Fig. K.21 shows the relation of (t)-(t/yi)1/3 and estimated constant a and b. Average BOD bottle reaction coefficient (k) is estimated 0.085 to 0.266 as shown in Table K.14.

6.3. Estimation of BOD Reaction Coefficient in Klong

In this section, BOD reaction coefficient in klong will be estimated, based on the data surveyed in K. Lat Phrao discribed in Section K.6.1.

6.3.1 Calculation Model

Streeter and Phelp's formula is available for estimateion of BOD reaction coefficient in klong.

$$L_L=(Lu-\frac{La}{2.31kr})10^{-krt}+\frac{La}{2.31kr}$$

where L_L=BOD at down-stream side (ppm)
Lu=BOD at up-stream side (ppm)
La=BOD producted from river-bed (ppm/day)
kr=BOD reaction coefficient ($=k_1+k_3$) (1/day)
k_1=BOD reaction coefficient by consumption of desolued oxygen (1/day)
k_3=BOD reaction coefficient by sedimentation (1/day)
t=Flow time in estimated section (day)

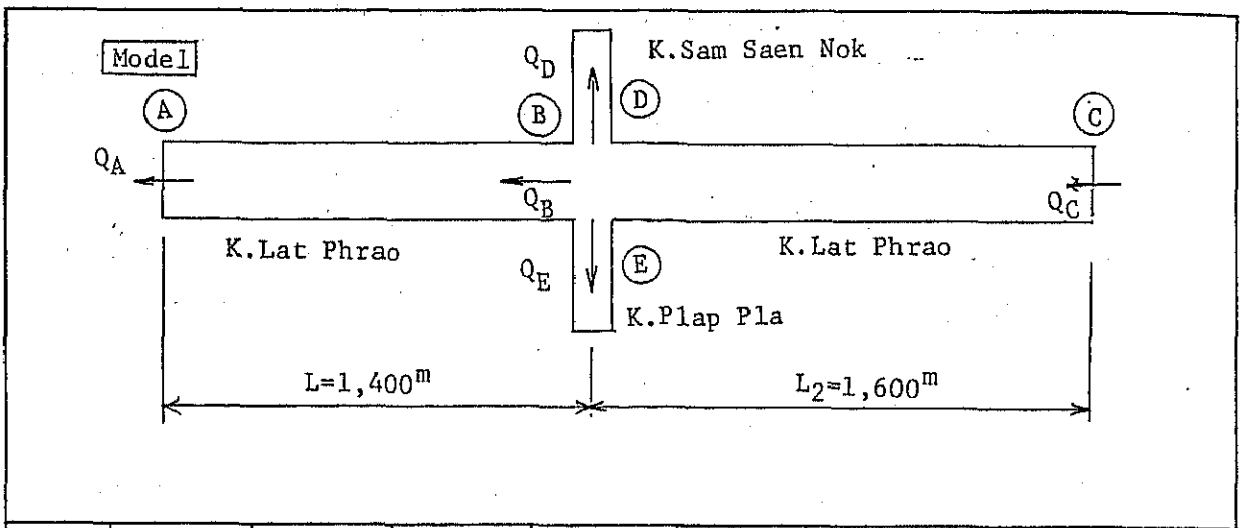
6.3.2 Discharge Balance in Surveyed Section

As the result of discharge measurement, the discharge flow in surveyed section is balanced as shown in Table K.15, considering average observation error.

6.3.3 Inflow BOD Load

Take into account of the number and scale of housings along the surveyed section, inflow BOD load need not be considered in this study except blanch klongs, K.Sam Saen Nok and K.Plap.Pla.

Table K.15 Discharge Flow in Surveyed Section



Survey No.	Q_A (m^3/Sec)	Q_B (m^3/Sec)	Q_C (m^3/Sec)	Q_D (m^3/Sec)	Q_E (m^3/Sec)	$n1=\left\|\frac{Q_B-(Q_C-Q_D-Q_E)}{Q_B}\right\|$	$n2=\left\|\frac{Q_A-Q_B}{Q_A}\right\|$
1	4.68	4.16	4.65	0	0.58	0.02	0.01
2	3.52	4.00	4.60	0.48	0.39	0.07	0.13
3	5.68	5.24	6.26	0	0.91	0.02	0.08
4							

6.3.4 Calculation of BOD Reaction Coefficient

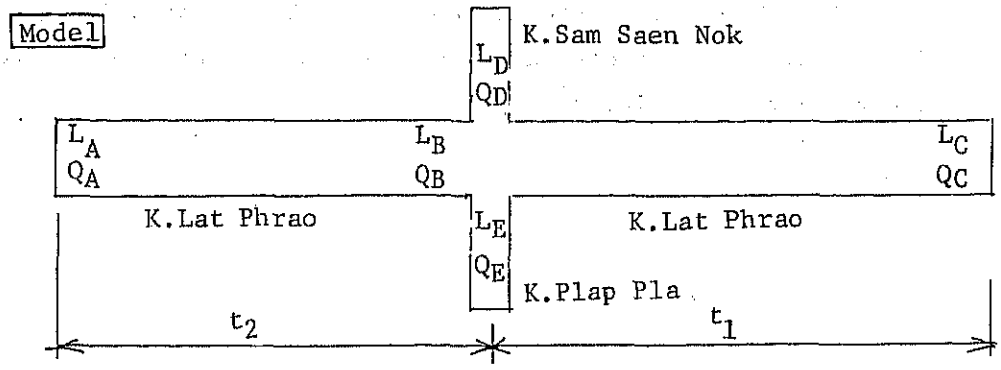
Assuming the discharge flow is balanced in survey section, BOD produced from klong bed is not considered and water quality at down stream of branch klong is mixed completely in cross section, BOD at Station B and A are estimated by following Streeter and Phelp's formula,

$$L_B=\frac{Qc.Lc.10^{-krt1}-Q_D.L_D-Q_E.L_E}{Qc-Q-Q} \quad .....(1)$$

$$La=L_B.10^{-krt2} \quad .....(2)$$

where, each sign is shown in Table K.16,

Table K.16. Surveyed Data for BOD Reaction Coefficient



Survey	BOD (ppm)					Discharge (m^3/Sec)					Flow Time (day	
No.	L_A	L_B	L_C	L_D	L_E	Q_A	Q_B	Q_C	Q_D	Q_E	t1	t_2
1	18	19	24	22	20	4.07	4.07	4.65	0	0.58	0.12	0.11
2	11	13	12	6	16	3.73	3.73	4.60	0.48	0.39	0.12	0.11
3	9	10	12	8	10	5.35	5.35	6.26	0	0.91	0.02	0.08
4												

Note: L_A-L_C: BOD at Station A-C in K.Lat Phrao

Q_A-Q_B: Discharge at Station A-C in K.Lat Phrao

L_D, L_E: BOD of branch klong, K.Sam Saen Nok and K.Plap Pla

Q_D, Q_E: Discharge of branch klong, K.Sam Saen Nok and K.Plap Pla

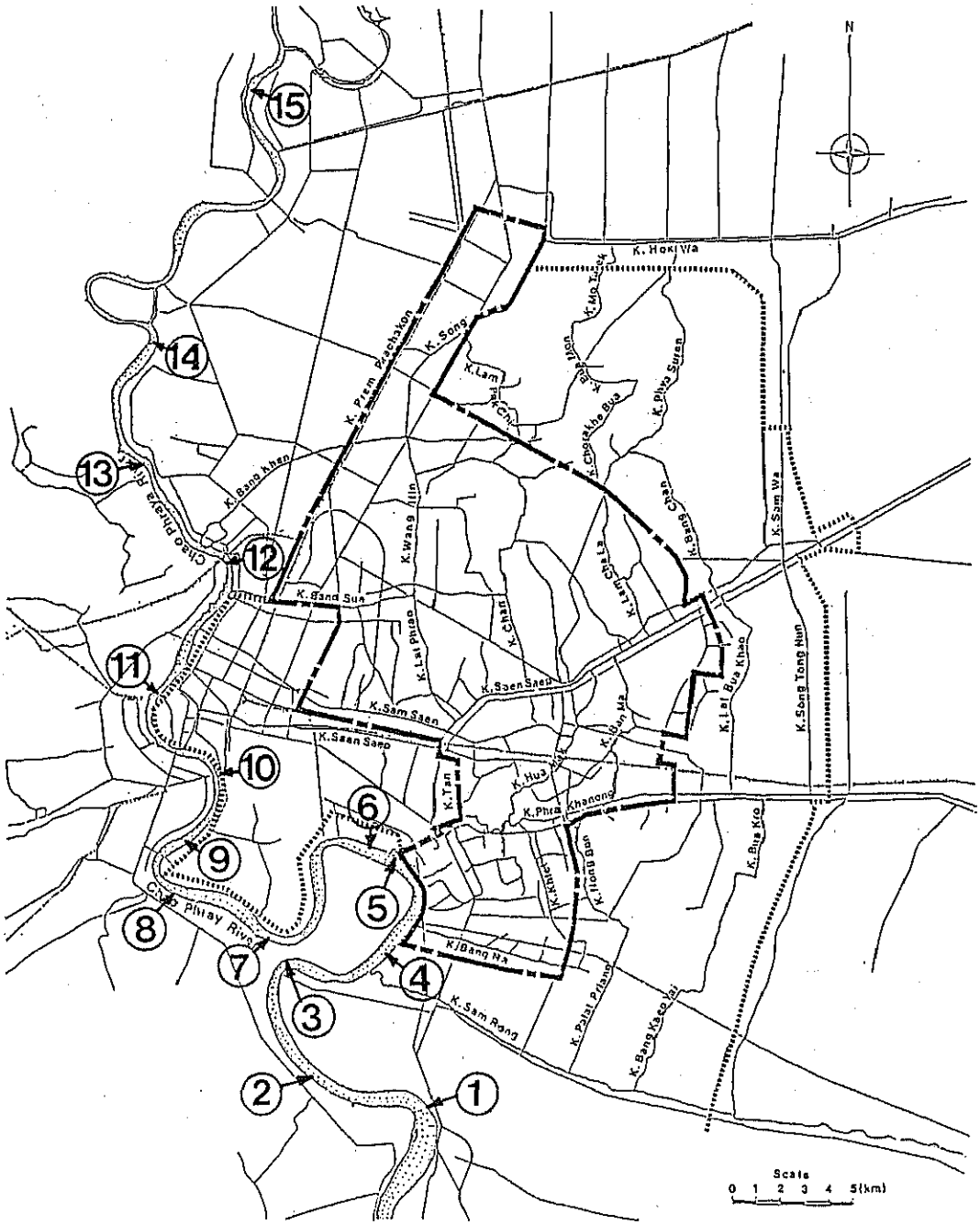
t_1, t_2: Flow time

Amount of discharge is corrected to make balance

BOD reaction coefficient in klong(kr) is estimated 0.20 to 1.07 by graphical method as shown in Fig. K.22, which is the relationship with BOD at Station A and B and kr.

In general, the value of kr is observed between almost same and twenty times in compare with value of kl, because kr is caused mainly by sedimentation. Accordingly, in case of estimateion of water quality after completion of sewerage system, it is adequate to adopt a value of kl instead of kr, as BOD reaction coefficient. Because sedimentary suspendid solids and organics are removed by wastewater treatment plant.

In this time, the number of sampling for BOD reaction coefficient is only three samples for one klong, so in future, it is necessary that the BOD reaction coefficient study for another klongs in the Master Plan Area is continued to confirm the reasonable value of BOD reaction coefficient.



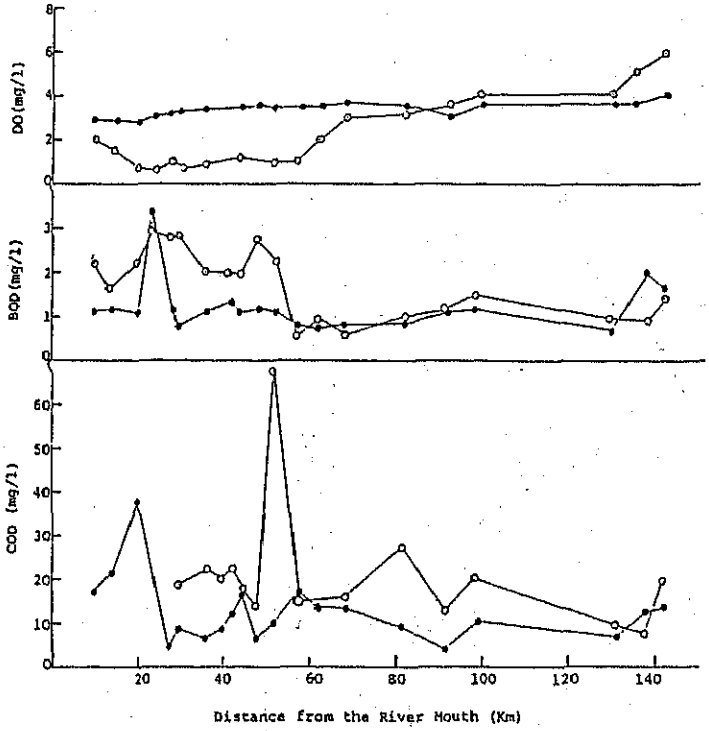
Name of Sampling Station

1. Phra Samut Chedi (10 km)
2. South Electric-Generation Plant (14 km)
3. Phra Pradaeng (20 km)
4. Wat Yothin Pradit (24 km)
5. The Mouth of K. PhraKhanong (28 km)
6. Port Authority of Thailand (30 km)
7. Rice-Bran Oil Factory (36 km)
8. Bangkok Bridge (42 km)
9. Tobacco Factory (44 km)
10. Memorial Bridge (48 km)
11. The Mouth of K. Thae Waet (52 km)
12. Phrarammok Bridge (52 km)
13. Wat Chalermrakeit (62 km)
14. Wat Cheunglen (68.8 km)
15. Nonthaburi Bridge (82.8 km)
16. Phathun Thani (91.6 km)
17. Sam Khok (98.6 km)
18. Bang-Pa-in Paper Mill (131.1 km)

Fig. K.1 LOCATION OF SAMPLING STATIONS FOR WATER QUALITY STUDY IN THE CHAO PHRAYA RIVER

FEASIBILITY STUDY ON FLOOD PROTECTION/DRAINAGE PROJECT IN EASTERN SUBURBAN-BANGKOK

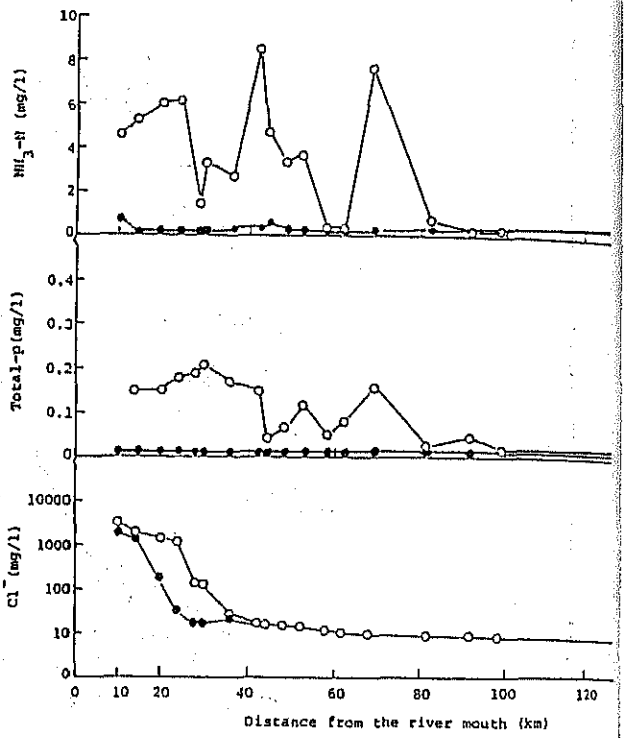
JICA 2529B.E 1986A.D



DO, BOD, and COD Distribulions in the Chao Phraya River

o——o : April 1984 as dry season

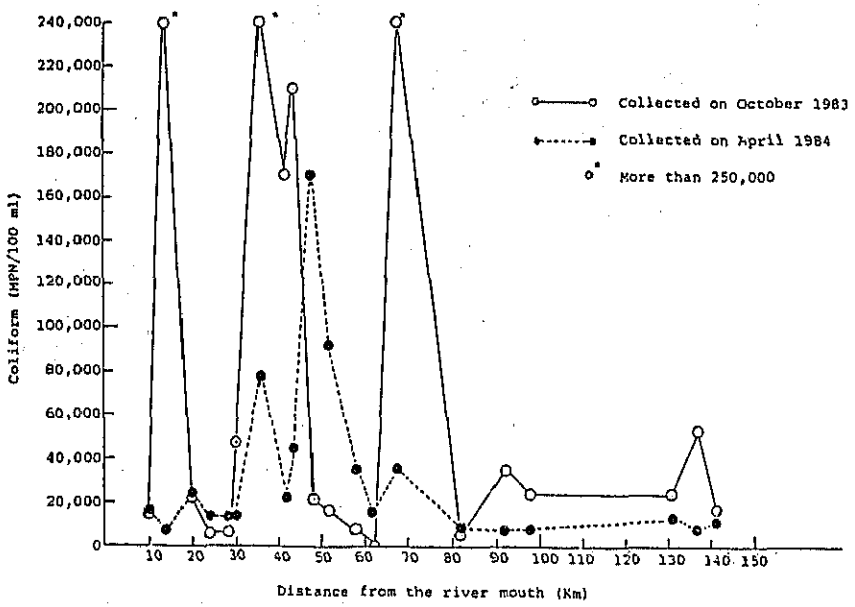
•——• : October 1983 as rainy season



Distribution of NH_3-N, Total-p, and Chloride Ion in the Chao Phraya River.

o——o April 1984 as dry and hot season.

•——• October 1983 as rainy season.

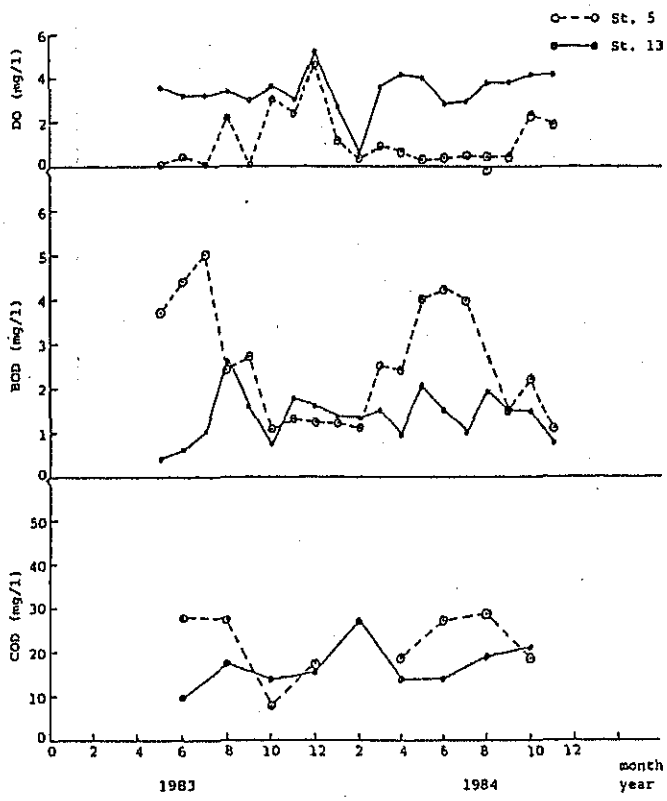


Distancial Distribution of Coliform in the Chao Phraya River

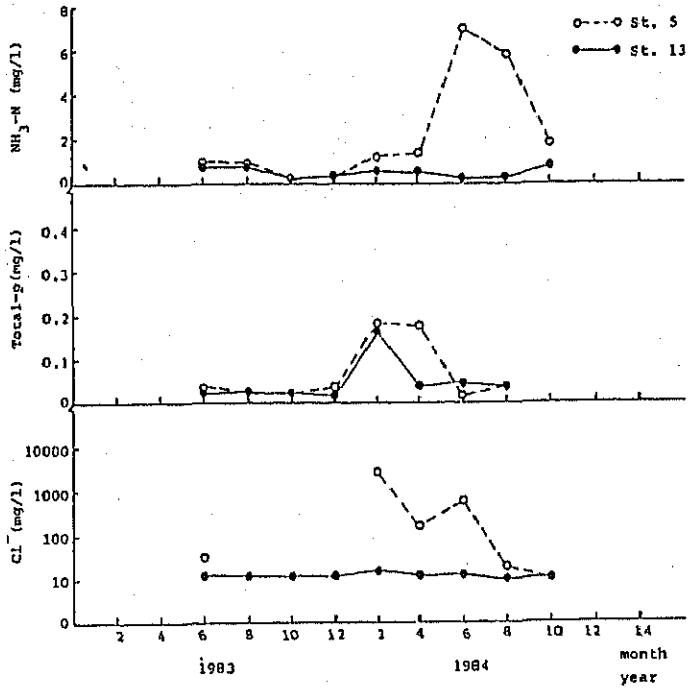
Fig. K.2	DISTANCIAL DISTRIBUTION OF WATER QUALITY IN THE CHAO PHRAYA RIVER

FEASIBILITY STUDY ON FLOOD PROTECTION/DRAINAGE PROJECT IN EASTERN SUBURBAN-BANGKOK

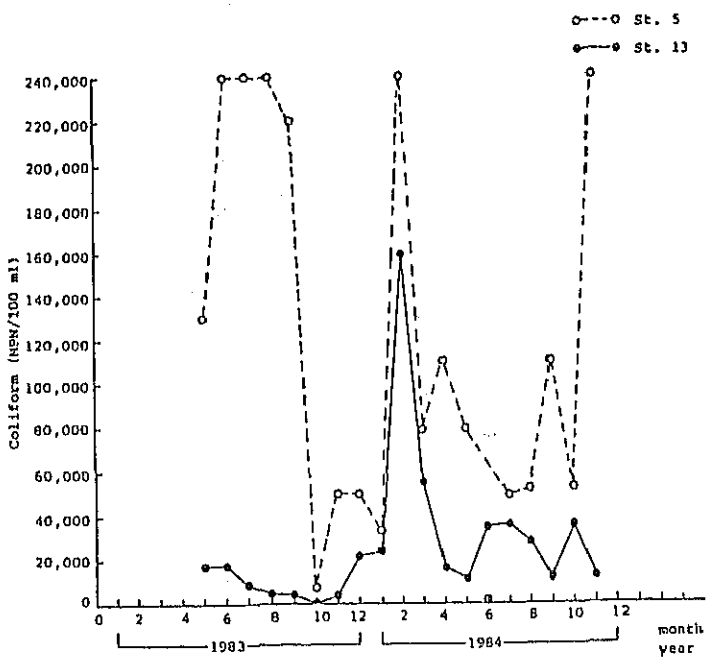
JICA 2529B.E 1986A.D



Monthly Changes of Dissolved Oxygen, Biological Oxygen Demand, and Chemical Oxygen Demand in the Chao Phraya River.



Monthly Changes of NH_3-N, Total-p, and Chloride Ion Concentrations in the Chao Phraya River.

