

4. 質問書の回答

- 要請の背景は？

- タイ国側実施体制の確認 SEWAGE WORKS MANAGEMENT PLAN

- 下水道整備の計画は？ (1991 - 2002)

- 業務実施状況は？

1. Plan's owner

Sanitary Engineering division and Planning Division, PWD

2. Plan's Director

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3. Target areas of plan

Major municipalities, Major areas adjacent to the water bodies such as rivers and seas, Major areas in tourism potential, Major development areas.

4. Period of the Project

12 Years (1991 - 2003)

5. The relation with The Sixth National Economic and Social Development Plan.

In the last decade, the economic and social development has been rapid and remarkable. A large amount of money was invested in many field and the production of domestic products was promoted for competition with foreign countries. Especially, the tourism development has been strongly supported by public relations in internationally and domesticly well-known areas.

As a result of rapid change in economic and social development, the environment became polluted. It is true that the pollution began long time ago, but it does not have strong affect in the past. Nowadays, environmental problems such as wastewater, garbage etc. have bad effects directly and indirectly. It will sadly affect people and become obstacles for economic and social development in this country in the future.

Wastewater problem is important. The government became interested

in solving this problem seriously. Wastewater elimination plan is a sub-plan of public health development plan and is included in development standard service system of the sixth national economic and social development plan. Later, the sixth national economic and social development plan was revised in accordance with the policy of the Government on March 21, 1989. Water pollution management plan is part of natural resources and environment development plan. It shows that the government realize the wastewater problem.

6. The concernment of the fourth text of the Ministry of the Interior

Wastewater elimination is the main policy of the Ministry of the Interior. So, the wastewater elimination plan is sub-plan of public health development plan. One important point is to set up the wastewater and excretion elimination system in the places where polluted water has bad effect on people's health. The development of public health system is in the development basic service system of the fourth text of the Ministry of the Interior (1987 - 1991).

7. Principle and reason

7.1 The state of the problem and Vital of problem

Wastewater problem is one of the main issues for communities. In the past, wastewater management is not paid attention because the population is not so large in each community. As the quantity of wastewater is limited, self-purification system of the nature can keep the water clean. The cost of construction and operation and maintenance (O&M) for wastewater treatment system is high and the design of the system requires expertise. Therefore, the local government can not take responsibility of this problem.

When the time passing by and communities grow bigger, the increasing quantity of wastewater make the water in rivers and channels polluted. If we don't do anything about increasing wastewater and fail to eliminate the pollutants, it will be damage the quality of the living environment, the source of natural water to be used for public health will be destroyed. It will also cause lack of clean water. Although it does not have bad smell from rotten water, it can cause water-borne disease. It's dangerous for

people's health. So, it's essential for the government to solve wastewater problem urgently to protect the people from trouble.

Wastewater problem makes community's environment and water quality degenerate. The first problem is wastewater from community to waterway such as; wastewater in Bangkok and perimeter drain to Chao Phraya river. 75% of wastewater comes from communities. Nowadays, the water pollution problem become serious in such areas as: Lower Chao Phraya River from Singburi, Angthong, Ayutthaya, Nonthaburi, Pathum Thani, Bangkok and Samut Prakarn. The center urban city in regions; such as; Chiang Mai, Hat Yai, Nakhon-Rachasima, Korn Kaen and tourism areas such as; Pattaya, Phuket, Samui Island, Hau Hin, Cha-Am also have same problem. If the government have not a plan to solve wastewater problem, environment will be damaged by the increasing population and economic activities, and water pollution problem will have terribly bad effect. It will be very hard to solve the problem and to spend a lot of budget in the future.

7.2 Situation of water resources deterioration

The water quality of the lower parts of major rivers in Thailand: Chao Phraya, Tha Chin, Mae Klong and Bang Pakong rivers was found to be deteriorated especially in the dry season. The water quality of the upper parts is not in serious situation but there is a trend that it can become worse to water use in the future. The problems of water quality arose from the discharge of wastewater from various sources in the river basin such as communities and industrial sources. Moreover, agricultural activities may become the significant waste contributors in the near future. As can be seen in the case of water pollution in the lower part of Tha Chin river, the main sources pollutants are plant cultivation, livestock raising and agriculture along the river banks and khlongs connected to the rivers.

In addition, the water sources next to the sea are under the influence of salinity intrusion from the estuaries. In some cases, impacts is obvious in water uses for agriculture and water supply. In the case of Bang Pakong river, the water inflow and streamflow are very low but the seawater intrudes at the same time and causes the problems mentioned above.

The results of water quality monitoring for major rivers can be concluded as follows:

1). Chao Phraya River

a) In dry season, the water quality of Lower Chao Phraya from the river mouth in Changwat Samut Prakarn up to Changwat Nonthaburi is lower than the standard and not suitable for water supply, industry and coastal fisheries. The dissolved oxygen is less than 2 mg/l most of the time, especially the dissolved oxygen at Bangkok Port is nearly zero. The coliform bacteria was found to be 1,270,000 and 1,735,000 MPN/100 ml in 1985 and 1986 respectively which are higher than the standard value for Class 3 (not more than 20,000 MPN/100 ml). The water quality of the middle part of Chao Phraya River from Changwat Nonthaburi to Ayutthaya tend to be deteriorating especially at Tambol Samlae, Changwat Pathum Thani where is the pumping station of Metropolitan Waterworks Authority for Bangkok water supply is located.

b) The investigation of sewage and water pollution in Bangkok Metropolitan area and vicinities indicated that the discharges of sewage from various activities and buildings in BMA into Chao Phraya River were approximately 137,200 kg BOD/day loading of which the restaurants and markets were major contributors (apart from domestic discharges). The 60-70% of organic loading came from domestic sources and 30-40% from industries which contributed most of inorganic wastes including toxic substances and heavy metals. Thailand Development Research Institute (TDRI) and Japan International Cooperation Agency (JICA) projected that if no actions are taken, the lower part of Chao Phraya river will be polluted and cannot be used within 12 years. (2000 AD.)

2). Tha Chin River

a) The deterioration of water quality in Tha Chin river is rather serious, especially in the lower part from Changwat Samut Sakhon to Nakhon Pathom because the dissolved oxygen is less than 2 mg/l throughout the year. The river is most polluted at Amphoe Sam Phran. It happens as the

river flow is very low and there are dense distribution of factories especially the food industries, poultry and pig farms and also aquaculture that discharge the high loading of organic wastes into the water sources in both Changwats. It was found that, in the area of Changwat Samut Sakhon at the lower part of Tha Chin river, the coliform was as high as 240,000 MPN/100 ml which exceed the standards for Class 3 water sources.

b) However, most of heavy metal contents all along the river were well within the standards except that mercury content at Amphoe Bang Len, Nakhon Pathom was high at 10-14 mg/l compared to standard of 2 mg/l. Organochlorine pesticides were found to exceed the standard. Moreover, as Tha Chin river has the same headwater as Chao Phraya river and there are many Khlongs connecting to Chao Phraya river, when the water quality of Chao Phraya river is worse, the water quality of Tha Chin river will be inevitably worse too.

