Table 15.5 indicates that Zone 2 and Zone 4 are the highest priority areas followed by Zone 1. Among these high priority areas of Zone 2, 4 and 1, the construction of sewerage facilities for Zone 4 is already scheduled by BMA. The next to the above high priority zones are Zone 3 and 10. Others can be evaluated as low priority zones.

The results of above evaluations indicate that Zone 2 and Zone 1 are first priority areas, and Zone 3 and 10 are second ones. Zone 4 is excluded from the order of priority for sewerage construction in this Master Plan.

15.2 Implementation Schedule

Implementation schedule for the first 20 years should be established with due attention to adequate timing of construction and availability of financial sources. In order to establish the most realistic schedule, considerations should also be given to local potentiality for construction works and reasonable magnitude of investment for 20 years. Although the study made in previous section 15.1 indicates that, among 9 sewerage zones (excluding Zone 4), Zone 2, Zone 1, Zone 3 and Zone 10 have higher priority from the technical and economical points of view, it is not possible to construct sewerage facilities for all of these four zones within 20 years.

If construction are to be implemented in two zones of Zone 2 and Zone 1, total construction cost of 6,000 million baht will be required including all sewer pipes of 1,000 km length, 2 treatment facilities and 9 pumping stations. This amount of cost is considered as the maximum budget to be considered by the government and, therefore, implementation schedule for the first 20 years are discussed for Zone 1 and Zone 2 only.

Implementation schedule based on sub-zone by dividing above two zones into smaller area has been attempted. Suz-zones which are delineated by alignment of trunk sewer and characteristics of area, are shown in Table 15.6 and Figure 15.1.

Table 15.6 Frame and Work Items

Sub-Zone	Served Area (ha)	Served Population (Persons)	Waste Load Generated (kg/d)	Construction					
				Trunk Sewer (m)	Branch & Lateral Sewer (m)	House Connection (No.)	Pumping Station (No.)	Treatment Facility (m^3/d)	Construction Cost (million Baht)
1-A	665.40	232,900	19,800	5,300	127,800	42,300	0	81,200	656.0
1-B	543.22	184,200	9,600	2,700	105,900	33,500	1	41,100	318.2
1-C	617.23	157,900	8,200	1,500	121,900	28,700	2	36,400	321.0
1-D	1,017.51	248,900	13,000	4,700	198,800	45,300	0	57,700	662.6
1-E	556.64	194,800	14,000	3,000	108,400	35,400	1	58,300	354.3
Sub-Total	3,400.00	1,018,700	64,600	17,200	662,800	185,200	4	274,700	2,312.1
2-A	1,027.83	306,700	33,700	1,000	0	-	0	129,400	378.5
2-B	487.89	230,900	26,800	6,600	0	-	1	106,700	414.8
2-C	258.04	111,600	13,600	4,800	0	-	0	54,300	168.5
2-D	113.46	9,100	500	0	22,700	1,700	1	2,700	46.4
2-E	302.07	52,700	7,500	3,700	56,700	9,600	1	31,300	268.2
2-F	1,410.71	112,800	10,400	3,500	278,600	20,400	2	50,700	652.1
Sub-Total	3,600.00	823,800	92,500	19,600	358,000	31,700	5	375,100	1,928.5
Total	7,000.00	1,842,500	157,100	36,800	1,020,800	216,900	9	649,800	4,240.6

15.2.1 Implementation Order of Sub-zones in Zones 1 and 2

The implementation schedule for zones 1 and 2 is determined by the order of priority of each sub-zone derived from the characteristics of each area and the alignment of trunk sewer. The alignment of trunk sewer is clear from the proposed layout plan presented in Chapter 12, while the characteristics of each sub-zone are discussed and evaluated hereinafter.

On the basis of the frame of sub-zone and the major work items summarized in Table 15.6, the evaluation of priority on sub-zone are carried out. Evaluating factors which include sanitary condition and economical aspects are (1) waste load generation per area, (2) population density, and (3) construction cost per person The figures of above factors in every sub-zone and order of priority among 11 sub-zones are presented in Table 15.7.

As shown in Table 15.7, the implementation of sewerage system construction should start from sub-zones 2-B, 2-C and 2-A, and due to the alignment of trunk sewer, sub-zone 2-A is recommended to be the first order to construction, followed by sub-zones 2-B and 2-C. Table 15.7 also indicates that next to sub-zones 2-A, 2-B and 2-C, sub-zones 1-A and 1-E are given high priority, but, situation may be changed after construction of sub-zones 2-A, 2-B and 2-C, due to the following reasons.

(1) The construction of Zone 2 treatment facilities is carried on.

(2) The rest of sub-zones in zone 2 are close to treatment site on construction and already within served area.

(3) Construction of another treatment facilities will hamper the expansion of served area, because it takes a long time of at least 3 years from the beginning of construction to starting of preparation of a new treatment facilities.

Table 15.7 Evaluation for Order of Priority in Zone 1 and Zone 2

Zone	Sub-Zone	Waste Load Generated Per Area (kg/day/ha)	Order	Average Population Density in the first 20 years (persons/ha)	Order	Construction Cost Per Person (baht/person)	Order	Total of Order	Evaluated Order of Priority
1	1-A	29.8	4	320	3	3,081	7	14	5
	1-B	17.8	7	310	5	1,890	4	16	6
	1-C	13.3	8	220	7	2,364	6	21	7
	1-D	12.6	9	190	8	3,427	8	25	8
	1-E	25.2	5	320	3	1,989	5	13	4
2	2-A	32.8	3	290	6	1,270	1	10	3
	2-B	54.9	1	500	1	1,700	3	5	1
	2-C	52.7	2	460	2	1,420	2	6	2
	2-D	4.4	11	100	10	4,090	9	30	10
	2-E	24.8	6	180	9	4,933	11	26	9
	2-F	7.4	10	100	10	4,622	10	30	10

Taking the results indicated in Table 15.9, together with the above mentioned conditions and the alignment of trunk sewer into account, it is recommended that the construction of sewerage facilities will start from sub-zone 2-A followed by 2-B, 2-C, 2-D, 2-E and 2-F, and that after construction of zone 2, zone 1 is undertaken.

On the basis of the rating system and various reasons adopted and present and expected future conditions in the area, the initial stages of construction would be selected, but, the order of implementation in later stages should be reviewed at least every 10 years, because sanitary conditions and sewerage requirement are changeable.

15.2.2 Implementation schedule

According to the order of construction proposed in previous section 15.2.1, two sets of alternatives are prepared in order to consider the magnitude of investment for 20 years. The two alternatives are as follows.

Alternative (I) : Construction for the whole area of Zone 2 for 20 years starting from sub-zone 2-A at first stage of 5 years with the construction cost of approximately 700 million baht. Total construction cost for 20 years is estimated as approximately 2,700 million baht at the end of 2523 (1980) price level, as shown in Table 15.8.

Alternative (II) : Construction for the whole area of Zone 2 and Zone 1 for 20 years with total construction cost of 5,800 million baht at the end of 2523 (1980) price level, as shown in Table 15.9.

Table 15.8 Construction Cost Estimate By Stage (Alternative I)

Million Baht at the End of 2523 (1980) Price Level

Stage	1st		2nd		3rd		4th		Total	
Served Area	2-A		2-B, 2-C		2-D, 2-E, Part of 2-F		The rest of 2-F		Zone 2	
Item	Total		Total		Total		Total		Total	
	Local Currency	Foreign Currency	Local Currency	Foreign Currency	Local Currency	Foreign Currency	Local Currency	Foreign Currency	Local Currency	Foreign Currency
A. Sewer	75.8		173.7		292.6		456.9		999.0	
	15.2	60.6	94.8	78.9	198.0	94.6	365.5	91.4	673.5	325.5
B. Pumping Station	0		29.7		13.4		5.2		48.3	
	0	0	8.9	20.8	4.0	9.4	1.6	3.6	14.5	33.8
C. Treatment Facility	302.7		249.6		221.5		103.6		877.4	
	90.8	211.9	74.9	174.7	66.5	155.0	31.1	72.5	263.3	614.1
D. Sub-Total	378.5		453.0		527.5		565.7		1,924.7	
	106.0	272.5	178.6	274.4	268.5	259.0	398.2	167.5	951.3	973.4
E. Engineering Fee (Dx10%)	37.9		45.3		52.7		56.6		192.5	
	10.6	27.3	17.9	27.4	26.8	25.9	39.8	16.8	95.1	97.4
F. Contingency [(D+E)x20%]	83.3		99.6		116.0		124.5		423.4	
	23.3	60.0	39.3	60.3	59.0	57.0	87.6	36.9	209.2	214.2
G. Total	499.7		597.9		696.2		746.8		2,540.6	
	139.9	359.9	235.8	362.1	354.3	341.9	525.6	221.2	1,255.6	1,285.0
H. Land Acquisition	187.5		3.3		0.3		0.2		191.3	
	187.5	0	3.3	0	0.3	0	0.2	0	191.3	0
I. Total Government Contribution	687.2		601.2		696.5		747.0		2,731.9	
	327.4	359.8	239.1	362.1	354.6	341.9	525.8	221.2	1,446.9	1,285.0
J. Private Contribution	0		0		192.7		246.7		439.4	
	0	0	0	0	192.7	0	246.7	0	439.4	0
Grand Total	687.2		601.2		889.2		993.7		3,171.3	
	327.4	359.8	239.1	362.1	547.3	341.9	772.5	221.2	1,886.3	1,285.0

Table 15.9 Construction Cost Estimated By Stage [Alternative (II)]

Million Baht at the End of 2523 (1980) Price Level

Stage	1st		2nd		3rd		4th		Total	
Served Area	2-A & Land Acquisition		2-B, 2-C, 2-D, 2-E,		2-F, 1-A		1-B, 1-C, 1-D, 1-F		Zone 2 & Zone 1	
Item	Total		Total		Total		Total		Total	
	Local Currency	Foreign Currency	Local Currency	Foreign Currency	Local Currency	Foreign Currency	Local Currency	Foreign Currency	Local Currency	Foreign Currency
A. Sewer	75.8		399.8		907.7		1,200.9		2,584.2	
	15.2	60.6	239.6	160.2	653.3	254.4	856.6	344.3	1,764.7	819.5
B. Pumping Station	0		38.5		9.8		38.3		86.6	
	0	0	11.5	27.0	3.0	6.8	11.5	26.8	26.0	60.6
C. Treatment Facility	302.7		456.1		390.3		418.2		1,567.3	
	90.8	211.9	136.9	319.2	117.1	273.2	125.5	292.7	470.3	1,097.0
D. Sub-Total	378.5		894.4		1,307.8		1,657.4		4,238.1	
	106.0	272.5	388.0	506.4	773.4	534.4	993.6	663.8	2,261.0	1,977.1
E. Engineering Fee (Dx10%)	37.9		89.4		130.8		165.7		423.8	
	10.6	27.3	38.8	50.6	77.3	53.5	99.4	66.3	226.1	197.7
F. Contingency [(D+E)x20%]	83.3		196.8		287.7		364.6		932.4	
	23.3	60.0	85.4	111.4	170.1	117.6	218.6	146.0	497.4	435.0
G. Total	499.7		1,180.6		1,726.3		2,187.7		5,594.3	
	139.9	359.8	512.2	668.4	1,020.8	705.5	1,311.6	876.1	2,984.5	2,609.8
H. Land Acquisition	241.9		0		0		0		241.9	
	241.9	0	0	0	0	0	0	0	241.9	0
I. Total Government Contribution	741.6		1,180.6		1,726.3		2,187.7		5,836.2	
	381.8	359.8	512.2	668.4	1,020.8	705.5	1,311.6	876.1	3,226.4	2,609.8
J. Private Contribution	0		156.7		869.1		1,980.8		3,006.6	
	0	0	156.7	0	869.1	0	1,980.8	0	3,006.6	0
Grand Total	741.6		1,337.3		2,595.4		4,168.5		8,842.8	
	381.8	359.8	668.9	668.4	1,889.9	705.5	3,292.4	876.1	6,233.0	2,609.8

Note: Construction Cost in Table 15.8 and Table 15.9 are estimated based on the study performed in previous chapter 14, Cost of Proposed Sewerage System. In estimating the construction costs for foreign component, it is assumed that all equipment and materials which are not manufactured in Thailand will be imported. These include pumps, engines, valves, controlling devices, tunnel boring machine, and other equipments required for sewer, pumping station and treatment facilities. Engineering cost for the implementations of the proposed programs include the cost both detailed engineering design and construction supervision services. Foreign portion of engineering cost is assumed to be 60 percent of total engineering fee. Twenty percent of the estimated construction and engineering fee is considered as contingency allowance for the successful completion of the project. These percentages are assumed on the basis of similar nature of project experienced in Asian countries and also taking various factors available in the project area into account. Government Contribution; construction cost for public sewer, pumping station and treatment facilities. This amount of cost is to be borne by the government and collected from various sources as described in Chapter 17.

Private Contribution; construction cost for house connection including engineering fee and contingency.

The major difference between Alternative (I) and Alternative (II) is magnitude of investment for 20 years and degree of construction progress. The determination of magnitude of investment is mostly a matter of policy rather than engineering consideration. However, the amount of investment of 5,800 million baht estimated for Alternative (II) is considered to be relatively large for the city which will initiate construction of normal sewerage system for the first time. Moreover, implementation of Alternative (II) requires the heavy and extensive construction works of average 53 km length of sewers per one year throughout the full scheduled period of 20 years.

Taking into account the above conditions and situation of heavy traffic in scheduled area, Alternative (I) is recommended to undertake the sewerage construction effectively.

The recommended implementation program is summarized in Table 15.10, and construction cost and operation and maintenance cost are shown in Table 15.11 accordingly. The operation and maintenance cost are calculated in accordance with the basic study in Chapters 11 and 14, and expressed as the cumulative cost at each end of stage in terms of annual cost, which includes operation costs such as for costs of electricity and salary of operators and labors, and maintenance service cost of inspection and repairs for broken parts.