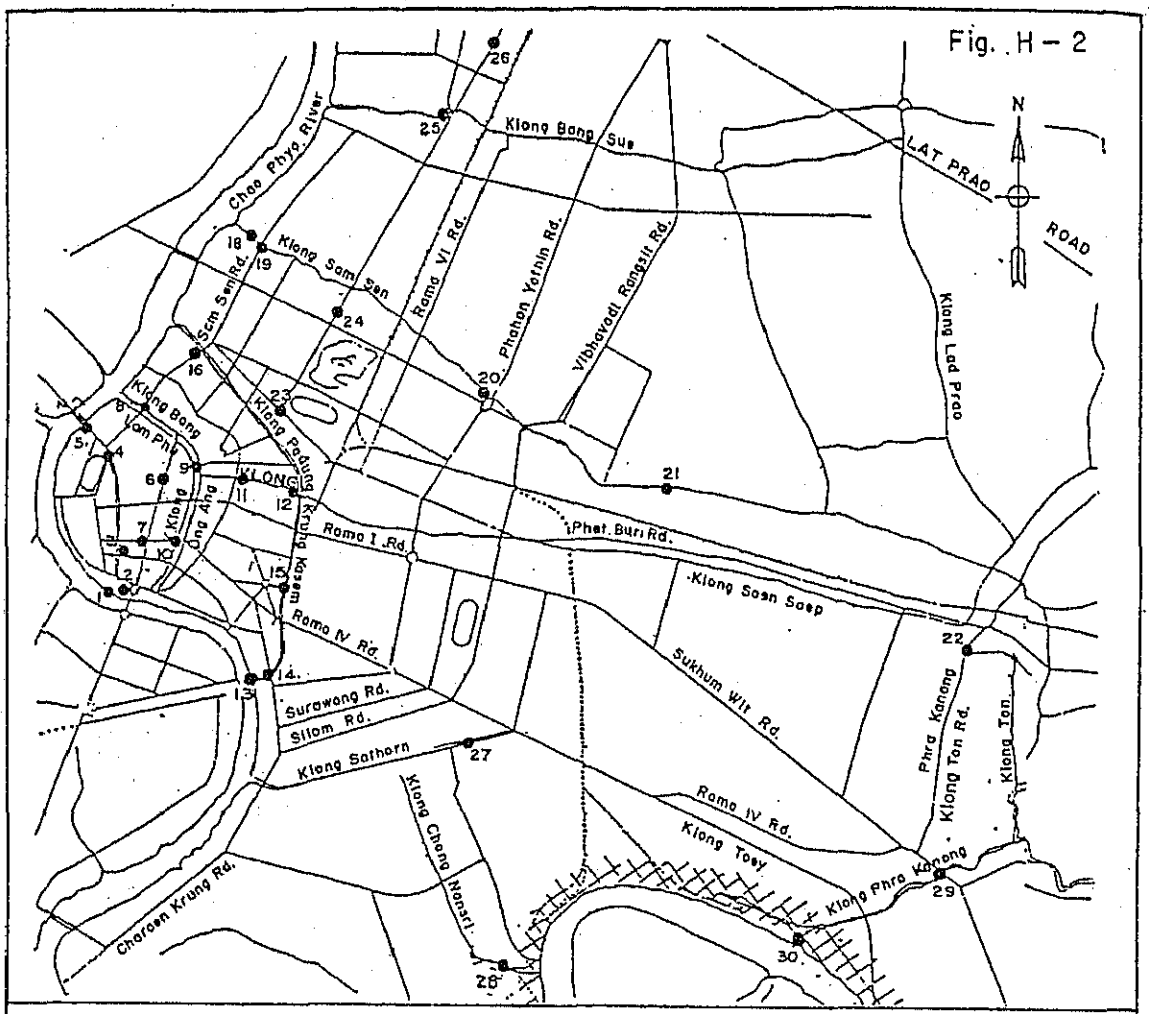


Monthly Distribution of Coliform in the Chao Phraya River.

Fig. K.3 MONTHLY DISTRIBUTION OF WATER QUALITY IN THE CHAO PHRAYA RIVER

FEASIBILITY STUDY ON FLOOD PROTECTION/DRAINAGE PROJECT IN EASTERN SUBURBAN-BANGKOK

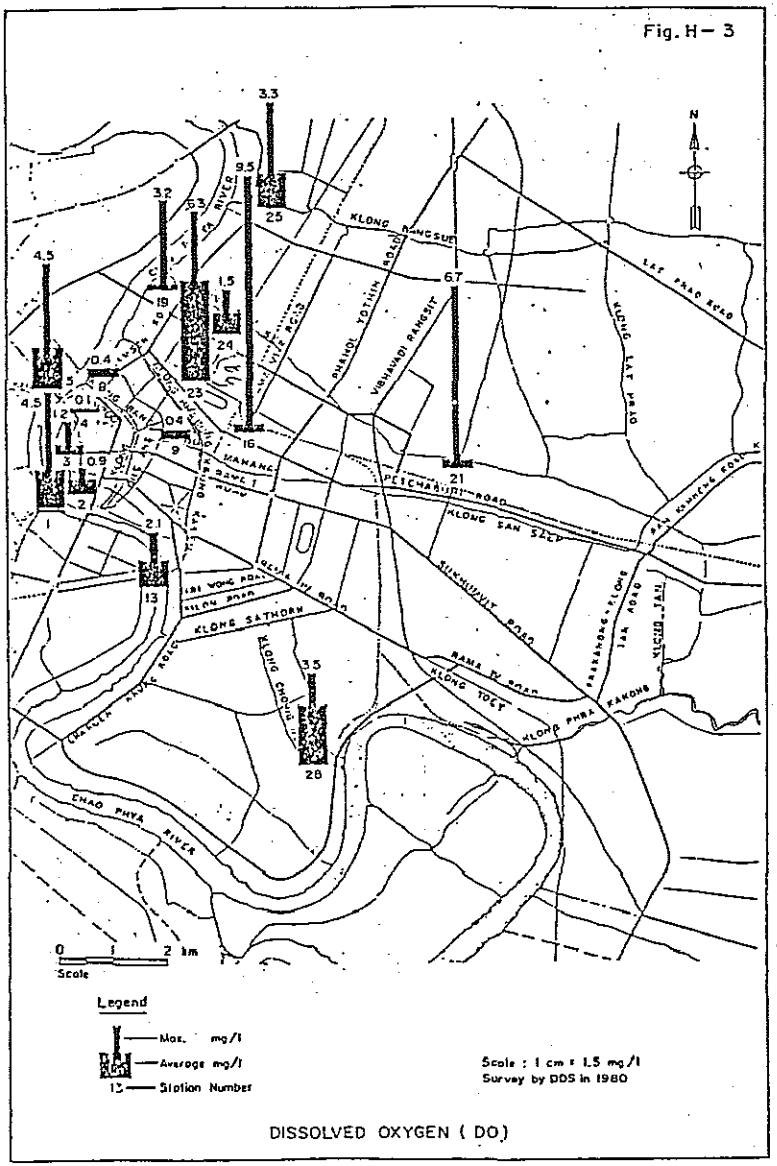
JICA 2529B.E 1986A.D



1.	Gate near Rachinee School	16.	Talat Tevaraj
2.	Gate near Rachinee School	18.	Boat Mae Pra
3.	Department of Lands	19.	Sam Sen Road
4.	Phanphipop Bridge	20.	Victory Monument
5.	Phrapinklao Bridge	21.	Din Daeng Asoke Cross
6.	BMA office (Klong Lord Nai Wat Rajanatda)	22.	Klong Ton pump station
7.	Tritong Road (Klong Lord Nai Wat Raj Boplt)	23.	Si Ayutthaya Road
8.	Talat Nana	24.	Setsatien School
9.	Phanfah Bridge	25.	Phibool Songkhram Bridge
10.	New Road	26.	Jatujak Park
11.	Chakrapadipong Road	27.	YMCA
12.	Talat Maha Nak	28.	Ring Road
13.	Talat Noi (outside pump station)	29.	Sukhum Wit Road
14.	Talat Noi	30.	Klong Toey
15.	BKK Railway Station		

LOCATION MAP OF SAMPLING STATIONS FOR WATER QUALITY

Fig. K.4 LOCATION MAP OF SAMPLING STATIONS FOR WATER QUALITY IN CITY CORE AREA



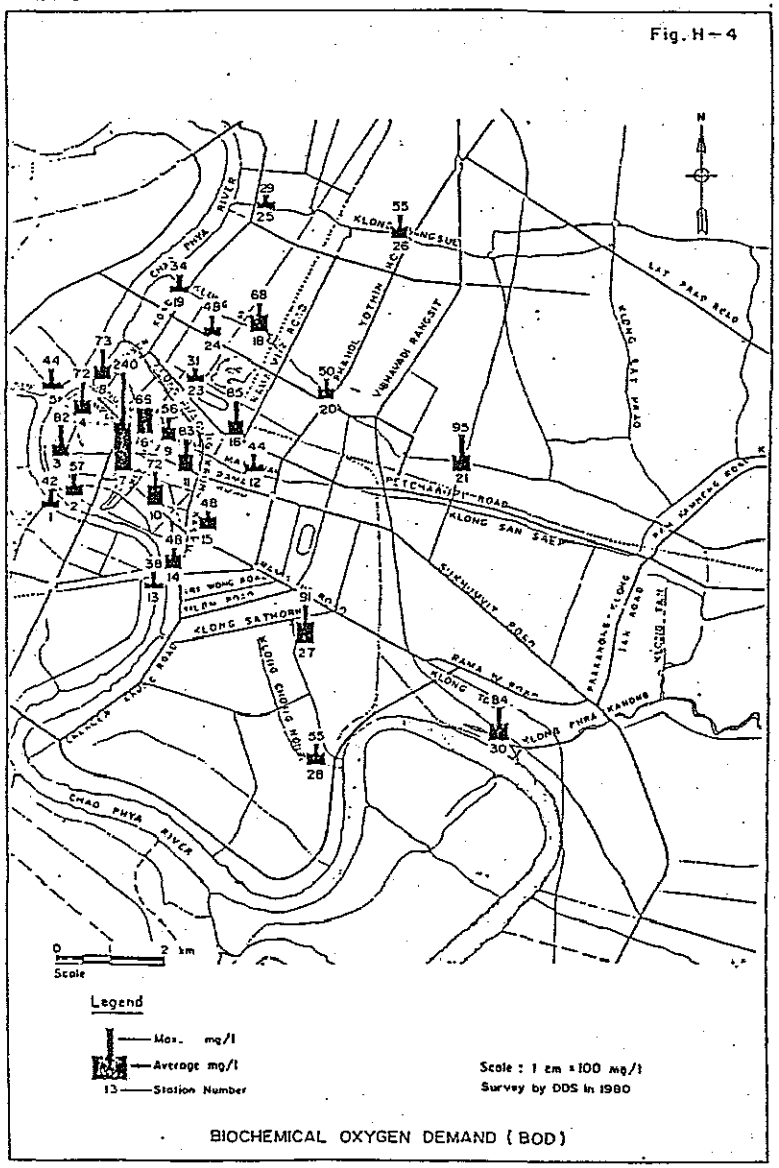
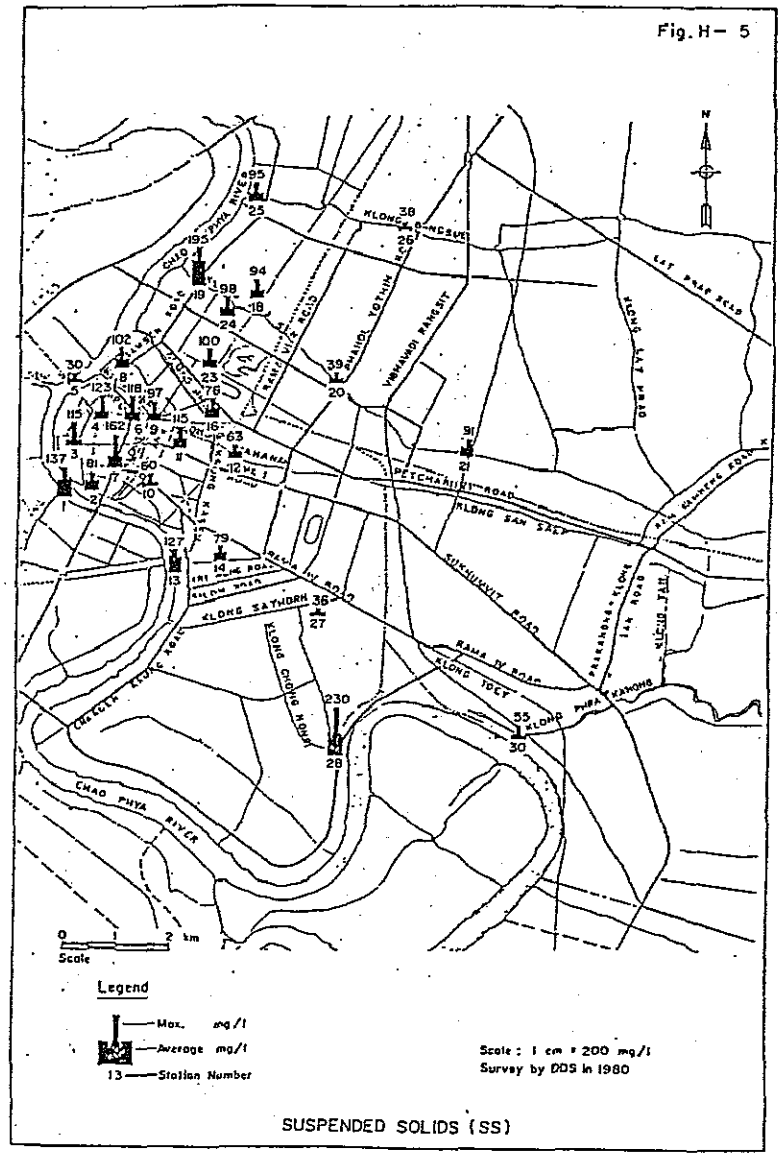


Fig. K.5	OBSERVED DISSOLVED OXYGEN AND BIOCHEMICAL OXYGEN DEMAND IN THE CITY CORE AREA

FEASIBILITY STUDY ON FLOOD PROTECTION/DRAINAGE PROJECT IN EASTERN SUBURBAN-BANGKOK



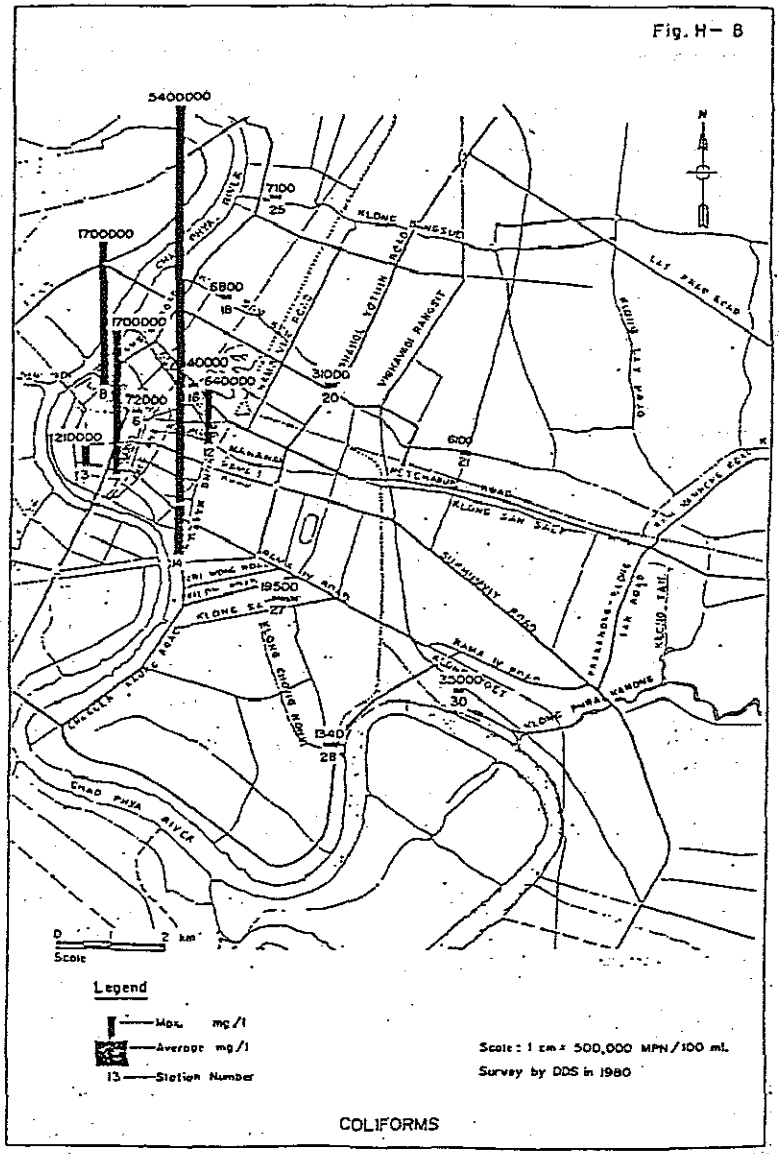
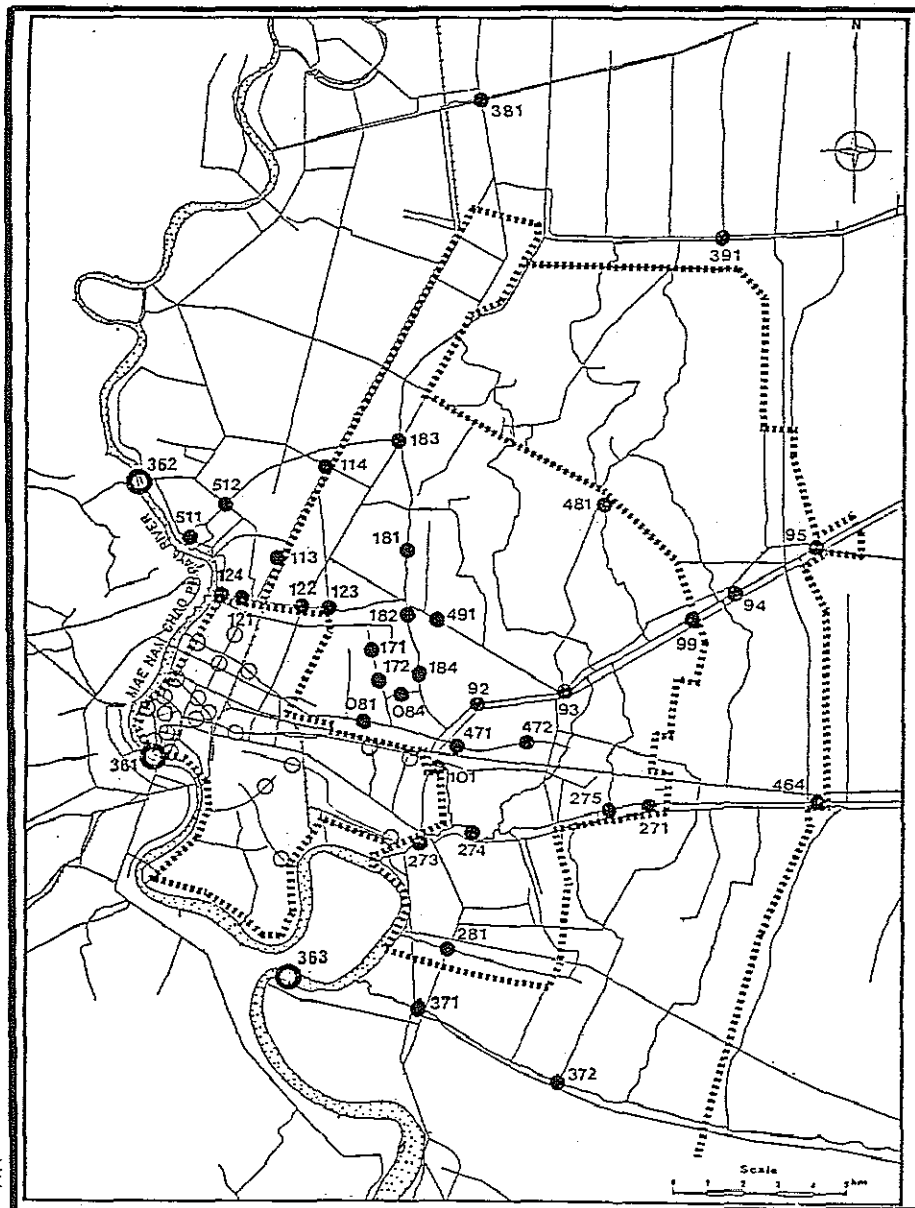


Fig. K.6 OBSERVED SUSPENDED SOLIDS AND COLIFORMS IN THE CITY CORE AREA

FEASIBILITY STUDY ON FLOOD PROTECTION/DRAINAGE PROJECT IN EASTERN SUBURBAN-BANGKOK

JICA 2529B.E 1986A.D



LEGEDD

: Sampling Station In Study Area

: Sampling Station In Core Area

: Sampling Station In Chao Phraya River

LIST OF SAMPLING STATION

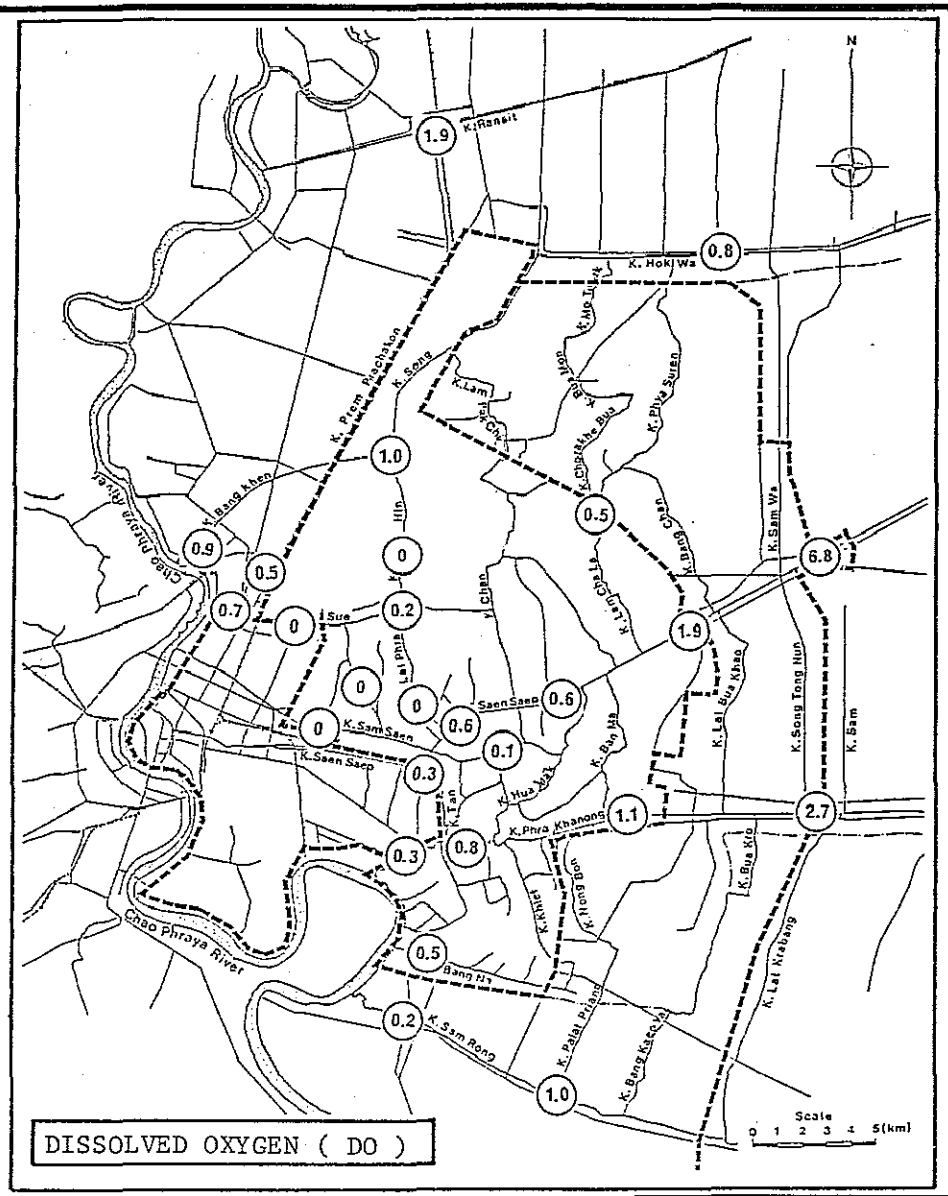
Name of Klong	Code No	Station
K. Sam Sen	081	Boat Haepra
"	084	Sam Sen Gate
K. Saen Saep	092	Mit Mahad Thai Bridge
"	093	Bang kapi Bridge
"	094	Bang Chan Estate
"	095	Minburi
"	099	Bang Kum Nun
K. Tan	101	K.Tan Pumping Station
K. Prem Prachakorn	113	Talat Bang Sue
K. Bang Sue	121	Song Kram Bridge
"	122	Paholyotin Center
"	123	Paholyotin Rd.
"	124	Wat Kave Far Gate
K. Huay Kwang	171	NHA Housing
"	172	Rachada Gate
K. Lat Phrao	181	Soi Saenanikom 1
"	182	Piboon Upatan School
"	183	Connection of K. Bangkhen
"	184	Wat Tepleela
K. Phra khanong	271	Wat Yang Sutaram
"	273	Phrakhanong Gate
"	274	Wat Mahabutre
"	275	Pattanakarn Rd.
"	464	Rom Klao Rd.