3). Bang Pakong River

a) The water quality of Bang Pakong river both upper and lower parts is still good but there are some trends that the middle part is polluted because of domestic effluents, factories and animal farms that discharge wastewater into the river, especially in the area of Amphoe Muang, Changwat Chachoengsao which is densely populated. Poultry and pig farms also discharge wastes into the river. The coliform bacteria was found to be as high as 9,000 MPN/100 ml.

b) The major problems of Bang Pakong river are caused by the very far distance of salinity intrusion which may be 200 km from the river mouth in the dry season. Thus, this phenomenon causes impacts to water use for various activities in the river basin.

4). Mae Klong River

a) Generally, the water quality of Mae Klong river is better than any other major rivers. The average dissolved oxygen is approximately 4 mg/l all the year round. Most of sewage discharged came from the area of Ratchaburi and Kanchanaburi municipalities. The water flowing down run

through Ratchaburi had the coliform as high as 160,000 MPN/100 ml in 1986.

b) The river flow is rather low. There is higher trend that industries grow outside the area served by public wastewater treatment system. If wastewater were discharged into the river without any control, the water quality in the river will be degraded and affect the shellfish cultures near the coastal area close to Mae Klong estuary.

c) In dry season, the riverflow in the lower part is very low and there are impacts from salinity intrusion. The distance of intrusion is short compared to other major rivers, but a large portion of area close to river mouth in Samut Songkhram are plantations and orchards. If the riverflow is lower, cash crops may be damaged as happened before in Amphoe Muang, Amphawa, Bang Khonthi.

5). Other water sources

a) Other water sources are increasingly polluted because of the growth and development of communities. The discharge of wastewater or toxic substances from the communities and factories into the water courses resulted in the deterioration of water quality especially in the lower part of rivers such as Ping, Chee, Mun, Ta Pi-Phum Duang, Narathiwat, Prانبuri, Phetchaburi, Rayong. Many natural Klongs such as Mae Kha (Chiang Mai), Samrong (Songkhla), and Klong Toei (Hat Yai) were turned into big sewers of towns, affecting directly to the public health and environment of the communities. People living in downstream area such as Nong Han (Sakhon Nakhon) cannot use water from those sources and Bung Boraphet was also in the same situation.

b) The water quality in Ta Pi-Phum Duang river tends to be polluted. In the beginning of 1988, the dissolved oxygen at some points was less than 1 mg/l or nearly nil due to the water released from the dam, and wastewater from other activities. In the case of Ping river, cadmium content was found to be high in 1984 because of the leakage of wastewater into the river.

6). Coastal Area

At present, the quality of sea water is not yet polluted except some densely populated areas where communities, industries and tourism continue to grow. The result of coastal water quality monitoring in the areas of east coast, upper south, and west coast of Phuket indicated that Chonburi, Bang Saen, Pattaya, Ban Phe, and Ban Don had a lot of coliform bacteria which exceed the water quality standard (Draft). Heavy metal contents were well within the standard.

7.3 Past Record of the Sewage Works

The PWD has been making efforts to solve the sewage problem in Thailand.

(1) Wastewater treatment at Pattaya

a) North-South Pattaya

- period 1984-Jan 1986, construction stage 1, budget 27.51 Mil ฿ , capacity RBC 4,000 m³/day.
- period 1989-1991, construction stage 2, budget 69,784 mil ฿ , capacity RBC 13,000 m³/day.

b) Chom Tien-Na Kluer Beach

- period 1989-1990, F/S & D/D, budget 16.9 Mil ฿ .
- period 1990, construction stage 1.

(2) Patong Beach, Phuket

- period 1988, construction stage 1, budget 15.45 mil ฿ , capacity Oxydation Ditch 2,250 m³/day.
- period 1990, construction stage 2, budget 19.125 mil ฿ , capacity OD 5,250 m³/day.

(3) Tambol Hua Hin Municipality

- period 1989-1990, construction stage 1, budget 43.29 mil ฿ , capacity RBC 4,000.

(4) Nakhon Phathom Municipality

- period 1988-1989, F/S,D/D, budget 7 mil ฿ ,
- period 1990, construction, capacity Stabilization Pond 15,000 m³/day.

- (5) Nakhon Ratchasima
 - construction, budget 88.5 mil฿ , capacity Stabilization Pond 32,000 m³/day.
- (6) Khon Kaen Municipality
 - period 1988, construction, budget 59 mil ฿ , capacity Stabilization Pond 25,000 m³/day.
- (7) Tambol Panat Nikhom Municipality
 - construction (Design PWD, Construction City, budget 15 mil฿ , capacity Oxidation 2,000 m³/day.
- (8) Bang Sean Municipality
 - period 1990, F/S,D/D, budget 8.5 mil฿ .
- (9) Lame Cha Bang
 - period 1989, F/S,D/D.
- (10) Phuket Municipality
 - asking for JICA's aid, main plan and F/S.

8. The aim of wastewater management project.

- (1) To build up sewerage system in area's problem.
- (2) To keep effluent quality control within standard and to improve or restore living environment.
- (3) To build up natural resources especially in tourist area because it directly affects economy in each community.

9. Characteristic of main work

- (1) Survey and feasibility study for wastewater management project.
- (2) Detail design in construction of sewerage system.
- (3) Construction of the facilities for drainage and wastewater treatment.
- (4) To maintain and operate the sewerage system at first stage before deliver to municipality.

10. Communities identified

Communities are identified by following reasons.

- (1) To be in accordance with the government's policy.

- (2) Major areas in tourism potential.
- (3) To be cities along the main rivers.
- (4) The situation of the problem; such as, drainage, water pollution.
- (5) Major municipalities.
- (6) Population in each area.
- (7) The stage of preparation of the works; such as land acquisition and personnel.

