12,809		—	—		U/S of Srinakarind Dam
		13342	1,177.3		—	—			
1 6	4,900		1,035.6	5,074		0.33	1,617	0.32	D/S of Srinakarind Dam
		13132	1,035.6		K11	0.33			
Khwase Noi Basin									
1 7	3,720		1,893.1	7,042		1.18	4,390	0.62	U/S of Khao Laem Dam
		13352	1,893.1		K13	1.18			
1 8	6,950		1,553.5	10,793		0.52	3,614	0.33	D/S of Khao Laem Dam
		13211	1,213.9		K10	0.84			
		13352	1,893.1		26	0.19			
Lower Mae Klong Basin									
1 9	7,650		1,039.5	7,952		—			
		13171	1,039.5						

Table 4-2 (1) ACCOMPLISHMENT OF WATER CONTROL AT KEY PLACES

Month	Chao Phraya Dam								Naresuan Dam							
	Half-Month Hstd			dH/	Half-Month Qstd/Qav.(CMS)			dQ/	Month	Half-Month Hstd			dH/	Half-Month Qstd/Qav.(CMS)			dQ/
	27	28	29	day	27	28	29	day		27	28	29	day	27	28	29	day
	cm	cm	cm	cm				CMS		cm	cm	cm	cm				CMS
Apr.1	23	5	15	11	2/96	1/87	1/81	1	Apr.1	0	0	0	2	59/238	13/338	46/231	33
2	9	25	20	11	2/96	9/86	1/81	3	2	0	0	0	2	20/257	30/336	25/218	26
May 1	10	16	33	10	4/95	5/90	24/91	5	May 1	0	0	0	2	40/190	49/273	34/237	35
2	14	15	2	7	5/80	3/82	241/298	38	2	0	0	0	2	28/126	43/151	41/257	26
Jun.1	22	28	4	11	133/173	21/94	160/312	35	Jun.1	0	0	0	2	45/195	21/82	53/283	35
2	8	41	2	6	128/269	6/84	42/451	32	2	27	5	0	4	45/92	43/126	37/292	28
Jul.1	72	41	17	18	58/108	10/89	175/263	35	Jul.1	112	0	0	15	51/113	34/120	83/220	40
2	14	32	31	11	107/224	14/89	132/185	30	2	29	10	0	7	54/92	89/106	85/193	35
Aug.1	22	11	14	12	2/78	14/84	129/230	33	Aug.1	6	23	5	10	43/108	6/27	41/97	27
2	35	17	2	10	8/86	12/80	88/272	32	2	0	17	5	6	30/235	39/64	109/131	30
Sep.1	20	18	7	9	130/178	237/144	188/279	*	Sep.1	0	7	0	3	92/395	146/184	89/169	61
2	6	7	5	4	81/192	20/105	197/356	46	2	0	17	0	6	95/224	126/101	34/35	47
Oct.1	6	2	12	5	120/295	22/78	55/142	25	Oct.1	25	39	0	11	171/206	4/3	30/48	32
2	3	2	21	5	109/334	*	7/84	63	2	19	38	0	8	96/134	157/198	33/43	41
Nov.1	15	2	15	8	48/126	28/121	3/83	11	Nov.1	30	12	0	8	107/181	55/21	42/187	34
2	2	2	12	6	28/129	18/123	0/80	11	2	23	13	0	7	29/191	75/150	37/192	29
Dec.1	13	2	20	11	32/115	19/110	56/101	13	Dec.1	22	0	0	4	23/87	12/84	37/139	21
2	20	22	11	11	1/82	18/61	98/186	14	2	0	0	0	3	17/29	11/35	18/27	12
Jan.1	29	25	40	13	4/76	46/111	6/71	7	Jan.1	24	3	0	2	43/108	7/21	29/31	15
2	11	29	20	14	6/77	0/88	2/65	2	2	0	0	0	1	21/174	16/62	61/119	26
Feb.1	14	35	20	10	5/81	*	2/70	*	Feb.1	0	0	0	1	35/201	32/146	53/244	24
2	13	10	24	10	0/80	1/81	7/84	2	2	0	0	0	2	27/264	34/169	59/229	31
Mar.1	12	20	32	11	1/80	1/82	15/89	2	Mar.1	0	0	17	2	51/295	43/230	32/197	28
2	7	8	20	7	3/83	1/82	8/75	2	2	0	0	0	3	47/326	13/281	31/166	26

N.B. 1. Half-Mon. Hstd (or Qstd) means standard deviation of daily water level (or flow) in each half-month of 3 years.
2. dH(or dQ)/day means average of daily water level (or flow) difference in consequtive 2 days on half monthly basis.
3. Qav. means average flow in each half-month of 3 years.
4. * means value not calculated due to missing records.
5. "27", "28" and "29" are B.E. 2527, 2528 and 2529 (A.D. 1984, 1985 and 1986) respectively.

Table 4-2 (2) ACCOMPLISHMENT OF WATER CONTROL AT KEY PLACES

Month	Yom Weir								Month	Manorom Reg.							
	Half-Month Hstd			dH/	Half-Month Qstd/Qav.(CMS)			dQ/		Half-Month Hstd			dH/	Half-Month Qstd/Qav.(CMS)			dQ/
	27	28	29	day	27	28	29	day		27	28	29	day	27	28	29	day
	cm	cm	cm	cm				CMS		cm	cm	cm	cm				CMS
Apr.1	20	11	51	12	0/0	0/0	0/0	0	Apr.1	16	8	14	6	18/134	9/148	7/152	*
2	78	106	*	*	2/1	0/0	0/0	1	2	8	19	20	9	12/140	19/120	10/144	7
May 1	16	37	91	*	4/2	0/0	0/0	1	May 1	10	11	53	10	10/119	10/119	42/131	11
2	38	62	66	33	21/9	10/5	0/0	5	2	11	15	13	10	5/90	10/90	30/107	7
Jun.1	24	57	104	24	33/22	17/11	23/14	14	Jun.1	24	29	5	13	7/101	20/102	43/95	10
2	48	40	67	15	1/0	0/0	5/3	1	2	10	41	3	7	6/108	26/85	3/147	5
Jul.1	52	49	68	23	3/1	6/2	1/0	2	Jul.1	69	42	20	17	31/76	24/116	9/152	11
2	241	24	62	*	5/2	6/3	15/4	5	2	15	31	34	11	18/104	45/162	20/135	12
Aug.1	43	16	15	12	14/7	12/4	56/64	15	Aug.1	22	12	16	12	9/104	9/163	15/137	6
2	12	14	21	8	38/25	67/74	9/7	22	2	36	18	6	10	17/155	12/151	2/150	5
Sep.1	23	15	44	14	165/198	70/78	116/112	65	Sep.1	23	17	11	12	27/180	13/153	15/138	7
2	10	11	17	7	16/21	47/38	80/55	26	2	7	23	10	6	15/195	*/*	18/191	*
Oct.1	5	29	*	*	15/26	9/3	23/12	8	Oct.1	8	12	13	6	22/200	32/152	9/196	9
2	20	33	22	13	108/62	32/19	5/2	23	2	6	37	24	10	5/212	53/148	19/167	10
Nov.1	23	39	20	16	0/0	10/2	0/0	2	Nov.1	16	25	15	13	24/175	4/199	2/178	7
2	1	8	17	13	1/2	37/56	0/0	8	2	3	11	11	9	19/190	28/161	9/163	9
Dec.1	22	1	9	13	1/0	3/8	0/0	1	Dec.1	9	17	21	12	21/100	26/56	18/154	10
2	16	42	12	9	0/0	1/0	0/0	0	2	30	24	21	15	8/50	21/66	10/68	8
Jan.1	26	3	7	7	0/0	0/0	0/0	0	Jan.1	24	26	28	10	15/41	9/71	12/26	4
2	4	3	2	2	0/0	0/0	0/0	0	2	23	30	19	16	14/107	20/54	26/54	9
Feb.1	4	4	5	2	0/0	0/0	0/0	0	Feb.1	15	35	24	11	4/107	22/114	9/122	5
2	3	3	5	2	0/0	0/0	0/0	0	2	12	10	22	9	7/135	8/127	23/149	6
Mar.1	3	2	6	2	0/0	0/0	0/0	0	Mar.1	13	19	32	10	22/131	11/149	17/159	9
2	3	11	9	4	0/0	0/0	0/0	0	2	7	4	22	6	5/156	3/164	*/*	*

N.B. 1. Half-Mon. Hstd (or Qstd) means standard deviation of daily water level (or flow) in each half-month of 3 years.
2. dH(or dQ)/day means average of daily water level (or flow) difference in consequtive 2 days on half monthly basis.
3. Qav. means average flow in each half-month of 3 years.
4. * means value not calculated due to missing records.
5. "27", "28" and "29" are B.E. 2527, 2528 and 2529 (A.D. 1984, 1985 and 1986) respectively.