Table 15.10 Recommended Implementation Program in Four Stages

Stage	Sewerage Sub-zone to be Implemented	Served Area (ha)	Served Population in 2545(2002)	Construction				
				Trunk Sewer (m)	Branch & Lateral Sewer (m)	House Connection (No.)	Pumping Station (No.)	Treatment Facility (m^3/d)
First 2526 - 2530 (1983 - 1987)	2-A	1,027.83	306,700	1,035	-	-	0	129,400
Second 2531 - 2535 (1988 - 1992)	2-B 2-C	745.93	342,500	11,390	-	-	1	161,000
Third 2536 - 2540 (1993 - 1997)	2-D 2-E a part of 2-F	593.43	76,000	4,125	114,500	13,900	3	40,400
Fourth 2541 - 2545 (1998 - 2002)	the rest of 2-F	1,232.81	98,600	3,100	243,500	17,800	1	44,300
Total	Zone 2	3,600.00	823,800	19,650	358,000	31,700	5	375,100

Table 15.11 Construction Cost and Operation and Maintenance Cost

Million Baht at the End of 2523 (1980) Price Level

Stage	Construction Cost		Cleaning Equipment Cost	Cumulative Operation & Maintenance Cost at Each End of Stage in Terms of Annual	
	Government Contribution	Private Contribution (House Connection)	Government Contribution	Government Contribution	Private Contribution (House Connection)
First 2526 - 2530 (1983 - 1987)	687.2	0	0	21.0	0
Second 2531 - 2535 (1988 - 1992)	601.2	0	1.2	48.0	0
Third 2536 - 2540 (1993 - 1997)	696.5	192.7	0.8	56.0	0.8
Fourth 2541 - 2545 (1998 - 2002)	747.0	246.7	1.2	65.0	2.7
Total	2,731.9	439.4	3.2	-	-

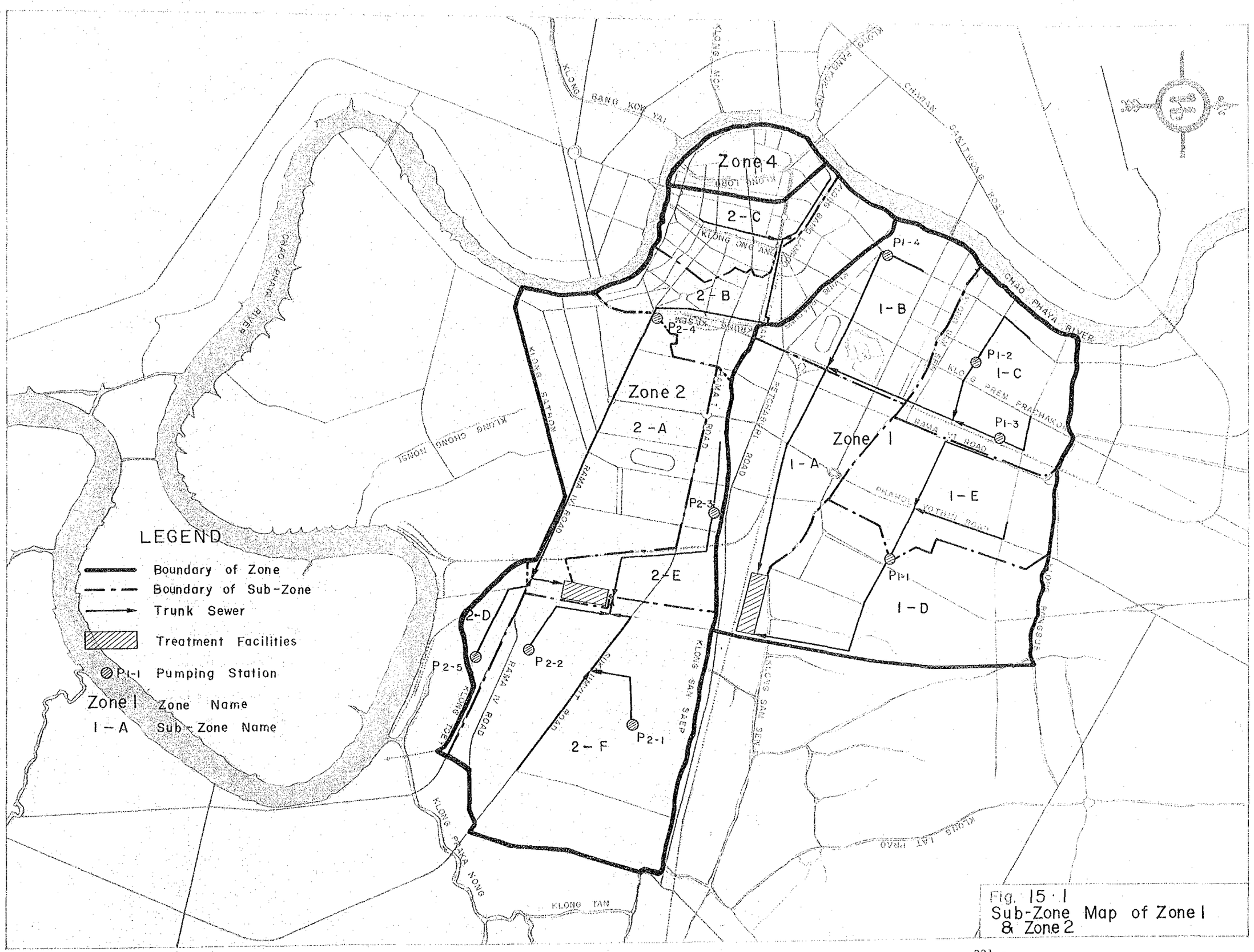


Fig. 15 · 1
Sub-Zone Map of Zone 1
& Zone 2

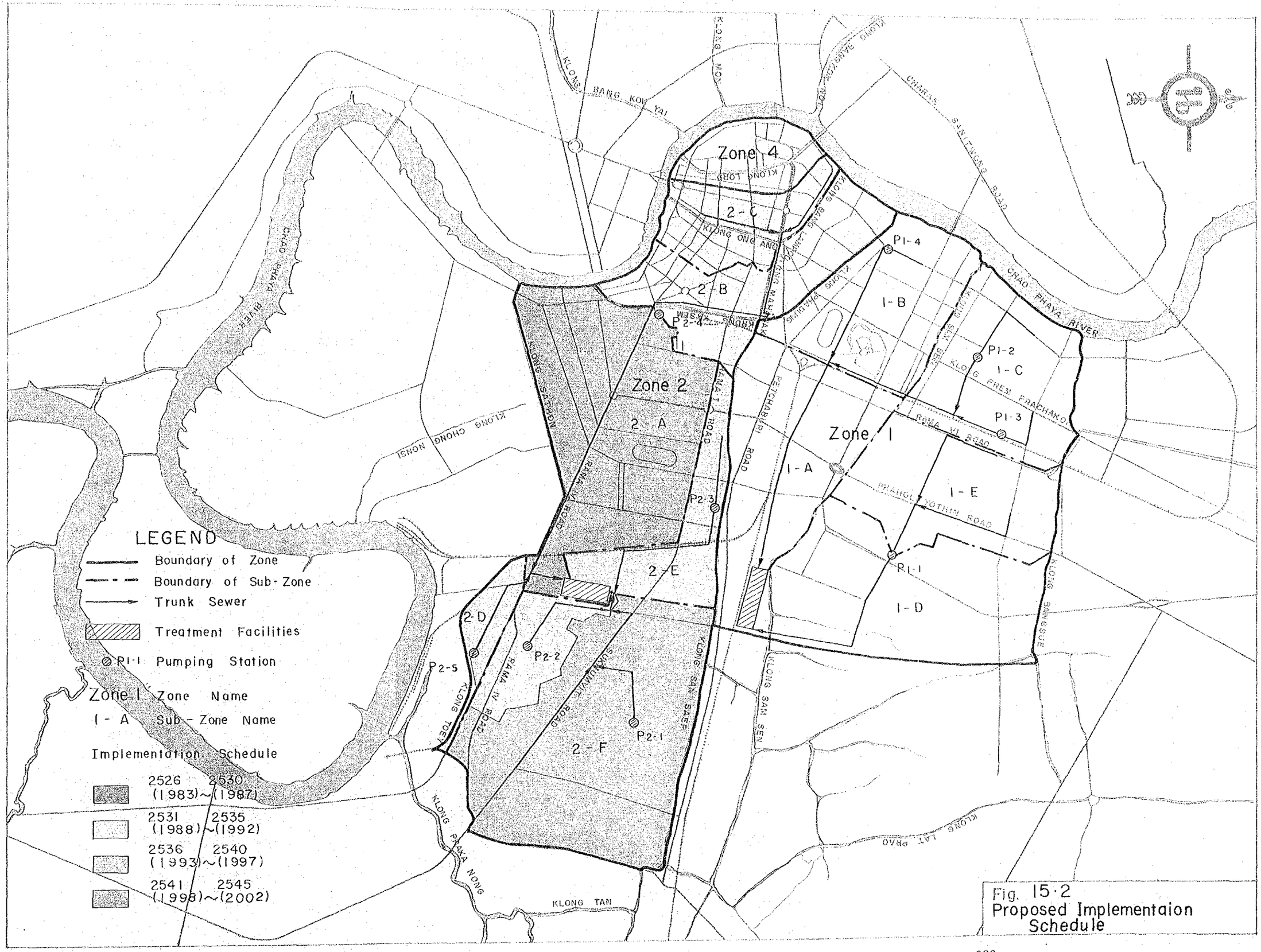


Fig. 15·2
Proposed Implementaion Schedule

CHAPTER 16

ADMINISTRATIVE AND FINANCIAL STUDY

The capital of Thailand was originally Ayuthaya which was located at the west bank of Chao Phya River. This capital was, however, transferred to the site of the east bank of the River, the strategic location for the defence against potential siege and attack from the external areas. The new capital by the name of Bangkok was thus established in 2325 (1782). Since then the extensive development has been undertaken, especially, the development during the past half century is remarkable and in less than three decades the area of the city has increased four and a half times, the population and the budget six and a half times in terms of the purchasing power. The expansion of population is, among others, overwhelming attributed by constant migration into Bangkok where socio-economic development and job opportunity attract the inflow of population. Among the many development projects recently undertaken the public works related to infrastructure system development such as water supply and drainage system project have been significantly emphasized in the light of accelerating growth of population. And further requirement for the development of wastewater disposal system has recently been raised to cope with the increasing load of wastewater which is detrimental to the sanitary of the environments including the rivers and klongs, the main water ways in Bangkok.

The Master Plan for the sewerage development project for the greater Bangkok Metropolitan area had already been prepared in 2511(1968) including its administrative and financial aspects although its implementation has been kept intact. The physical as well as economic condition has been changed since 2511(1968) and the previous plan would no longer be consistent with the present situation. The new preliminary study was, therefore, undertaken and completed early this year 2523(1980) and subsequently new Master Plan Study was initiated from end August 2523(1980). This chapter is dealt with the administrative aspects of the sewerage project with recommendation on general management including organizational and legal arrangements.

16.1 Existing Administrative System

The major development projects in Thailand which will include proposed project in Bangkok are largely implemented by the involvement of government agencies at national level and local or regional level depending on the magnitude of the development plan.

National Level

At the national level, several agencies are involved in the various aspects of the development project. The major government agencies under Prime Minister are assumed to have direct bearing in the sewerage project implementation, are as follows. (Refer to Figure 16.1)

1) Ministry of Interior
2) Ministry of Finance
3) Ministry of Public Health
4) Ministry of Industry
5) Budget Bureau
6) National Economic and Social Development Board (NESDB)
7) National Environmental Board (NEB)

The National Economic and Social Development Board (NESDB) is instrumental, as the central planning agency, to develop a planning policies and guidelines for the development. The Board is chaired by the Prime Minister while members of the Cabinet serve as advisors to the Board. The members of the Board are consisting of qualified personnel in various field and high ranking government officials. NESDB has, therefore, access to the highest political leadership through such organizational advantage. The planned policies and measures proposed by the planning agency as NESDB are implemented through the resolutions of the Council of Ministers with necessary legislative arrangements.

At the stage of the implementation, the Budget Bureau and the Ministry of Finance take parts in the preparation of the annual budget and making revenue estimates. Although there is no clear division of responsibility between Budget Bureau and Ministry of Finance at implemen-

tation stage of the plan, the Ministry of Finance has largely responsibility of making revenue estimates including foreign loan administration through Project Loan Operation Division of the Fiscal Policy Office while Budget Bureau has the authority in the annual budget preparation in accordance with proposed development plan.

The Ministry of Interior plays a dominant role to serve as the coordinating body through which the approval of the highest political leadership and budget supports as government grants are given to authorities responsible for the implementation of the various development projects, and exerts an extensive control over the activities of the local and regional authorities.

The Ministry of Public Health is concerned with public health, sanitation and medical services in whole Thailand and is responsible for technical and legislative supports for sanitary conservation program, preparing legal provisions necessary for implementing the program.

The National Environment Board (NEB) is indirectly related to the development projects particularly to wastewater disposal system development. NEB was recently established as an advisory body for any development projects related to national environmental quality. NEB conducts study and research of the environmental condition and performs amendment of laws and provision of guidelines for the enhancement of the national environmental quality.

The Ministry of Industry is authorized to control the industrial establishment and pertinent industrial wastewater discharge which will be discharged to the natural or public water ways.

The organization chart for the above agencies at national level is indicated by the Figure 16.1.

Legal Level

(1) Bangkok Metropolitan Administration (BMA)

The proposed Study Area in Bangkok Metropolis is administered by the Bangkok Metropolitan Administration (BMA) which was founded in 2515 (1972)

merging the former Municipality of Bangkok and Thonburi. BMA has principally been established as a local municipal government to exert an autonomy with minimal control from the central government. The executive body of BMA is headed by a Governor and four Deputy Governors who are elected for four years terms. The Governor as the chief executive of the BMA is under the ultimate control of Bangkok Metropolitan Assembly, a legislative body consisting of 45 assemblymen elected each representing approximately 100,000 persons from the 24 administrative districts covering an area of 1,589 km^2 with population of 4.7 million.

BMA is organized into 11 bureaus and 24 district offices directly responsible for activities of local interests under Secretary of State for Bangkok Metropolis as indicated by the Organization Chart, Figure 16.2. BMA's main policy is land use planning, environmental development, economic and social development and internal development of BMA.

BMA's functions are: maintenance of roads, water ways and drainage system, cleanliness, sanitation and orderliness of the city and public welfare including public health and medical services, conservation of the environment. The functional involvement of central government agency is, however, significant and major public utilities such as transportation, electricity, water supplies, telephone are under the jurisdiction of other central government agency and some functions normally expected to be under BMA are under the jurisdiction of central government, and quasi-government enterprises and other Ministries of central government. Among such organizations of central government, the ministry of the Interior exerts direct control over BMA and the Prime Minister and the Cabinet have the ultimate authority. The followings are functional units of BMA more or less related to the proposed Study.

(2) Bureau of Drainage and Sewerage (BDS)

BDS is recently established in BMA in 2520(1977) as a separate bureau with primary objective to alleviate or possibly eliminate the recurrent flooding and to dispose ever-increasing wastewater which is one of the major concerns of BMA. BDS is currently exerting efforts in cleaning, dredging and improving numerous klongs throughout the city as one of the measure for the flood protection, especially during the rainy season.