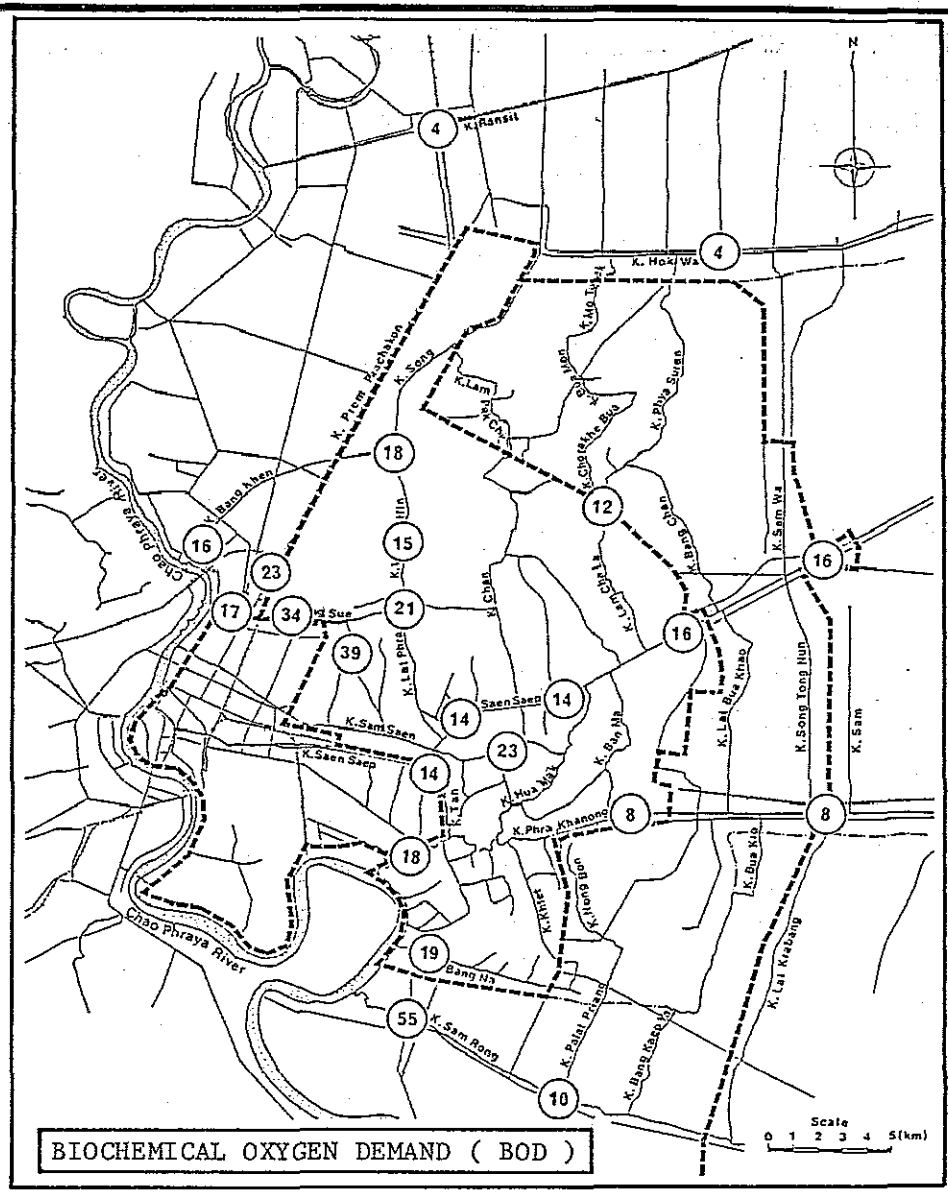
Name of Klong	Code No	Station
K. Bang Na	281	Sukumvit Rd.
Chao Phraya River	361	Middle Side of Bangkok
"	362	Nontaburi
"	363	Prapadang
K. Sam Rong	371	Sukumvit Rd.
"	372	Wat Nam Dang
K. Rung sit	381	Rungsit Bridge
K. Hok Wa	391	
K. Kra Cha	471	Saeree Housing
"	472	Hau Mark Golf Court
K. Lam Chala	481	
K. Chao Kun Sink	491	Lat Phrao Rd.
K. Bang Khen	511	Bang Khen Pumping Station
"	512	Wat Tang Luang

Fig. K.7 LOCATION MAP OF SAMPLING STATION IN THE STUDY AREA

FEASIBILITY STUDY ON FLOOD PROTECTION/DRAINAGE PROJECT IN EASTERN SUBURBAN-BANGKOK

JICA 2529B.E 1986A.D





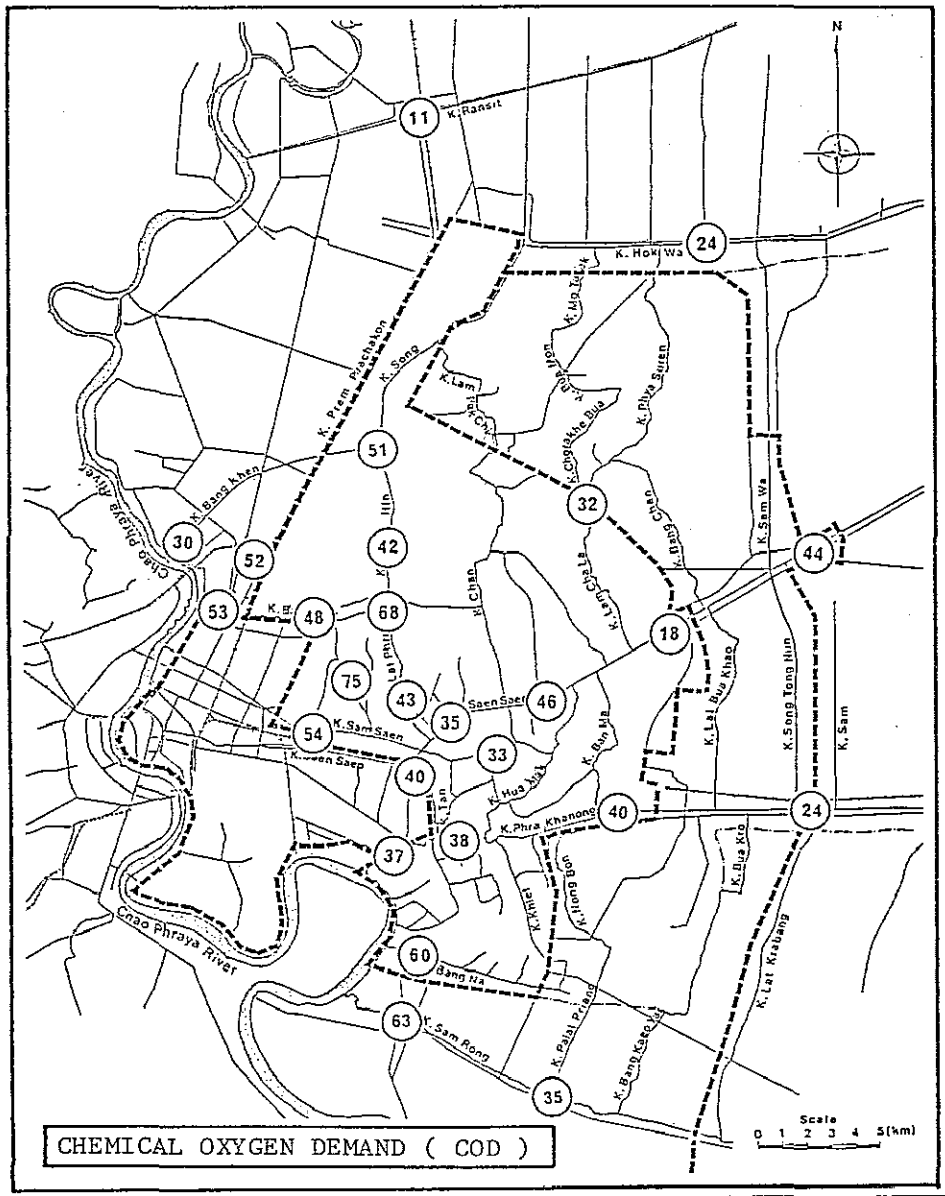
Unit : mg / l

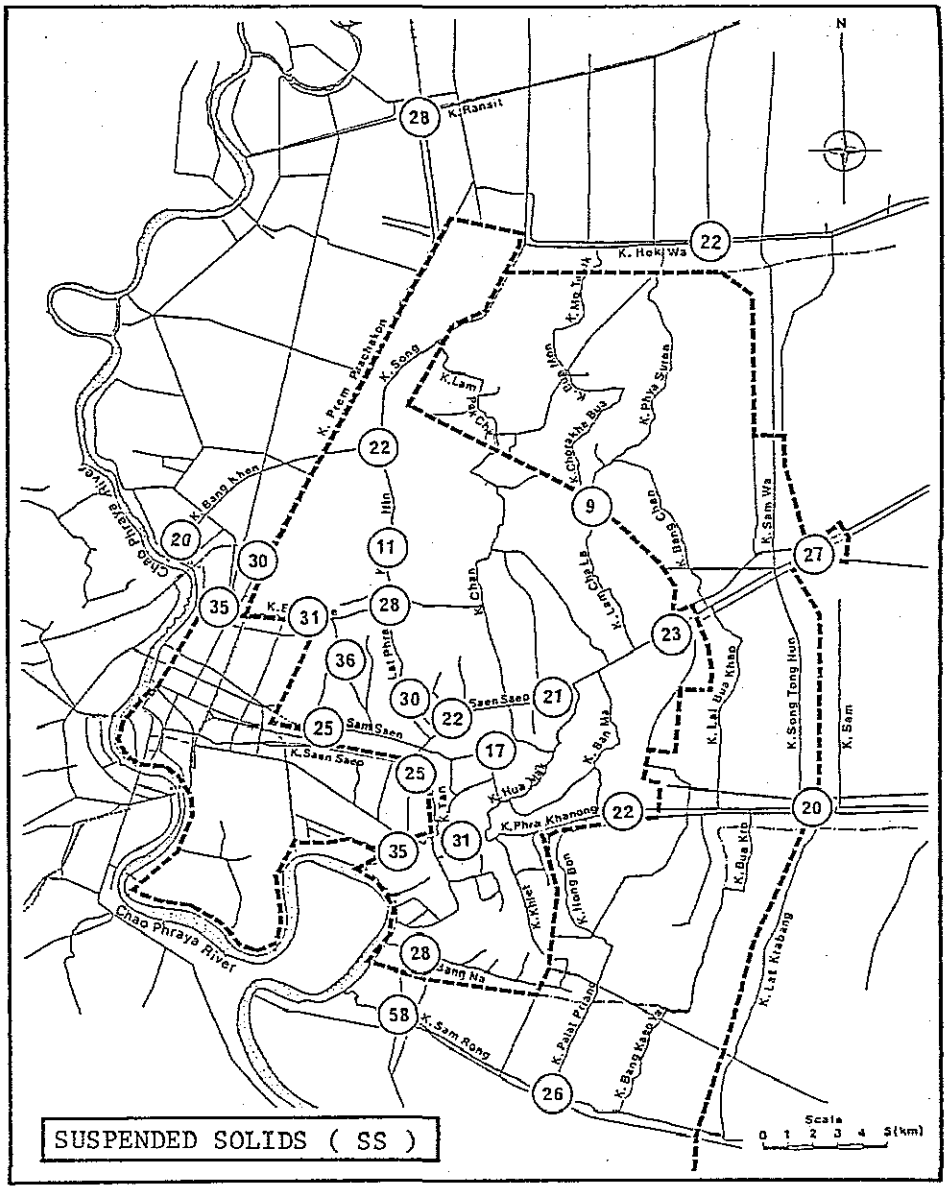
Survey by DDS between 1980 and 1985

Fig. K.8 OBSERVED AVERAGE VALUE OF DISSOLVED OXYGEN AND BIOCHEMICAL OXYGEN DEMAND IN THE STUDY AREA

FEASIBILITY STUDY ON FLOOD PROTECTION/DRAINAGE PROJECT IN EASTERN SUBURBAN-BANGKOK

JICA 2529B.E 1986A.D





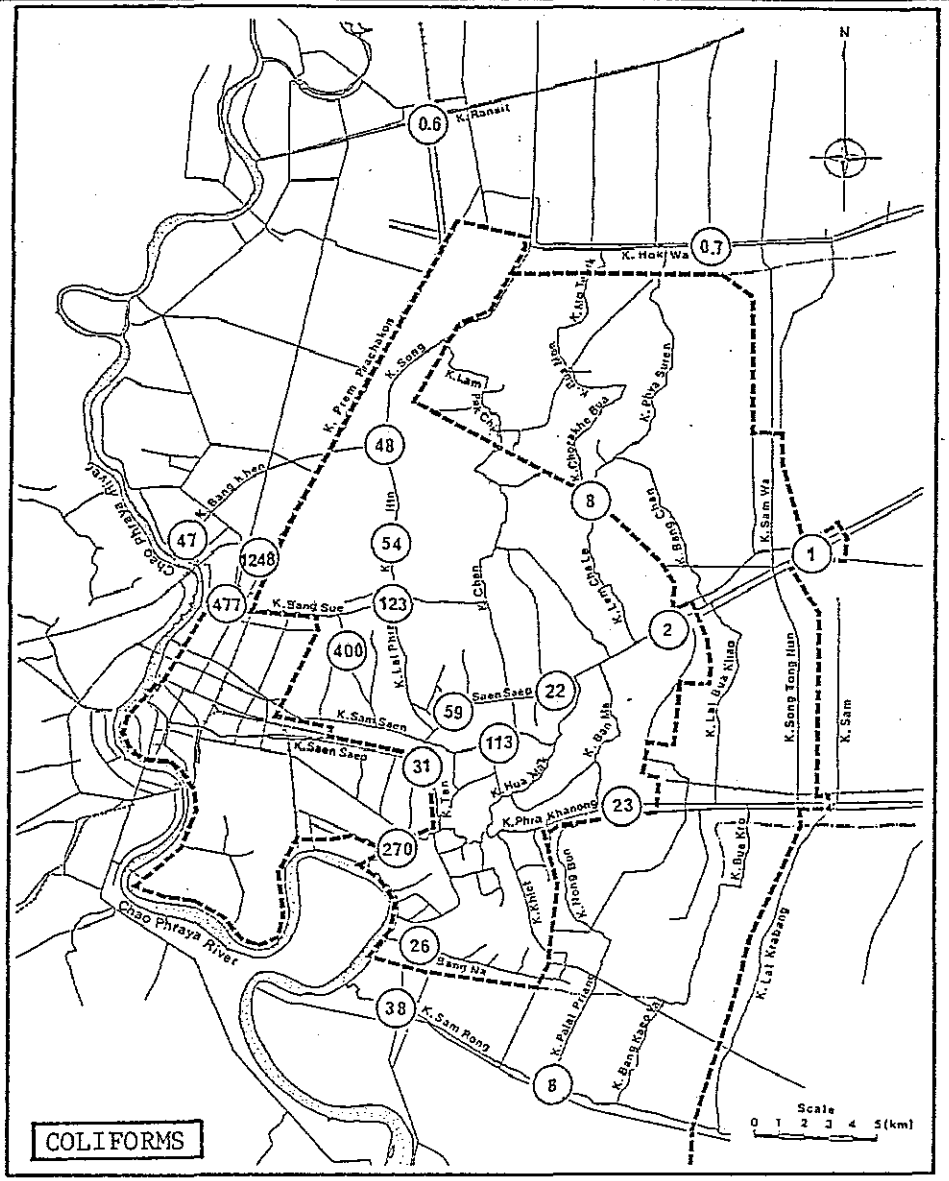
Unit : mg / 1

Survey by DDS between 1980 and 1985

Fig. K.9 OBSERVED AVERAGE VALUE OF CHEMICAL OXYGEN DEMAND AND SUSPENDED SOLIDS IN THE STUDY AREA

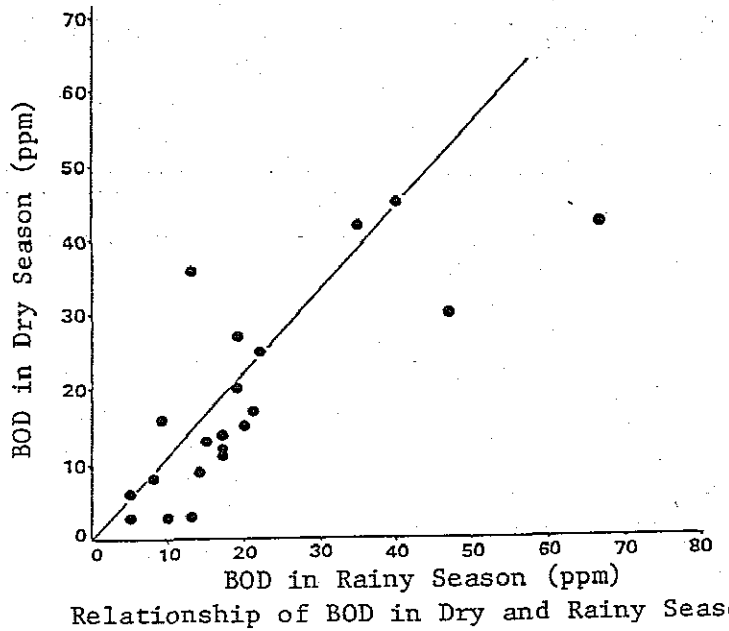
FEASIBILITY STUDY ON FLOOD PROTECTION/DRAINAGE PROJECT IN EASTERN SUBURBAN-BANGKOK

JICA 2529B.E 1986A.D

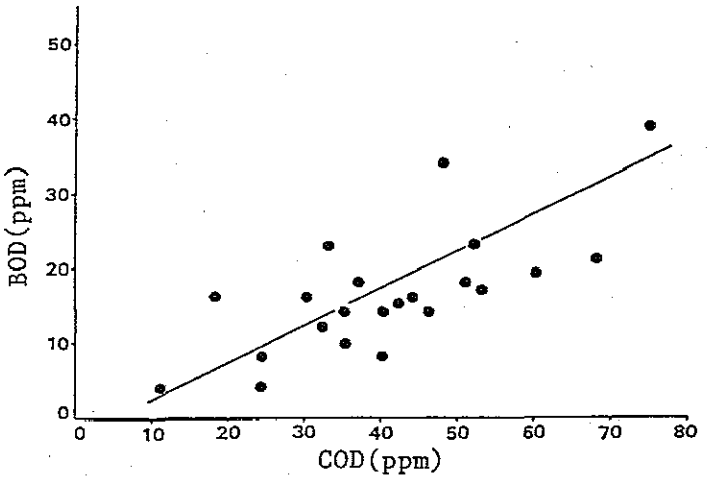


Unit : x 10^4 MPN / 100 ml

Survey by DDS between 1980 and 1985



Relationship of BOD in Dry and Rainy Season



Relationship of BOD and COD

Fig. K.10 OBSERVED AVERAGE VALUE OF COLIFORMS RELATIONSHIP OF BOD IN DRY AND RAINY SEASON AND RELATIONSHIP OF BOD AND COD IN THE STUDY AREA

FEASIBILITY STUDY ON FLOOD PROTECTION/DRAINAGE PROJECT IN EASTERN SUBURBAN-BANGKOK

JICA 2529B.E 1986A.D

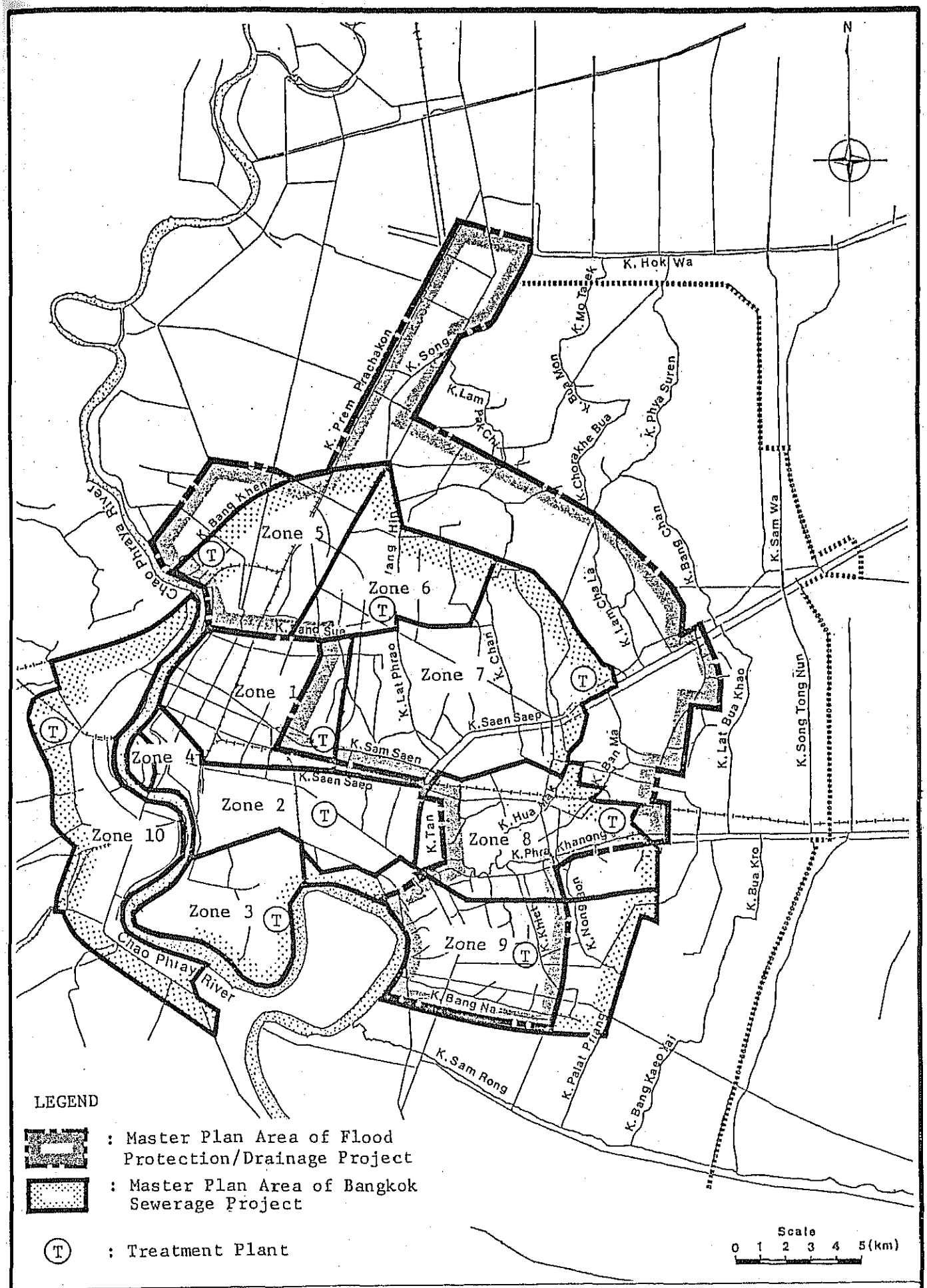
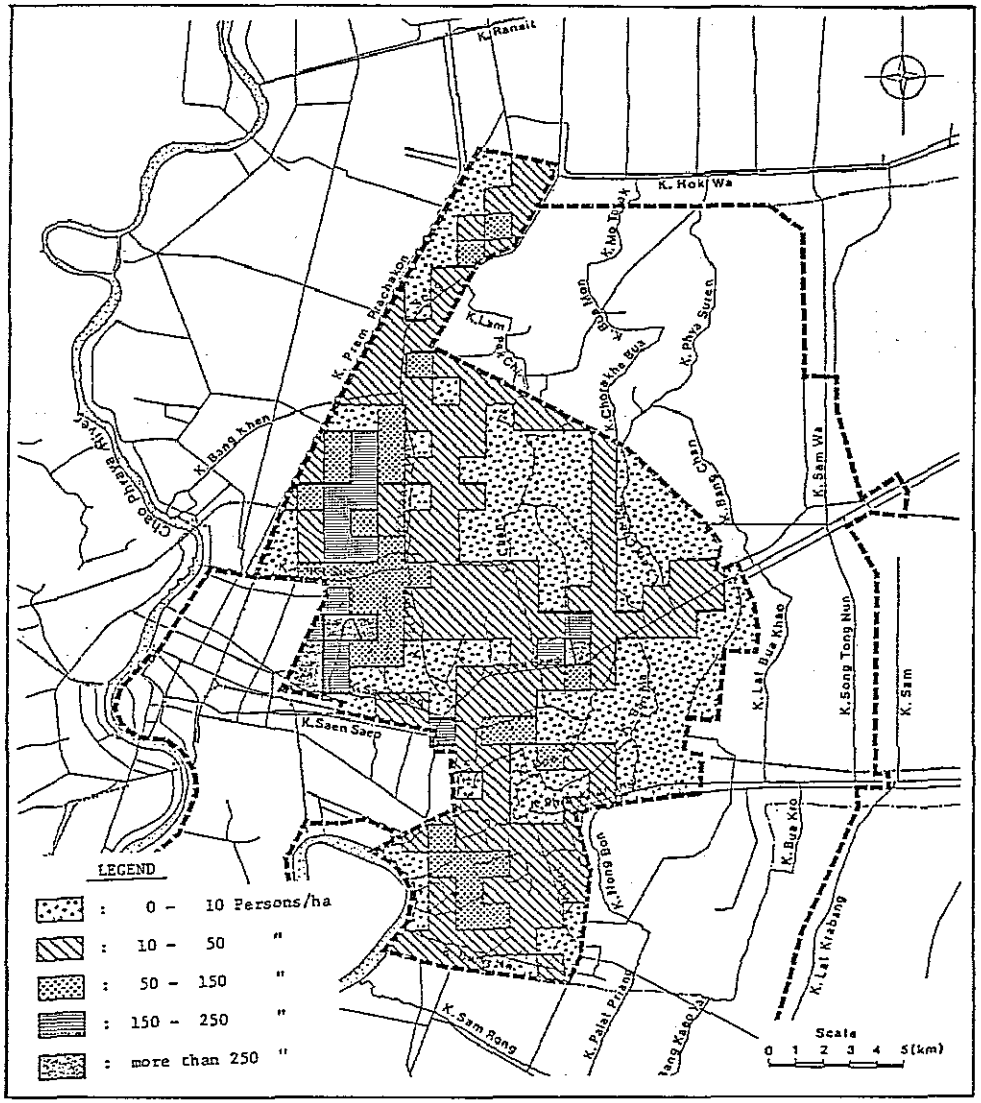