Table 4-2 (3) ACCOMPLISHMENT OF WATER CONTROL AT KEY PLACES

Month	Chong Kae Reg. Half-Month Hstd 27	28	29	dH/day	Half-Month Qstd/Qav.(CMS) 27	28	29	dQ/day	Month	Khok Kathiem Reg. Half-Month Hstd 27	28	29	dH/day	Half-Month Qstd/Qav.(CMS) 27	28	29	dQ/day
	cm	cm	cm	cm				CMS		cm	cm	cm	cm				CMS
Apr.1	*	5	14	7	19/119	8/132	10/142	5	Apr.1	28	16	6	11	22/103	11/113	10/123	6
2	*	12	30	12	10/121	18/107	11/134	6	2	8	43	10	15	13/98	14/90	12/110	7
May 1	*	14	42	15	11/104	11/104	39/126	9	May 1	32	38	24	19	13/85	10/93	32/122	9
2	*	11	6	7	5/75	10/85	28/89	6	2	5	41	39	13	5/70	8/77	19/93	6
Jun.1	*	32	36	21	4/82	15/95	45/82	9	Jun.1	17	22	45	19	3/78	11/88	31/78	8
2	*	41	20	14	5/91	16/73	3/136	5	2	13	11	3	8	8/84	20/76	3/126	5
Jul.1	*	15	31	11	18/70	21/103	13/140	9	Jul.1	10	18	16	11	21/71	15/93	16/122	10
2	*	10	9	8	17/88	41/139	19/127	9	2	42	13	13	13	16/88	33/120	18/116	8
Aug.1	*	14	35	9	7/87	9/144	15/119	6	Aug.1	35	24	14	15	5/69	9/107	17/100	6
2	*	19	3	5	16/127	5/126	3/132	5	2	9	11	6	7	11/93	13/105	4/118	5
Sep.1	*	11	11	6	22/144	8/130	15/120	5	Sep.1	6	8	31	8	18/100	9/94	13/122	6
2	*	25	8	15	14/165	40/68	22/153	12	2	7	22	9	9	7/124	31/164	10/100	11
Oct.1	*	21	6	9	23/170	31/109	6/173	9	Oct.1	7	17	2	6	24/163	8/118	5/119	6
2	*	8	17	8	3/181	42/130	13/149	8	2	8	20	3	6	17/166	14/158	6/99	7
Nov.1	*	5	27	12	22/152	6/165	6/149	6	Nov.1	6	7	25	6	15/100	12/135	12/103	8
2	*	15	42	15	15/160	17/149	11/134	7	2	29	26	37	19	15/133	12/133	16/105	7
Dec.1	*	28	19	11	20/84	39/63	10/143	11	Dec.1	46	53	20	20	17/96	32/96	15/133	10
2	*	64	12	14	5/41	70/79	16/68	20	2	83	46	18	19	8/56	13/73	18/70	8
Jan.1	36	10	8	14	10/33	6/64	14/26	3	Jan.1	26	13	27	13	18/43	5/73	16/31	4
2	79	17	20	18	16/92	17/44	24/47	9	2	14	32	23	17	14/86	10/61	19/49	7
Feb.1	28	18	6	10	6/93	22/103	12/114	5	Feb.1	19	15	20	12	7/87	16/90	10/100	5
2	9	27	19	11	10/118	9/116	21/140	6	2	26	23	21	12	10/102	8/91	21/125	6
Mar.1	44	52	7	18	19/117	13/137	17/150	8	Mar.1	56	33	9	18	22/107	15/114	19/134	9
2	40	6	32	9	5/140	3/153	10/131	3	2	19	5	10	8	9/123	3/136	10/117	4

N.B. 1. Half-Mon. Hstd (or Qstd) means standard deviation of daily water level (or flow) in each half-month of 3 years.
2. dH(or dQ)/day means average of daily water level (or flow) difference in consequtive 2 days on half monthly basis.
3. Qav. means average flow in each half-month of 3 years.
4. * means value not calculated due to missing records.
5. "27", "28" and "29" are B.E. 2527, 2528 and 2529 (A.D. 1984, 1985 and 1986) respectively.

Table 4-2 (4) ACCOMPLISHMENT OF WATER CONTROL AT KEY PLACES

Month	Roeng Rang Reg. Half-Month Hstd 27 cm	28 cm	29 cm	dH/day cm	Half-Month Qstd/Qav.(CMS) 27	28	29	dQ/day CMS	Month	Maharaj Reg. Half-Month Hstd 27 cm	28 cm	29 cm	dH/day cm	Half-Month Qstd/Qav.(CMS) 27	28	29	dQ/day CMS
Apr.1	13	6	8	5	23/77	7/166	6/114	5	Apr.1	14	8	15	6	3/27	1/10	3/26	2
2	52	9	20	18	11/91	22/97	12/100	9	2	11	18	21	10	4/33	3/13	2/27	2
May 1	18	15	25	13	17/75	10/92	25/111	9	May 1	10	17	32	11	3/30	4/12	4/22	2
2	9	11	17	7	6/48	14/80	19/85	6	2	11	14	3	7	2/19	0/5	7/21	2
Jun.1	15	13	22	15	9/61	16/81	33/69	8	Jun.1	23	30	4	12	8/15	3/9	3/24	2
2	8	7	2	6	8/75	21/63	2/122	5	2	8	70	3	12	6/10	1/17	4/6	1
Jul.1	18	6	6	9	28/58	15/84	12/113	11	Jul.1	70	43	16	16	2/17	8/18	5/13	3
2	13	9	8	8	20/80	33/97	14/106	7	2	14	31	31	11	5/18	9/34	4/13	2
Aug.1	29	7	11	12	11/56	11/83	15/84	10	Aug.1	28	11	15	15	4/31	10/50	14/41	6
2	17	8	2	6	11/58	13/69	4/96	7	2	36	19	3	10	10/56	5/60	5/50	5
Sep.1	8	7	15	6	21/64	11/55	18/102	8	Sep.1	18	(18)	9	*	5/66	4/63	8/51	2
2	*	28	9	10	9/86	36/141	11/72	10	2	9	8	11	7	1/69	2/70	4/67	2
Oct.1	*	6	8	5	29/127	7/88	9/84	8	Oct.1	9	3	14	5	1/69	1/72	1/68	1
2	*	14	10	8	20/149	15/124	12/70	8	2	3	4	24	6	0/69	0/71	2/65	1
Nov.1	*	5	20	6	20/75	11/119	12/62	9	Nov.1	16	3	16	9	3/66	1/72	2/66	1
2	*	4	31	10	18/106	13/111	16/80	7	2	2	1	12	7	0/68	9/68	1/64	2
Dec.1	*	12	9	8	19/94	43/93	14/116	11	Dec.1	9	2	23	9	21/34	11/13	6/61	4
2	*	27	10	8	13/49	18/73	22/65	8	2	20	22	14	10	3/3	2/1	11/8	2
Jan.1	17	19	12	9	20/43	12/77	13/30	6	Jan.1	(29)	25	47	24	0/0	0/0	0/0	0
2	8	23	14	12	7/89	11/49	21/45	9	2	12	29	20	13	0/0	0/0	0/0	0
Feb.1	8	15	14	10	4/89	21/86	10/98	6	Feb.1	13	35	20	10	1/0	0/0	6/8	1
2	9	13	7	7	9/102	13/83	16/117	2	2	12	12	22	10	2/6	9/11	5/8	2
Mar.1	18	17	13	11	18/100	18/105	20/128	9	Mar.1	12	20	32	10	2/8	2/31	5/4	2
2	8	3	6	5	8/117	2/118	9/113	3	2	8	5	20	7	3/10	3/27	2/6	2

N.B. 1. Half-Mon. Hstd (or Qstd) means standard deviation of daily water level (or flow) in each half-month of 3 years.
2. dH(or dQ)/day means average of daily water level (or flow) difference in consequtive 2 days on half monthly basis.
3. Qav. means average flow in each half-month of 3 years.
4. * means value not calculated due to missing records.
5. "27", "28" and "29" are B.E. 2527, 2528 and 2529 (A.D. 1984, 1985 and 1986) respectively.