BDS is headed by a Director who reports to one of the four Deputy Governors of BMA. BDS is organized into six divisions such as (1) Office of Secretary, (2) Technical, (3) Drainage Control, (4) Canal Maintenance, (5) Waste Water Treatment and (6) Special Project Divisions as shown in Figure 16.3. The special Project Division has recently be provided envisaging the increasing importance of project implementation. The total staff of BDS is approximately 1,500 consisting of about 30 engineers, 160 technicians, 170 administrative personnel and 1,100 laborers. The significant numbers of temporary laborers are also employed to undertake the cleaning of canals and the contracting firms are engaged to perform the most construction work of canals and parts of its maintenance work. The expenditures of BDS are met by funds drawn from BMA within the limitation of annual or supplemental budget of BMA.

(3) Bureau of Sanitation (BOS)

This bureau was created by BMA in 2520(1977) as one of the two bureaus split from the former Bureau of Cleansing. BOS has about 1,200 employees mainly responsible for the disposal of night soil including solid waste of the BMA's 24 districts and control of disposal sites, rufuse dump and compost plants. The expenditures of BOS are met by allocation of BMA budget. In FY 2522(1979) this was totalled 227 million baht.

(4) Bureau of Public Works (BPW)

BPW is one of the bureau which have more influence over the constructions and control of city's infrastructure, such as public buildings, roads in Bangkok Metropolitan area. BPW has more than 2000 permanent employees. BPW is organized into six divisions of Construction Supervision and Inspection, Building Control, Design, Right of Way and Land Acquisition, Construction and Maintenance of Road. The Secretariat (Administrative), BPW has the responsibility to coordinate utilities installations with other agencies such as Metropolitan Waterworks Authority (MWWA), Highway Department and Metropolitan Electricity Authority (MEA).

(5) Bureau of Finance

This Bureau administer and control the revenue and expenditure for the BMA's activities including accounting, auditing and budget planning.

Figure 16.1 The Organization Units Concerned at National Level

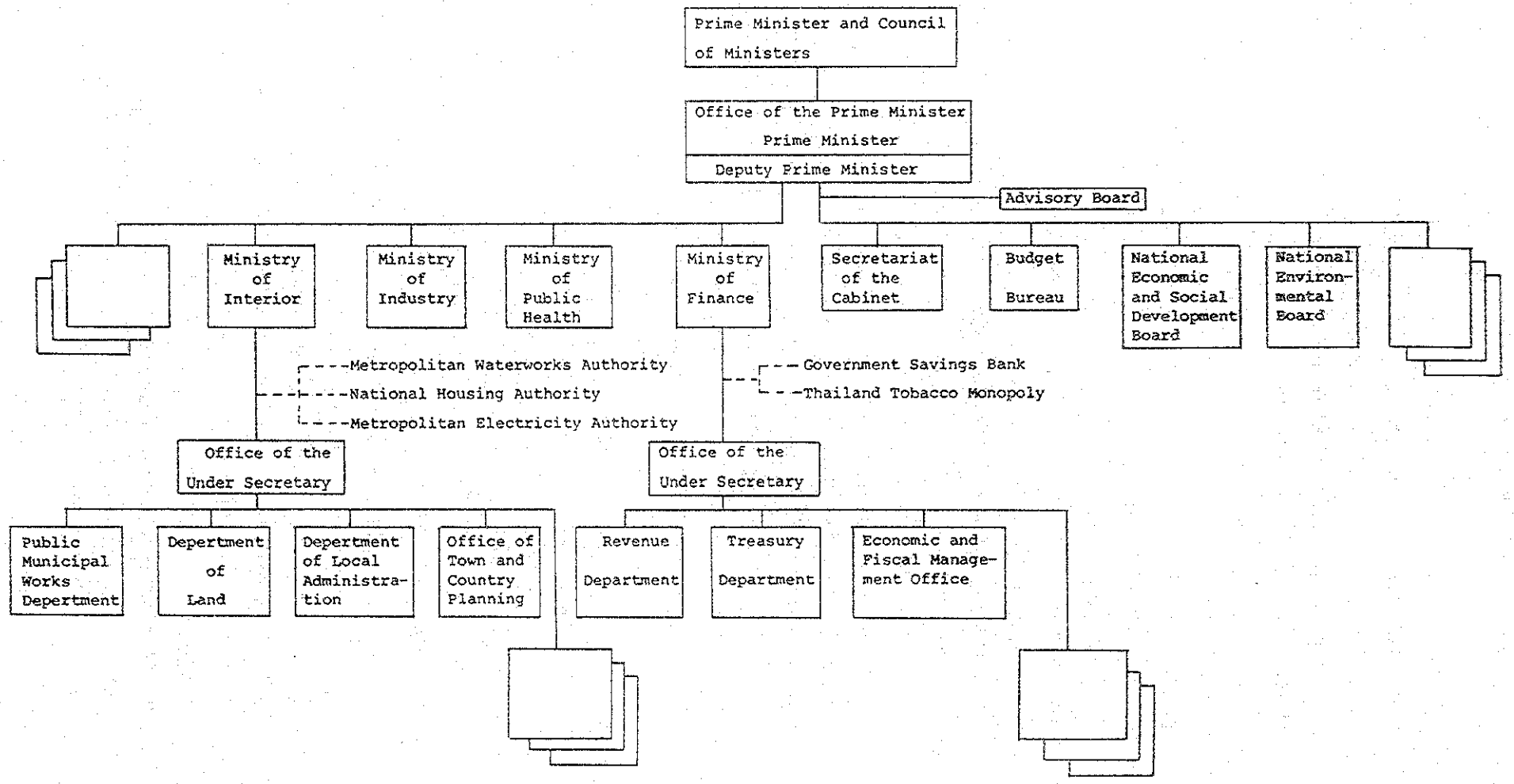


Figure 16.2 The Organization Units Concerned at Local Level
(Bangkok Metropolitan Administration)

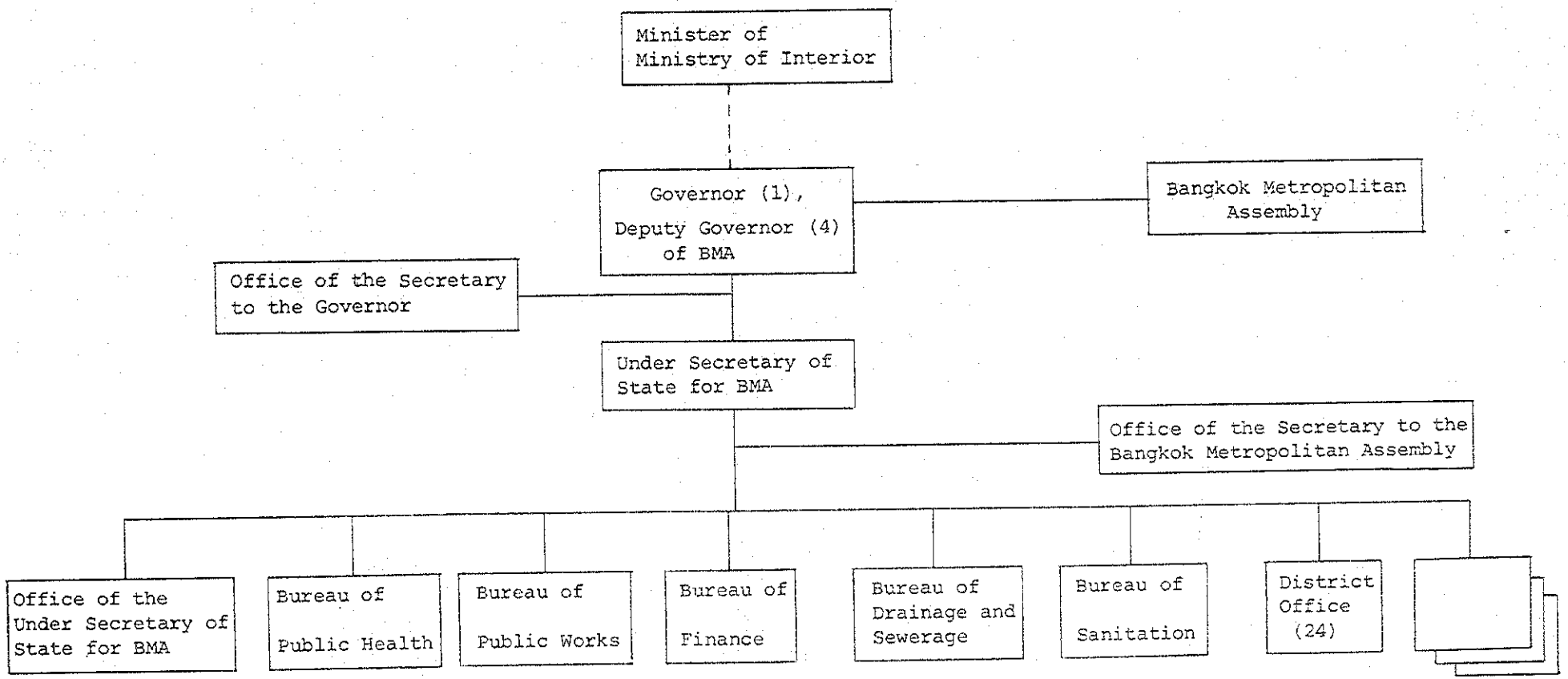
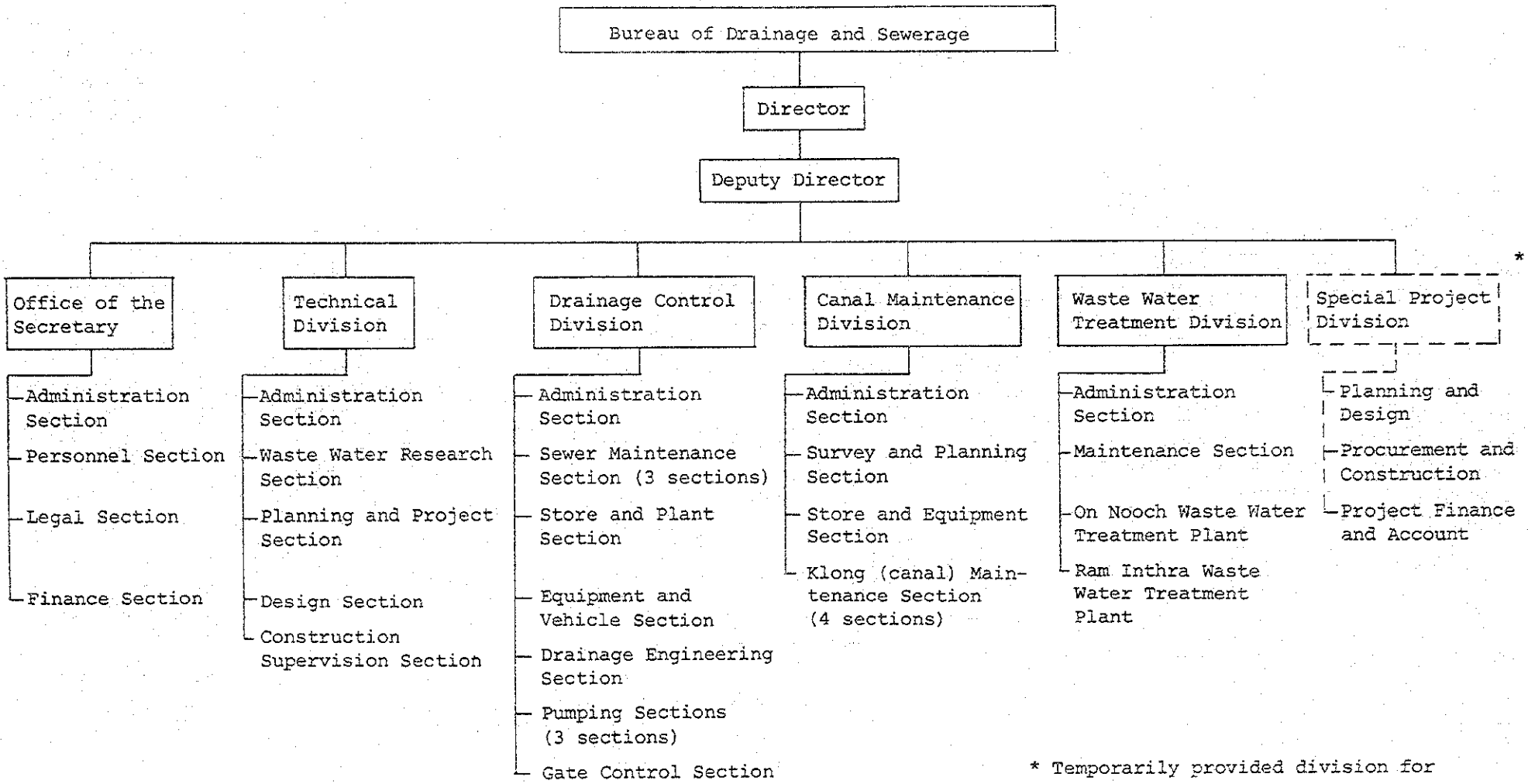


Figure 16.3 Existing Organization of Bureau of Drainage and Sewerage(BDS)



(6) Bureau of Policy and Planning

This Bureau was recently created in BMA in order to evaluate all projects and programs newly proposed. Such evaluation are submitted to BMA's Governor and the central government to be utilized as supporting data for the selection of project priorities.

(7) Bureau of Public Health

This Bureau controls every aspects related to public health and environmental sanitary conservation and exerts an examination of any proposed utility system planning to conform to their public health criteria.

(8) Twenty Four (24) District Offices

Each district office located in 24 districts in the Metropolitan area represents BMA's authority in dealing with local day to day activities.

16.2 Existing Financing Situation

The existing financial situation of the Bangkok Metropolitan Administration (BMA) has been reviewed under the basic assumption that BMA would undertake the execution and management of the proposed sewerage project. As mentioned in previous paragraph BMA is organized into 11 bureaus and 24 district offices with specific functions assigned. Such divisions has, however, no independent accounting system except for the expenditure recording practice. The annual budget to meet the expenditure is allocated by BMA's bureau of finance.

BMA's most recent revenue in 2522 (1979) to meet the equivalent amount of expenditure is approximately 3,000 million baht and substantial part of income is derived from the taxation occupying about 75 percent of total income. The other sources of income are subsidy from the central government about 10 percent and other miscellaneous income about 15 per-

cent of total income. The major portion of budget is distributed to (1) civil works related to public utilities development and improvement and (2) educational services occupying about 27 percent and 20 percent of total BMA's expenditure respectively.

The expenditure related to drainage improvement and maintenance is 135 million baht approximately 4 percent of total expenditure and expenditure for sanitary improvement is 230 million baht approximately 7 percent of total expenditure. The high proportion of the government expenditure is increasingly necessitated to meet the demand to maintain the growth and improve the quality of economic and social life in the Bangkok Metropolitan area.