11. Plan and estimation of the allowances of wastewater management

From the details of allowances estimate plan for wastewater management project about 65 project, the outline is as follows,

YEAR	WORK				BUDGET (milg)
	F/S (PROJECT)	CON.DESIGN (PROJECT)	CON. (PROJECT)	OPERATION (PROJECT)	
1991	11	8	2	-	101.1
1992	6	12	9	-	549.9
1993	6	6	21	-	1185.2
1994	5	6	25	2	1514.2
1995	6	5	25	6	1328.0
1996	7	6	24	6	1141.4
1997	7	7	15	15	522.1
1998	7	7	18	4	553.5
1999	-	7	20	5	543.1
2000	-	-	21	6	515.0
2001	-	-	14	7	300.0
2002	-	-	7	7	145.0

NOTE

1. Wastewater management project in the rest land will be done in 1999 by working in wastewater elimination plan stage 2.
2. The budget above does not include for the allowances of operating wastewater treatment plan.

12. The staff of wastewater management projects

Wastewater management projects employ consultant engineers for survey, feasibility study and detail design of the project. The staff of PWD will be in charge of controlling, surveying and inspecting consultant engineers' work including construction management control and operation wastewater treatment plan.

(1) Spurintendents for project constiting of preparation of the assignment of projects, consideration of prosposed projects, F/S, preparing construction and checking the progress of construction;the number of staff are:

Civil Engineer	1	person
Civil Foreman	1	ditto
Administrator	1	ditto

All of these staff will be responsible for 4 projects/year. The average number of project during the period of 1991 - 1999 = 31 project / year. So, we must use the staff = $31 / 4 = 8$ groups; the following:

Civil Engineer	3 - 5 (6)	8	person
Civil Foreman	2 - 4 (5)	8	ditto
Administrator	2 - 4	8	ditto

(2) The construction controller

Project Engineer	1	person
Civil Foreman	2	ditto

The average number of wastewater treatment construction in 1993 - 1999 = 21 project / year, use the staff

Project Engineer	21	person
Civil Foreman	42	ditto

(3) To operate wastewater treatment, the necessary are staff

Sanitary Engineer	1	person
Foreman of machine and electric equipment	1	ditto
Civil Foreman	1	ditto
Scientist	25	person

In this plan, we will have wastewater factory treatment plants during 1994 - 2002 = 8 plants / year, the necessary staff are:

Sanitary Engineer	8	person
Forman of machine and electric equipment.	8	ditto
Civil Foreman	8	ditto
Scientist	2	ditto

13. Operation and Maintenance (O&M)

After the PWD construct wastewater treatment system, the PWD will give technical assistance for O&M in the first year. After that, the system will be transferred from the PWD to municipality for O&M.

14. The effects from wastewater management

(1) To protect and maintain the environment in project area so that it does deteriorate.

(2) To reduce the risk from water - borne diseases.

(3) Government has revenue from wastewater treatment service for allowances in order to maintain and increase wastewater treatment service.

THE DETAIL OF PLAN AND THE ALLOWANCES ESTIMATE OF WASTEWATER MANAGEMENT PROJECT

UNIT:ml.¢

NO.	AREA	ACTIVITY	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
1	Phuket Municipality	F/S D/D CON.	0	0	90	90	92								
2	Udon Thani Municipality	F/S D/D CON.	0	0	44	44	46								
3	Nakorn Sawan Municipality	F/S D/D CON.		0	55	55	57								
4	Had Yai Municipality	F/S D/D CON.	0	0	47	47	47								
5	Chon Buri Municipality	F/S D/D CON.			0	50	50	50							
6	Chiang Mai Municipality	F/S D/D CON.		20	88	88	88								

NO.	AREA	ACTIVITY	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
7	Tambol Sri Racha Municipality	F/S D/D CON.	0	0	34	34									
8	Tambol San-Suk Municipality	F/S D/D CON.	8.5	20	60	60	60								
9	Nontha Buri Municipality	F/S D/D CON.		8.5	20	50	60	60	60						
10	Pathum Thani Municipality	F/S D/D CON.		4	5.5	60	60	60							
11	Samut Sakorn Municipality	F/S D/D CON.		4	5	45	45	45	45						
12	Ayuttaya Municipality	F/S D/D CON.		4	4.5	30	60	60							
13	Tambol Hua Hin Municipality	F/S D/D CON.		4.5	7.5	60	60	60	60						

NO.	AREA	ACTIVITY	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
14	Tambol Cha-Am Municipality	F/S D/D CON.		4.5	7.5	60	60	60	60						
15	Sakon Nakorn Municipality	F/S D/D CON.		0 2	20	20									
16	Samui Island Municipality	F/S D/D CON.		7.5	11.5	70	70	70	70						
17	West Phuket Municipality	F/S D/D CON.		12.5	17.5	70	70	70	70						
18	Ban Phae	F/S D/D CON.		4.5	5	54	63	63							
19	Karnchanaburi Municipality	F/S D/D CON.		5	7	60	70	70							
20	Ubon Ratchathani Municipality	F/S D/D CON.		0	0	65	65	65	65						

NO.	AREA	ACTIVITY	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
21	Karasin Municipality	F/S D/D CON.		0	0	28	28	28							
22	Song Kār Municipality	F/S D/D CON.			3.4	5.1	60	60	60						
23	Surat Thani Municipality	F/S D/D CON.			3.1	4.7	50	50	50						
24	Pitsanulok Municipality	F/S D/D CON.			3.2	4.8	53	53	53						
25	Racha Buri	F/S D/D CON.			2.5	3.2	35	35	35						
26	Rayong Municipality	F/S D/D CON.			3.1	4.7	50	50	50						
27	Samut Prakarn Municipality	F/S D/D CON.			5.6	8.4	100	100	100	100					

NO.	AREA	ACTIVITY	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
28	Chanthaburi Municipality	F/S D/D CON.				2.7	4	40	40	40					
29	Chainat Municipality	F/S D/D CON.				2.2	3.3	25	25						
30	Singburi Municipality	F/S D/D CON.				2.2	3.3	30	30						
31	Angthong Municipality	F/S D/D CON.				2.2	3.3	25	25						
32	Suphanburi Municipality	F/S D/D CON.				2.2	3.3	25	25	25					
33	Chiengray Municipality	F/S D/D CON.				2.8	4.7	35	35	35					
34	Krabee Municipality	F/S D/D CON.					2.2	3.3	25	25	25				

NO.	AREA	ACTIVITY	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
35	Tang Municipality	F/S D/D CON.				2.5	3.8	35	35	35					
36	Pang-Nga Municipality	F/S D/D CON.				2.2	3.3	15	15	15					
37	Chachoengsao Municipality	F/S D/D CON.				2.2	3.3	30	30	30	30				
38	Saraburi Municipality	F/S D/D CON.				4.2	7.6	40	40	40	40				
39	Lampang Municipality	F/S D/D CON.					2.2	3.3	30	30	30	30			
40	Samut Songkram Municipality	F/S D/D CON.					2.7	4	40	40	40	40			
41	Prachin Buri Municipality	F/S D/D CON.					2.2	3.3	15	15	15	15			