Table 4-2 (5) ACCOMPLISHMENT OF WATER CONTROL AT KEY PLACES

Month	Singburi Siphon								Month	Borromathat Reg.							
	Half-Month Hstd			dH/	Half-Month Qstd/Qav.(CMS)			dQ/		Half-Month Hstd			dH/	Half-Month Qstd/Qav.(CMS)			dQ/
	27	28	29	day	27	28	29	day		27	28	29	day	27	28	29	day
	cm	cm	cm	cm				CMS		cm	cm	cm	cm				CMS
Apr.1	8	17	23	12	0/8	1/3	0/0	0	Apr.1	14	8	14	6	8/84	8/110	7/81	3
2	17	28	17	15	1/7	1/6	0/0	1	2	9	18	20	9	3/94	15/111	6/59	4
May 1	18	*	3	6	3/1	3/7	0/0	1	May 1	10	11	34	9	10/74	10/95	19/65	6
2	18	*	5	7	2/1	0/3	0/0	0	2	11	15	2	7	4/53	15/60	3/31	3
Jun.1	39	*	11	10	1/0	2/5	0/0	1	Jun.1	21	28	4	11	6/62	9/32	15/69	4
2	44	*	22	28	1/1	1/8	0/0	1	2	8	41	2	7	4/72	14/47	0/86	3
Jul.1	26	27	34	20	5/11	3/7	5/9	2	Jul.1	67	42	17	16	9/51	11/66	7/91	5
2	17	18	47	11	1/10	6/15	3/8	1	2	13	32	31	11	2/51	34/96	4/77	6
Aug.1	36	23	27	22	5/9	3/23	9/22	3	Aug.1	22	11	14	11	8/54	29/142	9/72	7
2	19	11	17	13	6/31	2/26	1/29	2	2	37	18	2	10	66/150	38/219	39/86	13
Sep.1	7	13	16	9	1/35	4/28	3/29	1	Sep.1	20	17	7	9	15/253	19/245	33/213	10
2	17	7	12	8	3/31	1/32	2/25	2	2	6	7	5	4	0/265	29/239	40/215	6
Oct.1	24	7	9	8	2/31	1/32	1/23	1	Oct.1	6	2	12	4	0/266	16/253	12/251	4
2	14	13	9	10	6/26	1/31	1/22	2	2	3	2	24	5	2/266	0/261	17/260	3
Nov.1	12	4	6	9	8/25	0/30	1/23	1	Nov.1	17	2	15	8	4/265	0/261	9/248	4
2	10	9	16	9	6/25	1/31	2/24	2	2	2	2	12	7	1/265	51/165	18/209	8
Dec.1	53	59	16	19	10/29	7/6	2/28	4	Dec.1	8	2	20	9	36/219	23/94	42/130	13
2	30	7	45	17	13/9	00	6/3	2	2	20	20	20	11	40/72	20/39	15/53	8
Jan.1	25	4	*	*	0/0	0/0	0/0	0	Jan.1	23	25	28	10	0/30	0/21	5/31	1
2	28	12	*	*	0/0	0/0	0/0	0	2	12	30	20	14	14/40	5/22	11/30	4
Feb.1	12	53	71	38	0/0	0/0	3/1	0	Feb.1	15	36	24	11	7/66	15/55	4/69	3
2	61	15	37	25	2/1	0/0	4/3	1	2	13	10	22	9	6/86	5/67	5/80	2
Mar.1	31	22	21	14	2/4	0/0	3/1	1	Mar.1	12	19	32	10	9/100	10/74	5/82	5
2	26	27	17	12	3/5	0/0	2/1	1	2	7	4	20	6	0/121	4/90	3/88	2

N.B. 1. Half-Mon. Hstd (or Qstd) means standard deviation of daily water level (or flow) in each half-month of 3 years.
2. dH(or dQ)/day means average of daily water level (or flow) difference in consequtive 2 days on half monthly basis.
3. Qav. means average flow in each half-month of 3 years.
4. * means value not calculated due to missing records.
5. "27", "28" and "29" are B.E. 2527, 2528 and 2529 (A.D. 1984, 1985 and 1986) respectively.

Table 4-2 (6) ACCOMPLISHMENT OF WATER CONTROL AT KEY PLACES

Month	Chanasutr Reg. Half-Month Hstd 27	28	29	dH/day	Half-Month Qstd/Qav.(CMS) 27	28	29	dQ/day	Month	Yang Manee Reg. Half-Month Hstd 27	28	29	dH/day	Half-Month Qstd/Qav.(CMS) 27	28	29	dQ/day
	cm	cm	cm	cm				CMS		cm	cm	cm	cm				CMS
Apr.1	9	3	5	5	5/63	7/60	6/50	3	Apr.1	22	6	10	9	4/51	8/45	6/44	3
2	10	4	6	5	14/62	11/57	8/36	5	2	11	11	16	12	1/50	10/40	7/31	2
May 1	4	7	6	5	11/45	10/50	19/37	6	May 1	19	12	25	17	11/27	10/34	18/33	7
2	8	4	2	4	5/20	4/25	3/9	2	2	14	12	18	13	3/8	6/17	4/8	3
Jun.1	9	12	9	9	9/35	10/22	18/39	4	Jun.1	26	22	16	14	8/20	9/12	18/32	5
2	7	8	3	5	5/44	15/44	3/60	3	2	8	16	13	10	6/31	14/31	5/57	4
Jul.1	18	6	5	6	13/34	8/62	6/61	4	Jul.1	13	11	9	9	12/22	9/50	6/56	4
2	6	9	5	8	4/27	25/80	4/54	5	2	9	13	18	11	2/21	26/73	6/46	7
Aug.1	12	9	6	7	11/38	17/94	10/57	8	Aug.1	24	9	10	8	13/34	13/77	11/45	8
2	7	13	5	4	48/89	25/150	20/49	11	2	31	15	10	12	40/65	25/131	16/28	9
Sep.1	8	9	6	7	18/174	12/162	37/164	11	Sep.1	13	7	6	7	17/137	9/138	36/136	10
2	2	5	3	3	2/190	25/180	24/142	6	2	7	7	4	6	1/149	24/152	26/119	6
Oct.1	2	7	3	3	2/197	11/162	12/167	5	Oct.1	5	7	3	4	2/156	8/137	15/139	5
2	2	7	5	2	4/193	10/181	6/168	3	2	7	8	2	5	6/155	11/151	6/142	4
Nov.1	5	3	5	3	5/193	5/181	7/158	4	Nov.1	4	4	5	4	7/151	5/150	8/130	4
2	2	12	4	4	1/200	47/106	15/138	8	2	3	6	8	6	2/164	45/84	16/117	8
Dec.1	8	7	4	6	25/172	7/72	25/94	10	Dec.1	7	9	7	8	17/149	6/56	23/72	10
2	8	6	4	5	35/69	16/43	14/40	7	2	19	20	*	*	30/61	13/42	12/38	9
Jan.1	8	6	11	6	1/30	1/27	5/18	1	Jan.1	14	15	26	15	4/28	4/27	7/18	4
2	6	4	16	7	14/38	4/21	9/21	4	2	11	13	25	14	13/39	5/21	9/19	5
Feb.1	6	7	5	5	5/54	17/51	7/58	5	Feb.1	16	10	11	14	4/51	16/50	8/54	5
2	6	5	3	4	4/63	4/61	3/53	2	2	16	9	15	12	2/55	6/54	6/51	4
Mar.1	8	7	8	7	8/71	4/59	7/61	3	Mar.1	9	5	13	9	7/57	3/55	7/52	4
2	8	5	5	5	5/74	8/62	2/49	4	2	9	10	8	10	4/60	6/55	3/41	3

N.B. 1. Half-Mon. Hstd (or Qstd) means standard deviation of daily water level (or flow) in each half-month of 3 years.
2. dH(or dQ)/day means average of daily water level (or flow) difference in consequtive 2 days on half monthly basis.
3. Qav. means average flow in each half-month of 3 years.
4. * means value not calculated due to missing records.
5. "27", "28" and "29" are B.E. 2527, 2528 and 2529 (A.D. 1984, 1985 and 1986) respectively.