The present collection of revenue of BMA is authorized by Municipal Revenue Act B.E. 2497 (1954). This Act includes the procedure of the taxation which is the main source of BMA's revenue. The Land Development Tax Act B.E. 2508 (1965) and House and Land Tax B.E. 2457 (1932) specify the provisions dealing with above mentioned two kinds of taxes on real estates. The rate for house and land tax is a flat rate of 12.5 percent of the annual rental or equivalent value of the house and land. The land development tax is levied in 43 tax rates for 43 different prices of land. The tax ranges from 0.5 baht per rai(1,600m^2) to 400 baht per rai with 100 baht per rai for each subsequent increase of land value of 100,000 baht per rai thereafter.

The present taxation system for above is, however, based on the extensive exemption which is resulted in a limited tax revenue. As for the land development tax, the owners of the house built on small land in the Metropolitan area are exempted from the land tax due to regalized tax exempted land area of 0.25 rai or 100 square wah (400 m^2). The tax for house and land is levied on the owners of house and land which are utilized for the commercial purposes such as rental and other profit making business, and taxes are exempted for those houses in which the owners themselves reside.

The new attempt has recently been made to amend both of above two kinds of taxation systems by the Finance Ministry and the Cabinet has already approved the proposal for such amendment. The amendment includes the reduction of the maximum tax exempted area from 100 square wah to 50 square wah and increase of tax rate for the higher land value as well as taxation on owners of real estate for non-commercial purpose who have ever been tax exempted.

In addition to above taxes there are other categories of taxes levied on liquor and refreshment sales, business and purchase, signboard, animal slaughtering business, vehicle, gambling, entertainment and rice which are to be exported. Among above taxes, BMA is collecting directly house and land tax, land development tax, tax on signboard and slaughtering, and other six categories of tax are collected by other government agency mainly by Ministry of Interior, providing that proceeds are transferred to BMA after reducting necessary expenses.

16.3 Existing Regulations

As there is no complete sewerage system except for quasi wastewater disposal system such as storm sewer and septic tank systems, the regulation normally required for the sewage works is not available. There are, however, several laws and ordinances to administer the sanitary control which is closely related to the objective of sewerage development. Such regulations related to sanitary control are:

(1) Public Health Act B.E. 2484 (1941)
(2) Act for the cleanliness and Orderliness of the Country B.E. 2503 (1960)
(3) Building Control Act B.E. 2522(1979) and its By-Law
(4) Bangkok Metropolitan Administration Act B.E. 2518 (1975)
(5) City Planning Act B.E. 2518(1975)
(6) National Environmental Quality Act (No. 2) B.E. 2521 (1978)
(7) Notification of the Ministry of Industry issued under the Factories Act B.E. 2512(1969)
(8) By-Law of Bangkok Metropolis on Control of Trade which is objectionable or may be dangerious to Health B.E. 2519 (1976)

(1) Public Health Act B.E. 2484 (1941)

This Act appears comprehensive in its wide coverage of sanitary control for the area where no sewerage services are available. This Act regulates the disposal of rubbish, filth and drift and authorizes the local authority to issue by-law or rules which stipulates the method and procedure of such disposal. The other items to be controlled by local authority are commercial undertakings to be objectional or injurious to health and unsanitary dwelling place, latrines, night soil receptacles, urinals, nuisance including places and facilities, watercourse and drain in such a state to be hazardous to health. This Act has penal clause but the amount of fine is minimal not exceeding 50 - 100 baht.

(2) Act for the Clealiness and Orderliness of the Country B.E. 2503(1960)

This Act is established to regulate and control mainly the public offence including disturbance and unti-aesthetic activities. Such forbidden activities include passing fecal matter as urine on the road or any place of public places visible from the road or public or disposing into the river or canal with the local authority's poster forbidding such acts, and the owners of food or refreshment shops, are required to provide lavatories for persons'willing to pay.

(3) Building Control Act B.E. 2522(1979) and its Municipal By-Law, B.E. 2522(1979)

The above Building Control Act and its Municipal By-Law are renewed version of respective old Control of the Construction of Buildings Act B.E. 2479(1936) and Municipal Regulation on Building Control B.E. 2483(1940). The Act stipulates mainly control on the building construction as licensing, construction modification, tearing down and removal of buildings including a provision to empower local authority to issue By-Laws to control, among others, design and number of bath-rooms and toilets. The Municipal By-Law, namely, the BMA's Regulation of Building Control, B.E. 2522(1979) issued on the above Act includes following provisions in its Section 8, Sanitation.

No. 84 Buildings in construction shall have the systems of storm water, wastewater drainage, which are adequate.

No. 85 The slope of drain pipe from Buildings to public drain in drainage be set in gradient of 1:200 and try to keep it. In case of circular pipe the manhole have to be built at every interval of not more than 12.00 m, at every change of and at every point of interconnection between a private property to the public drain.

No. 86 The waste drain in buildings must be at least 10 cm wide before it reaches a public drain. There must be an opening for inspection where a refuse screen must be installed. These shall allow convenient inspection and the building owners have to take care about that.

No. 87 The Industry, Hospital, Fresh goods Market, Restaurant, Building Complex, Dormitory and Commercial Buildings have to build a disposal system for the wastewater, before discharge to the public drain.

No. 88 The Building in which people may live in/or otherwise utilize must be equiped with adequate sanitary facilities, and these must at least include the followings:

Type of Building	Latrine for Excrement	Urinal	Wash-basin
Each Unit of Residential Building	1	-	-
Each Unit of Building Complex	1	-	1
Raw House and attached Commercial Buildings (which is not taller than 3 stories in any section)	1	-	1
Attached Commercial Buildings (which is taller than 3 stories in any section)	2	1	1
Hotel/room	1	-	1
Dormitory/50 m^2	1	-	1
Office Building, School, Hospital & Commercial Buildings/75 m^2	1	1	1
Assembly Hall and Theatre/250 m^2	1	1	1
Industrial Factory/400 m^2	1	1	1

The excess of specified areal sizes shall be taken as a full size.

No. 89 The inner area of a toilet room shall not be smaller than 0.9 m^2, width 0.9 m. In case bathing is included the area shall not be smaller than 1.50 m^2. The configuration shall allow ease of cleansing and ventilation shall be provided by an opening of at least in an area not less than 10 percent of the floor area or otherwise a force ventilation shall be provided.

No. 90 The latrine for excrement shall be the type which allows cleansing with water and discharge into a septic tank-seepage pit.
A latrine which is built within a distance of 20.00 m from public canal and water courses must be made into a water tight tank.

No. 91 A complex building for residential purpose or large buildings which are neither a row house nor an attached commercial building which occupies area more than 2,000 m^2, or a hotel shall have an area for garbage disposal without causing any nuisance to the nearby building.

Note: Manhole is the opening where the inspection of the flowing condition of water in the drain may be made possible.

(4) Bangkok Metropolitan Administration Act B.E. 2518 (1975)

This Act empowers BMA to execute the following duties, among others, related to the proposed sewerage project.

1. Control on sanitary in public places and entertainment places
2. Activities to enhance public health, family sanitation and medical care
3. Development and improvement of public uitlities facilities
4. Maintenance of cleanliness and order of the metropolitan area
5. Construction and maintenance of streets, water ways, and drainage

The financial procedures for BMA are stipulated for the following items such as (a) Tax, license fee or service fee

(b) Revenue and expenditure

(c) Borrowing money and payment of loan

(d) Commercial activities of BMA

(e) Issuance of Bonds

In each case a draft by-law shall be proposed by the council of BMA to be enforced subject to approval of the Governor of BMA. BMA is empowered by its Section 68 of the Act, among others, render services to private individuals, state agencies or other official units by receiving fees. Section 81 specifies the authorized revenue of BMA which include income from public utility fee, license fee, fines, service fee, loans and subsidy through central government, assistance from foreign and international agency with the consent of the Cabinet, taxes and other duty fees. This Act authorizes the central government to supervise the administration and financial operation of BMA.

(5) City Planning Act B.E. 2518(1975)

This Act specifies the formation of City Planning Committee for Bangkok Metropolis and empowers the Committee to play instrumental role to proceed the comprehensive city planning and other utilities project planning by virtue of the Ministerial Regulation issued by the Minister of Interior. The land and other immovable property are expropriated under the law on expropriation of immovable property.

(6) National Environmental Quality Act (No. 2) B.E. 2521 (1978)

This is a revision of old Act enacted in B.E. 2518(1975) with broad objective to conserve and improve the environmental and sanitary condition in whole Thailand by establishing the "National Environment Board" as an advisory board for any development plan, project, standard including recommendation and amendment of laws related to the environmental quality. The office of the National Environment Board entrusted by National Environment Board has the duty to carry out the study, research of the environmental conditions and quality to be used for the standard or the guidelines for the enhancement of the national environmental quality.

The Prime Minister may, under this Act, require the categories and magnitude of Projects of the government agencies and other private organization to submit the study report for prevention of and remedy for the adverse effects on the environmental quality during preparation stage of the project to National Environment Board and such report shall be approved prior to further proceedings. The Prime Minister also has

a power to issue an order prohibiting the person from causing such danger or damage which will intensify environmental pollution. This Act has also the penal provision for the persons who violates or fails to comply with order of the Prime Minister and other law, rule or regulation concerning the control of environmental quality.

(7) Notification of the Ministry of Industry issued under the Factories Act B.E. 2512 (1969)

Under the Factories Act, the person obtaining a license to operate the factory are legally required to make an arrangement for the removal of wastewater and shall be punished with fine not exceeding 2,000 baht in case they failed to comply with above requirement. Above Notification is issued by virtue of above regulation to notify the details of required arrangement for wastewater disposal specifying allowable chemical components.

(8) By-Law of Bangkok Metropolis on Control of Trade which is objectionable or may be dangerous to Health B.E. 2519 (1976)

This By-Law is issued basically in conformance with Public Health Act B.E. 2484 (1941), Sections 7 - 9 which generally stipulates about licensing the commercial undertakings subject to public health control. This By-Law regulates the sanitary systems required including discharge of all kinds of trade and factories, installment of drains for wastewater drainage, toilet, refuse receptacles to prevent any annoyance in accordance with the advice of the Public Health Officials.

16.4 Administrative Recommendation

(1) Coordinating Committee

At the initial step to formulate the administrative structure the necessary jurisdictive arrangement would be required to allow the proposed sewerage project to be legally and politically accepted. It is therefore desirable to formulate a Project Steering Committee chaired by

the Governor of BMA comprised of the representatives from various government agencies and entities having controlling power over technical as well as policy matters.

Such agencies and entities are: National Economic and Social Development Board (NESDB) to be dealt with submitting recommendation and advice on project formulation as the central planning agency. Ministry of Public Health as an advising agency with respect to adequacy of the arrangement for wastewater disposal, Ministry of Industry as a controlling body of the industrial wastewater disposal, and National Environmental Board (NEB) concerning broad aspects of environmental health matters.

The Project Steering Committee as proposed are expected to serve as a coordinating body to the high ranking officers concerned in the Central Government and contribute to the formation of the proposed project including administrative and legislative procedures. It is expected that the Committee members will meet periodically according to need to discuss the problem and action to be taken in broad terms for expeditious implementation of the project with mutual understanding (or an agreement when necessary) among agency concerned.

(2) Bangkok Metropolitan Administration (BMA) and Bureau of Drainage and Sewerage (BDS)

As stated earlier there exists an organization of Bureau of Drainage and Sewerage (BDS) to be responsible for the sewerage operation and management in the Bangkok Metropolitan Administration (BMA). The organization and administrative recommendation are therefore presented in this chapter on the basic understanding that BMA could be delegated to undertake the project designating the BDS as its implementing agency, subject, however, to the approval of the Minister of Interior. BMA is legally authorized to execute the duty of public health control, among others, in that sewerage development works are duly construed to be included.

The BDS has limited experience presently for the sewerage system construction as well as its operation and maintenance because no sewerage system in the administrative boundary of BMA is available except

for the storm-water and rudimentary private wastewater disposal system and they are mainly involved in day to day remedial works dealing with cleaning of canals and improvement of existing drainage in conjunction with flood protection problem.

The organizational arrangement would, therefore, be required for the successful implementation of the proposed program either by mobilizing the existing functions or by expanding the present organizational structure. The required administrative arrangements to function for the project should be based on the firmly established objectives

1) to establish effective organization for physical and financial management of the sewerage works, staffed with adequate number of qualified personnel,
2) to provide a dependable services for wastewater collection, treatment and disposal in an efficient manner at the lowest possible cost and
3) to coordinate with other agencies, government and private, and integrate the sewerage development program into overall health and sanitation improvement program.

(3) Required Functions

Such administrative arrangement will include the clear division of responsibility of existing units or proposed new units and pertinent personnel recruitment schedule. The functions normally required for the sewerage works and the organization chart as well as personnel requirement are presented in the subsequent paragraphs for the purpose to provide the guideline based on which the practical organizational set-up can be achieved with adequate modification in compliance with existing situation.

Finance

This function is one of the major administrative support for sewerage works management. A separate financial unit exclusively for sewerage operation is required to maintain the financial records of the sewerage system including budgeting, accounting and payroll and billing. Such separate accounting system would provide adequate information for evaluating and controlling sewerage operation and would serve as a rational cost basis for planning future expansions of the sewerage works. If the

agency receives the central government and external foreign loans this separate accounting is particularly important to furnish the lending agency with accurate operating results of the sewerage works.

Legal Administration

The legal arrangement would be required during the construction of sewerage system for easements, rights-of-way, contracting and other necessary proceedings for the legal settlement for any conceivable disputes in connection with sewerage operation.

Personnel

The personnel recruitment, wage and salary administration and staff training will be required.

Procurements

Procurement and supply of local and offshore materials is required to be handled in internal coordination with financing unit.

Monitoring & Surveillance

This function includes monitoring and surveillance on water quality of industrial wastes, wastewater, and treatment facility effluents with necessary laboratory test and analysis, the data from which will be applied for the improvement of their operation and/or system themselves.

Planning and Design

This function includes development of the plan and preparation of engineering design and specification necessary to receive tenders for all new construction of sewerage including service connection with pertinent cost estimation, drawings and reproduction of engineering plans, and the issuance of permits for new service connections requested by the owners of buildings.

Construction

This functional units would be responsible for supervisory services of all new construction work with attendant surveys and inspections to assure compliance with regulation and required specification.

Operation and Maintenance

The operating functions basically consist of proper operation of treatment facilities, pumping stations, diversion systems operation in order to achieve desired quality of wastewater effluent and proper disposal of plant effluent and uninterrupted conveyance of wastewater, and surveillance and monitoring of the industrial wastewaters. The maintenance functions include maintenance and repair of equipments, treatment facilities, pumps, plant premises structures, gate, pipes, outfalls, waterways, canals and drainage ditches by conducting routine inspection for physical damage and obstruction in the sewer as including control of the illegal discharge entry and handling of customer complaints.