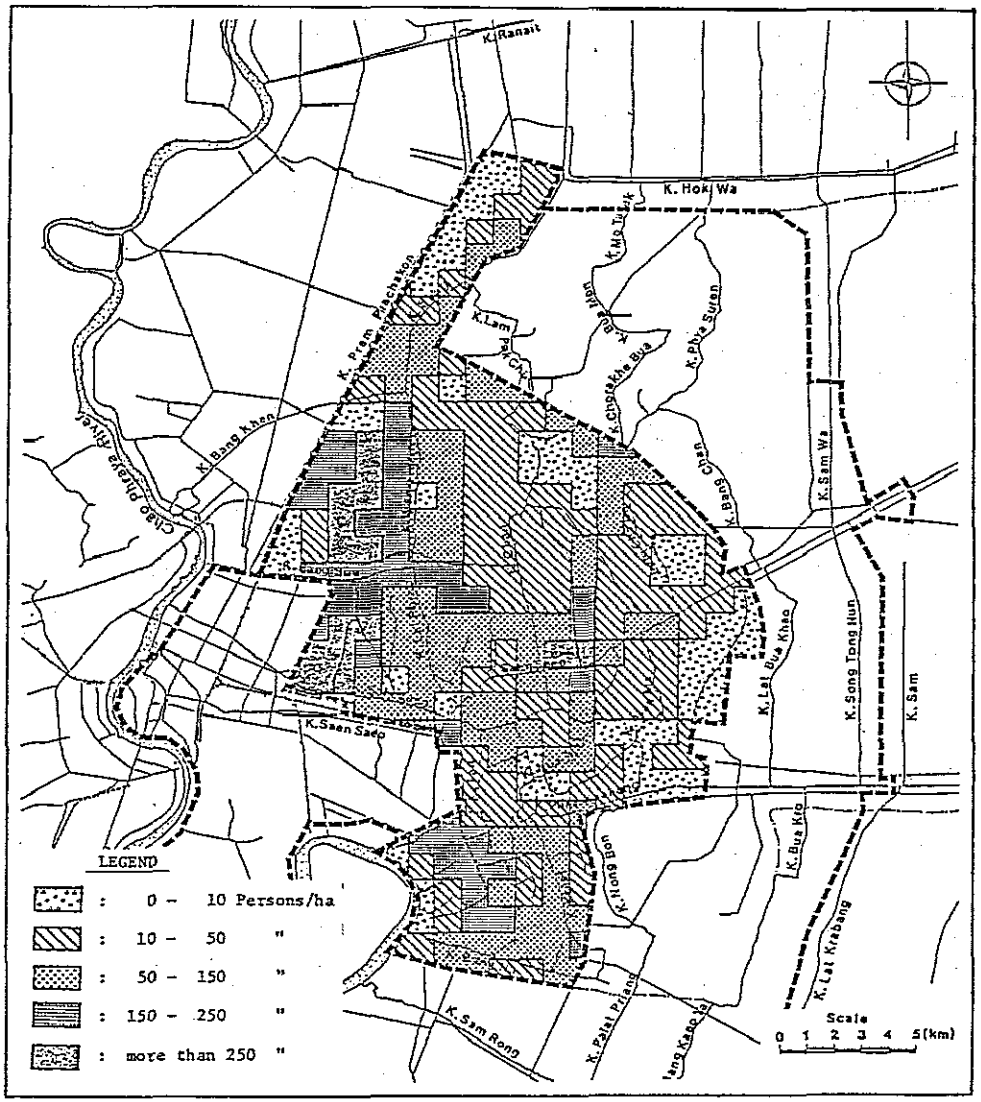
Fig. K. 11 STUDY AREA FOR MASTER PLAN OF FLOOD PROTECTION/DRAINAGE PROJECT AND BANGKOK SEWERAGE PROJECT (1981)

FEASIBILITY STUDY ON FLOOD PROTECTION/DRAINAGE PROJECT IN EASTERN SUBURBAN-BANGKOK

JICA 2529B.E 1986A.D



1983



2000

Fig. K.12	POPULATION DENSITY IN THE MASTER PLAN AREA

FEASIBILITY STUDY ON FLOOD PROTECTION/DRAINAGE PROJECT IN EASTERN SUBURBAN-BANGKOK

JICA 2529B.E 1986A.D

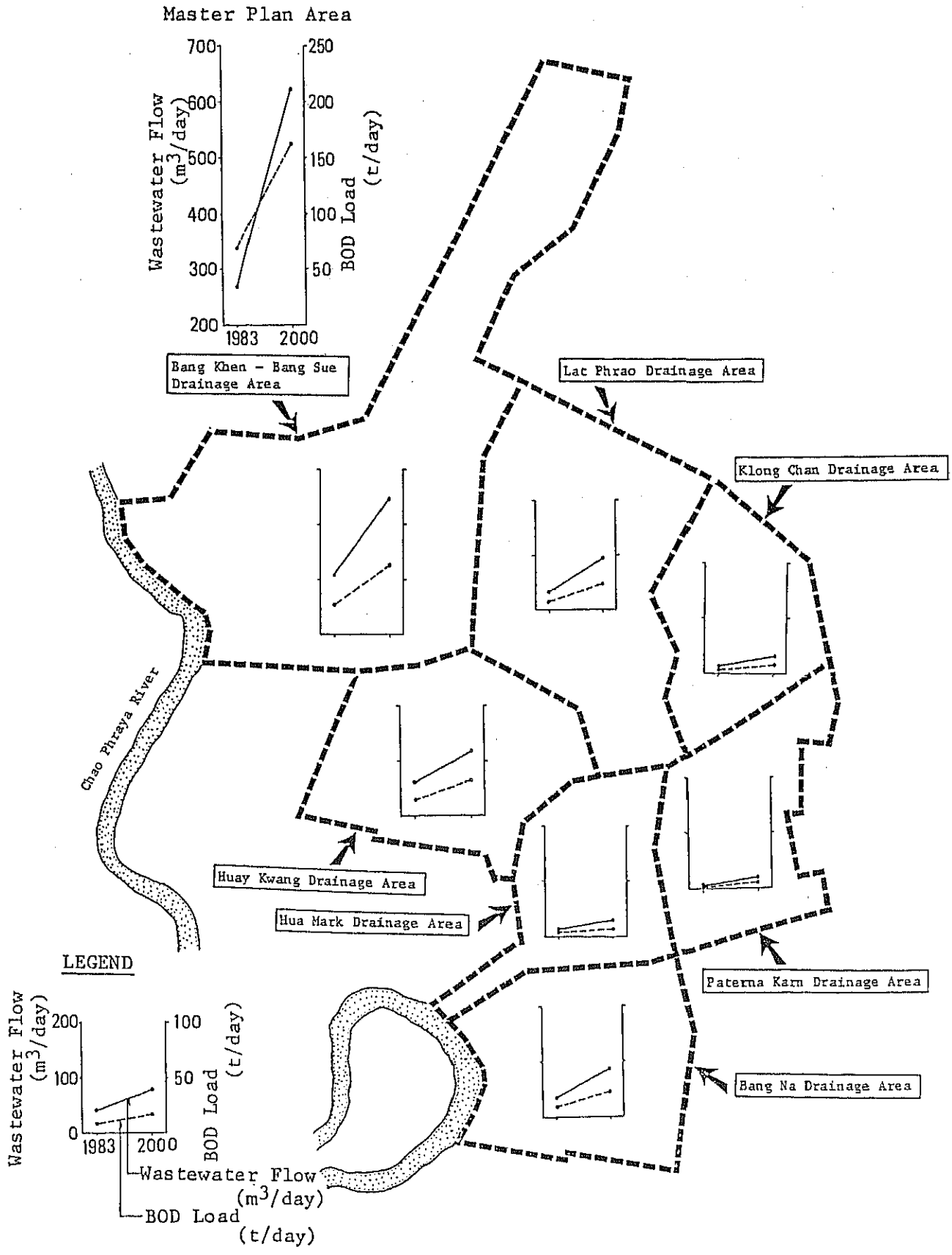
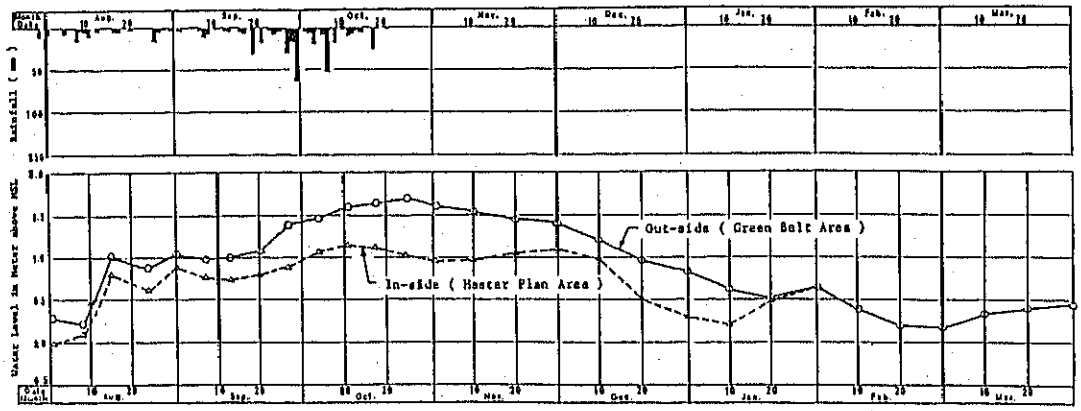


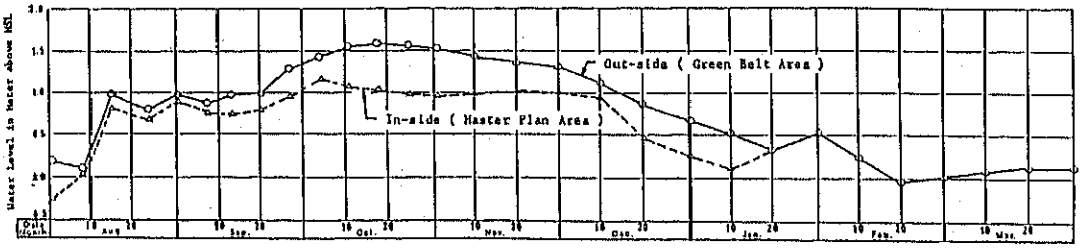
Fig. K.13 ESTIMATED WASTEWATER FLOW AND BOD LOAD IN 1983 AND 2000 AD

FEASIBILITY STUDY ON FLOOD PROTECTION/DRAINAGE PROJECT IN EASTERN SUBURBAN-BANGKOK

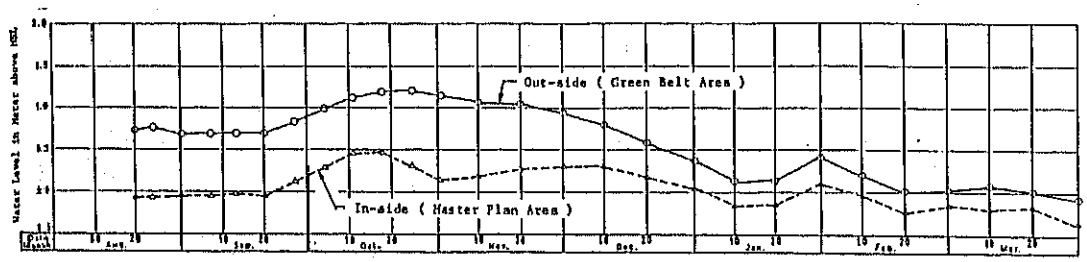
JICA 2529B.E 1986A.D



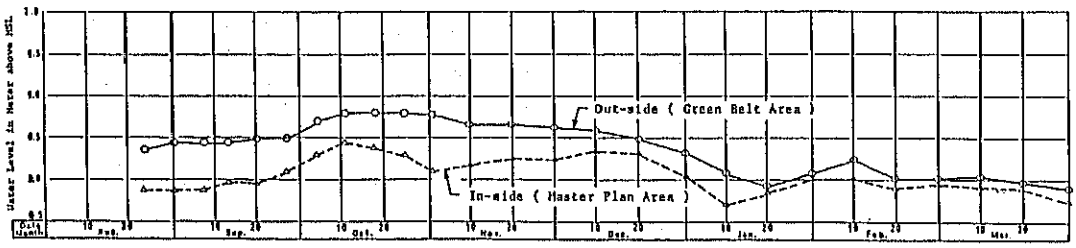
Regulator No. ① along Green Belt (K.Sai Tai)



Regulator No. ③ along Green Belt (K. Phraya Surain)

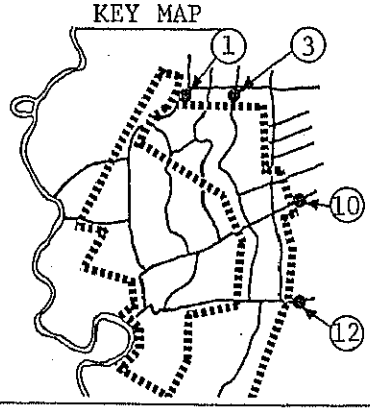


Regulator No. ⑩ along Green Belt (K.Saen Saep)



Regulator No. ⑫ along Green Belt (K.Phra Khanong)

KEY MAP



Name of Regulator

① : K. Sai Tai

③ : K. Phraya Surain

⑩ : K. Saen Saep

⑫ : K. Phra Khanong

Source : R I D

Fig. K.14 OBSERVED WATER LEVEL AT LEGULATOR ALONG GREEN BELT BETWEEN AUGUST, 1984 AND MARCH, 1985

FEASIBILITY STUDY ON FLOOD PROTECTION/DRAINAGE PROJECT IN EASTERN SUBURBAN-BANGKOK

JICA 2529B.E 1986A.D

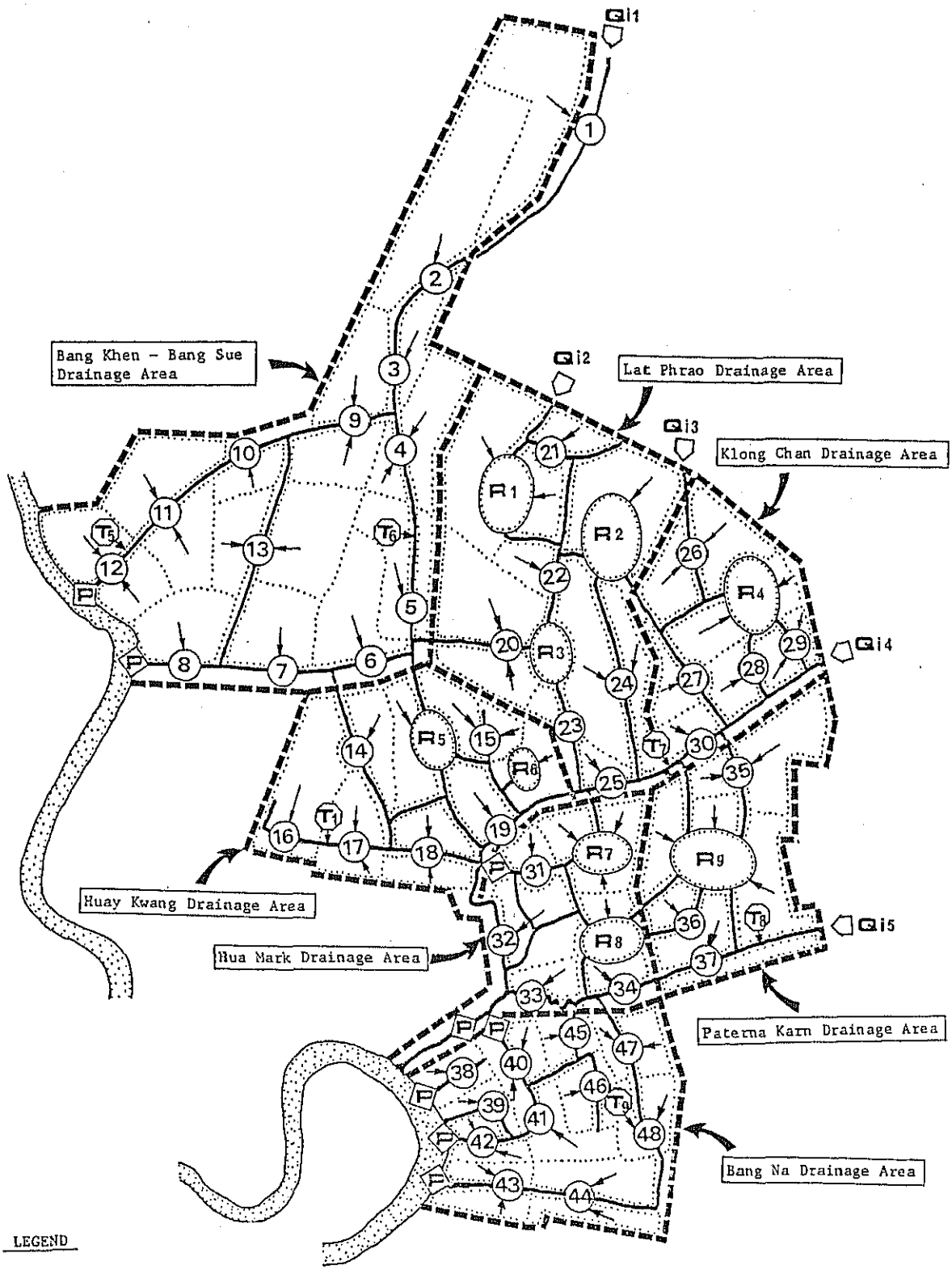
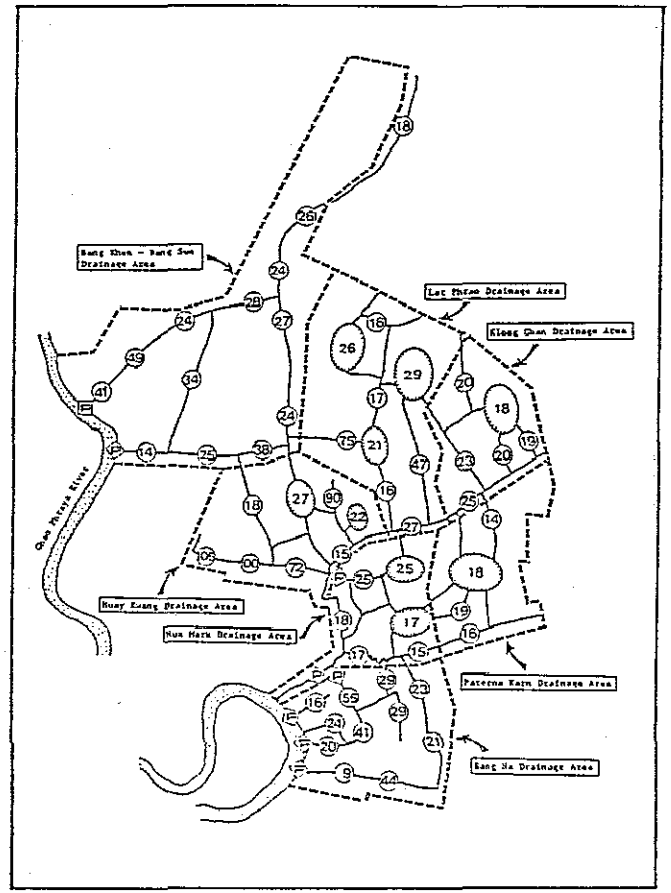


Fig. K.15 KLONG NETWORK AND LOCATION MAP OF WASTEWATER INFLOW POINTS

FEASIBILITY STUDY ON FLOOD PROTECTION/DRAINAGE PROJECT IN EASTERN SUBURBAN-BANGKOK

JICA 2529B.E 1986A.D



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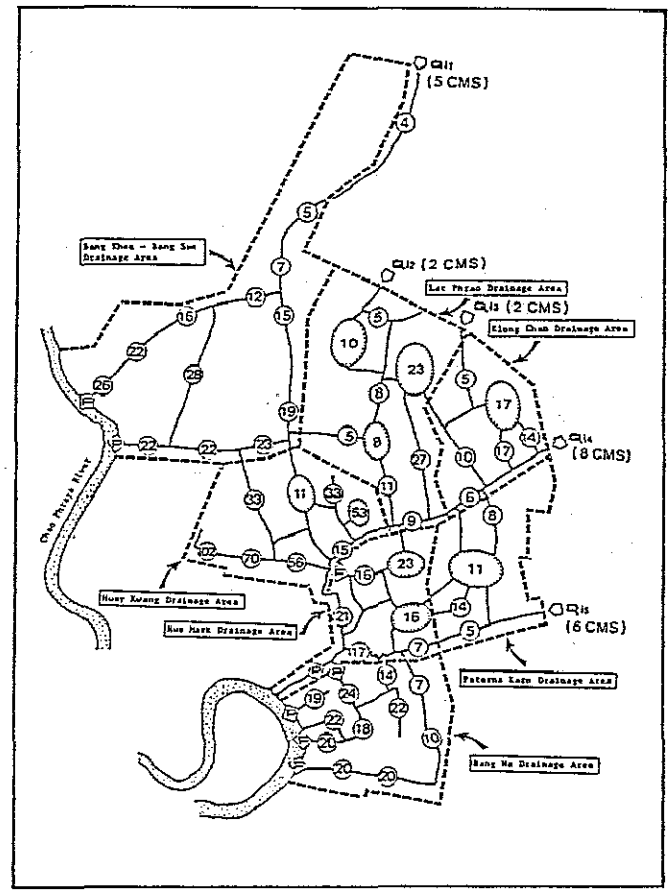

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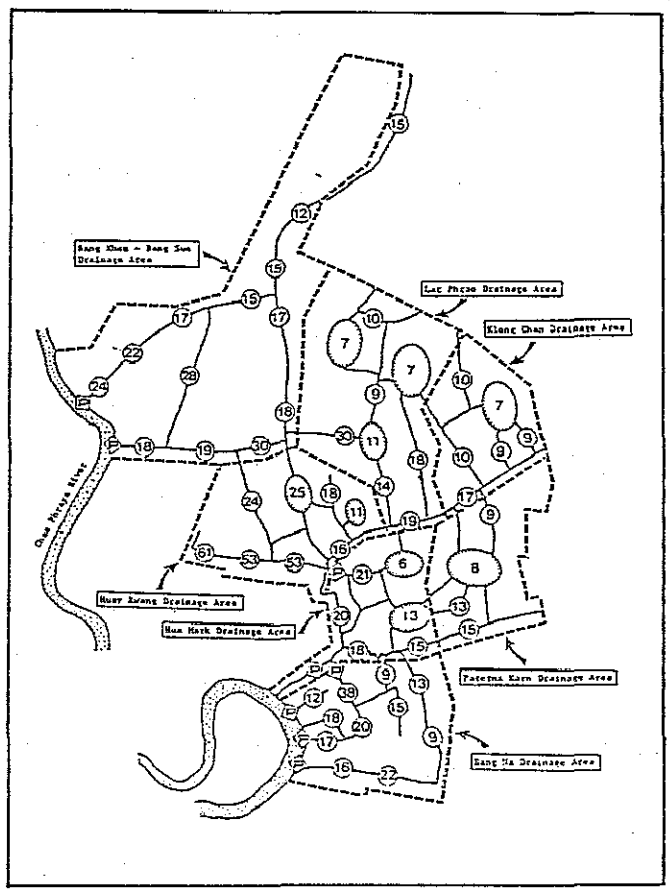


Case No : RP-001

LEGEND

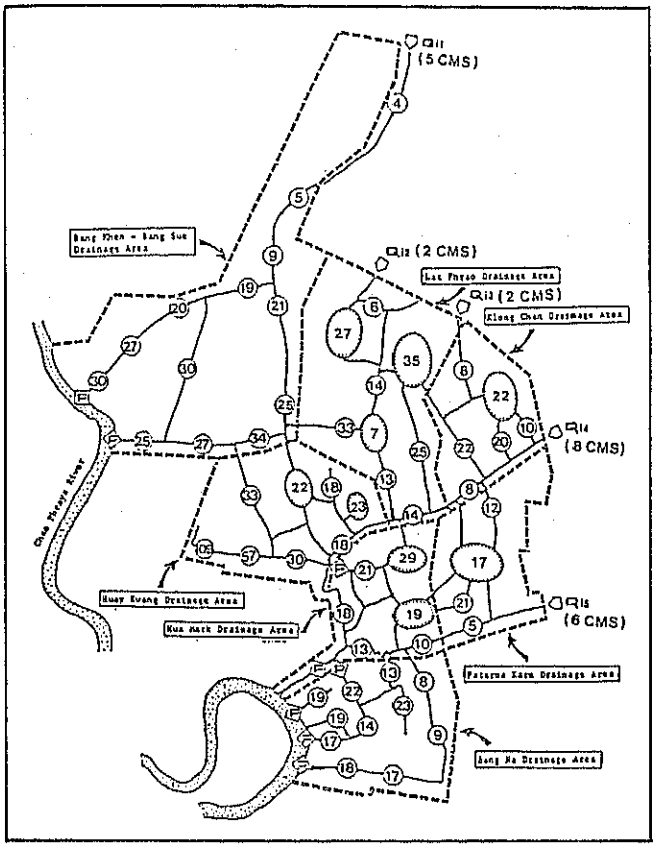
- : Boundary of Drainage Area
- (23) : BOD of Klong (ppm)
- (9) : BOD of Retarding Area (ppm)
- P : Pumping Station
- T1 : Wastewater Treatment Plant
- Qi1 : Inflow of Flushing Water

Note : Case Nos are indicated in Table K.8.