Table 4-2 (7) ACCOMPLISHMENT OF WATER CONTROL AT KEY PLACES

Month	Phoniathep Reg. Half-Month Hstd 27 cm	28 cm	29 cm	dH/day cm	Half-Month Qstd/Qav.(CMS) 27	28	29	dQ/day CMS	Month	Thabote Reg. Half-Month Hstd 27 cm	28 cm	29 cm	dH/day cm	Half-Month Qstd/Qav.(CMS) 27	28	29	dQ/day CMS
Apr.1	14	8	14	6	11/113	5/138	10/116	4	Apr.1	7	3	4	3	11/111	3/128	11/110	3
2	8	20	21	9	6/116	7/125	10/98	3	2	4	7	9	4	7/115	8/121	10/94	3
May 1	10	10	41	9	3/120	10/96	38/93	4	May 1	4	4	9	4	0/119	9/92	38/93	4
2	10	*	5	*	9/86	8/71	12/55	5	2	5	3	6	4	8/85	9/68	12/54	5
Jun.1	22	30	4	12	1/101	10/79	46/128	8	Jun.1	4	12	8	5	11/100	9/73	41/120	7
2	8	42	3	7	0/110	21/96	18/105	6	2	2	12	9	5	0/108	22/90	25/104	7
Jul.1	68	*	17	*	25/66	18/109	10/94	7	Jul.1	13	12	7	6	26/64	18/106	11/88	7
2	15	31	26	3	22/22	42/97	14/80	10	2	13	27	7	9	29/27	40/92	13/76	14
Aug.1	39	11	16	15	8/65	10/107	12/63	5	Aug.1	4	8	10	5	8/61	10/102	10/58	5
2	35	17	3	10	20/104	0/101	0/50	5	2	8	11	10	7	30/93	1/92	2/44	8
Sep.1	21	17	10	9	66/149	10/85	31/93	16	Sep.1	10	9	12	9	62/141	8/79	30/87	16
2	8	10	7	4	57/177	5/99	14/76	17	2	10	13	7	6	36/182	6/98	14/69	10
Oct.1	7	8	13	5	19/190	26/73	23/60	12	Oct.1	9	14	8	6	49/168	26/70	23/53	14
2	5	13	22	6	15/214	60/86	19/74	17	2	10	23	6	6	15/202	50/70	18/63	15
Nov.1	16	9	15	10	52/184	23/114	6/70	13	Nov.1	8	6	11	7	46/178	22/109	6/64	13
2	4	3	10	8	15/212	18/90	1/51	8	2	6	14	13	8	12/203	20/89	3/46	9
Dec.1	9	6	22	9	33/150	19/30	2/52	6	Dec.1	4	18	11	10	30/147	13/44	2/51	10
2	20	21	21	11	37/55	0/20	10/38	5	2	12	12	7	7	36/54	2/17	11/38	5
Jan.1	22	26	45	14	7/38	6/23	2/28	2	Jan.1	12	11	8	6	7/37	6/22	0/27	2
2	12	29	19	12	18/57	5/32	11/49	4	2	11	12	12	8	18/56	0/30	11/45	3
Feb.1	16	34	24	11	4/79	15/66	3/80	3	Feb.1	16	6	3	5	5/77	15/64	5/75	3
2	13	13	22	12	3/90	1/80	10/93	1	2	7	9	7	6	3/87	1/79	8/89	2
Mar.1	12	19	30	10	15/113	13/80	10/108	7	Mar.1	11	5	6	5	15/109	7/79	13/98	6
2	9	4	19	6	5/145	9/121	2/121	3	2	5	11	7	4	34/128	7/116	2/110	9

N.B. 1. Half-Mon. Hstd (or Qstd) means standard deviation of daily water level (or flow) in each half-month of 3 years.
2. dH(or dQ)/day means average of daily water level (or flow) difference in consequtive 2 days on half monthly basis.
3. Qav. means average flow in each half-month of 3 years.
4. * means value not calculated due to missing records.
5. "27", "28" and "29" are B.E. 2527, 2528 and 2529 (A.D. 1984, 1985 and 1986) respectively.

Table 4-2 (8) ACCOMPLISHMENT OF WATER CONTROL AT KEY PLACES

Month	Samchook Reg. Half-Month Hstd 27 (cm)	28 (cm)	29 (cm)	dH/day (cm)	Half-Month Qstd/Qav.(CMS) 27	28	29	dQ/day (CMS)	Month	Pho Phya Reg. Half-Month Hstd 27 (cm)	28 (cm)	29 (cm)	dH/day (cm)	Half-Month Qstd/Qav.(CMS) 27	28	29	dQ/day (CMS)
Apr.1	5	2	2	2	10/88	6/106	7/89	6	Apr.1	6	4	2	4	3/31	6/34	13/38	4
2	2	2	3	2	28/79	47/80	11/78	8	2	9	2	16	5	2/29	9/39	11/25	6
May 1	3	1	4	3	5/92	8/96	24/88	8	May 1	5	5	1	2	3/30	8/36	33/59	7
2	4	2	3	3	24/62	12/74	10/46	8	2	12	5	9	5	4/23	9/31	8/17	6
Jun.1	7	3	5	3	40/77	29/61	30/97	9	Jun.1	19	9	12	5	9/33	10/37	29/49	6
2	1	1	2	2	38/87	31/93	19/93	12	2	8	17	15	5	6/45	14/39	15/47	7
Jul.1	6	2	2	3	23/63	19/95	25/62	11	Jul.1	11	11	20	8	25/47	12/43	13/33	8
2	*	3	2	*	13/25	34/71	14/75	11	2	8	19	18	7	11/28	31/49	14/50	10
Aug.1	43	2	3	8	4/49	7/74	16/29	5	Aug.1	19	4	18	8	2/29	8/39	33/59	9
2	7	2	4	4	23/76	7/72	10/51	8	2	17	6	9	5	10/34	20/54	28/47	10
Sep.1	3	2	5	3	32/112	11/64	12/102	11	Sep.1	14	11	9	6	43/82	29/34	27/110	18
2	3	3	4	4	35/143	21/110	7/58	10	2	11	7	6	5	40/124	52/68	20/41	17
Oct.1	2	3	2	2	53/147	28/63	24/48	19	Oct.1	2	7	10	4	10/139	10/33	30/42	11
2	2	3	9	4	17/178	49/83	17/44	16	2	2	2	6	3	14/145	25/124	8/17	14
Nov.1	2	2	2	3	28/162	17/109	21/53	17	Nov.1	2	2	2	2	32/117	22/68	14/29	16
2	*	4	4	*	45/179	13/102	5/46	14	2	7	7	8	4	12/152	18/88	8/16	11
Dec.1	3	5	3	4	48/136	57/97	6/55	28	Dec.1	12	13	8	5	17/117	18/81	11/26	15
2	4	8	6	6	40/85	15/23	13/38	12	2	2	3	6	3	27/51	27/23	12/24	15
Jan.1	4	7	7	3	*/*	9/17	3/17	4	Jan.1	5	12	4	6	6/39	5/11	5/14	4
2	14	13	11	8	31/43	8/25	19/34	8	2	8	16	4	5	9/37	5/18	8/21	5
Feb.1	7	14	2	5	8/53	13/55	9/75	5	Feb.1	7	24	5	6	7/33	4/28	10/46	5
2	10	5	2	5	3/64	6/66	6/75	3	2	7	11	5	5	0/29	5/31	8/35	4
Mar.1	11	8	2	6	12/79	22/52	9/83	6	Mar.1	15	14	12	6	1/29	3/30	7/47	3
2	9	2	2	3	4/113	8/91	8/83	5	2	9	13	9	5	5/44	3/31	6/37	4

N.B. 1. Half-Mon. Hstd (or Qstd) means standard deviation of daily water level (or flow) in each half-month of 3 years.
2. dH(or dQ)/day means average of daily water level (or flow) difference in consequtive 2 days on half monthly basis.
3. Qav. means average flow in each half-month of 3 years.
4. * means value not calculated due to missing records.
5. "27", "28" and "29" are B.E. 2527, 2528 and 2529 (A.D. 1984, 1985 and 1986) respectively.