(4) Suggested Organization

The most functions required for sewerage works appear to be established already in present BDS as can be seen in the Figure 16.3. These existing units, however, are mainly dealing with drainage and canal systems only. It is therefore desirable to integrate the required functions for sewerage works as mentioned in preceeding paragraphs into the present organization. The drastic reform or expansion of the existing organization in a short period is not desirable, however, because they accompany significant difficulties in personnel recruitment and time-consuming jurisdical procedures. In view of the long ranged sewerage development the more simplified and economized organizational arrangement should be emphasized with maximum utilization of existing units for the initial step providing that step by step upgrading should be attempted over a number of years with ultimate objective to set up the desired organization.

Based on the exemplary set-up of functions principally accepted as indicated by Figure 16.4, the initial step organization assumed to function for approximately 10 years (2526 - 2536) is suggested as charted in Figure 16.5. In this organizational arrangement as charted by Figure 16.5 the existing sections of Technical Division are assumed to be expanded for the required sewerage functions. The monitoring and surveillance should be undertaken by the Waste Water Research Section and those functions of plan and design as well as construction should be performed by existing sections of Planning Project Section, Design Section and Con-

struction Supervision Section. The new Sewerage Control Division is recommended to be added to perform the other required functions as administration, operation and maintenance for sewers, pumping stations and treatment facilities.

The strengthening of the staff by recruiting the qualified engineers and experts is a vital aspect of the organizational program especially at the initial stage of the project. It is anticipated that difficulties may arise in such recruiting since the qualified professionals in the field of sewerage are not sufficiently available internally in the existing bureau except for the laborers who are comparatively sufficient in number to be involved in sewerage works. The present staff of Technical Division would be therefore required to exert the efforts to be involved in the sewerage functions until newly required functions become viable and adequately staffed. The assistance of the foreign consultants experienced in the field of sewerage project might also be recommended with vigorous training program to transfer the skills and expertise to the staff of proposed sewerage organization.

After the initial stage of the organizational development the more complete organizational arrangement should be attempted for the future time span to the year and after the year 2543 (2000). Such arrangement is objected to remodel the organization into three main divisions of responsibility, i.e., Sewerage, Drainage and Administration with more clear-cut responsibility, avoiding the functional duplication and confusion as charted by Figure 16.6.

In this organizational arrangement the Drainage Control Division, Canal Maintenance Division, Special Project Division (flood protection) and drainage functions for plan & design and construction of Technical Division as proposed in initial organization are suggested to be incorporated to function exclusively for drainage works.

The Sewerage Control Division, Wastewater Treatment Division and sewerage functions for wastewaster research, plan & design and construction supervision of Technical Division in the initial organization are incorporated. The wastewater research section would be developed to Monitoring & Surveillance Division to function for water quality control and the Wastewater Treatment Division would be transferred to new Division of Special Wastes Treatment Division to deal with indigenous task for the disposal and treatment of special wastes such as leachate and night soil sludge. All administrative sections in the initial organization are suggested to be combined to function for overall administrative works on an equal base with other engineering units.

The required staff are estimated for each organization as shown by Tables 16.1 and 16.2 in accordance with the organizational development from the initiation of the project up to the year 2543 (2000) and after.

Figure 16.4 Exemplified Organization Chart of Functional Units for Sewerage Works

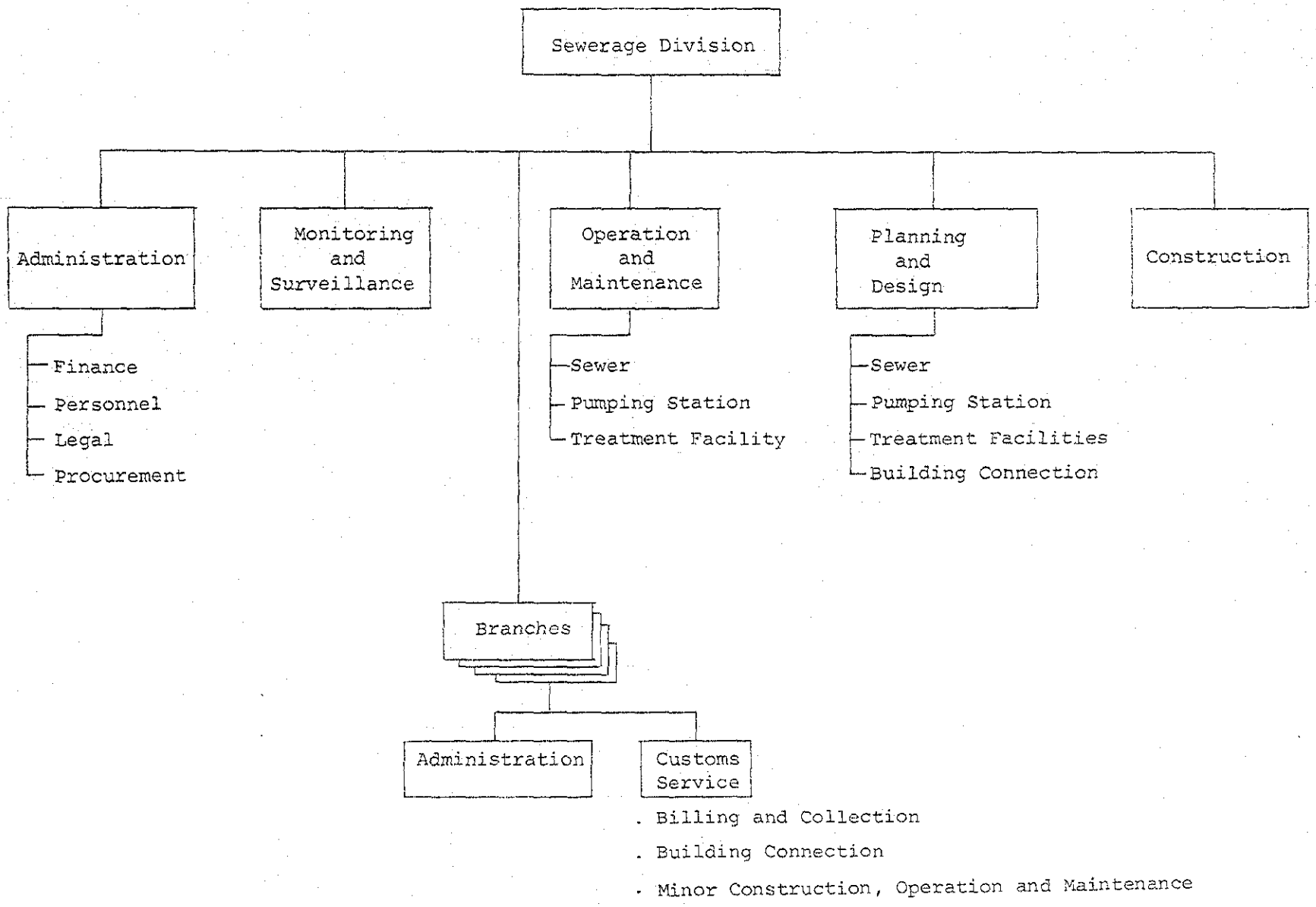


Figure 16.5 Suggested Initial Organizational Arrangement

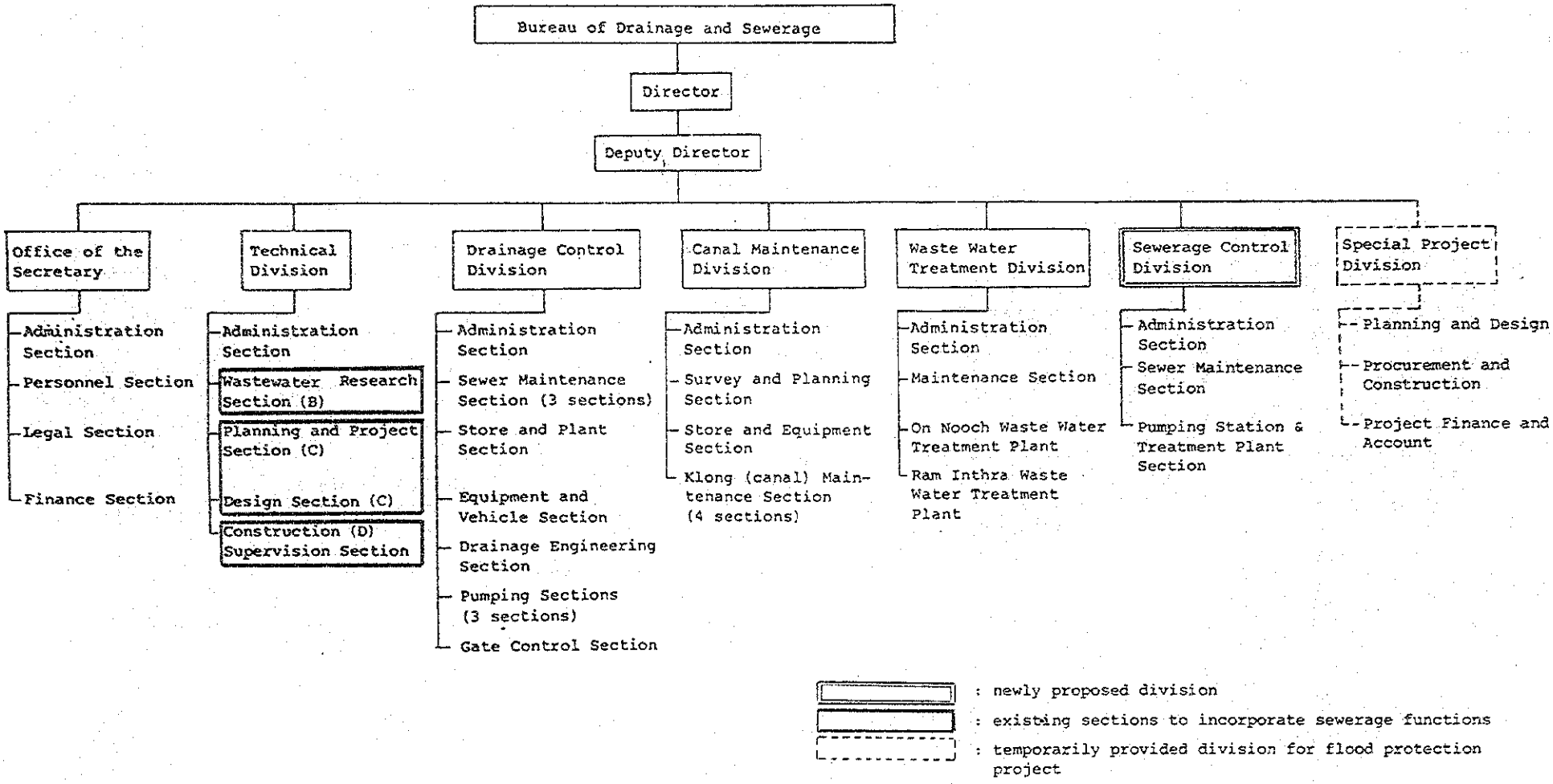


Figure 16.6 Suggested Prospective Organizational Arrangement

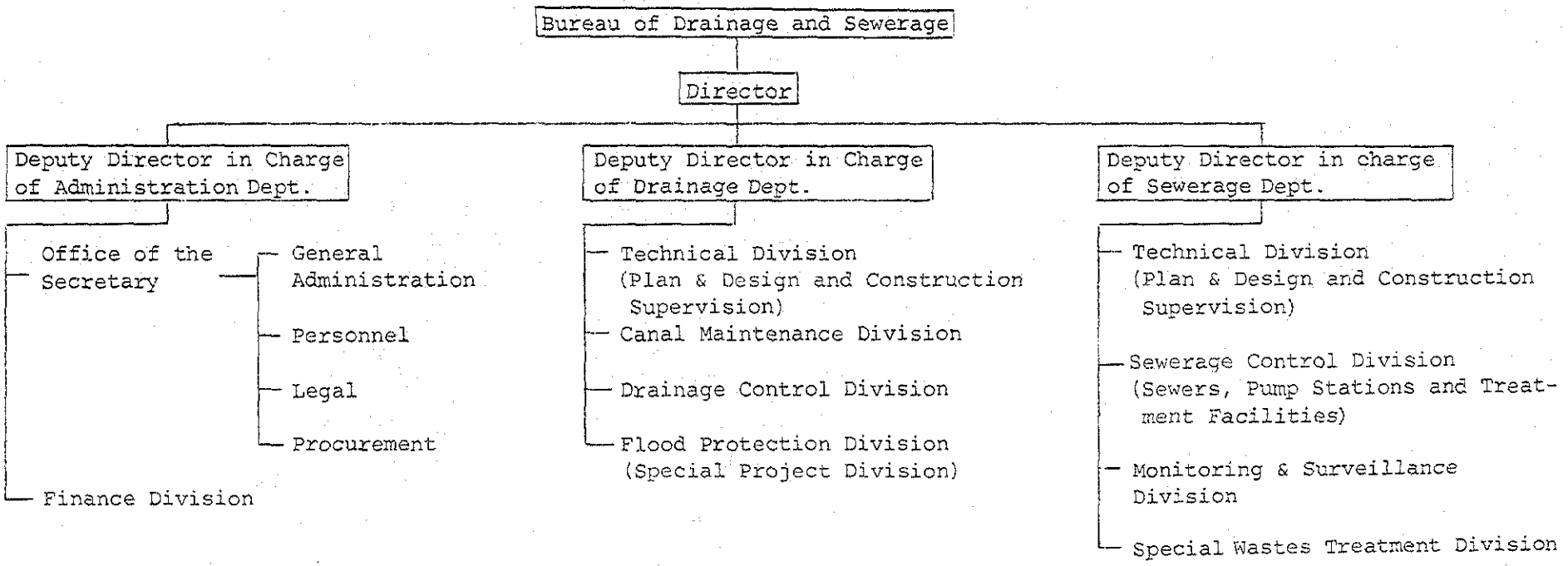


Table 16.1 Schedule of Estimated Staff Requirement for Initial Organization

Job Title	Number of Staff Required at the End of Year		
	2526(1983)	2531(1988)	2536(1993)
Sewerage Control Division			
Division Head	1	1	1
Secretary-Typist	1	1	1
Administration Section			
Head	1	1	1
Personnel Officer	1	1	1
Budget Officer	1	2	2
Accounting Officer	1	2	2
Legal Officer	-	1	1
Clerk	1	3	3
* Sewer Maintenance Section			
Head	1	1	1
Civil Engineer	-	1	1
Operator	-	-	2
Labor	-	4	8
Pumping Station & Treatment Facility Section			
Head	1	1	1
Civil Engineer	-	2	2
Mechanical Engineer	-	1	1
Electrical Engineer	-	1	1
Assistant Engineer	-	1	1
Operator	-	11	13
Labor	-	16	17

- to be continued -

Job Title	Number of Staff Required at the End of Year		
	2526(1983)	2531(1988)	2536(1993)
** Technical Division			
Wastewater Research Section			
Head	1(1)	1(1)	1(1)
Biologist	-	1(1)	1(1)
Chemist	-	1(1)	1(1)
Surveyor	-	2(1)	2(1)
Project Planning and Design Section			
Head	1(1)	1(1)	1(1)
Sanitary Engineer	-	2(1)	2(1)
Mechanical Engineer	1	1	1
Assistant Engineer	-	1	1
Draftsman	-	4(2)	4(2)
Construction Supervision Section			
Head	1(1)	1(1)	1(1)
Civil Engineer	-	1	1
Assistant Engineer	-	1(1)	1(1)
Inspector	-	1	1
Labor	-	2(2)	2(2)
Total	13(3)	71(12)	80(12)

Note: * Numbers of staff in Sewer Maintenance Section are those required only for newly constructed sanitary sewers providing that existing storm sewers will be controlled by Sewer Maintenance Section in Drainage Control Division.