Fig. K.16 BOD DISTRIBUTION DIAGRAM IN 1983

FEASIBILITY STUDY ON FLOOD PROTECTION/DRAINAGE PROJECT IN EASTERN SUBURBAN-BANGKOK

JICA 2529B.E 1986A.D



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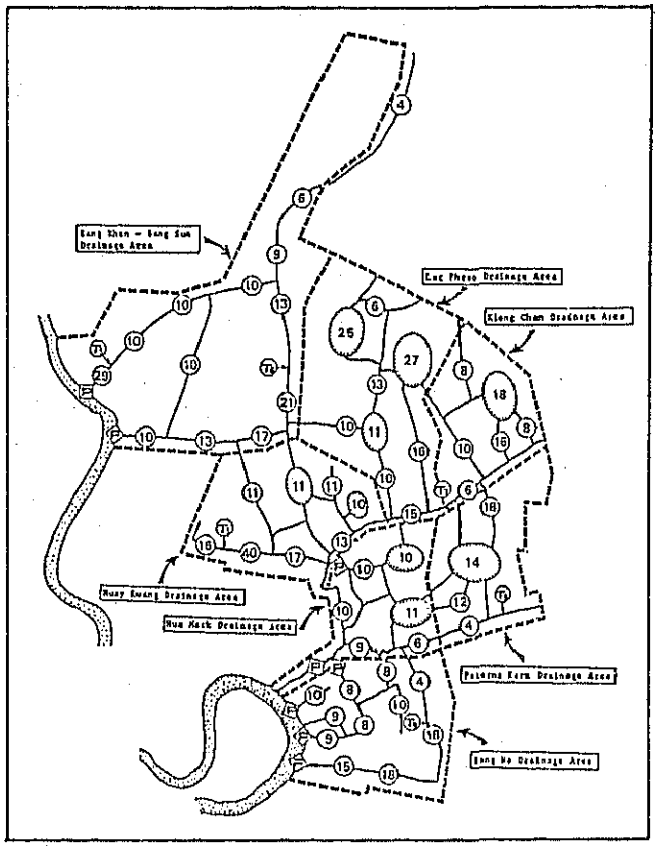

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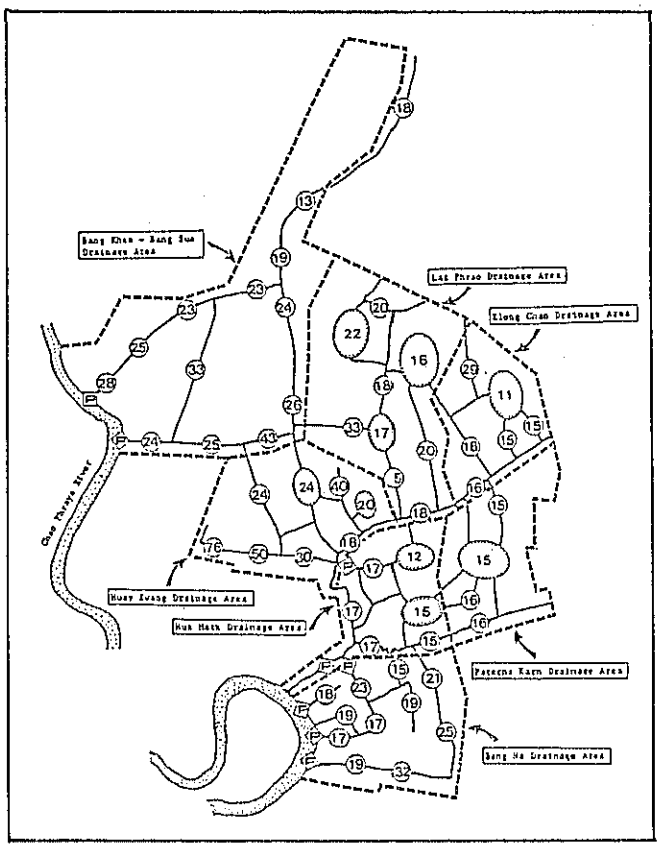

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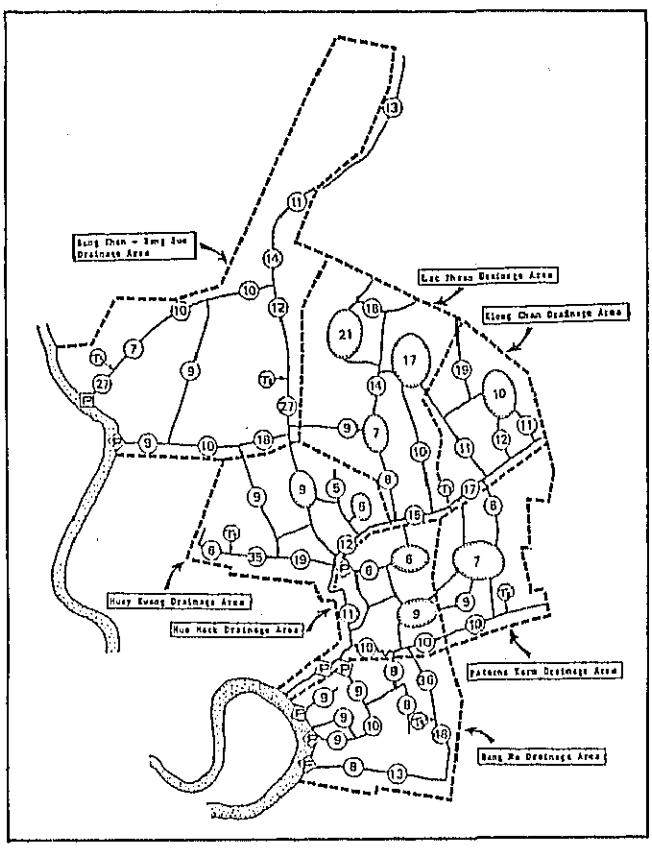


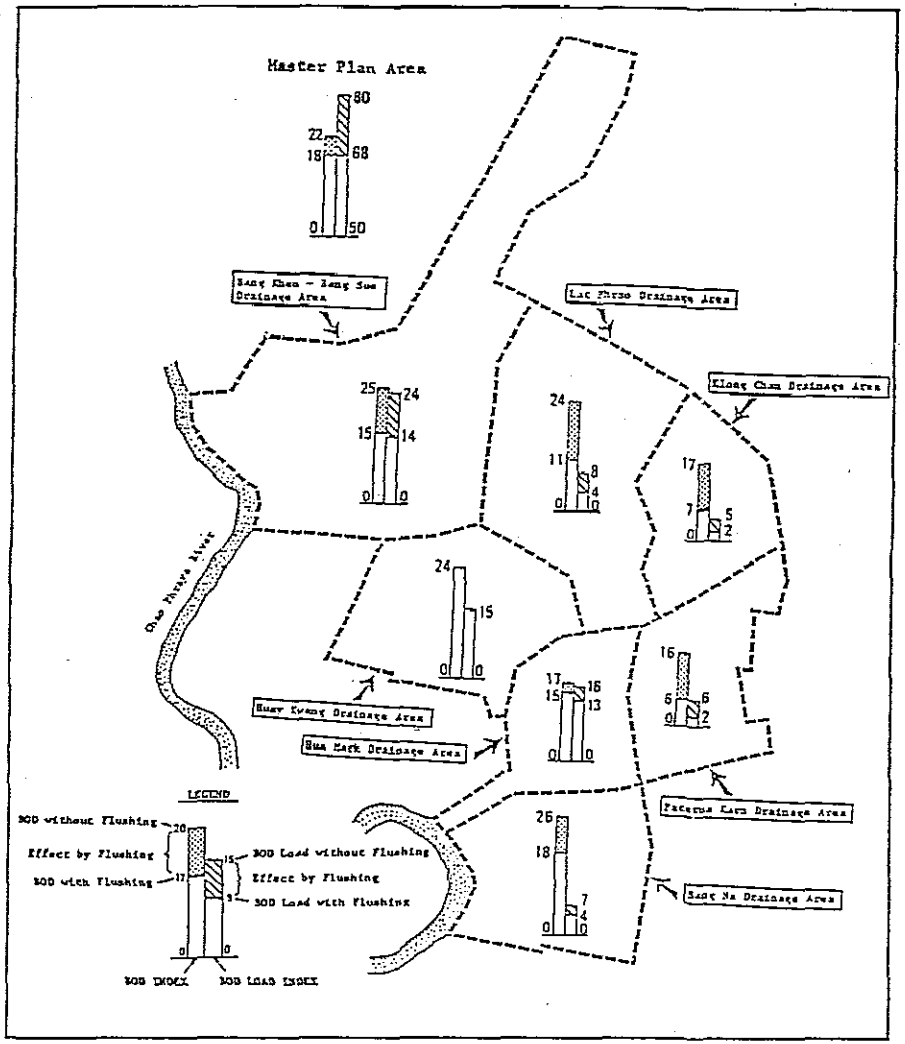
Case No : RF-002

Note : Case Nos and legend are indicated in Table K.8 and Fig. K.16 respectively.

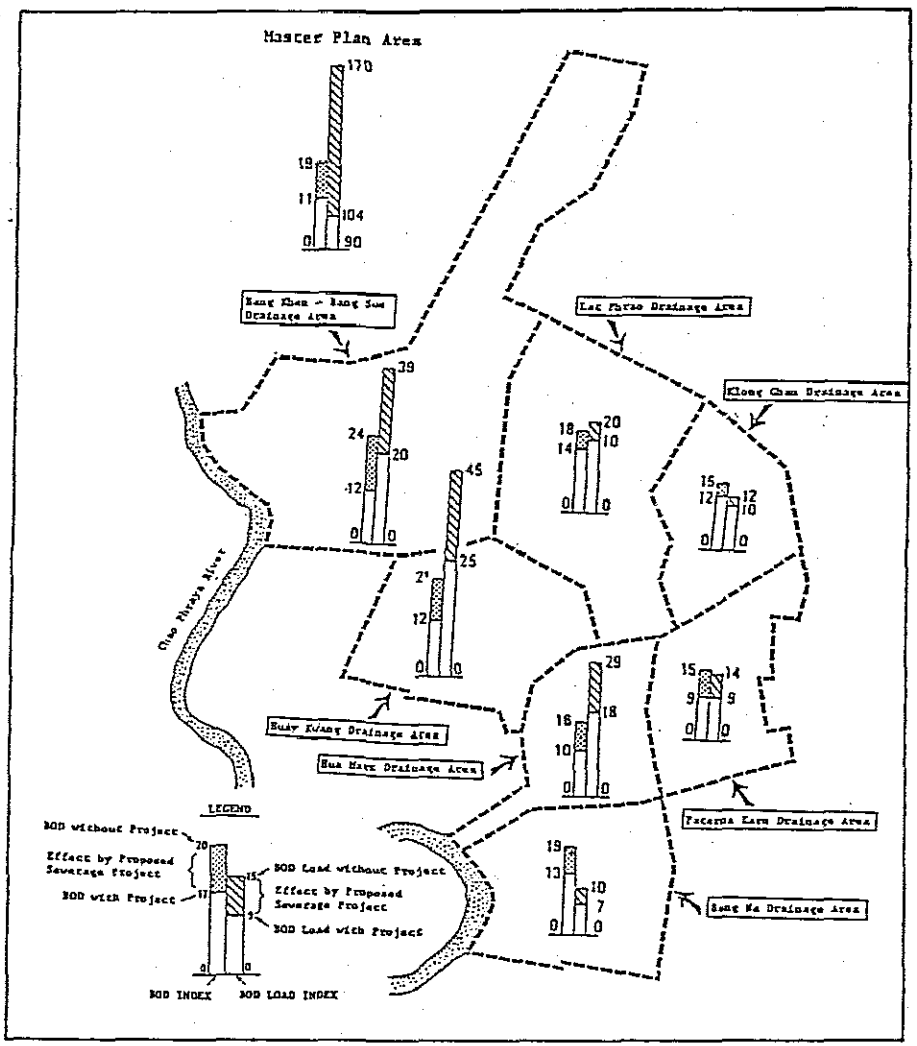
Fig. K.17 BOD DISTRIBUTION DIAGRAM IN FUTURE 2000 AD

FEASIBILITY STUDY ON FLOOD PROTECTION/DRAINAGE PROJECT IN EASTERN SUBURBAN-BANGKOK

JICA 2529B.E 1986A.D



Effect of Flushing Water from Outer Area in 1983 AD



Effect of Bangkok Sewerage Project in Future 2000 AD

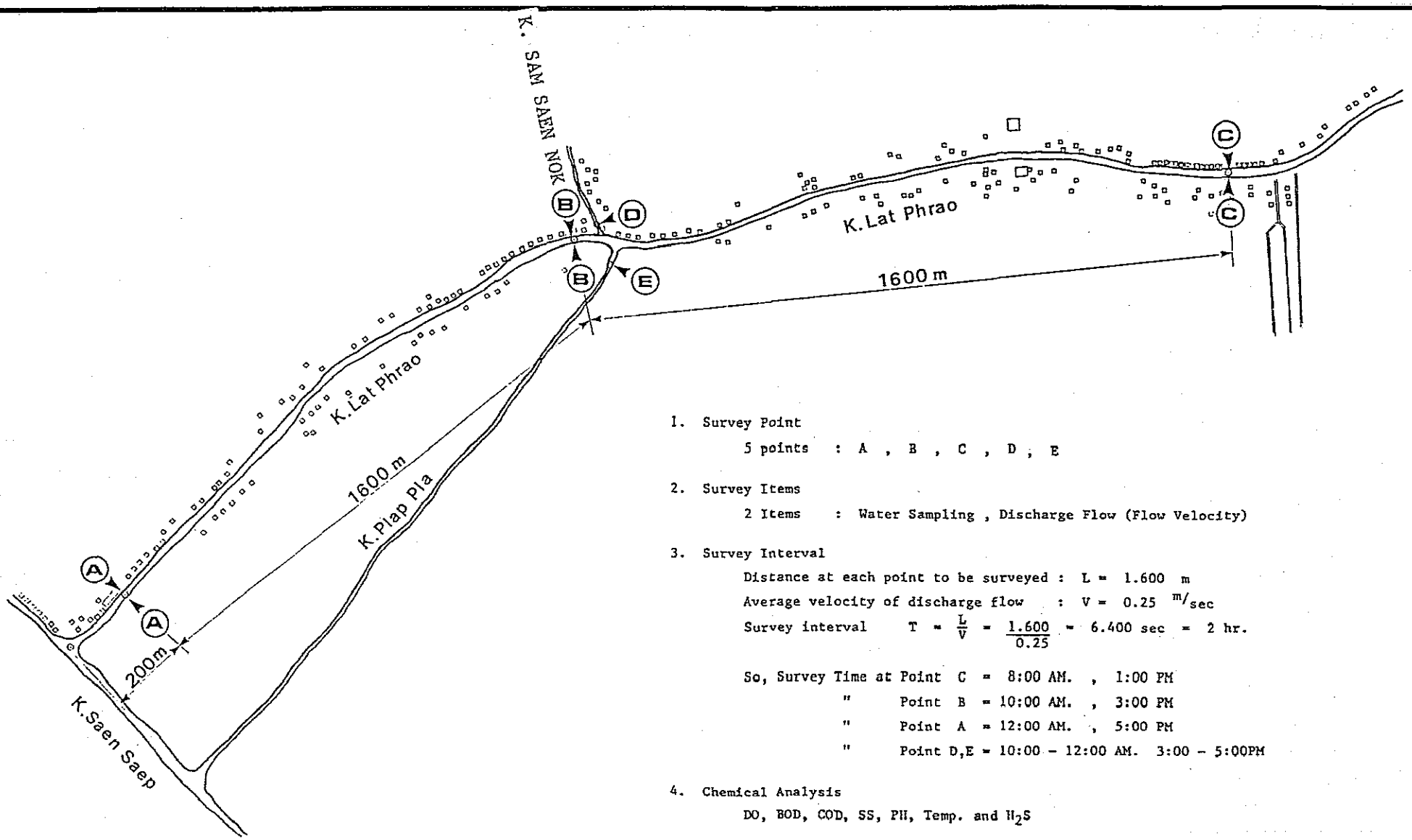
Note:1. Bangkok Sewerage Project is Master Plan proposed by JICA in 1981.

2. These effect is estimated by complete mixed flow model.

Fig. K.18	EFFECT OF FLUSHING MEASURES AND BANGKOK SEWERAGE PROJECT

FEASIBILITY STUDY ON FLOOD PROTECTION/DRAINAGE PROJECT IN EASTERN SUBURBAN-BANGKOK

JICA 2529B.E 1986A.D



1. Survey Point

   5 points : A , B , C , D , E

2. Survey Items

   2 Items : Water Sampling , Discharge Flow (Flow Velocity)

3. Survey Interval

   Distance at each point to be surveyed : L = 1.600 m

   Average velocity of discharge flow : V = 0.25 $^{m}/_{sec}$

   Survey interval $T = \frac{L}{V} = \frac{1.600}{0.25} = 6.400$ sec = 2 hr.

   So, Survey Time at Point C = 8:00 AM. , 1:00 PM

   " Point B = 10:00 AM. , 3:00 PM

   " Point A = 12:00 AM. , 5:00 PM

   " Point D,E = 10:00 - 12:00 AM. 3:00 - 5:00PM

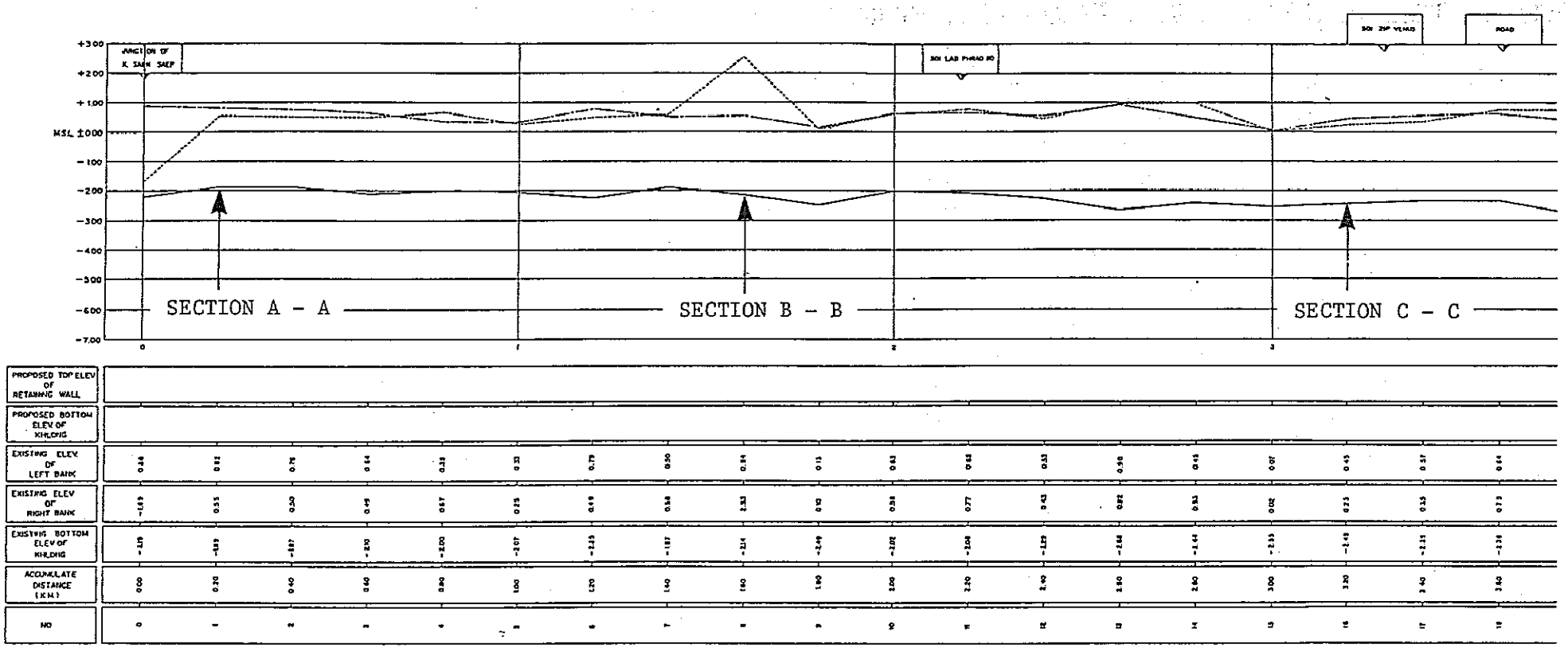
4. Chemical Analysis

   DO, BOD, COD, SS, PH, Temp. and H_2S

Fig. K.19 PLAN OF SURVEY SECTION FOR BOD REACTION COEFFICIENT

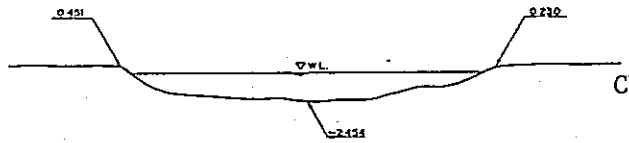
FEASIBILITY STUDY ON FLOOD PROTECTION/DRAINAGE PROJECT IN EASTERN SUBURBAN-BANGKOK

JICA 2529B.E 1986A.D



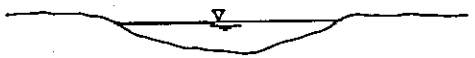
PROFILE OF K. LAT PHRAO

SECTION A - A



SECTION C - C

CROSS SECTION OF K. LAT PHRAO
SCALE : 1 / 400



SECTION D - D

CROSS SECTION OF K. SAM SAEN NOK SCALE : 1 / 300

SECTION E - E

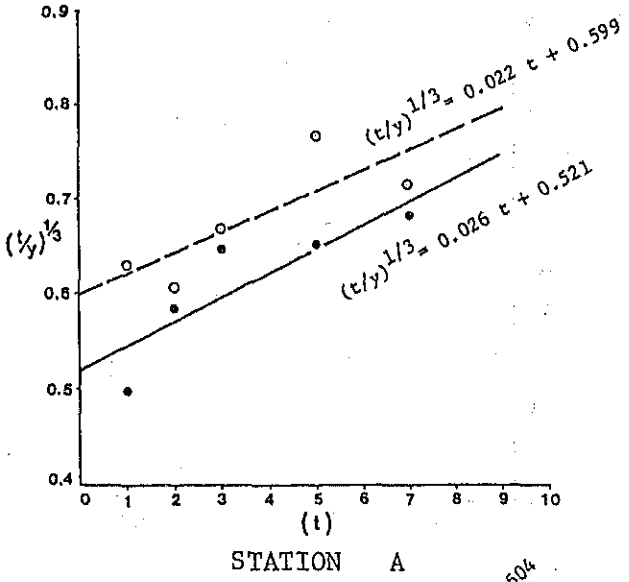
CROSS SECTION OF K. PLAP PLA SCALE : 1 / 300