Table 4-2 (9) ACCOMPLISHMENT OF WATER CONTROL AT KEY PLACES

Month	Phak Hai Reg.							
	Half-Month Hstd			dH/	Half-Month Qstd/Qav.(CMS)			dQ/
	27	28	29	day	27	28	29	day
	cm	cm	cm	cm				CMS
Apr.1	0	12	2	2	2/1	0/0	4/1	1
2	0	9	16	5	2/2	2/1	5/7	2
May 1	20	5	40	7	5/6	3/3	23/21	3
2	5	5	60	11	5/4	3/8	6/29	3
Jun.1	15	12	4	5	3/3	3/2	16/11	2
2	2	23	7	4	1/0	0/0	6/21	3
Jul.1	3	10	14	4	4/3	4/2	6/7	2
2	5	15	5	4	6/7	8/9	10/11	3
Aug.1	23	5	8	7	0/0	0/0	10/15	2
2	19	9	4	5	0/0	0/0	2/1	1
Sep.1	5	2	23	5	0/0	0/0	0/0	0
2	7	12	3	5	6/1	13/11	0/0	3
Oct.1	7	4	3	2	0/0	0/0	0/0	0
2	2	7	4	1	0/0	0/0	0/0	0
Nov.1	1	12	2	3	0/0	9/8	0/0	2
2	0	7	1	2	0/0	17/11	0/0	2
Dec.1	11	9	25	5	20/37	7/3	15/32	5
2	24	20	17	8	7/56	6/38	5/59	3
Jan.1	6	17	21	6	6/36	11/29	13/46	5
2	7	9	14	5	7/5	0/0	2/1	1
Feb.1	2	16	16	4	2/1	3/2	0/0	1
2	9	7	4	4	0/0	4/2	0/0	1
Mar.1	2	5	4	2	1/0	0/0	0/0	0
2	2	5	4	3	0/0	5/3	0/0	1

N.B. 1. Half-Mon. Hstd (or Qstd) means standard deviation of daily water level (or flow) in each half-month of 3 years.
2. dH(or dQ)/day means average of daily water level (or flow) difference in consequtive 2 days on half monthly basis.
3. Qav. means average flow in each half-month of 3 years.
4. * means value not calculated due to missing records.
5. "27", "28" and "29" are B.E. 2527, 2528 and 2529 (A.D. 1984, 1985 and 1986) respectively.

Table 4-2 (10) ACCOMPLISHMENT OF WATER CONTROL AT KEY PLACES

Month	Makamtao Reg. Half-Month Hstd 27 cm	28 cm	29 cm	dH/day cm	Half-Month Qstd/Qav.(CMS) 27	28	29	dQ/day CMS	Month	Phokoi Reg. Half-Month Hstd 27 cm	28 cm	29 cm	dH/day cm	Half-Month Qstd/Qav.(CMS) 27	28	29	dQ/day CMS
Apr.1	15	8	14	6	1/30	0/25	1/25	1	Apr.1	12	11	5	7	4/11	2/11	2/15	1
2	9	19	20	9	5/31	2/26	1/26	1	2	16	15	*	*	1/14	1/13	3/6	1
May 1	13	12	46	10	2/35	3/22	3/25	2	May 1	9	7	10	14	2/10	2/12	4/4	1
2	10	16	5	8	1/30	5/16	4/22	2	2	4	8	20	8	2/8	4/6	1/2	1
Jun.1	21	29	4	12	2/34	1/20	2/29	1	Jun.1	8	7	10	7	2/3	1/7	3/7	1
2	8	41	3	7	11/23	3/18	1/30	2	2	11	16	8	7	1/9	5/11	1/9	1
Jul.1	68	45	16	17	7/11	5/14	10/14	2	Jul.1	42	2	16	11	5/6	1/15	4/7	1
2	21	33	31	14	1/20	3/21	1/15	1	2	59	14	14	19	1/1	4/7	0/00	1
Aug.1	23	10	16	12	2/17	7/29	3/16	2	Aug.1	22	5	33	15	4/5	4/14	1/1	2
2	36	18	4	11	7/27	2/37	4/22	2	2	14	4	13	7	4/13	1/16	1/2	1
Sep.1	20	17	10	10	2/35	5/32	11/25	3	Sep.1	18	4	10	6	1/15	1/15	2/11	1
2	8	11	8	4	6/34	15/14	6/25	3	2	3	8	6	4	1/15	8/9	0/16	1
Oct.1	7	3	13	5	5/31	4/35	3/28	2	Oct.1	2	14	5	6	1/15	5/12	3/13	1
2	4	14	25	7	1/36	12/25	3/29	2	2	2	7	8	4	0/15	1/15	5/13	1
Nov.1	16	11	15	10	0/35	9/28	1/32	3	Nov.1	5	2	7	2	0/16	1/14	4/13	0
2	3	3	12	7	4/33	7/17	6/25	2	2	2	10	7	5	0/15	4/12	0/9	1
Dec.1	9	6	24	10	6/20	2/21	4/25	2	Dec.1	11	8	7	5	2/15	0/5	3/14	1
2	21	20	21	10	1/12	7/13	3/18	1	2	33	48	21	16	5/4	2/2	6/7	1
Jan.1	24	28	27	9	3/10	2/8	3/7	1	Jan.1	17	47	12	17	0/00	00	0/1	0
2	13	28	20	12	1/6	3/9	3/12	1	2	36	24	23	15	5/4	2/1	6/4	1
Feb.1	16	36	26	11	2/9	1/13	2/10	1	Feb.1	5	12	2	5	1/11	3/11	0/15	1
2	9	10	22	9	3/13	1/13	0/8	1	2	5	6	4	4	1/14	1/14	0/14	0
Mar.1	11	18	29	10	2/22	1/14	8/13	2	Mar.1	8	14	5	4	1/14	1/9	1/14	1
2	7	5	24	7	0/25	4/24	3/24	1	2	12	7	4	4	1/14	2/14	1/14	1

N.B. 1. Half-Mon. Hstd (or Qstd) means standard deviation of daily water level (or flow) in each half-month of 3 years.
2. dH(or dQ)/day means average of daily water level (or flow) difference in consequtive 2 days on half monthly basis.
3. Qav. means average flow in each half-month of 3 years.
4. * means value not calculated due to missing records.
5. "27", "28" and "29" are B.E. 2527, 2528 and 2529 (A.D. 1984, 1985 and 1986) respectively.

Table 4-2 (11) ACCOMPLISHMENT OF WATER CONTROL AT KEY PLACES

Month	Chaoched Reg. Half-Month Hstd 27	28	29	dH/day	Half-Month Qstd/Qav.(CMS) 27	28	29	dQ/day	Month	Rama VI Barrage Half-Month Hstd 27	28	29	dH/day	Half-Month Qstd/Qav.(CMS) 27	28	29	dQ/day
	cm	cm	cm	cm				CMS		cm	cm	cm	cm				CMS
Apr.1	6	7	7	3	0/0	0/0	0/0	0	Apr.1	34	6	8	8	0/0	*	*/*	0
2	5	6	12	4	0/0	0/0	0/0	0	2	19	10	15	7	0/0	*	*/*	0
May 1	13	11	21	4	4/2	0/0	1/0	1	May 1	16	16	22	11	0/0	16/51	53/111	12
2	4	3	18	5	0/0	0/0	0/0	0	2	12	16	15	9	0/0	30/58	13/38	8
Jun.1	8	7	15	3	0/0	0/0	0/0	0	Jun.1	16	18	24	14	22/21	*	0/23	8
2	1	18	8	3	0/0	0/0	0/0	0	2	4	16	5	7	15/39	*	19/51	9
Jul.1	13	10	6	4	0/0	0/0	0/0	0	Jul.1	16	11	14	9	38/32	*	5/34	12
2	15	5	12	4	0/0	0/0	0/0	0	2	13	7	26	11	30/52	31/87	30/74	18
Aug.1	14	6	16	5	0/0	0/0	0/0	0	Aug.1	29	5	7	10	0/0	18/43	92/170	13
2	18	8	4	4	0/0	0/0	0/0	0	2	11	6	4	6	32/36	37/113	79/92	26
Sep.1	15	6	16	4	0/0	0/0	0/0	0	Sep.1	8	10	15	8	26/73	28/164	133/237	28
2	10	10	5	3	0/0	0/0	0/0	0	2	13	49	10	13	33/50	228/671	51/72	57
Oct.1	8	1	4	2	0/0	0/0	0/0	0	Oct.1	11	13	18	8	31/47	138/344	48/78	53
2	1	10	2	2	0/0	0/0	0/0	0	2	8	10	46	17	30/57	87/401	*/*	34
Nov.1	1	3	1	2	0/0	0/0	0/0	0	Nov.1	25	4	20	9	31/25	61/229	*/*	27
2	3	3	2	1	0/0	0/2	0/0	0	2	14	7	15	10	31/22	20/111	*/*	13
Dec.1	8	6	3	2	8/11	0/1	0/0	1	Dec.1	7	13	27	13	25/78	42/108	11/68	17
2	22	32	26	8	16/40	2/4	1/3	5	2	5	8	10	7	19/34	27/69	27/27	10
Jan.1	20	20	19	7	1/3	1/2	1/3	0	Jan.1	17	19	22	8	3/8	17/45	*/*	7
2	3	15	13	4	*	0/0	0/0	0	2	9	14	9	12	*	*	*/*	*
Feb.1	2	15	13	3	*	0/0	0/0	0	Feb.1	13	11	15	10	*	*	*/*	3
2	3	3	2	2	*	0/0	0/0	0	2	19	13	*	4	*	*	*/*	*
Mar.1	1	3	2	2	0/0	0/0	0/0	0	Mar.1	19	20	*	11	*	*	*/*	*
2	2	2	7	2	0/0	0/0	0/0	0	2	13	2	*	5	*	*	*/*	*