NO.	AREA	ACTIVITY	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
42	Nakorn Nayok Municipality	F/S D/D CON.						2.2	3.3	15	15	15			
43	Tambol Varinchamrab Municipality	F/S D/D CON.						2.2	3.3	15	15	15			
44	Sukhothai Municipality	F/S D/D CON.						2.2	3.3	20	20	20			
45	Pechburi Municipality	F/S D/D CON.							2.2	3.3	25	25	25		
46	Phayao Municipality	F/S D/D CON.							2.2	3.3	20	20	20		
47	Yala Municipality	F/S D/D CON.							3.7	5.6	70	70	70		
48	Maharakarn Municipality	F/S D/D CON.							2.2	3.3	25	25	25		

NO.	AREA	ACTIVITY	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
49	Prachuab Khirikhan Municipality	F/S D/D CON.							2.2	3.3	15	15	15		
50	Nakhon Si Thammarat Municipality	F/S D/D CON.							3.2	4.6	50	50	50		
51	Surin Municipality	F/S D/D CON.							2.2	3.3	30	30	30		
52	Buriram Municipality	F/S D/D CON.								2.2	3.3	20	20	20	
53	Pattani Municipality	F/S D/D CON.								2.2	3.3	30	30	30	
54	Lopburi Municipality	F/S D/D CON.								2.2	3.3	25	25	25	
55	Bangbuathong Municipality	F/S D/D CON.								2.2	3.3	20	20	20	

NO.	AREA	ACTIVITY	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
56	Loei Municipality	F/S D/D CON.								2.2	3.3	15	15	15	
57	Utradit Municipality	F/S D/D CON.								2.2	3.3	25	25	25	
58	Yasothon Municipality	F/S D/D CON.								2.2	3.3	15	15	15	
59	Nan Municipality	F/S D/D CON.									2.2	3.3	10	20	20
60	Tak Municipality	F/S D/D CON.									2.2	3.3	10	20	20
61	Kamphaeng Municipality	F/S D/D CON.									2.2	3.3	20	20	20
62	Petchaboon Municipality	F/S D/D CON.									2.2	3.3	20	20	20

NO.	AREA	ACTIVITY	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
63	Roi-et Municipality	F/S D/D CON.									2.2	3.3	25	25	25
64	Chumponn Municipality	F/S D/D CON.									2.2	3.3	15	15	10
65	Narathiwat Municipality	F/S D/D CON.									2.2	3.3	30	30	30
TOTAL			8.5	101.0	549.9	1185.2	1514.2	1328.0	1141.4	522.1	553.5	543.1	515.0	300.0	145.0

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1	ACKY CONSULTANT CO.,LTD., 2102/31 Soi Decha Village Ramkhamhaeng Rd.,Huamark Bang Dapi,BANGKOK 10240 Tel. 374-4180,3740074	6	TORANEE TECH CO.,LTD., 584/34 Soi Yucharoen Asoke-Dindeang Rd.,Huai Kwang Bangkok Tel. 245-5474
2	CONSULTANT OF TECHNOLOGY CO., 9/171-2 Soi Mahard Thai 2 (Lard Prao 130) Lard Prao Rd. Khong Jun,Bang Kapi ,BANGKOK Tel. 377-0879	7	TEAM CONSULTANT CO,LTD., 51/301 Soi Drive in Lard prao RD.,Khong junB ang Kapi bangkok Tel. 377-1770-1
3	TESCO CO.,LTD., 21/13-14 Sukhumvit Soi 18 Khong Teoi, Pra Kha nong Bangkok Tel. 2581320	8	CHIENG MAI UNIVRSITY 130 Moo 1,huai Keaw Rd., T. Suthep,A. Muang Chieng Mai Tel. (053)211084 Ext 405,427,428
4	SOUTHEAST ASIA TECHNOLOGY CO., 123 Soi Ban Kloi Nua Sukhumvit Rd.,Soi 57 Pra Khanong,Bangkok Pra Khanong,Bangkok Tel.392-2711	9	MAHIDOL UNIVERSITY 2 Pran Nok Rd.Siriraj District Bangkok noi,Bangkok Tel.4115038
5	CHULALONGKORN UNIVERSITY CO., Phayathai Rd.,Phatumwan Bangkok 10500 Tel. 252-5929,251-4426-7	10	TECHNOLOGY H CO.,LTD., 65/3 Charieng 1,Sukhumvit 103 Bangna,Prakanong Bangkok 10260 Tel. 3984561

ORDER	NAMES, ADDRESSES	ORDER	NAMES, ADDRESSES
11	METRIC CO.,LTD., 132 Sinthorn Bldg., Wirless Rd.,Phatumwan Bangkok 10500 Tel. 2500580-3	16	S P S CONSULTING SERVICE CO., 1418/33 Phahonyothin Rd., Lardyao, CHATUJAK Bangkok 10900 Tel. 513-4221
12	ENVIRONMENTAL SYSTEM DESIEN CO.,LTD., 24/12 Soi Prasarnmitr Sukhumvit Rd., Bankok 10110 Tel. 2584213	17	PAL CONSULTANT CO.,LTD., 88/23-24 Tesabarn SongkroRd. Lardyao,Bangkhen Bangkok 10900 Tel. 580-5449,589-0686
13	S T S ENGINEERING CONSULTANT 196/10-12 Soi King Jinda Pradipat Rd.Sam Sen Nai Phayathai,Bangkok 10400 Tel. 278-2355	18	UNIVERSAL ENGINEERING CONSULTANT CO.,LTD., Ploymitr Bldg.,81 Sukhumvit2 Bangkok 10110 Tel. 2528372,2510040,2510689
14	SYSTEM ENGINEERING CO.,LTD., 45 Soi Attavimol Rajchaparob Rd.,Sam Sen Nai Phayathai,Bangkok 10400 Tel. 2342506,256-3101	19	OFFICE OF REMOTE SENSING & TECHNOLOGY OF THAILAND 196 Phahonyothin Rd., Bangken,Bangkok 10900 Tel. 5791121-30 Ext 2306
15	SONGKHA NAKARIN UNIVERSITY P.O.Box 1,T. Korhong A. Hatyai, Songkha Tel. 244877 Ext 2180,2181	20	N S CONSULTANT CO.,LTD., 1131/318 Sahakorn Kaehasatan Bldg.N akornchaisri Rd.,Dusit Bangkok 10300 Tel. 2436232