SECTION B - B

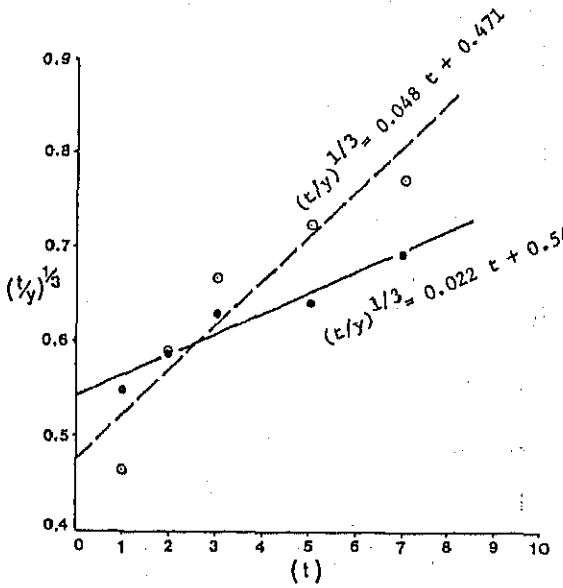
Fig. K.20 PROFILE AND CROSS SECTION OF SURVEY SECTION FOR BOD REACTION COEFFICIENT

FEASIBILITY STUDY ON FLOOD PROTECTION/DRAINAGE PROJECT IN EASTERN SUBURBAN-BANGKOK

JICA 2529B.E 1986A.D



STATION A



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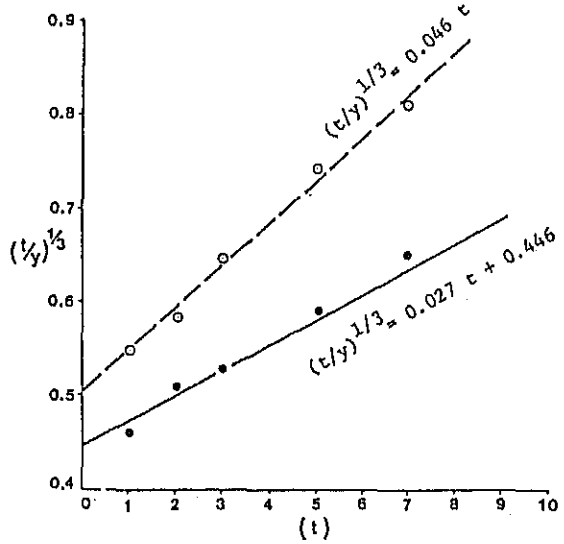
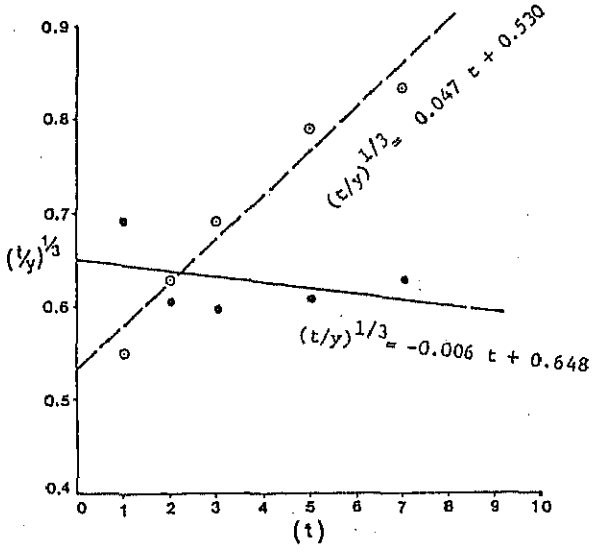
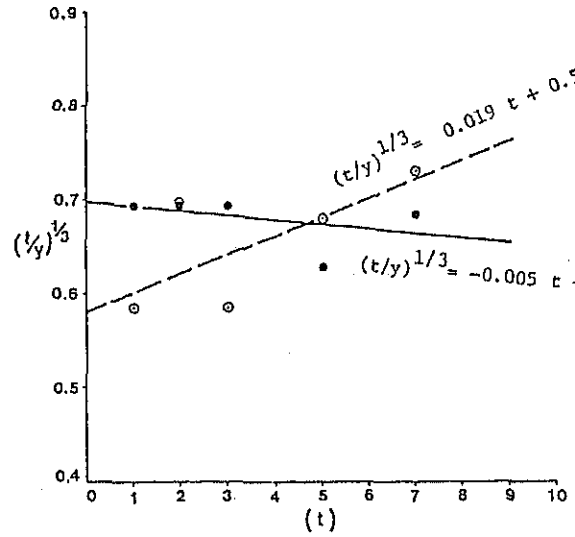


STATION C



STATION D



STATION E

LEGEND

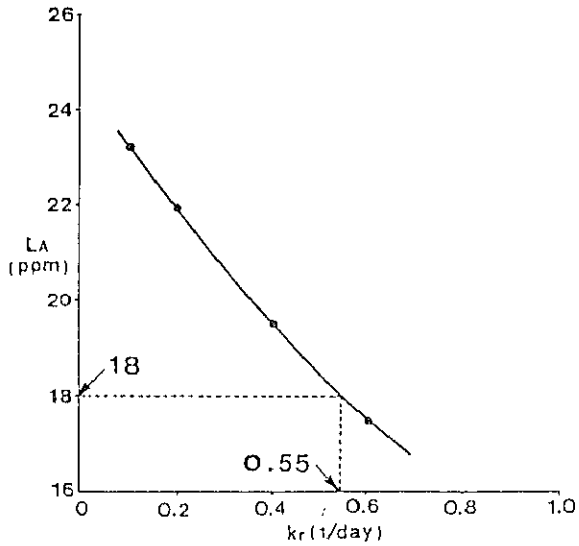
● :First Survey

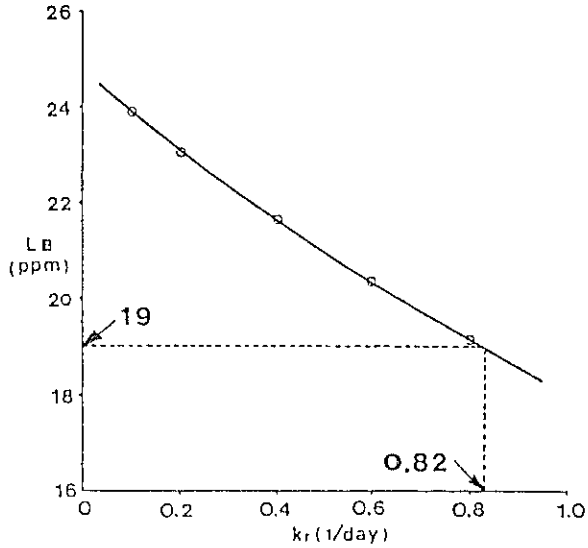
⊙ :Second Survey

Fig. K.21 RELATION BETWEEN OF (t) AND $(t/y)^{\frac{1}{3}}$

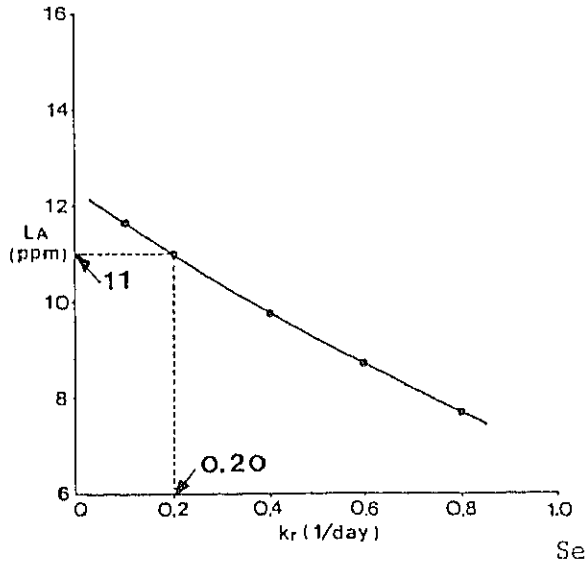
FEASIBILITY STUDY ON FLOOD PROTECTION/DRAINAGE PROJECT IN EASTERN SUBURBAN-BANGKOK

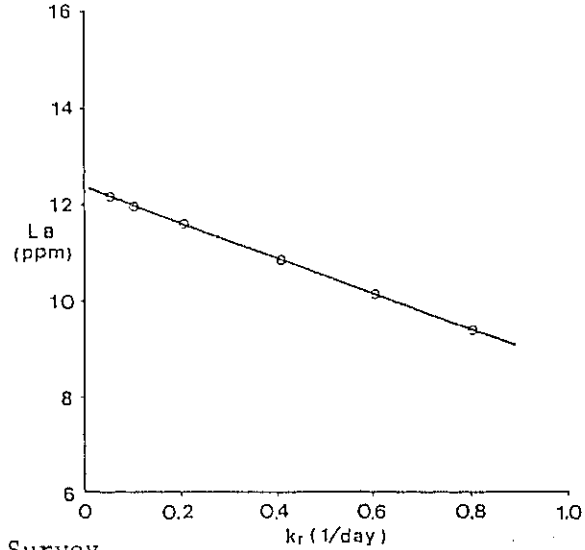
JICA 2529B.E 1986A.D



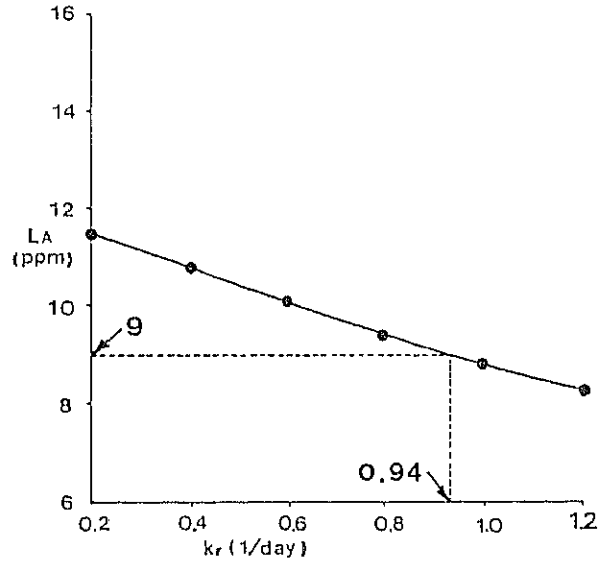


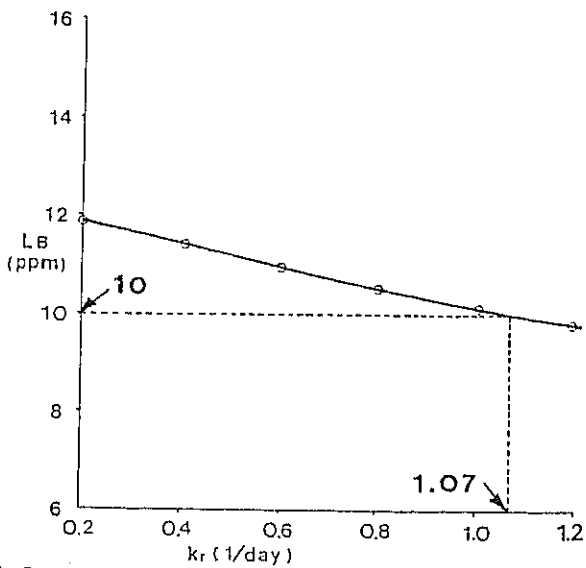
First Survey





Second Survey





Third Survey

Fig. K.22 RELATION BETWEEN LA, LB AND Kr

FEASIBILITY STUDY ON FLOOD PROTECTION/DRAINAGE PROJECT IN EASTERN SUBURBAN-BANGKOK

JICA 2529B.E 1986A.D

APPENDIX L

EVALUATION OF HYDRAULIC IMPACT TO SURROUNDINGS

APPENDIX L EVALUATION OF HYDRAULIC IMPACT TO SURROUNDINGS

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APPENDIX L. EVALUATION OF HYDRAULIC IMPACT TO SURROUNDINGS

For the implementation of the Project, environmental impact to the surroundings should be studied. In this Chapter, (1) Impact to highwater level of the Chao Phraya River caused by the planned pump discharge, (2) Hydraulic impact to the eastern paddy field located between Green Belt Area and Master Plan Area, are described.

1. Impact to High Water Level of the Chao Phraya River.

1.1 General

After implementation of the flood protection and drainage project in the City Core Area and the Eastern Suburban Area, the total pump discharge of about 420 CMS will be drained into the Chao Phraya River.

This study is made for the estimation of the water level ascension in the Chao Phraya River due to the pump discharge.

In rainy season, the low elevation and flatness of Bangkok plain over the central valley of the Lower Chao Phraya River Basin retains the rainwater for extended periods of time. In the flood plains of the Chao Phraya River from Chai Nat to Bang Sai, flooding generally extends from August to October. In the reach of the River from Bang Sai to the River mouth, flooding mainly extends from September to November. Owing to the flooding in upstream of Bangkok, the discharge near Bangkok is usually very lower than in upstream.

At present, reliable data of the discharge near Bangkok is nothing. Therefore, in this chapter, the high water levels were calculated for assumed discharge at Rama VI Bridge. The lowest stretch of the River of 60km from Rama VI Bridge to the River Mouth is a portion of analysis.

1.2 Basic Data for Analysis

1) Data of the Chao Phraya River.

The data for discharge, cross sections and high water level of the Chao Phraya River near Bangkok are obtained from the following reports.

* Salinity Instrusion in the Chao Phraya River and Mae Klong Rivers. March 1978 A.I.T.

** Flood Routing and Control Alternatives of Chao Phraya River for Bangkok. March 1985 A.I.T.

*** Preliminary Study Report on Flood Protection/Drainage Project in Eastern Suburban Bangkok, March 1983.

The past discharge in the Chao Phraya River could be collected only in the upstream and the discharge near Bangkok is nothing at all. For reference, Fig. L.1 and L.2 show the observed discharge in the upstream of the Chao Phraya River.

The high water level of the Chao Phraya River near Bangkok are recorded sufficiently to calculate the high water level of 100 year return period by the statistic analysis. These data are collected from the Preliminary Study Report on Flood Protection/Drainage Project in Eastern Suburban Bangkok.

2) Tidal Information

Table L.1 shows the tidal information of Bangkok Port, Phra Phradeng, Pak Nam, and Fort Phrachul.

Table L.1 Tidal Information of the Chao Phraya River

TIDES	BANGKOK PORT	PHRA PRADAENG	PAK MAN *	FORT PHRACHUL *
HIGHEST HIGH WATER	+1.93 m. (1978)	+1.93 m. (1970) (1978)	+2.04 m. (1970)	+2.22 m. (1970)
MEAN HIGH WATER SPRING	+1.28	+1.31	+1.35	+1.39
MEAN HIGHER HIGH WATER	+1.11	+1.10	+1.10	+1.16
MEAN HIGH WATER NEAP	+0.95	+0.95	+0.97	+0.94
MEAN HIGH WATER	+0.89	+0.94	+0.91	+0.95
MEAN TIDE LEVEL	+0.23	+0.17	+0.11	+0.13
MEAN SEA LEVEL (KO LAK STANDARD)	±0.00	±0.00	±0.00	±0.00
MEAN LOW WATER	−0.48	−0.54	−0.65	−0.63
MEAN LOW WATER NEAP	-0.71	-0.72	-0.75	-0.83
MEAN LOWER LOW WATER	-0.88	-0.94	-1.07	-1.12
MEAN LOW WATER SPRING	-1.04	-1.15	-1.22	-1.29
LOWEST LOW WATER	-1.72 (1968)	-1.78 (1967)	-1.90 (1968)	-1.79 (1956)
MEAN SPRING RANGE	2.34	2.45	2.57	2.67
MEAN NEAP RANGE	1.66	1.66	1.71	1.76
MEAN RANGE	1.99	2.04	2.18	2.24

Note: * The values are not adjusted according to Land Subsidence.
Source: Port Authority of Thailand
Period of data is from 1940 to 1981

Fort Phrachul is located at the river mouth of the Chao Phraya River. The observed tidal wave pattern on Oct. 16, 1980 (spring tide condition at Fort Pharachul was selected as boundary water stage and following two patterns were used for analysis.

Pattern A: Actual observed tidal wave (spring tide)
(HWL +1.35 LWL -1.25)

Pattern B: Modified tidal wave for high water stage of 100 year return period.
(HWLK +1.90 LWL -0.70)

3) The Pump Discharge

The pump discharge were given by the followiong reports.

* Master Plan on Flood Protection/Drainage Project in Eastern Suburban-Bangkok March 1985 JICA

** Bangkok Flood Control and Drainage Project (City Core) Feasibility Report June 1984 BFCD

*** Urgent Flood Protection Measurers 1985/2 Plan The Committee of Flood Protection and Solution in Bangkok and the Vicimity.

Fig. L.3 shows the total pump discharge on the east bank of the Chao Phraya River.

1.3 The Method of Analysis

The unsteady flow model was applied for the estimation of water stage ascension in the Chao Phraya River.

The river model for the analysis is shown in Fig. L.3.

In order to obtain high water discharge, firstly, the water stage profile of the river is calculated for 4 kinds of discharge (Q = 200, 500, 1000, 1500 m^3/s) and for tide pattern A & B. By the comparison of obtained water stage and probable water stage of 100 year return period, the discharge are obtained for each tide pattern.

Based on these obtained discharge, the impact of pump discharge i.e. the water level rise is calculated.

1.4 The Result of the Analysis

The water stage profile of the river are calculated as shown in Fig. L.5. The probable water stage of 100 year return period are also shown in the same Fig. L.5. By the comparison between both data, the discharge at Rama VI Bridge are judged as 1500 m^3/s for case 1 (spring tide) and 200 m^3/s for case 2 (100 year return period tide.

Water stage rise for tide pattern A, at 48 km, 36 km, 28 km upstream from the River Mouth are estimated as 11 cm, 4 cm and 1 cm for each point and for tide pattern B are as 21 cm, 19 cm, 16 cm respectively.

For reference, timely variation of water stage in case of 1500 m^3/s discharge are shown in Fig. L.4 for with & without cases of pump discharge.

From the result of above analysis, in conclusion, the water level rise of the Chao Phraya River by the pump discharge of Eastern Suburb and Core Area of Bangkok is judged in the order of 20 cm at maximum for design rainfall.

1.5 Recommendation for Further Study

The analysis mentioned above, are only a sample analysis for general understanding on the problem. Following studies are recommended to be made for grasping more detailed information.

1) Collection of Data

At present, reliable data of the discharge of the Chao Phraya River near Bangkok is quite a few. Basic data is needed to be collected.

2) Survey on flooding in Upstream of Bangkok

Flooding upstream of Bangkok affects so largely to the discharge near Bangkok. Therefore actual flooding status in upstream of Bangkok is needed to be grasped especially for seasonal phenomenum.

3) Study on Simalteneous Occurance of Highwater Discharge and High Tide

From the result of the study by the Study Team, it is found that in case of simalteneous accurrance of highwater discharge of the Chao Phraya River and Highest tide, large flood in near Bangkok will occur. Fortunately, in the past such cases was not occured owing to the large flooding in upstream of Bangkok. On this regard, more detailed investigation is necessary to be made.

Tide Wave Pattern	Original Discharge of Chao Phraya R. Qo (m3/S)	Distance from River Mouth / Pump Discharge	48Km H.W.L. Zmax	48Km H.W.L. Δh (m)	48Km L.W.L. Zmin	48Km L.W.L. Δh (m)	36Km H.W.L. Zmax	36Km H.W.L. Δh (m)	36Km H.W.L. Zmin	36Km H.W.L. Δh (m)	28Km H.W.L. Zmax	28Km H.W.L. Δh (m)	28Km L.W.L. Zmin	28Km L.W.L. Δh (m)
A	500	Without	+1.74	0.18	-0.76	0.41	+1.64	0.15	-0.81	0.39	+1.54	0.15	-0.85	0.35
		With	+1.92		-0.35		+1.79		-0.42		+1.69		-0.50	
	1000	Without	+1.95	0.10	-0.15	0.42	+1.80	0.10	-0.35	0.41	+1.71	0.09	-0.48	0.37
		With	+2.05		+0.27		+1.90		+0.06		+1.80		-0.11	
	1500	Without	+2.10	0.11	+0.50	0.49	+1.88	0.04	+0.15	0.42	+1.76	0.01	-0.08	0.39
		With	+2.21		+0.99		+1.92		+0.57		+1.77		+0.31	
	2000	Without	+2.28	0.21	+1.16	0.42	+1.96	0.18	+0.67	0.42	+1.77	0.15	+0.34	0.41
		With	+2.49		+1.58		+2.14		+1.09		+1.92		+0.75	
	3000	Without	+3.14	0.30	+2.47	0.38	+2.56	0.30	+1.73	0.41	+2.22	0.27	+1.24	0.41
		With	+3.44		+2.85		+2.86		+2.14		+2.49		+1.65	
B	200	Without	+2.17	0.21	-0.62	0.31	+2.07	0.19	-0.59	0.29	+1.99	0.16	-0.58	0.26
		With	+2.38		-0.31		+2.26		-0.30		+2.15		-0.32	
	500	Without	+2.33	0.16	-0.36	0.35	+2.21	0.17	-0.39	0.32	+2.11	0.14	-0.41	0.29
		With	+2.49		-0.01		+2.38		-0.07		+2.28		-0.12	
	1000	Without	+2.53	0.08	+0.17	0.37	+2.39	0.11	+0.06	0.30	+2.29	0.11	-0.10	0.33
		With	+2.65		+0.54		+2.50		+0.36		+2.40		+0.23	
	1500	Without	+2.70	0.04	+0.75	0.39	+2.49	0.04	+0.44	0.39	+2.39	0.01	+0.25	0.35
		With	+2.74		+1.14		+2.53		+0.83		+2.40		+0.60	
	2000	Without	+2.81	0.11	+1.37	0.39	+2.52	0.09	+0.92	0.39	+2.35	0.07	+0.63	0.37
		With	+2.92		+1.76		+2.61		+1.32		+2.42		+1.00	
	3000	Without	+3.46	0.27	+2.61	0.37	+2.93	0.26	+1.90	0.40	+2.63	0.23	+1.45	0.38
		With	+3.73		+2.98		+3.19		+2.30		+2.86		+1.83	

Note 1. Tidal Ware Pattern A: Observed Water Stage on Oct. 26, 1980 at Fort Chula (HWL +1.35, LWL -1.25)
B: Modefied Water Stage of Pattern A (HWL +1.90, LWL -0.70)

2. Pump discharge (Qi) Qi = 424CMS

3. Δh is water stage ascension in meter

Table L.2 Water Stage Ascesion affected by the pump discharge

2. Hydraulic Impact to the eastern paddy area located between Green Belt Area and Master Plan Area.

2.1 Purpose

The eastern paddy area (319 sq.km) located between the Green Belt area and the master plan area is excluded from the master plan.

This area is now mostly the paddy field and has a large storm water retarding function for lessenning flood damage in eastern suburban area.

The purpose of this study are to estimate hydraulic impact to this area by the implementation of flood protection/drainage project in eastern suburban-Bangkok.

2.2 The Method of Analysis

The four basins storage model was applied as shown in Fig. L.6

The conditions of analysis are as follows.

- Rainfall ..... 5-years frequency of daily rainfall and three month durations.
- Land Subsidence .. Without (present) and with (future AD2000) land subsidence.
- Pump Discharge ... The capacities of Sam Rong pumping station are 75 CMS executed by the urgent flood protection measures of 1984 and 1985 stage.

2.3 The Result

The results are shown in Fig. L.6 and L.7.