N.B. 1. Half-Mon. Hstd (or Qstd) means standard deviation of daily water level (or flow) in each half-month of 3 years.
2. dH(or dQ)/day means average of daily water level (or flow) difference in consequtive 2 days on half monthly basis.
3. Qav. means average flow in each half-month of 3 years.
4. * means value not calculated due to missing records.
5. "27", "28" and "29" are B.E. 2527, 2528 and 2529 (A.D. 1984, 1985 and 1986) respectively.

Table 4-2 (12) ACCOMPLISHMENT OF WATER CONTROL AT KEY PLACES

Month	Phra Narai Reg. Half-Month Hstd 27 cm	28 cm	29 cm	dH/day cm	Half-Month Qstd/Qav.(CMS) 27	28	29	dQ/day CMS	Month	Phra Angatotsart Reg. Half-Month Hstd 27 cm	28 cm	29 cm	dH/day cm	Half-Month Qstd/Qav.(CMS) 27	28	29	dQ/day CMS
Apr.1	34	6	8	8	22/97	9/97	3/112	4	Apr.1	39	18	20	14	33/42	12/90	4/104	6
2	19	10	15	7	12/78	5/80	6/105	4	2	28	21	8	11	13/70	4/76	11/92	5
May 1	16	16	22	11	16/68	12/69	2/101	6	May 1	17	43	22	16	21/56	9/66	32/69	10
2	12	16	15	9	6/50	15/69	*/*	4	2	18	42	10	12	5/46	11/63	8/46	4
Jun.1	16	18	24	14	25/47	11/84	*/*	6	Jun.1	65	11	27	22	19/43	10/74	24/56	6
2	4	16	5	7	7/80	12/73	*/*	4	2	19	30	35	13	4/67	7/64	15/81	5
Jul.1	16	11	14	9	23/59	5/88	13/113	6	Jul.1	31	10	16	10	14/51	3/73	18/86	5
2	13	7	26	11	17/43	9/80	22/70	9	2	36	24	30	17	8/25	6/61	15/58	6
Aug.1	29	5	7	10	13/74	14/89	25/76	8	Aug.1	43	35	23	18	9/56	10/70	25/49	6
2	11	6	4	6	27/54	10/114	13/88	11	2	18	21	14	12	20/52	7/91	10/49	8
Sep.1	8	10	15	8	29/73	23/94	26/75	15	Sep.1	13	14	36	12	21/58	29/72	12/52	6
2	13	49	10	13	27/60	11/56	9/127	11	2	23	11	13	13	27/31	6/44	17/76	10
Oct.1	11	13	18	8	16/76	30/119	16/121	10	Oct.1	23	14	16	10	27/37	20/79	10/91	10
2	8	10	46	17	8/79	17/143	10/80	8	2	11	10	20	9	3/29	10/100	7/60	5
Nov.1	25	4	20	9	36/53	6/131	10/65	9	Nov.1	9	10	32	10	26/44	5/88	6/48	6
2	14	7	15	10	40/44	22/93	15/73	15	2	33	12	28	14	18/77	9/64	15/47	6
Dec.1	7	13	27	13	7/30	8/25	25/71	6	Dec.1	27	40	31	17	2/31	7/30	10/52	4
2	5	8	10	7	6/33	2/25	6/47	3	2	12	19	20	14	7/38	1/26	5/47	2
Jan.1	17	19	22	8	11/47	16/42	15/30	6	Jan.1	18	27	23	15	9/48	15/41	13/31	5
2	9	14	9	12	7/98	12/55	19/41	8	2	6	35	38	23	7/99	11/55	17/40	7
Feb.1	13	11	15	10	5/87	17/79	12/87	5	Feb.1	16	25	9	15	5/88	15/75	11/84	5
2	19	13	*	4	14/93	8/85	*/*	3	2	17	12	*	8	14/91	12/75	*/*	3
Mar.1	19	20	*	11	14/91	6/109	*/*	6	Mar.1	17	7	*	9	14/88	17/87	*/*	7
2	13	2	*	5	6/107	2/113	*/*	2	2	17	5	*	8	8/99	3/106	*/*	2

N.B. 1. Half-Mon. Hstd (or Qstd) means standard deviation of daily water level (or flow) in each half-month of 3 years.
2. dH(or dQ)/day means average of daily water level (or flow) difference in consequtive 2 days on half monthly basis.
3. Qav. means average flow in each half-month of 3 years.
4. * means value not calculated due to missing records.
5. "27", "28" and "29" are B.E. 2527, 2528 and 2529 (A.D. 1984, 1985 and 1986) respectively.

Table 4-2 (13) ACCOMPLISHMENT OF WATER CONTROL AT KEY PLACES

Month	Phra Sri Sacwaphak Reg. Half-Month Hstd 27	28	29	dH/day	Half-Month Qstd/Qav.(CMS) 27	28	29	dQ/day	Month	Phra Sri Sril Reg. Half-Month Hstd 27	28	29	dH/day	Half-Month Qstd/Qav.(CMS) 27	28	29	dQ/day
	cm	cm	cm	cm				CMS		cm	cm	cm	cm				CMS
Apr.1	36	26	16	15	4/28	10/44	2/32	2	Apr.1	36	26	16	15	22/25	5/43	5/69	4
2	20	18	19	12	7/33	2/28	4/29	2	2	20	18	19	12	9/30	2/46	9/60	4
May 1	20	24	28	15	12/28	5/30	8/22	3	May 1	20	24	28	15	9/29	12/33	22/40	5
2	36	28	20	17	7/24	4/43	4/15	4	2	36	28	20	17	6/19	3/18	4/22	2
Jun.1	41	18	32	23	12/19	3/43	5/15	4	Jun.1	41	18	32	23	16/21	7/26	19/33	5
2	33	26	33	16	2/27	8/26	5/29	3	2	33	26	33	16	7/31	3/31	14/44	4
Jul.1	40	11	14	16	6/18	3/37	3/29	2	Jul.1	40	11	14	16	7/26	3/29	19/49	3
2	25	13	25	16	1/10	3/31	2/21	2	2	25	13	25	16	6/9	5/23	13/32	5
Aug.1	27	14	53	30	7/24	4/25	7/23	3	Aug.1	27	14	53	30	7/25	7/35	14/23	4
2	33	23	46	20	10/25	5/49	5/25	4	2	33	23	46	20	7/19	7/36	8/13	4
Sep.1	20	15	28	12	13/28	14/35	4/22	3	Sep.1	20	15	28	12	8/24	16/28	7/24	3
2	34	9	15	15	10/49	3/22	7/31	4	2	34	9	15	15	12/47	2/15	12/33	4
Oct.1	17	18	15	12	8/54	6/34	4/36	3	Oct.1	17	18	15	12	8/53	14/34	4/45	3
2	8	12	23	10	0/60	4/41	4/23	2	2	8	12	23	10	1/60	5/47	6/23	2
Nov.1	21	13	43	16	15/48	2/33	2/19	3	Nov.1	21	13	43	16	14/47	3/42	3/18	3
2	39	9	57	27	10/25	3/27	5/14	2	2	39	9	57	27	11/42	3/29	12/22	4
Dec.1	13	18	37	14	0/10	3/16	2/13	1	Dec.1	13	18	37	14	1/21	3/18	6/31	2
2	12	15	22	16	0/11	0/13	1/14	0	2	12	15	22	16	8/23	0/13	3/32	2
Jan.1	30	13	26	18	3/11	4/18	2/16	1	Jan.1	30	13	26	18	5/37	11/22	11/15	4
2	7	44	31	22	7/36	2/17	1/16	2	2	7	44	31	22	3/64	9/37	16/24	6
Feb.1	13	17	13	12	4/29	9/22	6/17	3	Feb.1	13	17	13	12	4/60	11/49	5/65	4
2	24	22	*	12	4/58	4/25	*/*	*	2	24	22	*	12	15/57	9/47	*/*	2
Mar.1	24	9	*	10	4/40	6/21	*/*	3	Mar.1	24	9	*	10	15/45	14/64	*/*	5
2	22	13	*	11	6/53	2/32	*/*	3	2	22	13	*	11	4/41	2/73	*/*	2

N.B. 1. Half-Mon. Hstd (or Qstd) means standard deviation of daily water level (or flow) in each half-month of 3 years.
2. dH(or dQ)/day means average of daily water level (or flow) difference in consequtive 2 days on half monthly basis.
3. Qav. means average flow in each half-month of 3 years.
4. * means value not calculated due to missing records.
5. "27", "28" and "29" are B.E. 2527, 2528 and 2529 (A.D. 1984, 1985 and 1986) respectively.