** Figures in parentheses are numbers of existing staff who can be involved in sewerage works.

Table 16.2 Suggested Staff Requirement for Prospective Sewerage Organization up to the year 2546(2003) and after

Job Title	Number of Staff Required 2537(1994)-2546(2003)
Deputy Director	1
Secretary - Typist	1
Technical Division	
Division Head	1
Secretary	1
Plan and Design Section	
Head	1
Sanitary Engineer	2
Civil Engineer	1
Architect	1
Mechanical Engineer	1
Electrical Engineer	1
Assistant Engineer	5
Draftsman	5
Construction Supervision Section	
Head	1
Civil Engineer	1
Sanitary Engineer	1
Assistant Engineer	1
Inspector	2
Draftsman	1
Labor	5

- to be continued -

Job Titel	Number of Staff Required 2537(1994)-2546(2003)
Sewerage Control Division	
Division Head	1
Secretary	1
Sewer Maintenance Section	
Head	1
Civil Engineer	2
Operator	8
Labor	16
Pumping Station & Treatment Facility Section	
Head	1
Civil Engineer	3
Mechanical Engineer	1
Electrical Engineer	1
Assistant Engineer	3
Operator	18
Labor	25
Monitoring & Surveillance Division	
Division Head	1
Secretary	1
Sanitary Engineer	1
Biologist	1
Chemist	1
Assistant Chemist	2
Surveyor	4
Special Wastes Treatment Division	
Same as existing Wastewater Treatment Division	

Note: This staffing schedule is estimated based on the assumption that sewerage systems are completed in total zone 2 area.
The administration section required exclusively for sewerage works as proposed in 2536(1993) for initial organization would be incorporated into the Administration Dept. which would be function for overall administrative works for sewerage and drainage works.

(5) Coordination with Bureau of Sanitation (BOS)

The Bureau of Sanitation of BMA is presently responsible for the disposal of sludge from cesspools, septic tanks and other similar structures mobilizing the disposal vehicles and laborers appropriately decentralized among BMA 24 districts. It may be desirable for the Bureau of Drainage and Sewerage (BDS) to assume the responsibility for such disposal of sludge which will be closely related to the proposed wastewater disposal program. It would be advisable, however, to let the Bureau of Sanitation continue the function of sludge removal considering that proposed sewerage works is already expected to pose a huge burden on BDS. The BDS should be required to strictly coordinate with BOS dealing with sewerage works.

16.5 Financial Consideration

The financial implication for the proposed master plan of the sewerage system development is presented to highlight the necessary funding arrangement to be taken by the executive authority for the sound viable implementation with due consideration on existing financial practices in that the BDS, the proposed implementing agency for the project has presently no separate systematic accounting system for its own bureau, and its revenues are drawn from BMA as needed to meet its expenditures. The most desirable financial control system to be set up in an executive authority is a set of self-autonomous accounting system exclusively for sewerage project separated from other general accounting. Such financial system would be appreciated especially by the lending agency or other governing bodies who are required to provide the financial support and thereby authorized to supervise the financial management of the project.

It is, however, recommended to establish a more streamlined and less sophisticated system at the initial stage of the project providing that gradual improvements are exerted with ultimate objective of a complete set of the accounting system. The minimum requirement at the early

stage is to set up a practice to record all expenditures and revenues exclusively related to the project to identify the project cash flow. The basic concept for the financial planning for the project are presented in this section assuming that such accounting system is maintained in the executive authority.

(1) Cost Estimates

The required costs for the proposed project up to the year 2545(2002) are presented in Table 15.10 at the 2523(1980) prices. Such costs are generally escalated for the financing analysis assuming future price increases in the financial feasibility study. It is considered, however, not practicable to incorporate the effects of present inflation ratio into the cost estimation envisaged over 20 years since it is almost impossible to predict the realistic rates of inflation over extended period especially when the price indices in Thailand for the past few years indicate wide fluctuation due mainly to worldwide economic confusion. The average annual costs are therefore estimated on the basis of 2523(1980) prices to indicate largely the funding requirements of total master plan, providing detailed financial analysis incorporating the effects of realistic inflation is to be made in the subsequent feasibility study for the initial stage of construction which will not exceed over 5 years.

(2) Sources of Funds

The funds are required largely in two categories for the construction capital and recurrent costs for yearly operating and maintenance of the system, debt service (loan repayment), depreciation and other miscellaneous expenses.

1) Funds for the Construction Costs

The funds for the construction of the systems are normally met either by the loan or subsidy from the central government or from the external lending agencies or their combination. The sewerage project requiring

comparatively large magnitude of capital investment should be planned based on well arranged funding scheme without entailing unbearable burden on the executing agency otherwise it will be liable to be suspended or even left intact. If the funding capability of the executing agency is not sufficient, the subsidy from the central government to the possible extent may be desirable and more soft loans with low interest and longer period of repayment should be sought.

a. Government Subsidy

Although the direct subsidy from the central government may be desirable for the executing authority as stated above, discussion with government officials concerned were discouraging under the present economic and political situation where the central government is restricting the allocation of subsidy to BMA. It is clear, however, that some government supports will be required in a reasonable extent.

b. Loan from the international lending agencies

The international loans are broadly grouped by two categories as multilateral and bilateral loans. The multilateral loans are exemplified as loans from the World Bank and Asian Development Bank. The interest of such loans are presently ranging from 8 - 9 percent per annum and repayment period is normally 20 years with grace period of 5 years. The bilateral loans are exemplified by the loan from West Germany and U.S. or Japan with very concessionary terms, for exemple, low interest rates of 3 - 5 percent per annum and long maturity periods (up to 40 years) including extended grace period up to 10 years.

Such international loans are normally provided to finance the foreign currency portion of the project costs, however, in certain cases, local currency portion is also financed to the necessary extent.

c. Loan from the central government

The local currency portion of the capital costs are normally financed by the government through the national bank, wholly or partly depending on availability of other sources of capital as subsidy. The terms and condition of such loan is not fixed and flexible presently in Thailand. The recent government loan condition is not so favorable with approximate interest rate of at 10 percent and pay back period of 20 years.

d. Loan from the domestic commercial bank

Loans from the commercial bank can be sought when funds from other sources are difficult to obtain. The annual interests are, however, very high ranging 12 - 15 percent and repayment terms are very short. This type of loan is, therefore, not desirable for the financing of the proposed project.

e. Customer's Contribution

Capital contributions may be utilized to cover the wholly or partly the construction cost of the system taking the forms of levying the assessment on the property owners receiving direct benefits from the sewerage construction. The costs of connection of yard pipe (house connection) to the sewerage system can also be charged directly to the property owners.

2) Funds for the recurrent costs

The funds are normally required after the construction of the system to meet the annual costs including operation and maintenance costs, and debt service payment if any loan is provided. There are established practice in the developed countries that such recurrent costs are met by the users of the system who receive the benefits through the collection of sewerage use charges or taxation.

a. Sewerage Tax

The extensive revision of the existing taxation system would be required including legal arrangement if the collection of tax related to the sewerage cost is attempted.

b. Sewerage User Charge

There are several methods to collect the charges from the individual users of sewerage system as follows:

i) Pedestal Charge

The flat rate is multiplied by the number of water closet (WC) pedestal in the households to calculate the charges on the theory that the waste volume is linked with pedestal.

ii) Fixture-unit Charge

The number of water fixtures, such as faucets, water heaters, air coolers, and flush toilets, are multiplied by flat rate so as to provide the revenue required based on the theory that volume of waste discharge is related to the volume of water consumption, hence to the number of fixtures.

iii) Per Capita Charge

The charge is calculated multiplying the number of residents or employees in the households or commercial property by a flat rate fee based on the theory that volume of waste discharge is proportionate to the numbers of residents.

iv) Surcharge on Water Rate

The water rate surcharge is service charge related to water use which is calculated by adding a fixed rate to metered water consumption. This method would appear to be more logical as the volume of waste discharge is closely related to water consumption which is accurately metered.

Another benefit of this method would be that the collection of charges can be made without difficulty in combination of billing procedure for water supply already in existence. The collection of the charge is enforceable by cutting off the water supply in event of non-payment.

(3) Preliminary Financing Plan

The preliminary financing plans for the long ranged construction envisaged in the master plan have been designed based on the estimated costs shown by Table 15.8, assuming several potential sources of the capital which will have significant effect upon future cash requirements. It should be emphasized, however, that such plans at this stage of master planning are prepared to provide executive agency with general guiding idea to find means to finance the expected capital requirements for the project.

1) Capital Financing Plan

The capital outlays excluding house connection costs scheduled in the Master Plan are summarized as follows.

	1st Stage (percent)		2nd Stage (percent)		3rd Stage (percent)		4th Stage (percent)	
Foreign Currency (in Million Baht)	360	(52)	362	(60)	342	(38)	221	(22)
Local Currency (in Million Baht)	327	(48)	239	(40)	355	(62)	526	(78)
Total	687	(100)	601	(100)	697	(100)	747	(100)

a. Foreign Currency Financing

The foreign currency is required to cover the costs for the materails and equipments which are not locally manufactured and to be imported from foreign countires. Such foreign currency components are normally financed through international lending agency. The type of the loan to be selected for the project will impose a significant effect upon the financial viability of the project. Two alternative types of such loan with different sets of loan terms equivalent to those available in the international lending agencies and their debt service schedule are assumed in Tables 16.3 and 16.4 as a guiding indicators for the future financing approach to be selected by the government. The terms of the loans assumed are:

Loan Alternative I:	Interest rate:	9 percent per annum
	Terms of repayment:	20 years
	Grace period:	5 years
Loan Alternative II:	Interest rate:	3 percent per annum
	Terms of repayment:	30 years
	Grace period:	10 years

The assumed loan of Alternative I is equivalent to presently available loans of multilateral lending agency such as IBRD (World Bank) and ADB and the loan of Alternative II is assumed to be financed by the soft loan from the bilateral lending agency such as Overseas Economic Cooperation Fund (OECF), Japan. Although the final determination of the loan will depend upon the availability of the loan at the time of actual loan application, the soft loan of Alternative II with longer term of repayment and low interest rate with extended period of deferred payment of principal (grace period) is desirable to ease the finacing burden on the executive agency as shown in comparision of Tables 16.3 and 16.4 where annual repayment required for the soft loan is almost half of the another alternative loan.

Table 16.3 Estimated Annual Loan Repayment (Million Baht)

Loan Alternative I

Year	1st Stage Loan (360 Million Baht)	2nd Stage Loan (362 Million Baht)	3rd Stage Loan (342 Million Baht)	4th Stage Loan (221 Million Baht)	Total
2526(1983)	32.4	-	-	-	32.4
2527(1984)	32.4	-	-	-	32.4
2528(1985)	32.4	-	-	-	32.4
2529(1986)	32.4	-	-	-	32.4
2530(1987)	32.4	-	-	-	32.4
2531(1988)	44.6	32.6	-	-	77.2
2532(1989)	44.6	32.6	-	-	77.2
2533(1990)	44.6	32.6	-	-	77.2
2534(1991)	44.6	32.6	-	-	77.2
2535(1992)	44.6	32.6	-	-	77.2
2536(1993)	44.6	44.9	30.8	-	120.3
2537(1994)	44.6	44.9	30.8	-	120.3
2538(1995)	44.6	44.9	30.8	-	120.3
2539(1996)	44.6	44.9	30.8	-	120.3
2540(1997)	44.6	44.9	30.8	-	120.3
2541(1998)	44.6	44.9	42.4	19.9	151.8
2542(1999)	44.6	44.9	42.4	19.9	151.8
2543(2000)	44.6	44.9	42.4	19.9	151.8
2544(2001)	44.6	44.9	42.4	19.9	151.8
2545(2002)	44.6	44.9	42.4	19.9	151.8
2546(2003)	-	44.9	42.4	27.4	114.7
2547(2004)	-	44.9	42.4	27.4	114.7
2548(2005)	-	44.9	42.4	27.4	114.7
2549(2006)	-	44.9	42.4	27.4	114.7
2550(2007)	-	44.9	42.4	27.4	114.7
2551(2008)	-	-	42.4	27.4	69.8
2552(2009)	-	-	42.4	27.4	69.8
2553(2010)	-	-	42.4	27.4	69.8
2554(2011)	-	-	42.4	27.4	69.8
2555(2012)	-	-	42.4	27.4	69.8
2556(2013)	-	-	-	27.4	27.4
2557(2014)	-	-	-	27.4	27.4
2558(2015)	-	-	-	27.4	27.4
2559(2016)	-	-	-	27.4	27.4
2560(2017)	-	-	-	27.4	27.4
2561(2018)	-	-	-	-	-

Note: During the grace period for intial five years the interests only are charged and after the grace period the equal installments for interests and principals are assumed.