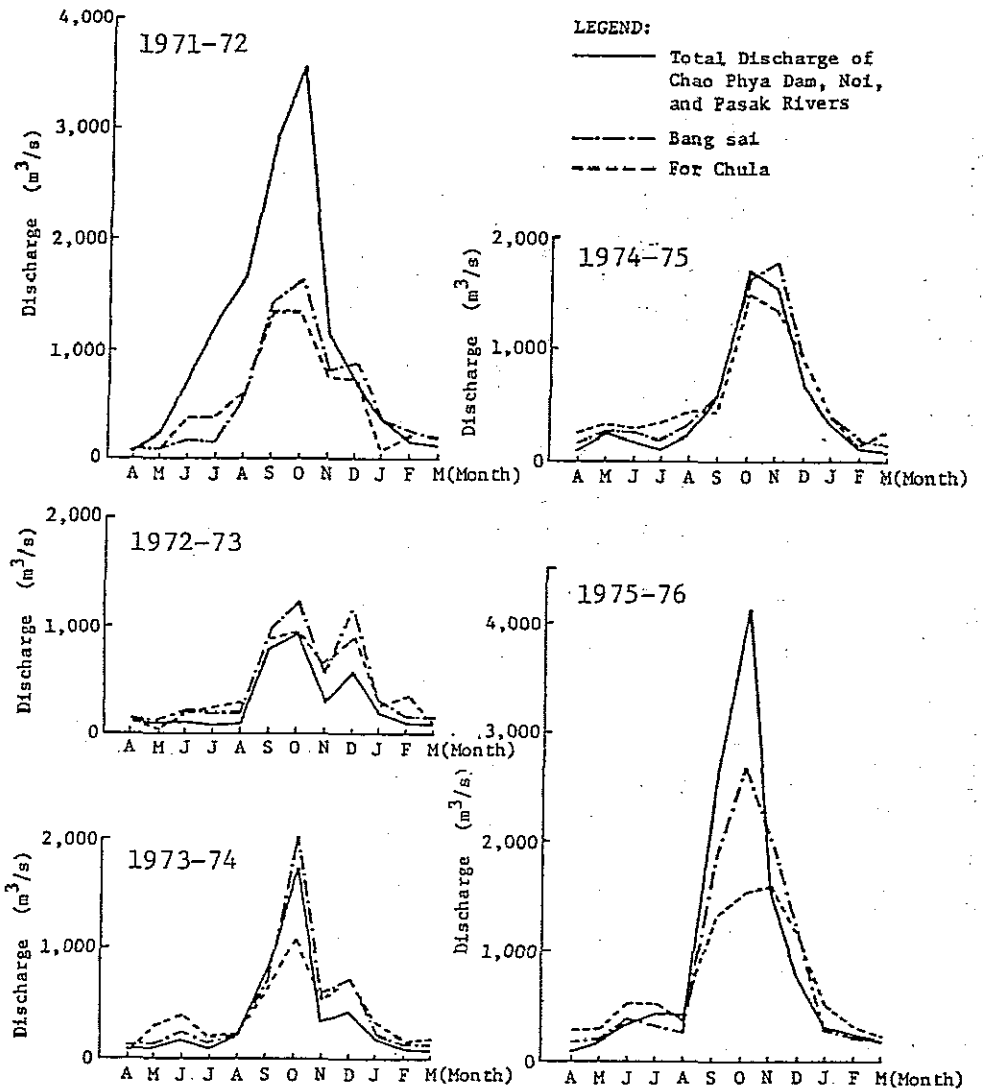
Fig. L.6 shows the maximum inundation depth above average paddy field land level and average duration period corresponded to calculated cases.

Fig. L.7 shows the variation of water stage due to the executed drainage facilities i.e. Sam Rong pumping station.

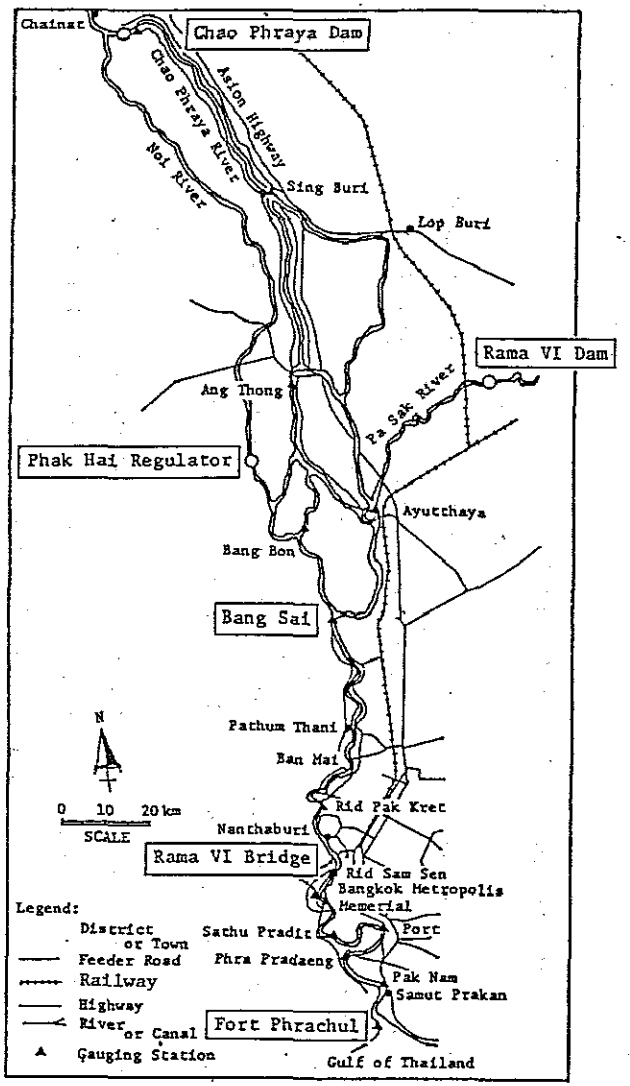
Before the execution of the Urgent Measures (before 1983 AD), the eastern paddy area are used to be flooded by large inflow from the outer area during flood Seasen mostly from September to November. Flood depth varies place by place. According to the breaf analysis made by the Study Team, maximum flood depth above average paddy field land level are estimated as 1.0 meter at northern part (Basin 4 in Fig. L.6) and 0.7 meter at Southes part (Basin 2 in Fig. L.6) for 5-year return period rainfall. And flooding period are estimated as about 4 months.

These flooding status are greatly improved by the execution of the Urgent Measures, especially by the construction of Sam Rong Pumping Station and the improvement of Klong Sam Rong. It can be seen from the Fig. L.7. In Fig. L.7, maximum flood depth at northern parts is estimated as about 40cm and at sourthern parts is about 20cm above average land level. And inundated duration is very lessened, 40 days in northern parts and 15 day in southern parts.

Even in 2000AD, maximum inundation depth is 50cm and maximum duration is 60 days in northern parts and very low in sourthern parts.



(1) Observed Discharge of the Chao Phraya River



(2) Location of Gauging Stations along the Chao Phraya River at Its Tribu

Source: Salinity Inotrusion in the Chao Phraya River and Mae Klong Rivers March, 1978. AIT

Fig. L.1 OBSERVED DISCHARGE OF THE CHAO PHRAYA RIVER

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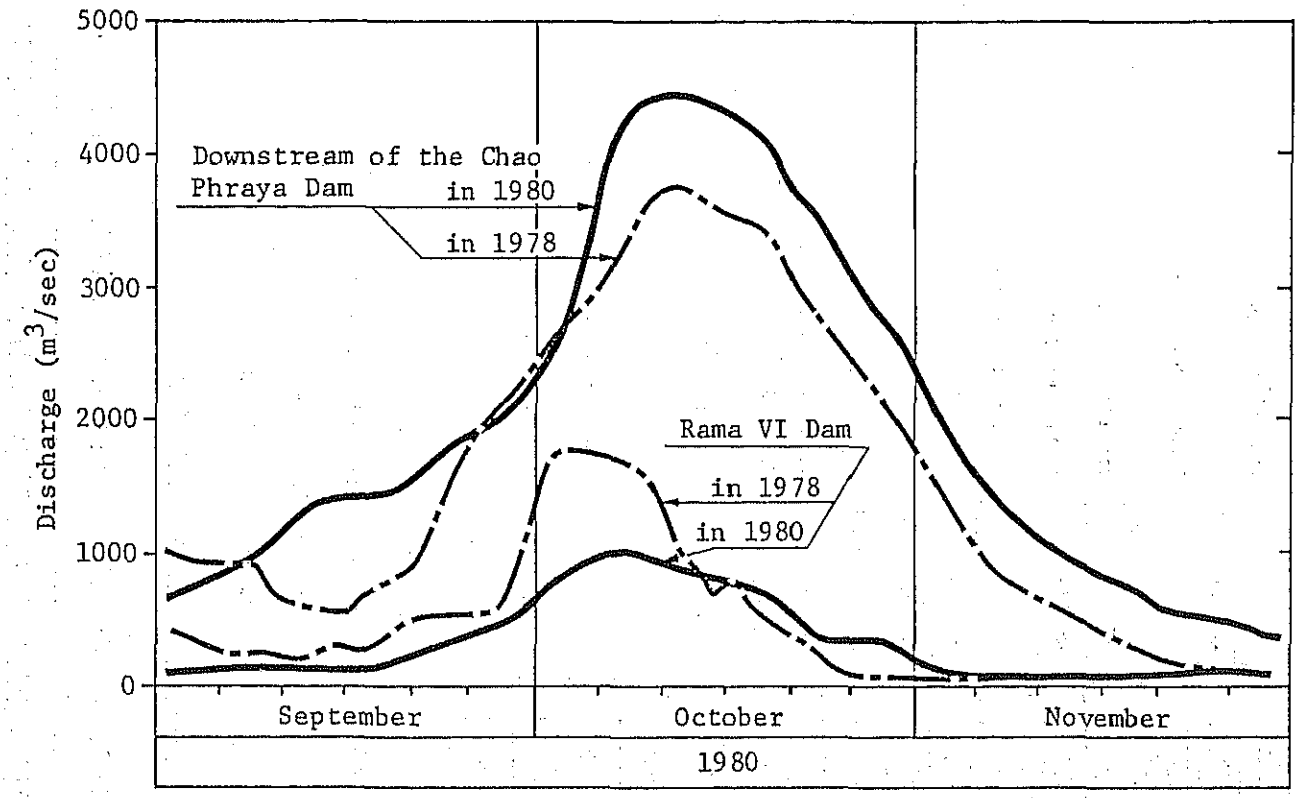
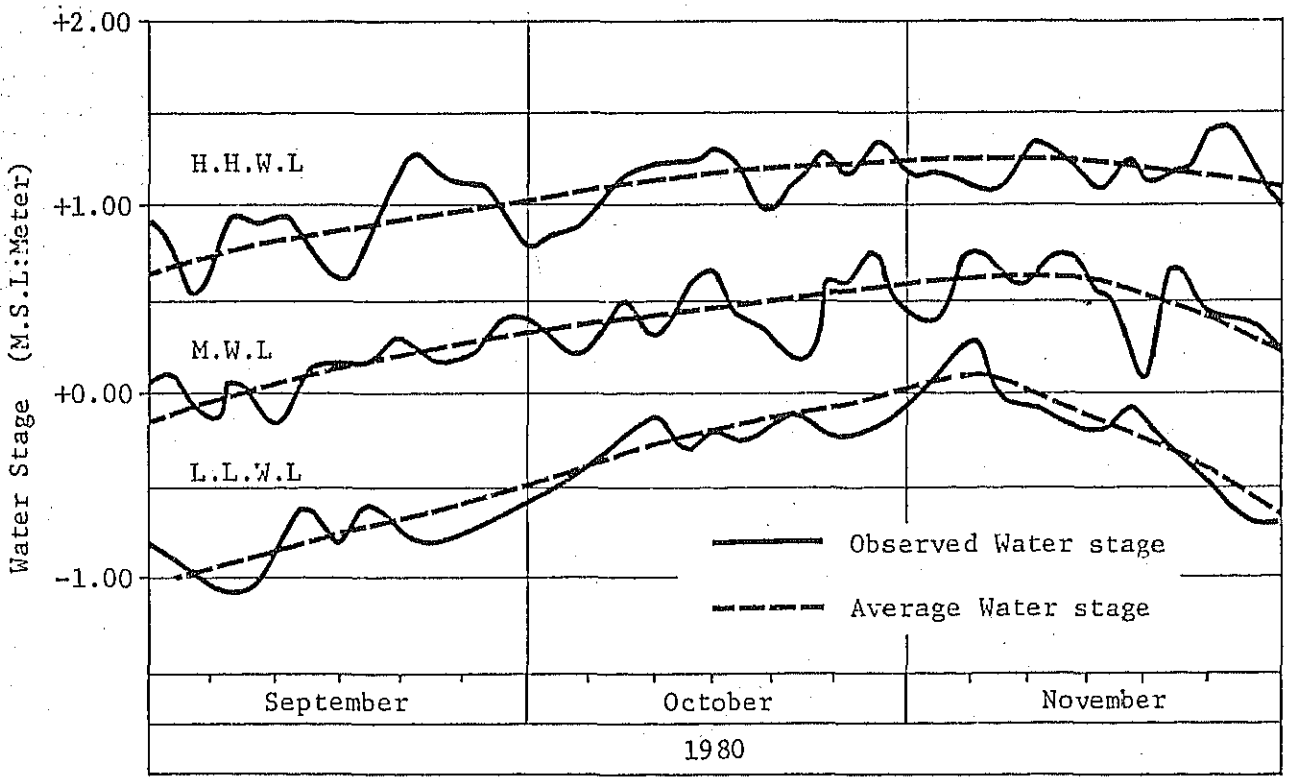


Observed Discharge Source; [Flood Routing And Control Alternatives of Chao Phraya River for Bangkok. AIT March 1985]



Water stage at Bangkok Port Source: [Master Plan on Flood Protection Drainage Project in Eastern Suburban-Bangkok JICA March 1985]

Fig. L.2 OBSERVED DISCHARGE AND WATER STAGE IN THE CHAO PHRAYA RIVER

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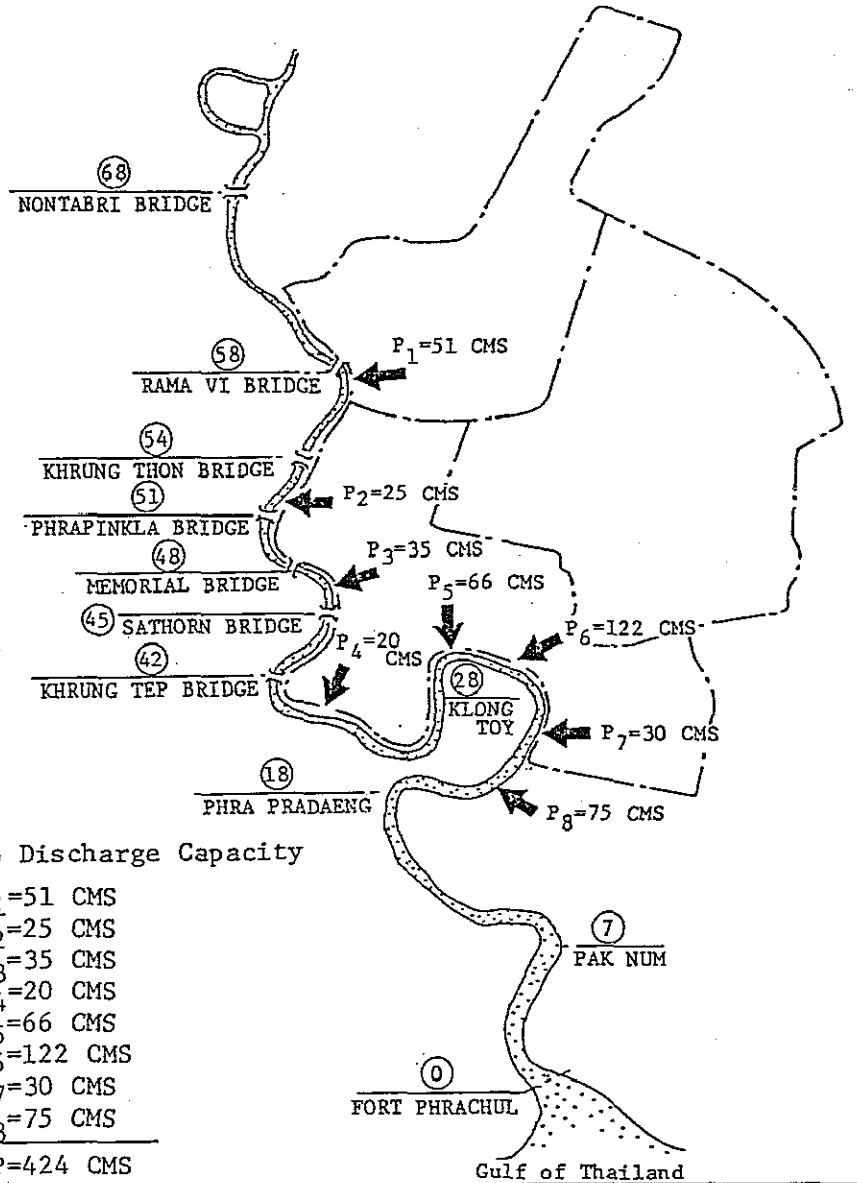
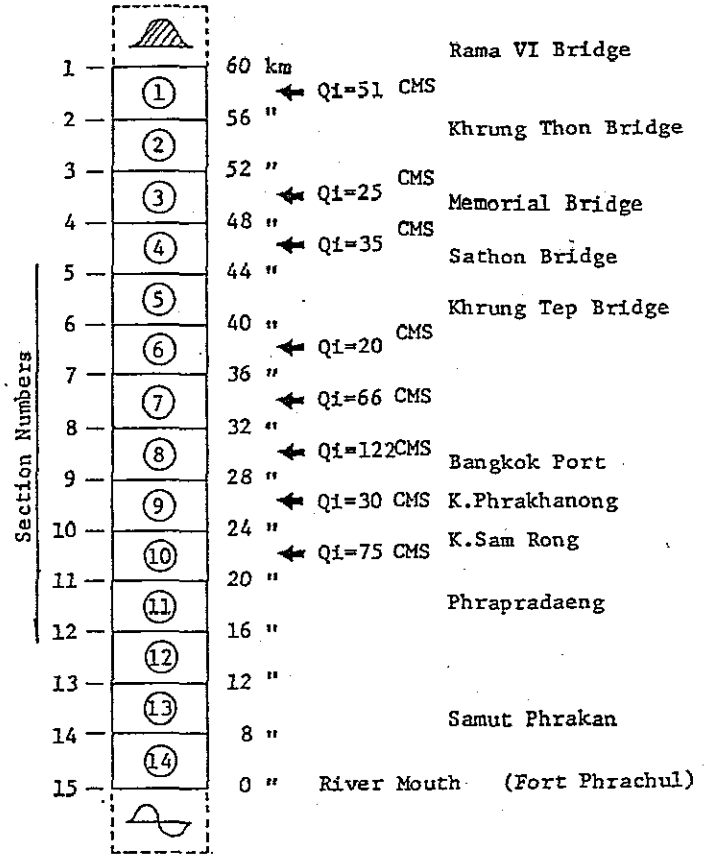


Total pump Discharge Capacity

P_1	51 CMS
P_2	25 CMS
P_3	35 CMS
P_4	20 CMS
P_5	66 CMS
P_6	122 CMS
P_7	30 CMS
P_8	75 CMS
P	424 CMS

Pump Discharge

⑧ : Number inside shows kilometer from river mouth.



Legend:
- Boundary discharge at Rama VI bridge
- Boundary water stage of the river
- Inflow by pump discharge
- ① Number of Simulation Block

River Model for Analysis

Fig. L.3 PLANNED PUMP DISCHARGES AND RIVER MODEL FOR ANALYSIS

FEASIBILITY STUDY ON FLOOD PROTECTION/DRAINAGE PROJECT IN EASTERN SUBURBAN-BANGKOK

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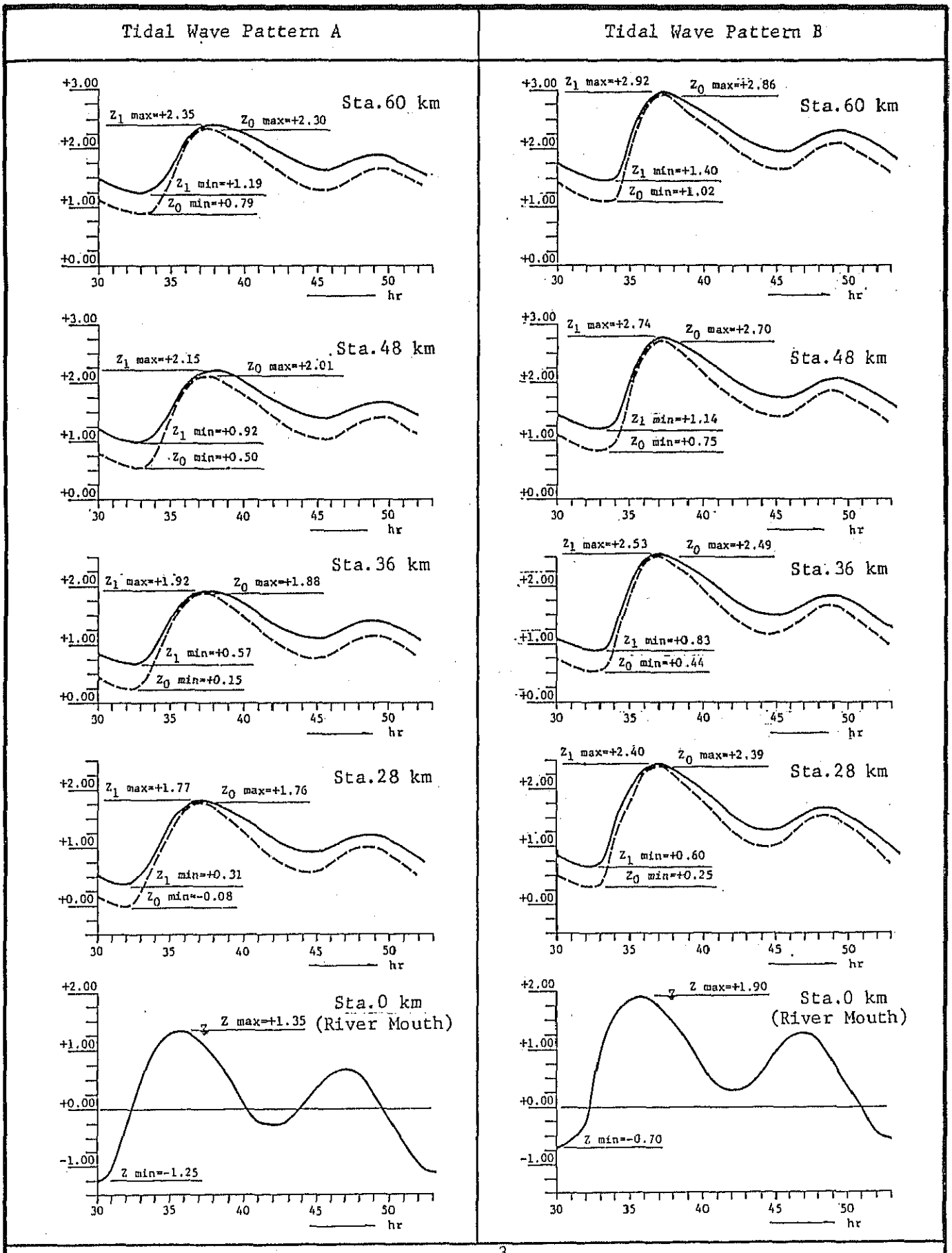

Legend —— With pump Discharge qi=424 m^3/sec

– – – Without Pump Discharge qi= 0 m^3/sec

Original Discharge of Chao Phraya R. Qo=1500 m^3/sec

Fig. L.4 WATER STAGE VARIATION AT RAMA VI BRIDGE (IN CASE OF 1500 CMS)

FEASIBILITY STUDY ON FLOOD PROTECTION/DRAINAGE PROJECT IN EASTERN SUBURBAN-BANGKOK

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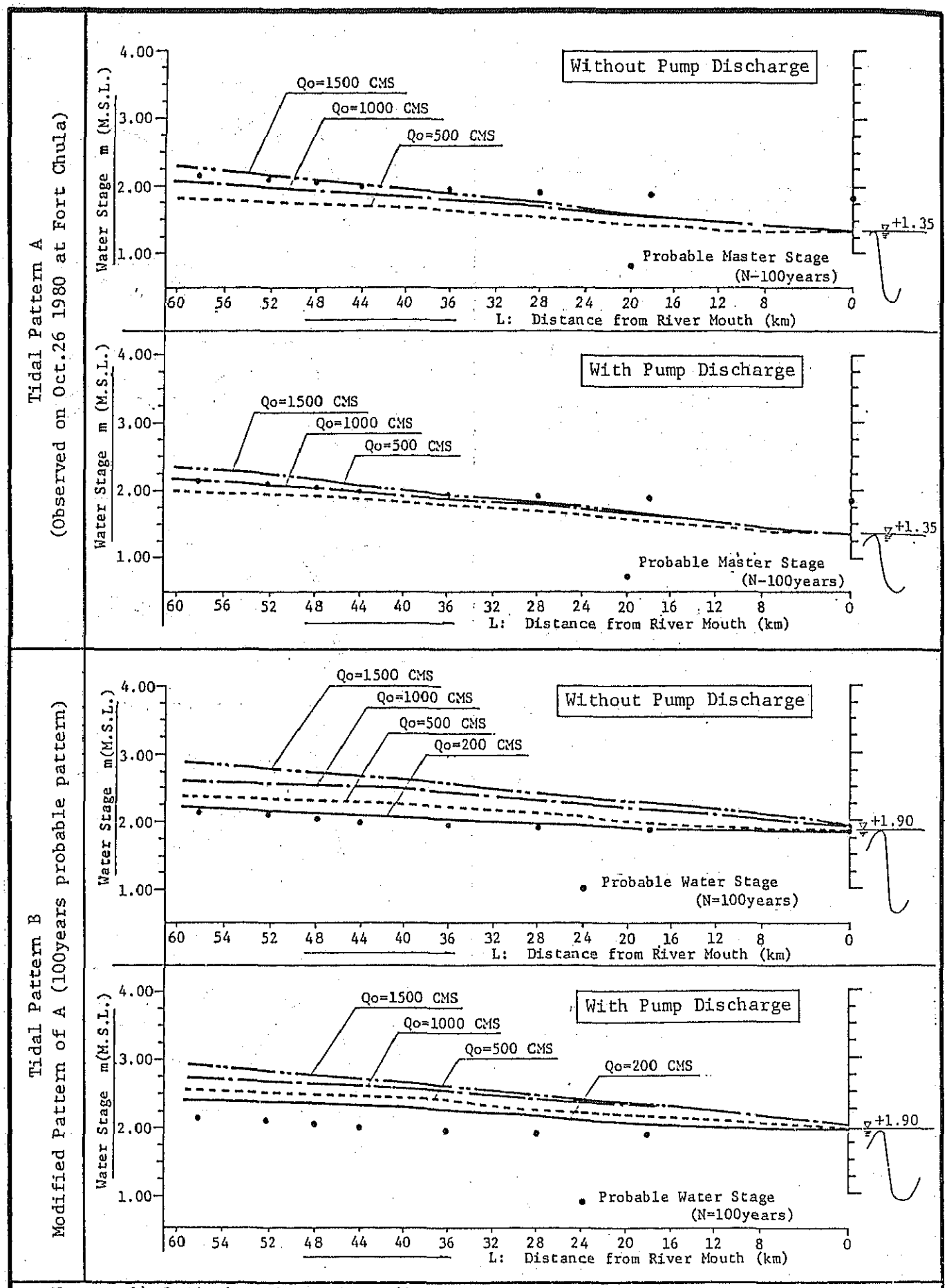