ORDER	NAMES, ADDRESSES	ORDER	NAMES, ADDRESSES
21	TAI-TAI ENGINEERING CO.,LTD., 2387 Ruam Thun Pattana Bldg. New Petburi Rd.,Bangkok 10310 Tel. 3191526-7	27	WATER AND ENVIRONMENT CONSULTANT CO.,LTD., 321/27 Nang Lin Gee Rd., Chong non cee,Yannawa Bangkok 10120 Tel. 2868010,2860112
22	EAST CONSULT CO.,LTD., 42/35 Sukhapiban 1 Rd. Khong Kum,Bangkapi, Bangkok 10230 Tel. 5103059	28	KHON KEAN UNIVERSITY A.Muang, KHON KEAN Tel. 241331-33
23	KASATSART UNIVERSITY 50 Phahonyothin Rd.,Bangkhen Bangkok 10900 Tel. 579-0172	29	ACT CONSULTANT CO.,LTD., 10th Fl.,Manorom Bldg., 3354 Rama IV Rd.,Prakanong Bangkok Tel. 2498585-91
24	TIPGO CONSULTANT CO.,LTD 118/1 Tama 6 Rd., Samsen Nai, Phayathai Bangkok 10400 Tel.	30	MACRO CONSULTANT CO.,LTD., 1420/1 Phahonyothin 46 Phahonyothin Rd.,Lardyao Chatujak,Bangkok 10900 Tel. 5137686
25	AIT 58 Phahonyothin Rd. A.Khong loong, Phatumthani Tel. 5290100-13	31	ASDICON COOPERATION CO.,LTD., 51/602 Lard Proa Soi 128/1 Khong Jun,Bang Khapi Bangkok 10240 Tel. 3774161
26	SGS ENVIRONMENTAL SERVICES CO. 994 Soi Thong lor,Sukhumvit Khong Ton,Prakhanong Bangkok 10110 Tel. 3927431-3	32	TIN SMELTING WARKS SIAM JAREOR CO.,LTD., 22/21 Kaseat Villa Bldg. Ngamvong Var Rd. Banglegang,Bangkok 10900 Tel. 5796182

b. 水質検査、解析が可能なローカル水質検査会社及び解析コスト

1. GOSHU KOHSAN CO.,LTD.

70 MOD 5 KINGKAEW RD.
BANGPHU SAMUTPRAKARN 10540
TEL. 316-8097, 316-6219-21
FAX. 316-8096

2. SGS ENVIRONMENTAL SERVICE CO.,LTD.

994 SOI THONG LOG, SUKHUMVIT 55
BANGKOK 10110
TEL. 392-1066 (16 LINES)
392-1481-90
392-1837-40
FAX. 381-1994

3. TESCO LTD.

21/11-14 SUKHUMVIT 18
ORAJHANONG, BANGKOK 10110
TEL. 259-5462-3
258-1340, 258-1320
FAX. 258-1313

4. TEAM CONSULTING ENGINEER CO.,LTD.

2790-2782 (51/301-5) SOI DRIVE-IN 2
LADPRAO 130 RD.,KLONG CHAN
BANGKAPI, BANGKOK 10240
TEL. 377-3480
377-1770-1
FAX. 375-1070

5. SOUTHEAST ASIA TECHNOLOGY CO.,LTD (SEATEC)

123 SUKHUMVIT 57 RD.,PRAKHANONG
BANGKOK 10110
TEL. 392-2711 (7 LINES)
FAX. 381-1142



1/2

Ref. No. WT-1201

Bangkok, December 6, 1991.

WASTE WATER ANALYSIS COST

1. <u>General</u>		Cost/Items
Turbidity	(NTU)	30.-
Color	(Pt-Co scale)	30.-
pH		30.-
Dissolved Solids	(ppm)	100.-
Suspended Solids	(ppm)	100.-
Permanganate Value	(ppm)	100.-
COD _{Mn}	(ppm)	100.-
COD _{Cr}	(ppm)	380.-
BOD ₅	(ppm)	380.-
Oil & Grease	(ppm)	250.-
Total Iron	(ppm. as Fe)	100.-
2. <u>Heavy Metal and Some Ions By A.A</u>		
Zinc	(ppm. as Zn)	150.-
Chromium	(ppm. as Cr)	150.-
Lead	(ppm. as Pb)	150.-
Copper	(ppm. as Cu)	150.-
Nickel	(ppm. as Ni)	150.-
Cadmium	(ppm. as Cd)	150.-
Aluminium	(ppm. as Al)	150.-
Barium	(ppm. as Ba)	150.-
Strontium	(ppm. as Sr)	150.-
Magnesium	(ppm. as Mg)	150.-
Manganese	(ppm. as Mn)	150.-
Sodium	(ppm. as Na)	150.-
Potassium	(ppm. as K)	150.-
Calcium	(ppm. as Ca)	150.-

3. Special

Gold	(ppm. as Au)	1,750.-
Arsenic	(ppm. as As)	500.-
Mercury	(ppm. as Hg)	500.-
Silver	(ppm. as Ag)	500.-
Selenium	(ppm. as Se)	500.-
Stannous	(ppm. as Sn)	500.-
Fluoride	(ppm. as F)	1,000.-
Boron	(ppm. as B)	100.-
Total Cyanide	(ppm. as CN)	630.-
Free Cyanide	(ppm. as CN)	250.-
Free Chlorine	(ppm. as Cl ⁻)	50.-
Phenol & Cresol		630.-
Formaldehyde		630.-
Sulfide	(ppm. as S ⁻)	150.-
Hydrogen Sulfide	(ppm. as S ⁻)	150.-
Total Nitrogen	(ppm. as N)	630.-
Ammonia Nitrogen	(ppm. as NH ₃)	630.-
Nitrate Nitrogen	(ppm. as NO ₃ ⁻)	630.-
Nitrite Nitrogen	(ppm. as NO ₂ ⁻)	630.-
Total Phosphate	(ppm. as PO ₄ ³⁻)	150.-
Phosphorus	(ppm. as P)	150.-
MLSS	(ppm.)	150.-
MLVSS	(ppm.)	380.-
Taste		30.-
Odor		
Dissolved Oxygen D.O.	(ppm.)	130.-
Moisture	(%)	250.-
Scale	One Sample	1,250.-
Total Organic Content (T.O.C.)	(ppm.)	500.-
Bacteria Count	(Colony/ml)	250.-
% NaCl	(ppm. as NaCl)	300.-
% Acidity	(ppm. as CaCO ₃)	50.-
Free acid H ₂ SO ₄	(ppm. as CaCO ₃)	150.-
Free acid HCl	(ppm. as CaCO ₃)	150.-
Anionic Synthetic Detergent		630.-