Table 16.4 Estimated Annual Loan Repayment (Million Baht)

Loan Alternative II

Year	1st Stage Loan (350 Million Baht)	2nd Stage Loan (362 Million Baht)	3rd Stage Loan (342 Million Baht)	4th Stage Loan (221 Million Baht)	Total
2526(1983)	10.8	-	-	-	10.8
2527(1984)	10.8	-	-	-	10.8
2528(1985)	10.8	-	-	-	10.8
2529(1986)	10.8	-	-	-	10.8
2530(1987)	10.8	-	-	-	10.8
2531(1988)	10.8	10.9	-	-	21.7
2532(1989)	10.8	10.9	-	-	21.7
2533(1990)	10.8	10.9	-	-	21.7
2534(1991)	10.8	10.9	-	-	21.7
2535(1992)	10.8	10.9	-	-	21.7
2536(1993)	24.2	10.9	10.3	-	45.4
2537(1994)	24.2	10.9	10.3	-	45.4
2538(1995)	24.2	10.9	10.3	-	45.4
2539(1996)	24.2	10.9	10.3	-	45.4
2540(1997)	24.2	10.9	10.3	-	45.4
2541(1998)	24.2	24.3	10.3	6.6	65.4
2542(1999)	24.2	24.3	10.3	6.6	65.4
2543(2000)	24.2	24.3	10.3	6.6	65.4
2544(2001)	24.2	24.3	10.3	6.6	65.4
2545(2002)	24.2	24.3	10.3	6.6	65.4
2546(2003)	24.2	24.3	23.0	6.6	78.1
2547(2004)	24.2	24.3	23.0	6.6	78.1
2548(2005)	24.2	24.3	23.0	6.6	78.1
2549(2006)	24.2	24.3	23.0	6.6	78.1
2550(2007)	24.2	24.3	23.0	6.6	78.1
2551(2008)	24.2	24.3	23.0	14.9	86.4
2552(2009)	24.2	24.3	23.0	14.9	86.4
2553(2010)	24.2	24.3	23.0	14.9	86.4
2554(2011)	24.2	24.3	23.0	14.9	86.4
2555(2012)	24.2	24.3	23.0	14.9	86.4
2556(2013)	-	24.3	23.0	14.9	62.2
2557(2014)	-	24.3	23.0	14.9	62.2
2558(2015)	-	24.3	23.0	14.9	62.2
2559(2016)	-	24.3	23.0	14.9	62.2
2560(2017)	-	24.3	23.0	14.9	62.2
2561(2018)	-	-	23.0	14.9	37.9
2562(2019)	-	-	23.0	14.9	37.9
2563(2020)	-	-	23.0	14.9	37.9
2564(2021)	-	-	23.0	14.9	37.9
2565(2022)	-	-	23.0	14.9	37.9
2566(2023)	-	-	-	14.9	14.9
2567(2024)	-	-	-	14.9	14.9
2568(2025)	-	-	-	14.9	14.9
2569(2026)	-	-	-	14.9	14.9
2570(2027)	-	-	-	14.9	14.9
2571(2028)	-	-	-	-	-

Note: During the grace period for initial ten years the interests only are charged and after the grace period the equal installments for interests and principals are assumed.

b. Local Currency Financing

The executive agency should generate the funds for the local currency portion of the project capital costs from the various sources. Although there has been the inherent controversy in identifying who should contribute the capital for sewerage construction since it involves various uncontrollable factors such as political constraints and priority evaluation of the proposed project, it is principally accepted that those communities and individuals who receive the benefits from the project should contribute the corresponding capitals. The financing sources for the proposed project in Bangkok are therefore assumed, in view of the above principle, to be the central government, BMA and individual property owners who are occupying the project area to receive the direct or indirect benefits from the sewerage systems.

The following suggestions have been made for the designing of future financing of local currency.

i. The central government would provide subsidy equivalent to approximately 10 percent of the total project costs on the assumption that the areas pertinent to the central government properties such as buildings, and facilities which will receive direct benefits of sanitary improvements occupy approximately 10 percent of the total project area.

ii. The BMA would provide local currency funds from its own budget equivalent to approximately 20 percent of the total project costs on the justifiable basis similar to above item 1.

iii. The remaining portion of the local currency would be founded by the capital contribution from the individual property owners of land households shop and factories distributed in the project area with due consideration on their financial capabilities.

iv. The central government loan would be provided to supplement the required funds if any of above funding sources of item 1 - 3 would not be available.

2) Financing for Recurrent Costs

As mentioned in previous paragraph (2) 2) Funds for the recurrent costs, the funds would be necessary to cover the costs for loan repayments and maintenance and operation normally required after the construction of the sewerage systems. The assumed annual costs for the repayments of the exemplified international loan in two alternatives are shown in Tables 16.3 and 16.4.

The approximate maintenance and operation costs are estimated including costs for repair, depreciation, power & fuel, personnel costs, and other miscellaneous costs. Such annual M/O costs to be incurred after the assumed construction of the sewerage systems to be implemented in four stages in the master plan are estimated to be approximately 65 million baht.

In order to recover such recurrent costs the sewerage user charge is suggested to be imposed pro rata to water consumption as the most rational method.

3) Summary of the preliminary financing plan

The basic requirement for the financial viability of the project is well arranged financing strategy which ensure the appropriate funding on rational base from government agencies concerned and individual beneficiaries with due emphasis on employing meaningful measure to lessen the financial burden of potential fund contributors within their financial and administrative capabilities.

The estimated costs vs. suggested funding sources are summarized as the following Table 16.5.

Table 16.5 Estimated Required Costs vs. Suggested Sources of Fund

Estimated Required Costs (Million Baht)		Suggested Sources of Fund
Capital Costs in Foreign Currency	1st Stage 360 2nd Stage 362 3rd Stage 342 4th Stage 221	to be financed by multilateral loan (Loan Alternative I) or bilateral soft loan (Loan Alternative II)
Capital Costs in Local Currency	1st Stage 327 2nd Stage 239 3rd Stage 355 4th Stage 526	to be financed by central government subsidy, BMA's budget allocation and customers capital contribution
Annual Recurrent Costs:		to be recovered by sewer User Charge to be imposed pro rata to water consumption
Debt Service Costs-Loan Alt.II	Max. 86	
(Loan Alt.I	Max.152	
Operation & Maintenance Cost	65	

16.6 Recommended Regulations

The existing regulations as referred previously are dealt segmentally with the sanitary control with common objective to ensure public health and protection of environment including klongs, Chao Phya river and other public water ways. Such regulations are, however, based on the rudimentary sanitary utility systems and they are so limited in scope and wordings that they appear inadequate to cope with the present deteriorated situations of environment especially in klongs and water ways mainly caused by recent urban and industrial development as well as population increase, requiring some amendments.

Most of such problems will be solved, however, if the proposed sewerage programs are implemented with pertinent legal arrangement. An explicit and comprehensive set of published regulation should, therefore, be prepared for such legal arrangement for the efficient implementation of the proposed sewerage master plan and subsequent control and operation of the system.

The application of such newly established legislation should be considered in a flexible manner in coordination with existing regulations under the jurisdiction of other government agencies such as National Environment Board, Ministry of Industry and Ministry of Health.

While detailed legislative provisions are beyond the scope of this study, the substantial principles normally employed for the sewerage ordinance are presented as follows as the guideline to be followed with adequate adjustment and amplification to conform to the existing conditions.

a. The purpose of the sewerage works should be defined with identification of the categories of the sanitary sewerage system.

b. The procedure to be taken and standard to be followed for the development and improvement of sanitary sewerage system should be stipulated indicating who will apply the plan and who will approve the plan.

c. The administrative and executive authority for the sewerage works should be defined in accordance with respective administrative area.

d. The stipulations which require the authorized persons with competent qualification for design and construction supervision of sanitary sewerage system including yard piping and service connection and plumbing should be provided.

e. The authorized person shall be given the power to permit any applicant who make any connection or plumbing with necessary instruction.

f. The wastewater disposal area or the area where sewerage service is available should be publicly noticed.

g. The use of public sanitary sewers should be enforced in the sewerage service area prohibitting the disposal of wastewater including fecal matters, urine and sullage water otherwise than to public sanitary sewer where public sanitary sewer is available.

h. The stipulations to control the private wastewater disposal system should be provided prohibiting the construction and maintain of any privy or cesspool, septic tank and requiring instead the installment of suitable flush toilets to be connected directly with public sanitary sewer providing public sewer is available within a reasonable distance, within appropriated duration after the date of official notice to do so.

i. Necessary provisions should be provided to empower the executive Authority to levy and collect charges including service charge and service connection charge imposing penalties and fines on delinquent customers. The Authority should be empowered to apply the loan or subsidies for the sanitary sewerage system management.

j. Necessary provisions should be provided to prohibit discharge of wastewater, which may have a deleterious effect upon the sewerage works, processes, equipment or receiving watercourse should be provided, subject to the establishment of specification of such prohibited substance.

The present Factory Act under the jurisdiction of Ministry of Industry is partly applicable to control such wastewater in the proposed project area. The factories under the control of this Act is, however, limited to those with more than seven workers and it is suggested, therefore, to provide specific regulations to control overall industrial wastewater without prejudice to the size of factory.

k. The stipulations should be provided to empower Authority to inspect the premises of business and commercial enterprises and households to examine compliance with regulations embodied in ordinances pertaining to sewerage.

l. The Authority should have the exclusive right to sample, test, and analyze wastewater in order to check the quality of wastewater being discharged into the public sanitary sewers.

m. The stipulations should be provided to empower the authority to require the owners of any establishment which discharge the waste unacceptable to public sewers to provide pretreatment facilities.

n. The provisions to empower the authority to purchase and acquire land or obtain easement or right-of-way for the purpose of sewerage works including eminent domain procedures.

o. Penalty provisions should be necessary to prosecute or punish the person who violate the provisions of the sewerage ordinance.

p. The plumbing code applicable to the special conditions would be necessary.

(1) Definitions

The wordings presently used in existing regulations are ambiguious which may cause unnecessary disputes and misleading results. The clear and concise definitions are recommended as presented in Annex 2 to be included in the proposed sewerage ordinance.

(2) Regulations to control the areas where sanitary sewerage system is not available

The sewerage ordinance as proposed previously is principally dealt with the public sanitary sewerage system. It is assumed, however, that the Authority will have to control the areas, under its jurisdiction, where public sanitary sewerage system is not available and private wastewater disposal system including septic tank are necessary. The specific regulations will therefore be necessary to be included in the proposed sewerage ordinance or alternatively to amend existing Municipal By-Law to include such regulations as listed below.

1) Where a public sanitary or combined sewer is not available, the building drain shall be connected to a private wastewater disposal system and/or industrial waste pretreatment devices. The owner(s) of houses, buildings, or properties, except those used for industrial purposes, shall first obtain a written permit to construct the private wastewater disposal system, such as a cesspool or a septic tank. The permit shall be issued by the Authority following the Authority's review to ensure compliance with the required minimum standards established by the appropriate government agency. In the case of industrial waste, or other types of inadmissible waste the permit shall be issued by Minister of Industry or his authorized representative after his review and approval of the plans and specifications for the construction of the industrial pretreatment devices. The Minister or his authorized representative shall be allowed to inspect the work at any stage of construction. The applicant for the permit shall notify the Minister when the work is ready for final inspection, and before any underground portions are covered. The inspection will be made within a reasonable time after receipt of notice by the Minister.

2) The type, capacity, location, and layout of a private wastewater disposal system shall comply with all recommendations of the Health Officer of the Authority and the Ministry of Public Health. No permit shall be issued for a private wastewater disposal system and/or industrial waste pretreatment system unless the construction plans and specifications for the said systems have taken into account the impermeability

of the soil, an acceptable area size for the system, the situation at the point of discharge of the septic effluent, the quality of the receiving water and the locality through which the septic tank effluent will flow. No septic tank except that whose design has been duly approved by the Authority shall be permitted to discharge to any natural outlet.

3) At such time a public sewer becomes available to a property served by a private wastewater disposal system, a direct connection from the building drain shall be made to the public sewer within 60 days in compliance with the Sewerage Ordinance. Any abandoned cesspools, septic tanks, and similar private wastewater disposal facilities shall be cleaned of sludge and filled with suitable filling materials.

4) The owner(s) shall operate and maintain private wastewater disposal facilities in a sanitary manner at all times, at no expense to the Authority. Sludge removal shall continue to be performed by the Municipal Bureau of Sanitation, BMA and by private contractors duly licensed by the said Bureau. The sludge shall be disposed of into designated discharge points along the sewer mains. The BOS and private contractors shall obtain from the Authority, a permit for the disposal of the sludge into the sewer mains.

5) No statement contained in this Article shall be construed to interfere with any additional requirements that may be imposed by the Ministry of Health, Ministry of Industry and Ministry of Interior.

CHAPTER 17

BENEFITS AND PROJECT JUSTIFICATION

Significant benefits to public health of the community can be derived from installation of an adequate sewerage system. The benefits to be derived from the construction and operation of the sewerage system as recommended in this Master Plan can be grouped into three categories, namely (1) Environmental benefits, (2) Individual benefits and (3) Economical benefits.

All anticipated benefits are evaluated for the sewerage project on the basis of either quantifiable or nonquantifiable benefits. Since the benefits are not wholly quantifiable, evaluation of nonquantifiable benefits should also be stressed in the overall economic justification of this kind of project.

17.1 Recognition and Measurement of Benefits

17.1.1 Water Pollution Control Benefits

From the current extensive survey of drains, klongs and river (presented in Chapter 6 Chao Phya River and Klongs), most of drains and klongs in urbanized area in the Study Area have been found to be polluted and more pollution is anticipated in the future. The Chao Phya River will be also polluted by discharge from klongs.

The reduction of waste loads or improvement of water quality in drains, klongs and the river can be considered one of the major benefits to be derived from the sewerage system. Waste loads discharged from sewerage served area will be reduced considerably through the treatment facility and such facility will improve the river water qualities making the river water useful as new water resources for various purposes.

17.1.2 Health and Sanitation Benefits

One of the major benefits from the proposed sewerage system will be the sanitation improvement resulting from removal of human excreta and other wastes from the community.

The benefit can be measured by calculating the costs to be saved by the reduction of incidence of the water-borne diseases as well as the mortality and morbidity of the populations served by the system.

A statistical data obtained from the Ministry of Health indicates that the average number of water-borne diseases, such as cholera, typhoid fever and dysentery in the Study Area was 1,680 per year from the year 2517 (1974) to 2521 (1978). Also, a survey on the cost for treatment and cure for the diseases indicates that the expenses for treating water-borne diseses, including the amount spent for medical care, are about 400 baht per person per day for an average of two weeks hospitalization at 2523 (1980) price level. Assuming that approximately 50 percent of these diseases attributable to unsatisfactory excreta disposal, and this can be eliminated by the sewerage system, the quantifiable cost is estimated to be about 4.7 million baht per year.

The major indirect costs can also be calculated assuming the average wage lost and the number of man-days lost due to disability derived from diseases. The wage lost is estimated to be about 0.3 million baht per year on an average at 2523 (1980) price level, assuming from the data collected that the average income per person is 380 baht per month. This is based on assumption that monthly income per house is 2,500 baht for 6.5 persons in one house.

17.1.3 Benefits derived from Reduced Expenditure for Sanitary Facilities

As described in Chapter 4, the existing excreta disposal systems in the Study Area are largely represented by two systems namely septic tank and cesspool. For operation and maintenance of these facilities, BMA

allocated budget amounting to 31 million baht in fiscal 2523 (1980), and this amount should be increased for more complete service as expected by public sewerage system. If the new public sewerage system is provided and these expenditures for existing facilities are eliminated, significant benefits can be expected both in terms of money and sanitary conditions of the area.