Note: 1) Qo is boundary river discharge at Rama VI bridge
2) This mark is 100years probable water stage

Fig. L.5 ANALYSED WATER STAGE PROFILE NEAR RIVER MOUTH

FEASIBILITY STUDY ON FLOOD PROTECTION/DRAINAGE PROJECT IN EASTERN SUBURBAN-BANGKOK

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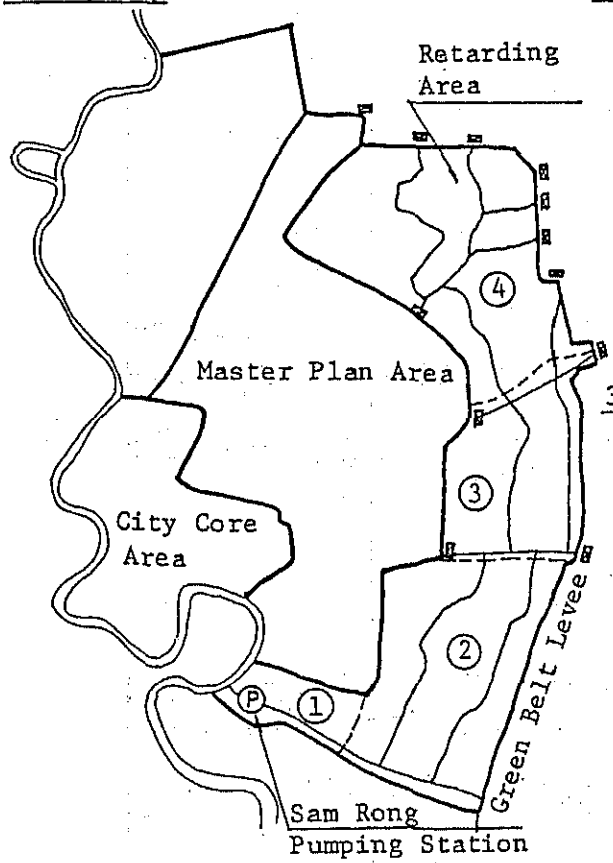
1) Key Map



2. Calculation Cases

CASE	Topo-graphy	Pump Capacity	Green Belt	2nd Barrier (Gate)	Klong Section
A	Present (1984)	3 CMS	Nothing	Nothing	Same as present
B	"	75 CMS	Existing	"	"
C	"	75 CMS	"	Existing	"
D	Future (2000)	75 CMS	"	"	"

3. Conditions of Analysis

1) Model : Storage Basin Model
2) Rainfall : 5 years Freq. Scale. AD1980 Pattern
3) Boundary Water Level : 100 years Freq. Scal. in Chao Phraya R. AD1980 Pattern at Bangkok Port
4) Boundary Inflow : Same as result of verification for flooding in 1980

Result of Analysis

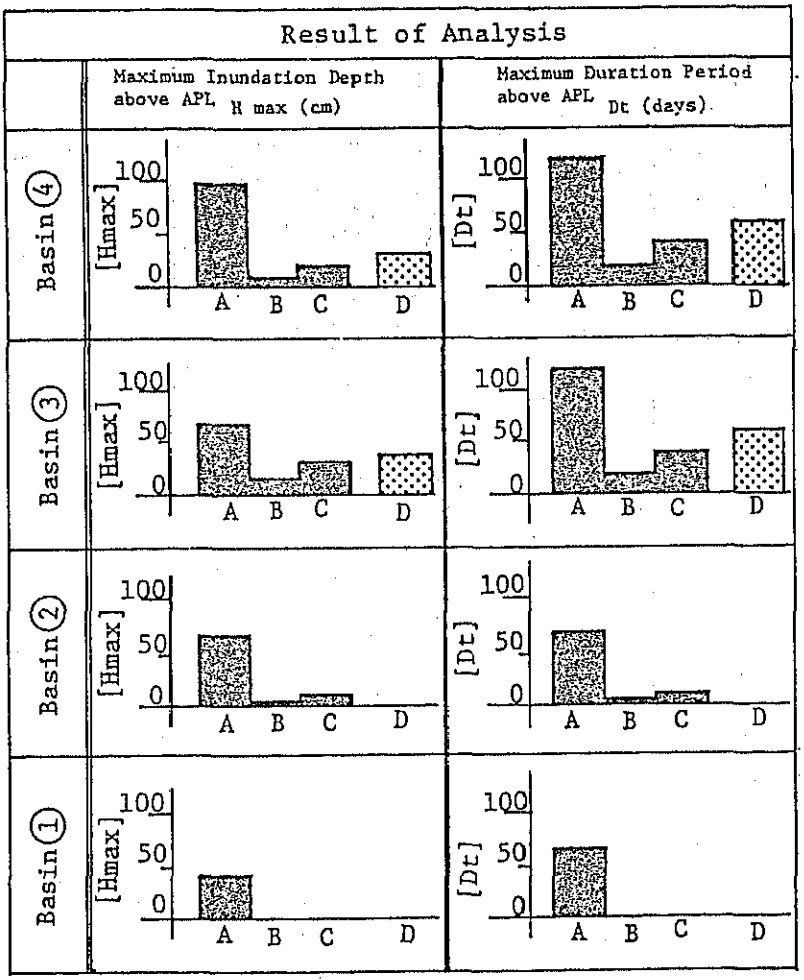


Fig. L.6 IMPACT OF THE PROJECTS TO THE RETARDING AREA -(1)

FEASIBILITY STUDY ON FLOOD PROTECTION/DRAINAGE PROJECT IN EASTERN SUBURBAN-BANGKOK

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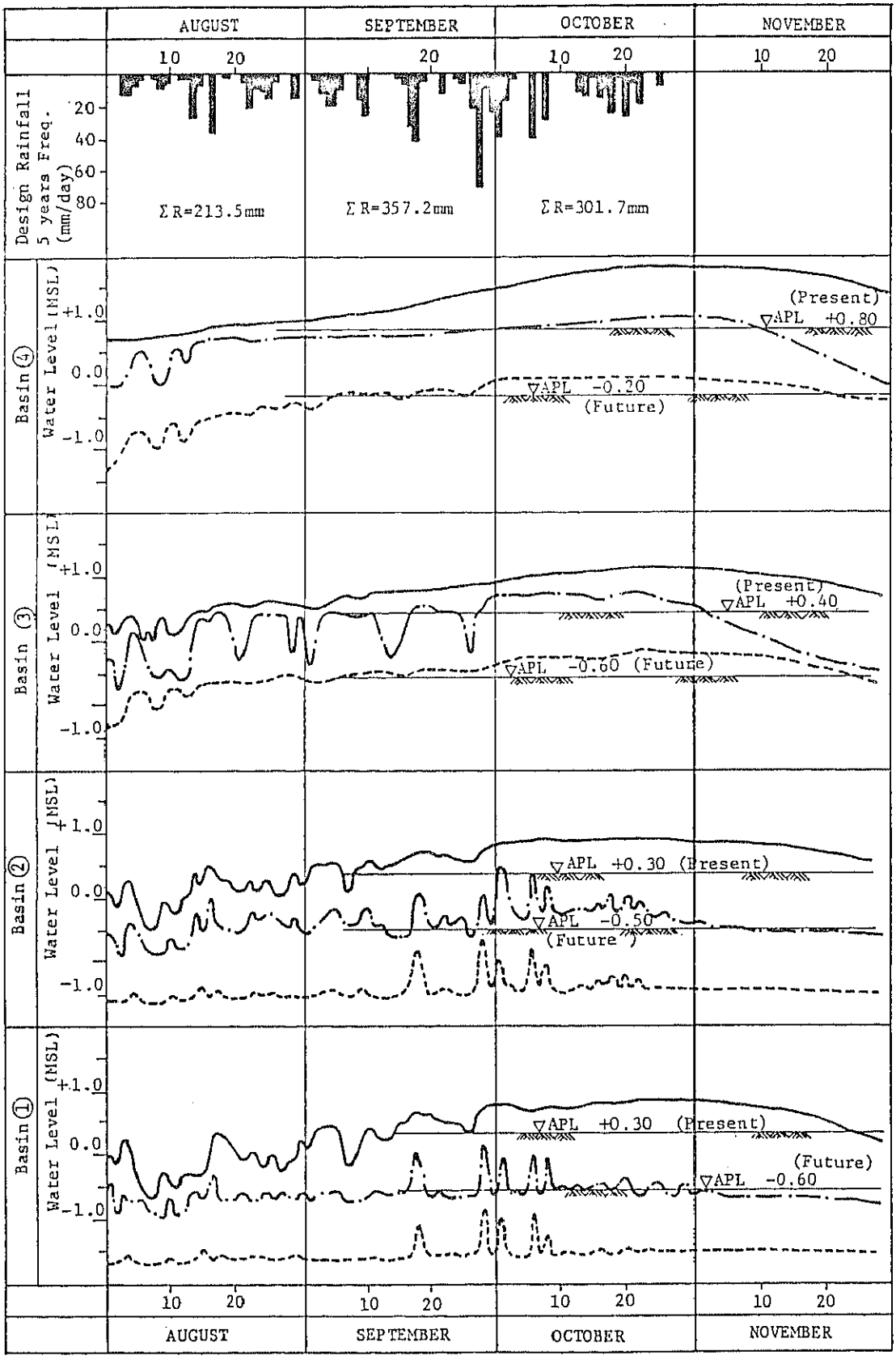

Legend

Simulated Water level of Case A
" Case B
" Case C

note: Caluculation Conditions are shown in Fig L.6

APL: Average paddy Field Land Level

Fig. L.7 IMPACT OF THE PROJECTS TO THE RETARDING AREA -(2)

FEASIBILITY STUDY ON FLOOD PROTECTION/DRAINAGE PROJECT IN EASTERN SUBURBAN-BANGKOK

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APPENDIX M

SCOPE OF WORK

SCOPE OF WORK

FOR

FEASIBILITY STUDY

ON

FLOOD PROTECTION/DRAINAGE PROJECT

IN

THE EASTERN SUBURBAN-BANGKOK IN THE KINGDOM OF THAILAND

AGREED UPON BETWEEN

THE BANGKOK METROPOLITAN ADMINISTRATION

AND

JAPAN INTERNATIONAL COOPERATION AGENCY

BANGKOK, 1985

Tsunekazu Fukui	Surin Chatchavarl
	on behalf of
Leader	The Governor
JICA Preliminary Study Team	Bangkok Metropolitan Administration

I. INTRODUCTION

In response to the request of the Government of Thailand, the Government of Japan decided to implement a Feasibility Study on the Flood Protection/Drainage Project in the Eastern Suburban-Bangkok in the Thailand (hereinafter refered to as "the Study"), within the general framwork of technical cooperation between Japan and Thailand, which is set forth in the Agreement on Technical Cooperation between the Government of Japan and the Government of Thailand, signed on November,1981.

Accordingly, the Japan International Cooperation Agency (hereinafter refered to as "JICA"), the official agency responsible for the implementation of the technical cooperation programme of the Government of Japan, will undertake the study, in accordance with the relevant laws and regulations in force in Japan and in close cooperation with the authories of Thailand. The Department of Drainage and Sewerage (hereinafter refered to as "DDS") of Bangkok Metropolitan Administration (hereinafter refered to as "BMA") shall act as counter agency to the Japanese Study Team and also as a coordinating body in relation with other relevant organizations for the smooth implementation of the study. The present document sets forth the Scope of Work for the study.

II. OBJECTIVE OF THE STUDY

The objective of the study is to examine the feasibility of the first stage programme proposed by the Master Plan. The first stage programme will consist of the following which are shown in the Annex I.

1) Construction of embankment and gates
2) Construction of pumping stations
3) Improvement of main klongs
4) Improvement of subklongs in high priority areas
5) Construction of main pipes in high priority areas
6) Establishment of Flood Control Operation System

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III. OUTLINE OF THE STUDY

1) Field Survey
   (a) Elaboration of Topographical survey of roads in main pipe serviced area and supplemental topographical survey of klongs
   (b) Existing flood protection/drainage facilities in Master Plan area
   (c) Confirmation for location of flood protection/drainage facilities planned
   (d) Reconfirmation of existing land use and trend
   (e) Review of relevant plans
   (f) Data collection of hydrological observation
   (g) Others

2) Construction Plan for Flood Protection/Drainage System and Facilities (Alternatives)
3) Study on Construction Method /Materials
4) Implementation Plan
5) Plan for Flood Control Operation System
6) Estimation of Costs
7) Organization and Operation/Management Plan
8) Financial Plan and Evaluation
9) Economic Evaluation (Sensitivity Analysis)
10) Environmental impact pertaining the water quality
11) Evaluation of the hydraulic impact to the surroundings

IV. WORK SCHEDULE

The study will be conducted in accordance with the tentative schedule as shown in the Annex II herewith attached.

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V. REPORTS

JICA shall prepare and submit the following reports in English to the Government of Thailand.

1) Inception Report
   30 copies
   within 2 months from the beginning of the study

2) Interim Report
   50 copies
   within 5 months from the beginning of the study

3) Draft Final Report
   60 copies
   within 7 months from the beginning of the study

4) Final Report
   200 copies and 100 summaries
   within 9 months from the beginning of the study

The DDS will submit her comments to JICA within one month after the receipt of Interim Report and Draft Final Report.

VI. UNDERTAKING OF THE GOVERNMENT OF THAILAND

In accordance with the Agreement on Technical Cooperation between the Government of Japan and the Government of Thailand, the Government of Thailand shall accord privileges, immunities and other benefits to the Japanese Study Team.

1. To facilitate the smooth conduct of the study, the Government of of Thailand shall take necessary measures:
   (1) to secure the Safety of the Study Team
   (2) to permit the members of the Japanese Study Team to enter, leave and sojourn in Thailand for the duration of their assignment therein, and exempt them from alein registration requirement and consular fees.
   (3) to exempt the members of the Japanese Study Team from taxes, duties and any charge on equipement, machinery and other materials brought into Thailand for the conduct of the study.

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(4) to exempt the members of the Japanese Study Team from income tax and charges of any kind imposed on or in connection with the implementation of the study.
(5) to provide necessary facilities to the Japanese Study Team for the remittance as well as utilization of the funds introduced into Thailand from Japan in connection with the implementation of the study.
(6) to secure permission for entry into private properties or restricted areas for the conduct of the study.
(7) to secure permission for the Study Team to take all data and documents (including photographs) related to the study out of Thailand to Japan.
(8) to provide the medical services as needed. Its expenses will be chargeable on members of the Japanese Study Team.

2. The Government of Thailand shall bear claims, if any arises against the members of the Japanese Study Team resulting from, occurring in the course of, or otherwise connected with the discharge of their duties in the implementation of the study, except when such claims arise from gross negligence or wilful misconduct on the part of the members of the Japanese Study Team.

3. DDS shall, at its own expense, provide the Japanese Study Team with the following, in cooperation with other relevant organizations:
(1) available data and information related to the study.
(2) counterpart personnel.
(3) suitable office space with necessary equipment.
(4) credentials or identification cards.

VII. UNDERTAKING OF JICA

For the implementation of the study, JICA shall take the following measures;
(1) to dispatch, at its own expense, study teams to Thailand

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(2) to pursue technology transfer to the Thai counterpart personnel in the course of the study.

(3) Topographical survey on klongs and roads related to the study.

(4) Other works pertaining to the outline of the study in item III.

VIII. JICA and DDS will consult with each other in respect of any matter that may arise from or in connection with the study.

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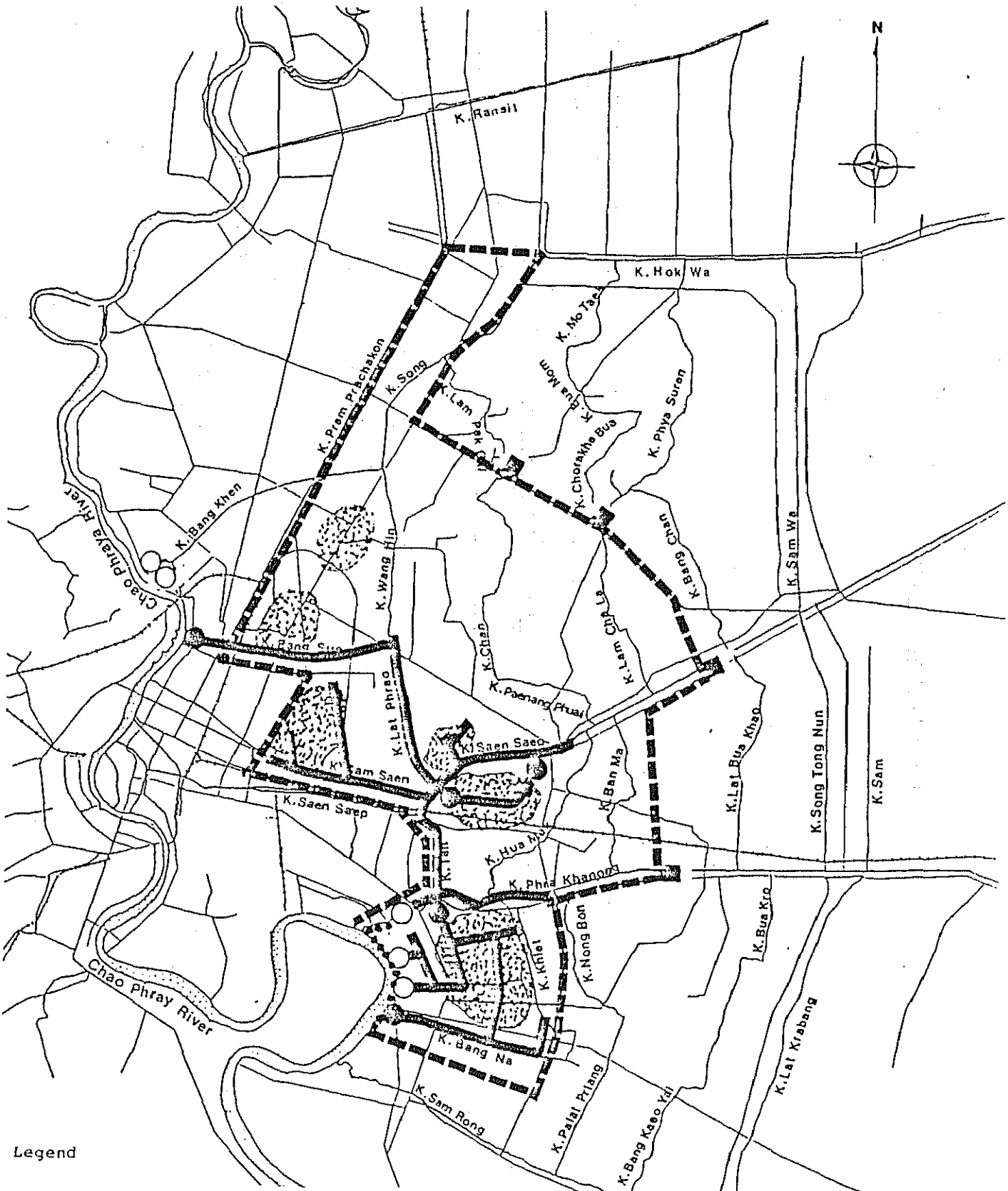


Annex I THE PROPOSED FACILITIES AT THE FIRST STAGE

ANNEX II

Tentative Schedule for the Feasibility Study

month	1	2	3	4	5	6	7	8	9	10	11
Feasibility Study		IC/R			IT/R		D/R		F/R		

* Remarks ▬ in Thailand

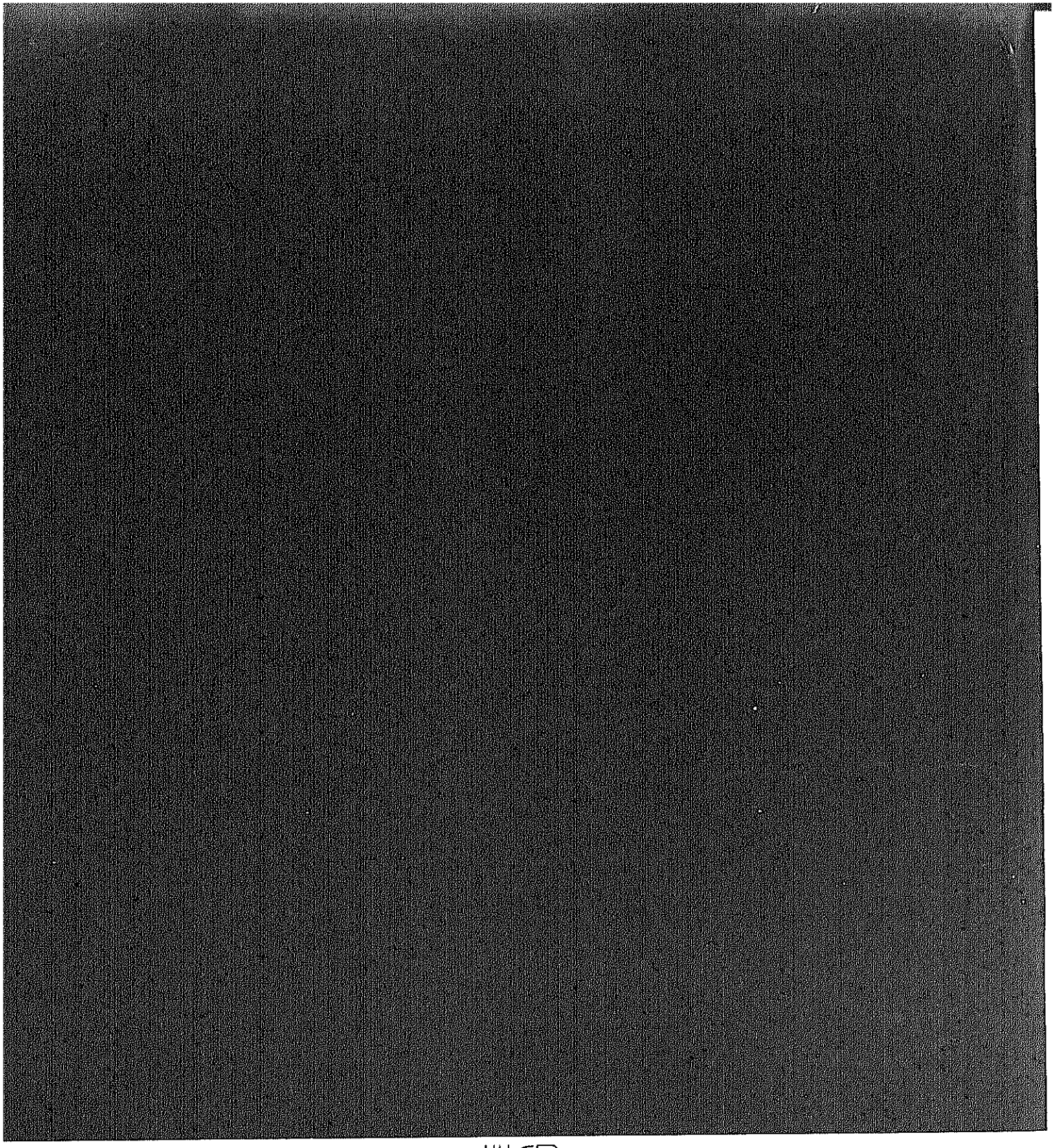
▭ in Japan

IC/R Inception Report

IT/R Interim Report

D/R Draft Final Report

F/R Final Report



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