7. 関連資料

アユタヤ、パトムタニ、ノンタブリ地域の洪水対策及び下水道の整備事業に関するSED作成のTOR概要は以下のとおり。

- (1) 実施期間 : Sanitary Engineering Division (SED)
Public Works Department
Ministry of Interior

(2) 調査実施場所

	M/Pの面積	F/Sの面積	Municipalityの人口
① Ayutthaya	5.6 km ²	1.4 km ²	77,000人
② PathumThani	4.1 km ²	1.5 km ²	15,000人
③ Nonthabri	7.4 km ²	3.9 km ²	233,000人

(3) 調査の種類及び調査期間

調査の内容は3地区とも、調査期間内にM/Pを先行させ、同時にF/S調査を行うものとしている。(1991年末の変更によりF/S調査のみ実施となった。)

	調査種類	調査期間	調査入月	調査内容
① Ayutthaya	F/S	12カ月	50~60M/F	同一パッケージとして 下水道整備調査
② Pathum Thani	F/S	12カ月	50~60M/F	
③ Nonthabri	F/S	10カ月	70M/F	洪水対策を含む下水道整備調査

(4) 調査団の構成

- ・都市計画
- ・社会経済
- ・水文解析
- ・水質分析
- ・下水道計画
- ・機材計画
- ・電気Engineer
- ・Civil Engineer
- ・環境
- ・施設計画・積算
- ・事業評価
- その他

(6) ノンタブリ地域のTOR概要

Objective of the Study

Protect Flood water, Wastewater Drainage and Wastewater Treatment

Nonthaburi Province

① 地域概要及び調査の背景

ノンタブリ県はバンコクの北部に位置し、首都バンコクの近隣都市として近年急激な発展を示している。県の面積は622km²でチャオピア川を挟み川の東西に都市化が進み、農業用地は工場地帯、住宅地、商業地帯に変貌している。1982年の県全体人口は420,000人であったが、2001年には700,000人に増加すると推定される。

現在、人口の多くはノンタブリ Municipality (市区域) 38.9km²に集中しており、人口は1987年で216,450人であった。

ノンタブリ県の地形は、チャオピア川下流域の大平原地帯の一部で、チャオピア川の大洪水にたびたび襲われて大きな被害を受けている。特に1978年と1983年の大洪水は多くの家屋、農地、公共機関等に大被害をこうむった。

バンコクと隣接するノンタブリ県は大きく発展しつつあるが、インフラ整備は進んでいない。特に下水道の整備はほとんど行われておらず、家庭雑排水及び汚水は未処理のまま市内の小水路を通過して直接チャオピア川に流入している。現状のまま放置すると大きな環境問題に発展すると推測されるので、公共事業局(PWD)は下水道整備のためのTORを作成し、F/S調査を行うこととした。

② 調査の目的

a. ノンタブリ地区の洪水対策及び下水道整備のためM/P (74km²) を行い、同時に核となる地区 (39km²) のF/Sを行うものである。(今回調査はF/Sのみ)

b. 調査の内容及び開発計画

- チャオピア川の洪水防護対策
- 洪水時期の都市内排水計画
- 家庭雑排水 (Wastewater) の収集、下水道施設計画
- 下水処理計画 等、4つの項目となっている。

③ 調査対象地域

M/P調査地域は、ノンタブリ Municipality (市内)、パケット Sanitary District 及びパケットとバンタラート水路の間の合計74km²である。

F/S調査地域はノンタブリ市内の39km²である。

④ 調査の範囲と計画策定・評価

M/Pは2011年を最終目標年とするが、F/Sではノンタブリ市内の下水道整備計画を策定し、早急に実施計画の立案を行うものとする。

a. 実施調査

- Data収集（調査に関する資料）
- 社会・経済分析
- 汚濁源の調査及び分析
- 自然状況の調査・解析
- 下水現況の調査・解析、将来予測
- 河川・道路・交通状況の調査
- チャオピア川の水質現況調査
- 調査地区の開発計画調査（インフラ整備、観光、市・県の開発計画 等）

b. 計画策定

・洪水対策計画

水文解析を行い、最適な洪水防護施設計画を立案する。また雨期洪水の排水計画（ポンプ排水）及び排水路網計画も行う。

・下水道整備計画

下水道整備は2011年を目標年次とし、下水排水量・下水道網下水処理施設の計画を行う。

c. 事業費の概算及び管理費（O/M費）

洪水対策、下水道整備の事業費の概算を行い、同時にO/M費の概算も行う。

d. 事業評価

経済評価の分析・環境評価、関連産業（農業・工業・商業）への効果及び評価、自然資源評価等を行う。

⑤ 調査実施組織

本件、M/P、F/Sの調査実施機関は内務省公共事業局であるが、調査の実施に際しては、ノンタブリ県及びノンタブリ市が協力して行うものとする。

⑥ 報告書

（注）当初の調査期間は540日となっているので、当初どおりの報告書作成計画を記載する。

- Inception Report

調査開始後60日以内に、タイ語で提出する（20コピー）

- Progress Report

調査開始後150日以内に、タイ語20コピーを提出

- Interim Report

調査開始後300日以内に、タイ語20コピーを提出
事業の概要、施設のレイアウト、概算工事予算等を記載する。

- Draft F/S Report

調査開始後450日以内に、タイ語20コピーを提出
調査全体の総括を記載する。

- F/S Report

調査開始後540日以内に、タイ語50部、英語25部を提出

- 調査全体総括報告書
- 事業の評価を含む調査の結論を記載する
- 収集資料（地図・水文・水質Data等）を1部提出

以上が、ノンタブリ地域のTORであるが、アコタヤ及びパトムタニもTORは同様となっている。

本件調査の基本構想（調査対象地図を含む）はOffice of National Environment Board (ONEB)、Ministry of Science, Technology and Energyが1990年12月28日実施した報告書が基本となっている。