Table 4-2 (14) ACCOMPLISHMENT OF WATER CONTROL AT KEY PLACES

Month	Phra Thammaracha Reg.							
	Half-Month Hstd			dH/	Half-Month Qstd/Qav.(CMS)			dQ/
	27	28	29	day	27	28	29	day
	cm	cm	cm	cm				CMS
Apr.1	25	19	13	9	6/44	5/23	2/40	2
2	11	11	8	5	3/35	1/7	2/39	2
May 1	30	11	15	8	12/26	4/5	2/38	2
2	33	14	12	10	4/17	2/1	1/37	2
Jun.1	30	19	21	13	7/22	3/3	17/25	5
2	15	24	18	13	3/37	10/22	8/35	3
Jul.1	8	7	14	9	1/36	2/23	8/11	3
2	21	16	26	14	11/4	6/24	13/25	5
Aug.1	8	11	17	9	4/7	5/9	13/21	2
2	16	12	12	10	2/6	4/18	8/33	3
Sep.1	12	6	10	8	4/9	3/22	5/15	2
2	11	11	7	6	10/23	7/13	2/21	2
Oct.1	10	11	5	4	6/23	4/10	8/40	2
2	4	6	11	5	1/18	1/18	14/28	2
Nov.1	14	9	9	5	1/18	1/20	1/11	1
2	18	10	9	8	9/30	1/14	3/10	2
Dec.1	13	20	30	11	10/22	4/16	8/19	3
2	5	7	39	7	0/7	3/8	5/15	2
Jan.1	12	19	25	10	2/7	8/10	5/9	2
2	12	18	21	13	5/53	9/27	9/10	5
Feb.1	8	18	16	11	5/42	6/39	2/39	3
2	23	5	8	7	8/39	6/33	1/39	3
Mar.1	23	14	16	9	8/31	14/30	3/43	3
2	28	14	20	11	7/23	3/39	4/41	3

N.B. 1. Half-Mon. Hstd (or Qstd) means standard deviation of daily water level (or flow) in each half-month of 3 years.
2. dH(or dQ)/day means average of daily water level (or flow) difference in consequtive 2 days on half monthly basis.
3. Qav. means average flow in each half-month of 3 years.
4. * means value not calculated due to missing records.
5. "27", "28" and "29" are B.E. 2527, 2528 and 2529 (A.D. 1984, 1985 and 1986) respectively.

Table 4-2 (15) ACCOMPLISHMENT OF WATER CONTROL AT KEY PLACES

Month	Phra Intharacha Reg.				Khlong Dam Reg.				Bang Thamru Reg.				Lat Krabang Reg.				Bang Kanak Reg.				Tha Khai Reg.				Phaktakong Reg.			
	Half-Month Hstd			dH/	Half-Month Hstd			dH/	Half-Month Hstd			dH/	Half-Month Hstd			dH/	Half-Month Hstd			dH/	Half-Month Hstd			dH/	Half-Month Hstd			dH/
	27	28	29	day	27	28	29	day	27	28	29	day	27	28	29	day	27	28	29	day	27	28	29	day	27	28	29	day
	cm	cm	cm	cm	cm	cm	cm	cm	cm	cm	cm	cm	cm	cm	cm	cm	cm	cm	cm	cm	cm	cm	cm	cm	cm	cm	cm	cm
Apr.	10	9	34	10	3	6	11	4	2	12	6	3	*	7	6	4	9	3	7	3	3	4	9	3	2	7	8	3
	5	4	8	4	16	13	3	5	14	13	4	4	*	11	5	5	9	11	7	4	11	6	7	4	18	13	5	5
May	16	10	20	8	3	12	23	6	3	19	29	7	*	7	31	6	9	10	24	4	*	11	23	*	5	13	27	6
	7	6	8	4	7	8	12	7	8	16	14	8	*	7	26	8	9	11	12	6	10	4	19	14	6	9	9	7
Jun.	15	5	18	8	24	8	9	8	25	12	7	5	*	12	6	6	25	11	9	8	31	9	13	7	28	*	11	8
	19	8	20	10	4	4	14	5	4	10	12	5	*	12	18	7	7	17	11	7	9	10	13	7	6	*	12	7
Jul.	16	7	4	6	17	12	18	9	19	8	12	6	*	7	15	6	25	8	13	7	26	6	16	5	15	17	12	7
	12	4	4	4	20	16	19	9	16	6	7	6	*	7	25	7	32	8	15	6	24	8	14	14	17	13	8	8
Aug.	12	3	15	5	19	27	23	11	17	9	10	6	*	17	15	8	36	5	20	8	30	7	14	9	21	8	9	6
	4	11	7	5	20	23	21	12	8	9	5	5	*	15	2	7	7	13	7	4	3	13	25	11	11	10	8	5
Sep.	5	4	12	5	19	22	15	11	6	11	5	5	4	10	7	6	3	10	15	4	1	6	20	9	9	7	13	6
	5	6	9	5	21	15	14	11	8	7	9	6	8	17	10	5	6	7	4	2	6	23	15	16	13	14	9	6
Oct.	5	8	9	5	15	17	22	10	11	10	14	8	7	1	5	2	3	7	5	2	3	19	12	11	4	13	13	7
	11	5	4	4	25	24	19	11	13	5	15	6	9	6	4	3	5	5	4	2	*	5	13	*	9	10	7	6
Nov.	9	4	3	5	24	21	22	12	7	10	15	5	4	5	10	4	4	4	10	3	5	2	26	13	3	6	9	5
	7	7	10	6	9	17	22	10	7	9	11	5	1	7	3	3	5	6	6	3	9	3	19	12	2	8	4	3
Dec.	11	13	14	5	9	15	10	9	7	5	6	5	2	3	2	2	7	10	7	4	10	8	10	8	3	8	3	2
	15	22	22	7	9	7	5	4	10	7	9	4	4	11	3	2	7	11	6	3	18	12	18	9	8	3	5	2
Jan.	20	20	14	12	11	11	9	4	10	10	17	7	14	13	4	5	5	6	9	5	13	22	20	8	11	15	9	6
	38	12	12	13	9	7	13	3	15	8	32	7	13	3	9	4	8	5	10	7	11	2	8	2	8	7	14	3
Feb.	19	34	21	13	4	8	13	6	9	5	8	3	13	6	3	4	15	13	16	6	4	8	3	2	3	6	3	2
	7	16	19	9	6	4	3	3	2	7	3	4	2	11	5	3	7	5	1	3	4	3	1	5	5	3	4	2
Mar.	7	35	9	8	3	6	3	2	2	11	1	2	2	4	7	3	6	8	2	3	6	5	*	*	3	3	2	2
	8	3	19	6	5	2	6	2	5	9	4	3	5	5	4	3	1	6	2	1	1	4	2	*	4	2	8	2

N.B. 1. Half-Mon. Hstd (or Qstd) means standard deviation of daily water level (or flow) in each half-month of 3 years.
2. dH(or dQ)/day means average of daily water level (or flow) difference in consequtive 2 days on half monthly basis.
3. Qav. means average flow in each half-month of 3 years.
4. * means value not calculated due to missing records.
5. "27", "28" and "29" are B.E. 2527, 2528 and 2529 (A.D. 1984, 1985 and 1986) respectively.

Table 4-3 ACCOMPLISHMENT OF WATER CONTROL AT KEY PLACES

Name of Struc.	No.of half-month ratio under good control (a)	(b)	(a)or(b)	% of Good Control	Av.dH /day cm	Av.dQ /day cms	
CHAO PHRAYA DAM	22/72	31/70	45/70	64	9.6		
RAMA VI BArrage	26/72	-	*A	36	9.5	20	
NARESUAN DAM	55/72	4/72	55/72	76		31	
YOM WEIR	21/72	36/72	41/72	58			
MANOROM REG.	-	32/70	*B	46	10.4	8.0	
CHONG KAE REG.	15/54	29/72	32/54	59	11.6	7.5	
KHOK KATHIEM REG.	21/72	28/72	36/72	50	12.7	7.0	
ROENG RANG REG.	30/65	12/72	31/65	48	8.9	7.5	
MAHARAJ REG	-	37/72	*B	51	10.3	2.0	
SINGBURI SIPHON	13/66	50/72	50/72	69	14.0	1.3(freq.zero Q)	
BOROMMATHAT REG.	-	37/72	*B	51	8.9	5.3	
CHANASUTR REG.	64/72	26/72	64/72	89	5.7	5.2	
YANG MANEE REG.	35/71	19/72	39/71	55	10.0	5.5	
PHAK HAI REG.	46/72	53/72	60/72	83	4.5	1.9	
PHONLATHEP REG.	-	29/72	*B	40	9.0	7.1	
THABOTE REG.	46/72	27/72	54/72	75	6.0	7.5	
SAMCHOOK REG.	67/70	15/71	67/70	96	3.9	10.2	
PHOPHYA REG.	45/72	11/72	49/72	68	5.0	9.0	
PHOKOI REG.	39/71	38/72	56/72	78	8.3	1.7	
CHAOCHED REG.	46/72	67/69	71/72	99	3.5	(mostly closed)	
MAKAMTAO-UTHONG HEAD	-	24/72	*B	33	9.5	1.7	
PHRA NARAI REG.	-	15/66	*B	23	9.5	7.0	
PHRA EKATHOTSAROT REG	9/69	13/69	18/69	26	13.4	5.8	
PHRA SRI SAOWAPHAK R.	5/69	20/69	24/69	35	16.1	2.5	
PHRA SRI SRIL REG.	5/69	13/69	16/69	23	16.1	3.6	
PHRA THAMMARACHA REG	19/72	25/72	34/72	49	9.0	2.7	
PHRA INTHARACHA REG.	38/72	-	38/72	53	7.0	-	
CHOLAHAN PHICHIT REG	30/72	-	30/72	42	7.3	-	
BANG THAMRU REG.	46/72	-	46/72	64	5.2	-	
LATKRABANG REG.	42/62	-	42/62	67	4.7	-	
BANG KANAK REG.	52/72	-	53/72	72	4.4	-	
THA KAI REG.	39/69	-	39/69	57	8.5	-	
PAKTHAKONG REG.	47/70	-	47/70	67	4,8	-	

(a) Under "good water level control", assumed as standard deviation of daily water level in each half-month is not more than 10 cm.
(b) Under "good flow control", assumed as standard deviation of daily flow in each half-monthly period is not more than 10 % or average half-monthly flow is not more than 5 CMS.
(a)or(b) Under "good control" assumed as satisfactory to the above (a) or (b).
*A Not calculated since flow deviation is not concerned with regulator operation.
*B Not calculated since water level is not concerned with regulator control.

Table 4-4 LIST OF DRAINAGE REGULATOR FOR FLOW MEASUREMENT

Regulator Name	Drainage Canal Name	Project Name	Regulator Demension		Remarks
			Type	Size(No.-W-H)	(Gate Opening)
Bang Chom Sri Regulator	Chainat-Pasak Main Drain 2	Maharaj Project	Slide Gate	3 - 6.0m - 3.0m	from Dec.10-20
Wat Manee Regulator	Chainat-Pasak Main Drain 3	Koke Kathiem Project	Radial Gate	3 - 6.0m - 6.0m	〃
Wat U-Rom Regulator	Maharaj Main Drain 2	Maharaj Project	Slide Gate	2 - 4.0m - 7.0m	from Dec.25
Kao Mao Regulator	D1L Pasak	Nakhon Luang Project	Drop Gate	3 - 6.0m - 4.2m	from Dec.10
Ban Pho Regulator	D2L Pasak	Nakhon Luang Project	Drop Gate	5 - 6 0m - 4.2m	from Dec.20
Bang Khum Regulator	Reong Rang Main Drain 1	Reong Rang Project	Slide Gate	3 - 6.0m - 6.1m	from Dec.20
Lum Chuad Regulator	Noi River Main Drain 2	Yang Manee Project	Radial Gate	3 - 6.0m -	from Dec.20-25
Nong Sa Rai Regulator	Noi River Main Drain 3	Yang Manee Project	Slide Gate	2 - 4.0m - 4.9m	from Dec.20
Phasi Charoen Regulator	Phasi Charoen Canal	Phasi Charoen Project	Slide Gate	1 - 6.0m - 3.0m	
Chularongkorn Regulator	Rangsit Canal	Rangsit Thai Project	Slide Gate	4 - 3.0m - 5.0m	

Table 4-5 DISCHARGE VOLUME FROM DRAINAGE REGULATOR

(Unit : MCM)

Regulator/Period	November			December			January			Total			
	0-10	11-20	21-30	0-10	11-20	21-31	0-10	11-20	21-31	Nov.	Dec.	Jan.	Nov-Jan
Lum Chuad Reg.													
1986-1987	9.29	10.46	11.64	11.98	10.99	15.65	33.81	25.35	3.92	31.40	38.62	63.08	131.10
1987-1988	1.33	12.23	17.58	15.42	12.15	7.82	10.99	28.72	3.57	31.14	35.39	43.28	109.81
Nong Sa Rai Reg.													
1986-1987	-	-	0.49	3.70	12.46	10.93	12.13	2.62	2.52	0.49	27.09	17.27	44.85
1987-1988	-	-	-	5.18	10.32	10.88	9.94	4.22	3.14	-	26.38	17.29	43.67
Phasi Charoeng Reg.													
1986-1987	7.87	2.66	5.32	2.72	0.92	6.50	2.81	6.51	5.38	15.85	10.13	14.70	40.68
1987-1988	9.74	11.02	8.37	6.38	7.75	9.08	5.18	7.76	6.77	29.13	23.20	19.70	72.03
Chularongkorn Reg.													
1986-1987	1.56	-	-	-	5.87	-	0.52	12.36	9.50	1.56	5.87	22.38	29.81
1987-1988	8.90	8.99	3.80	9.59	3.02	-	1.38	1.93	1.97	21.69	12.61	5.28	39.58
Wat U-Rom Reg.													
1986-1987	-	3.93	6.88	5.64	12.41	47.77	52.13	-	-	10.81	65.82	52.13	128.76
1987-1988	-			11.10	27.46	22.39	*	*	*	-	60.95	*	*

Note) - : Dry or Gate closed, * : Missing Data

Table 5-1 SAMPLING SITES OF WATER QUALITY SURVEY

River/Project	Station	Code
1. Environmental Items Analysis : 20 samples		
- Chao Phraya River	- Pathum Thani	PATT
	- RID Samsen	RIDS
- Suphan River	- Bang Len	BANL
	- Sam Phran	SAMP
	- Kratumban	KRTB
	- Samut Sakhon	SMSK
- Bang Pakong River	- Bang Kanak	BANK
	- Chachoengsao	CHAC
	- Bang Pakong	BANP
- Phasi Charoen Project	- Junction with Thawiwathana and Phasicharoen Canals	JTPC
	- Junction with Thawiwathana and Maha Saward Canals	JTMS
	- Phasicharoen Reg. (U/S, D/S)	PCRU, PCRD
- Khlong Dan Project	- Phra Khanong Reg. (D/S)	PRKR
	- Lat Krabang Reg. (U/S, D/S)	LKRU, LKRD
	- Bang Thamru Reg. (D/S)	BTRD
	- Cholahan Pichit Reg. (D/S)	CPRD
- Phra Ong Chaiyanuchit Project	- Junc. with Nakhon Neong Ket and Preng Canals	JNNP
	- Junc. with Pravaode Buri Ram and Preng Canals	JPBP
2. Heavy Metaric Analysis : 5 samples		
- Chao Phraya River	- RID Samsen	RIDS
- Shupan River	- Sam Phran	SAMP
- Bang Pakong River	- Chachoengsao	CHAC
- Phasi Charoen Project	- Junc. with Thawiwathana and Phashicharoen Canals	JTPC
- Phra Ong Chaiyanuchit Project	- Bang Bo	BANB