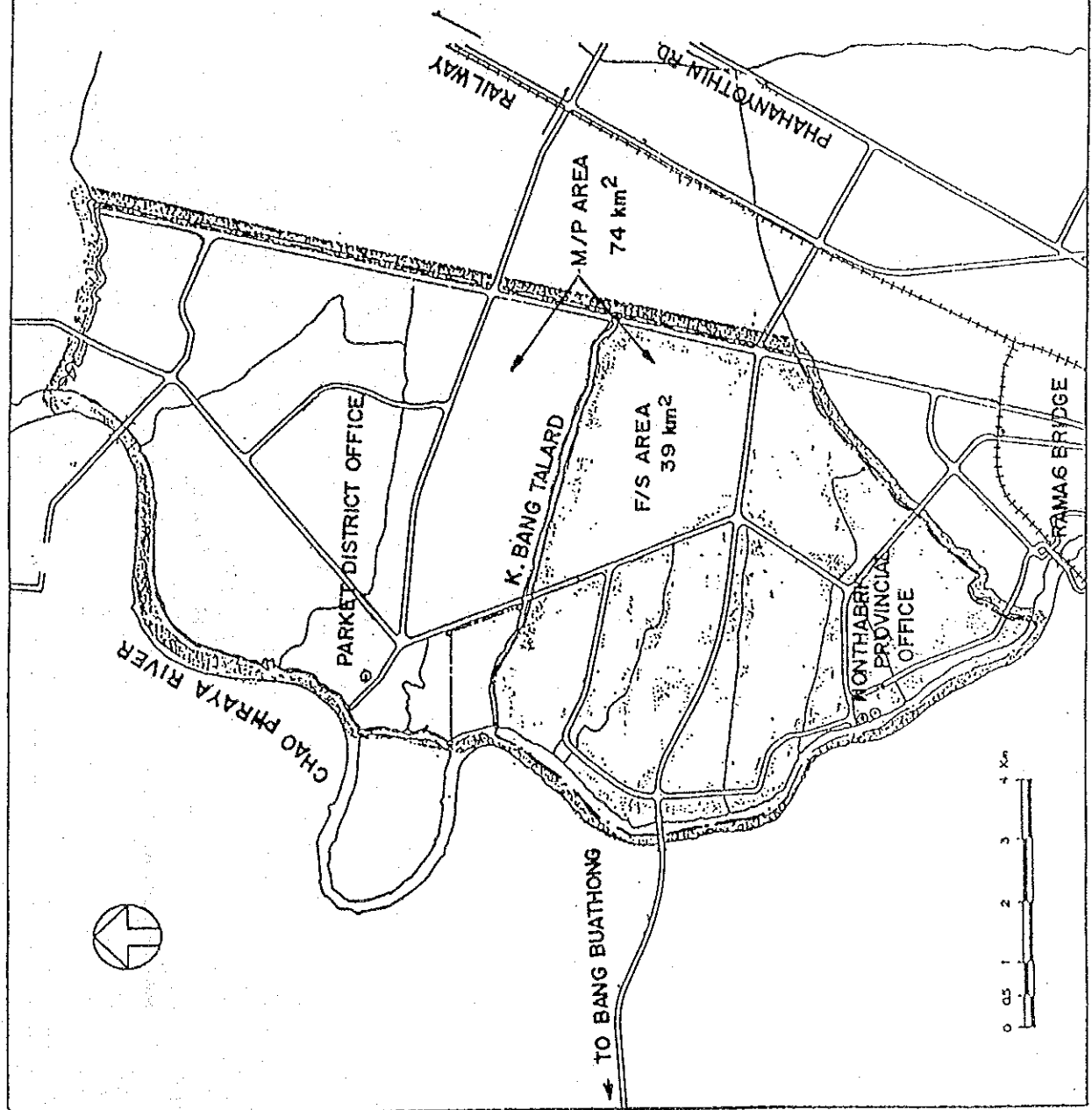
公共事業局（PWD）が計画している“チャオピア川下水道整備計画”を添付する。タイ国での行政年次は10月1日からよく年9月30日までである。

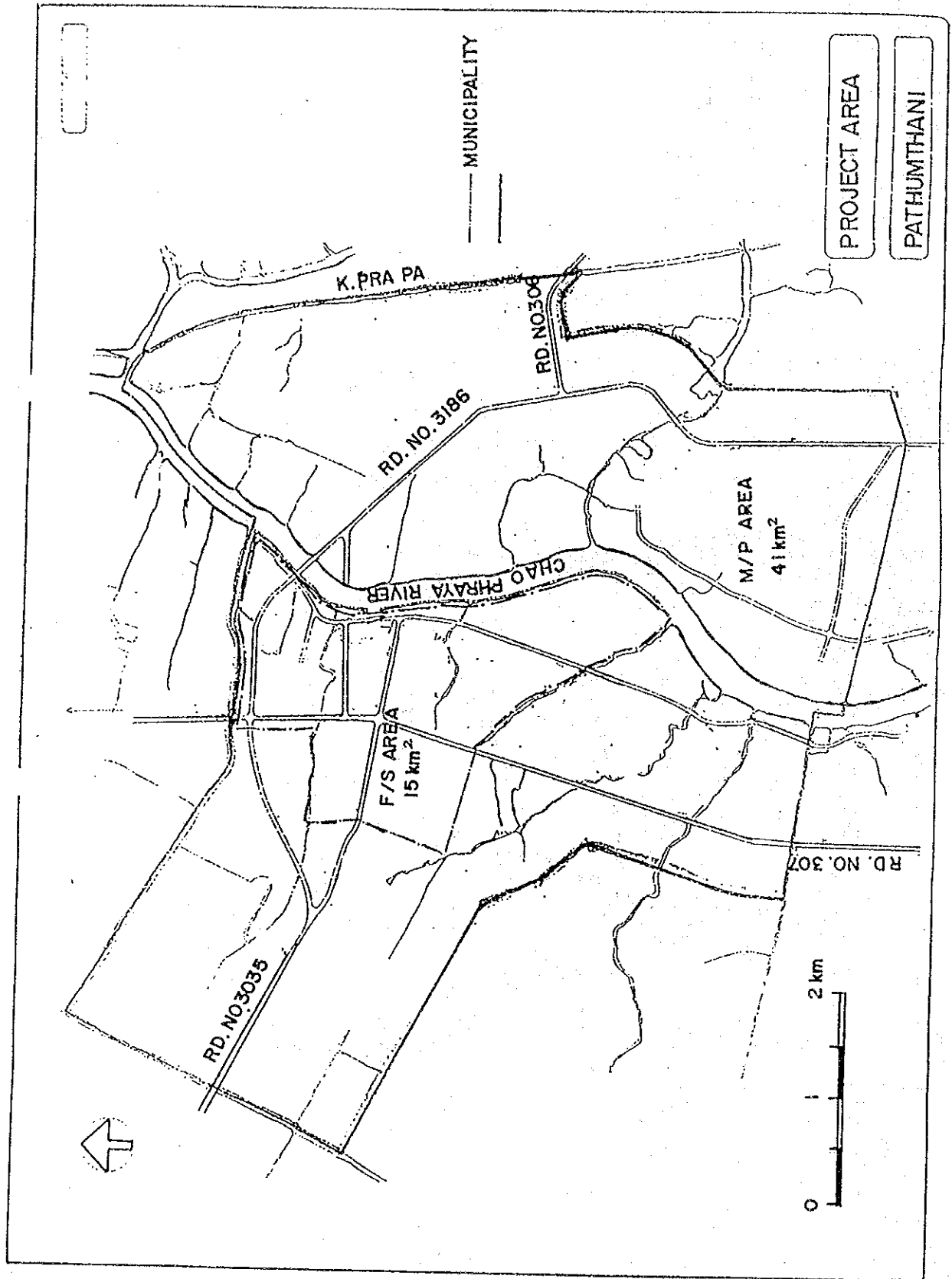
当計画書は、バンコク市内の下水道整備を除き総額 39億5,900万\$ 約206億3,000万円（91年12月5日現在）となっている。

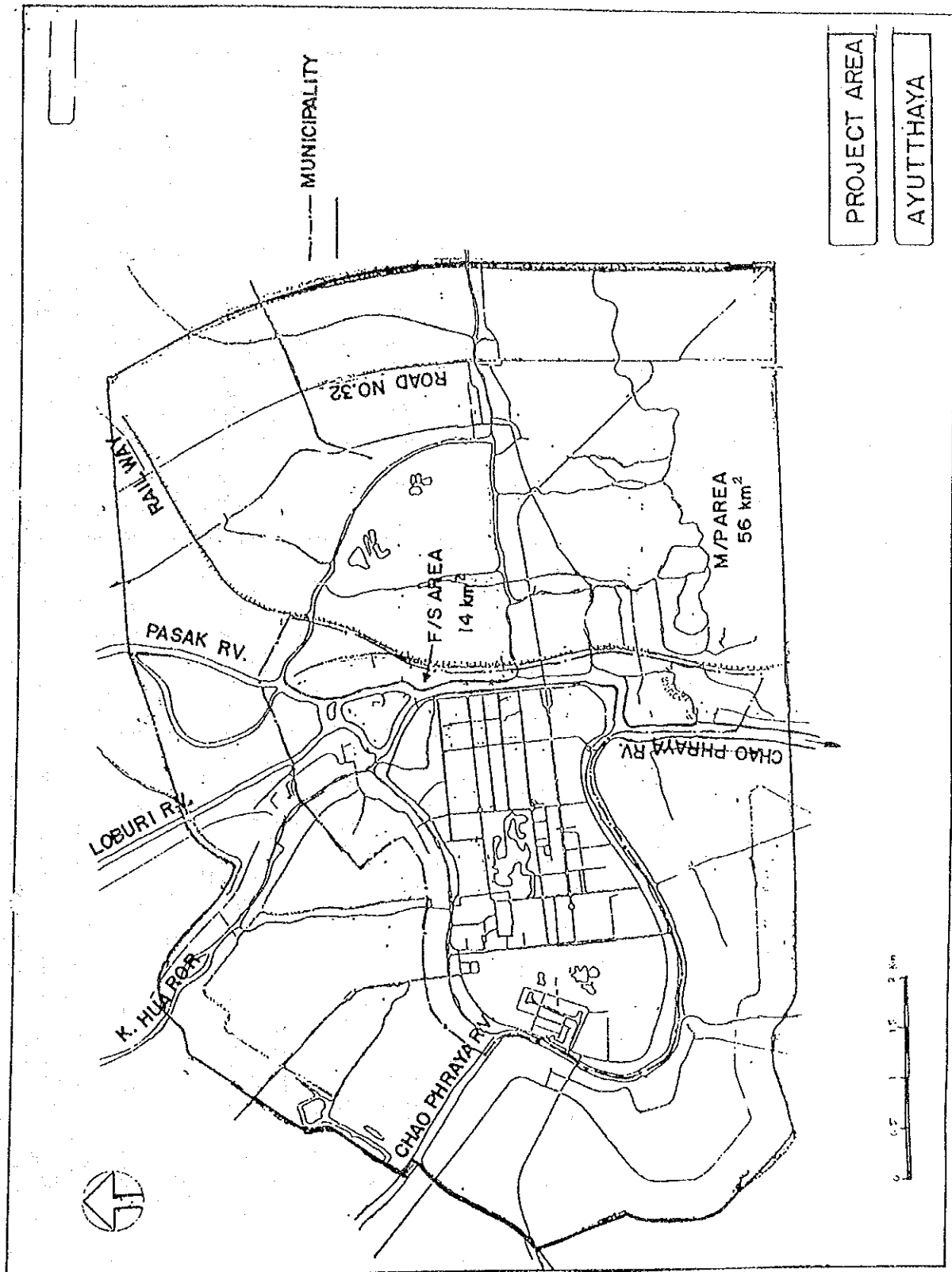
- MUNICIPALITY
- M/P AREA
- F/S AREA

PROJECT AREA

NONHABRI







CHOA PRAYA RIVER WATER POLLUTION TREATMENT PROJECT
 WORKING PLANS AND BUDGET

PUBLIC WORK DEPARTMENT
 MINISTRY OF INTERIOR
 OCTOBER 1991

ACTIVITIES	YEAR	1991	1993	1994	1995	1996	1997	1998
1. Singburi - FS - DD - CON. ----- Total 164 million	6 million		6	8	75	75		
	8 "							
	150 "							
2. ANGTHONG - FS - DD -CON. ----- Total 159 million	5 million	5						
	7 "	7						
	147 "		70	77				
3. PRAMOKE - FS -DD -CON. ----- Total 164 million	6 million		6	8	75	75		
	8 "							
	150 "							
4. AYUTTAYA - FS - DD - CON. ----- Total 330	8 million	8						
	12 "		12	100	100	110		
	310 "							
- TOTAL	817 million B.	20	94	193	250	260		

ACTIVITIES	YEAR		1992	1993	1994	1995	1996	1997	1998
5. PRATUMTHANI			6	10	82	82			
- FS	6 million								
- DD	10 "								
- CON.	164 "								

Total	180 million								
6. NONTHABURI & PAKET SANITARY DISTRICT			18	15	15	200	200	272	272
- FS	18 million								
- Dd	30 "								
- CON.	1 144 "								

Total	1,192 million								
7. SAMUT PRAKARN			15	15	15	200	200	300	300
- FS	15 million								
- DD	30 "								
- CON.	1,200 "								

Total	1,245 million								
8. PRAPADANG(SAMUT PRAKARN)			10	15	100	100	100	100	100
- FS	10 million								
- DD	15 "								
- CON.	500 "								

Total	525 million								
ALL TOTAL	3,959 million		69	149	805	832	780	672	672