Assuming the desludge service with frequency of once a year for 5.6 million population expected in 2543 (2000), operation and maintenance cost of excreta disposal system is calculated to be 300 million baht annum, based on assumed average desludge volume of 2.4 m^3 from 5 to 10 person who use septic tank and estimated unit cost for collection and treatment of sludge of 120 baht/m^3. (Refer to note below) If this can be eliminated by the sewerage system the monetary benefits to be derived will be annually 300 million baht at 2523 (1980) price level.

Note: Operation and maintenance cost of excreta disposal system is calculated as 20 baht/m^3 for treatment and 100 baht/m^3 for collection based on the following data and assumptions.

a) Construction cost of septic tank sludge plant at On Nooch is approximately 20 million baht at 2523 (1980) price level and operation and maintenance cost per annum is 15 percent of construction cost.

b) Purchase cost of sludge suction truck (capacity 5.0 m^3) is 1.5 million baht and working life of a truck is 10 years.

c) Ability of collection by one crew is 2 round trips per day.

d) Desludging crew consists of 3 persons with total wage of 47,000 baht/year.

17.1.4 Other Benefits

The sewerage system will raise the land value significantly. The additional land value will constitute a major economic benefits of the sewerage project in that, not only eliminating unsanitary conditions but also an additional revenue source of taxation can be expected.

In addition, other benefits, although mostly unquantifiable, can be expected as (1) reduction of discomfort and distress, (2) improvements of environmental aesthetics by elimination of the present wastewater odor emanating from drains and sludge accumulation, (3) reduction of groundwater contamination to be derived from improved measures for handling sanitary wastes.

17.2 Project Justification

In Bangkok the various efforts to provide city infrastructures have been exerted for the 200 years commemoration after the transfer of the capital. As one of the attempt to improve the city conditions in 2511 (1968), Sewerage Master Plan was prepared by CDM for Bangkok and Thonburi area. The Master Plan comprised of three plans, such as Sewerage, Drainage and Flood Protection. In spite of the CDM's recommendation which gave the first priority to sewerage implementation, no sewerage construction were performed because other important measures for city infrastructures had to be considered and inhabitants did not feel the immediate requirement of sewerage facilities.

Recently, the residents have been becoming aware of the increasing deterioration and pollution of the Chao Phya River and Klongs. The Authorities concerned have been urged to take a necessary remedial or protective measures for such pollution which constitutes a definite health hazards to inhabitants and substantial aesthetic nuisance. The construction of individual treatment facilities has been obligated to be involved in the housing schemes and industrial effluents are controlled by regulation.

Although such measures will partly mitigate the sanitary deterioration, overall control and improvement of environmental sanitation can not be achieved without a comprehensive sewerage systems.

The observation of existing situation and assumed tangible and intangible benefits apparently lead to conclusion that proposed sewerage development project is justifiable. If no sewerage system were provided in the area, sanitary conditions, which are already deplorable in many areas of the city, will become progressibly worse. Moreover, if this Project is not undertaken at this time, the cost escalation due to worldwide inflation might hamper the project implementation at later stage.

It is desirable that the Project start as earliest as possible as one of the basic public services for the improvement of city infrastructures which results in redevelopment of the city. Thus Bangkok Metropolis will join the great cities in the world as a sanitary and beautiful town as well as one of the center of politics, economy and culture in Asia.

CHAPTER 18

INTERIM MEASURES

Since it takes a long time to complete adequate sewerage system for the whole city area as proposed in the Master Plan, practical measures are required to meet the immediate need to improve the deteriorated environmental conditions until the time of complete sewerage system construction. Such measures are called Interim Measures which should be implemented by effective minimum capital expenses and it is desired that facilities to be constructed under interim measures will be effectively in conformance with future sewerage system proposed in the Master Plan.

Environmental and sanitary problems in Bangkok are enlarged mainly by pollution in drains, klongs and the Chao Phya River. For the solution of such problems the existing pollution have to be eliminated as soon as practicable. As a result of the field reconnaissance conducted by the study team aspects of pollution are identified as follows.

A.	Coliform contamination	drain and klongs
B.	Low DO value	klongs and the Chao Phya River
C.	Odor generation due to anaerobic condition and high BOD value	klongs

Causes of pollution listed above are considered as follows:

1) Incomplete excreta removal facilities,
2) Sullage water discharged from domestic, commercial and industrial origin,
3) Incomplete desludging system from individual excreta removal facilities,
4) Contaminated discharge from industrial origin,
5) Water stagnation in drains and klongs,
6) Sludge accumulation in drains and klongs,
7) Polluted discharge from existing drainage pumping station, named Rama IV and Kasem, and

8) Insufficient effluent from existing communal treatment facilities.

As previously described in this chapter, interim measures should be technically and financially feasible so that these measures can be implemented without funding difficulty and any conflict with the progress of sewerage constructions. Therefore, various measures for pollution control are evaluated for the solution of existing deteriorated conditions.

18.1 Consideration on Measures

Considerable measures to remedy the causes for pollution as listed in previous section from 1) to 8), are summarized as follows.

a) Improvement of excreta removal facilities

It is estimated that septic tanks similar to the type as recommended by BDS, BMA, are installed to cover approximately 30 percent of present population in Bangkok. The rest of 70 percent have only cesspool or incomplete facilities. In the area out of sewerage construction schedule, improvement or installation of better facilities for excreta removal are recommended. The facilities are recommended to have digestion tank with sludge and liquid separation devices, and permeation tank with sufficient capacity.

b) Desludging from individual excreta removal facility

Desludging work from individual excreta removal facilities is performed by Bureau of sanitation (BOS), BMA. The data for actual service in 2522 (1979) indicate the desludging volume of approximately 140,000 m^3 for the persons who required desludging work to BOS. BOS has sufficient equipments and man power to meet the requests from individual householders for sludge disposal. There are, however, many

illegal disposal without involvement of BOS and such illegal disposals are causing substantial pollution in klongs. It is therefore recommended that BOS perform routine inspections of it's controlling areas under the systematic program and perform desludging upon their own judgements whenever found necessary without relying on residents' requests.

c) Controlling measure for contaminated discharge from industrial origin

The Government of Thailand has long been ware of environmental pollution from industrial origin, and, in 2513 (1970), set up the "Effluent Criteria of Industrial Wastewater", in order to mitigate the deteriorated conditions. Ministry of Industry (MOI) has advised that larger factories install their own waste treatment facilities to keep the effluent criteria accordingly. Under the direction of MOI, 14 factories already have installed treatment facilities as shown in Table 8.3, Chapter 8. Moreover, the MOI directed not only the installation of treatment facilities but also rationalization of production process and provision of its own wastewater collection and treatment system in the industrial estates.

Since such controlling measures for contaminated discharge from industrial origin are implemented strenuously by MOI mentioned above, these problems related to industrial wastewater are not dealt with in the interim measures of Sewerage Master Plan.

d) Measures for water stagnation in drains

During rainy season klongs located in central area are usually shut out from the Chao Phya River water by existing gates and sand bags, and stormwater are drained by pumps. However, because of incomplete installation of gates or sand bags, water levels of klongs are affected by backing up of river water when tide of the Gulf of Thailand becomes high. When water levels of klongs rise

above the top of drain-outlets, self-cleansing velocity can not be maintained in the drains, which results in a water stagnation and significant deposits accumulation in drains.

It is required to keep water level of klongs low in order to maintain the capacity of drains for a satisfactory operation of drainage system, and drainage and flood protection project is timely undertaken by BDS, BMA. The problems of klong water level would be discussed on the basis of overall drainage evaluation in the drainage and flood protection project.

e) Dredging work from drain

Deposits accumulating in drains and ditches should be removed by periodical dredging. Equipment and man power required for such dredging work can be converted to the sewer cleaning work after construction of sewerage system.

f) Controlling measure for polluted discharge from existing drainage pumping stations, named Rama IV and Kasem

Water pollution of the Chao Phya River by discharges from existing drainage pumping stations have been causing problems. Nuisance is caused at Rama IV Pumping Station because of discharge of high BOD with black color from the existing drains used physically as combined sewers. In case of Kasem Pumping Station the problems are due to high BOD discharge, generation of H_2S gas and bubble forming, which caused by sludge accumulation and water pollution in klongs. The measures to mitigate those deteriorated conditions are cleaning and dredging of drains and klongs. For Rama IV Pumping Station drain cleaning work should be performed periodically. Since the studies about inlet klong of Kasem Pumping Station will be made by drainage and flood protection project now being undertaken by BDS, BMA, improvement of klong conditions would desirably be discussed in that project systematically. As present served area of above two pumping stations are included in the first and

second stages of proposed sewerage construction schedule, interim measures are not considered for these problems in this Sewerage Master Plan.

g) Maintenance work of existing treatment facilities

Operation and maintenance works of existing treatment facilities constructed by NHA, especially measurement of effluent quality and repairing work for broken devices, are not sufficient. These problems can be removed by systematic inspection and legitimate advices of lead engineer of operation and maintenance expert. Therefore, organization for operation and maintenance work is required to be expanded so that management, inspection and operation can be systematically performed.

18.2 Proposed Interim Measures

On the basis of discussion made in previous section, interim measures are proposed as follows.

1) Measures to be undertaken by BDS

a) Improvement of existing individual excreta removal facilities

In addition to the septic tanks similar to those recommended by BDS, BMA, about 70 percent of incomplete types of individual excreta removal facilities are estimated to be existing in the Study Area.

In the outside area of the sewerage implementation program incomplete types of individual excreta removal facilities are recommended to be improved to the septic tank system to be proposed by BDS in order to mitigate their possible pollution of the receiving water bodies and underground waters.

The proposed type of septic tank has been discussed with BDS's staffs, considering environmental requirement and effects of various types of septic tank.

Installation cost of the septic tank to be proposed assumed as approximately 10,000 baht or more for use of 5 to 10 persons.

b) Dredging and cleaning activities of drains

Pollution caused by solid wastes can be removed by periodical dredging of accumulated sludge in drains and ditches. Present dredging and cleaning capability of BDS are recommended to be increased gradually in accordance with the periodical dredging schedule to be established. In addition, it is recommended that prohibition of solid waste dumping into drains and ditches be intensified setting up a by-laws under the "Public Health Act, B.E. 2484 (1941)", in order to decrease the source of pollution.

Dredging and cleaning costs are estimated as 10 baht per one meter excluding cleaning machine purchase cost as described in Section 14.4.1, Basis of Operation and Maintenance Cost for sewers.

c) Sewerage system for new housing development schemes (BDS)

A number of housing development schemes have been undertaken by NHA and private developers in the Study Area. Development schemes conducted by NHA include the provision of sewerage system including treatment facility, whereas housing schemes by private developers incorporate provision of individual septic tanks only for human excreta, but sullage water is directly discharged into a nearby drain without any treatment.

For the sake of pollution control in the Study Area, every new housing schemes, regardless of the size, should provide with treatment facilities for both human excreta and sullage water.

such small scaled sewerage systems are desirable to be constructed counting on the easy connection to the public sewerage system to be constructed in the future according to the Master Plan.

Design criteria for collecting sewers should be the same as that recommended in Chapter 9, "Basis of Design". Treatment process varies due to the location of each housing scheme, because land cost significantly affects the construction cost of treatment facility. Therefore, treatment process and design criteria should be selected on the basis of the studies on construction cost and required effluent degree referring to Chapter 11, "Wastewater Treatment and Disposal".

2) Measures to be undertaken by BOS

a) Desludging from individual excreta removal facilities

Desludging work by BOS is actually performed by the request of owners of facilities. In order to solve the problems of environmental pollution, desludging service is recommended to be actively performed for the excreta removal facilities located in the contributing area of deteriorated klongs, such as Klong San Saep, Klong Toey and Klong San in accordance with program systematically established by environmental improvement schedule. For complying with above recommendation, sludge collection ability of BOS are proposed to expand about 10 percent of present power, taking into consideration the present capacity of treatment facilities for nightsoil and reasonable expenditure to be increased.

Estimated desludging and treatment cost are approximately 120 baht/m^3 including suction truck purchase cost, operation and maintenance cost assuming that work life of suction truck is 10 years.

3) Measures to be undertaken by NHA

a) Strengthening of operation and maintenance work for existing treatment facility

In order to operate and maintain sufficiently the exisiting treatment facilities scattered in BMA area and to inspect and led such work by minimum engineering staff, maintenance responsibilities of all treatment facilities, which are presently dispersed in branch offices of NHA where facilities are located, are recommended to be centralized in one unit. Such unit should be developed to have operation and maintenance section which will take care of not only treatment facilities of NHA, but also new sewerage system to be constructed by private developer.

ANNEX 1

ABBREVIATION

TECHNICAL TERMS

BOD	- Biochemical Oxygen Demand at 5 day 20°C
Cl^-	- Chloride Ion
COD	- Chemical Oxygen Demand
DO	- Dissolved Oxygen
DWF	- Dry Weather Flow
H_2S	- Hydrogen Sulfide
O & M	- Operation and Maintenance
pH	- pH Value
SS	- Suspended Solid
WT	- Water Temperature

UNITS

cm	- centimeter
g/day/cap	- gram per day per capita
ha	- hectare
hr	- hour
l/day/cap	- liter per day per capita
l/sec	- liter per second
m	- meter
m/sec	- meter per second
mm	- millimeter
m^2	- square meter
m^3	- cubic meter
mg/l	- milligram per liter
m^3/day	- cubic meter per day
m^3/min.	- cubic meter per minute
$m^3/day/m^2$	- cubic meter per day per square meter
kl/day	- kiloliter per day
km	- kilometer

GOVERNMENT AGENCIES

AIT	: Asian Institute of Technology
BDS	: Bureau of Drainage and Sewerage, BMA
BOS or BS	: Bureau of Sanitation, BMA
BMA	: Bangkok Metropolitan Administration
BPH	: Bureau of Public Health, BMA
BPW	: Bureau of Public Works, BMA
CDM	: Camp, Dresser & Mckee Consulting Engineers
CPD	: City Planning Division, Office of Under Secretary of State for BMA
CU	: Chulalongkorn University
DOI	: Dept. of Industry, Ministry of Industry
DTEC	: Dept. of technical and Economic Cooperation
EGAT	: Electricity Generating Authority Thailand
FRS	: Foreign Relations Section, Office of Under Secretary of State for BMA
HWD	: Highway Department, Ministry of Communication
JICA	: Japan International Cooperation Agency
LD	: Legal Division, Office of Under Secretary of State for BMA
MET	: Meteorological Dept.
MOA	: Ministry of Agriculture
MOI	: Ministry of Interior
MRD	: Mineral Resources Dept., Ministry of Industry
MU	: Mahidol University
MWWA	: Metropolitan Water Works Authority
NEB	: National Environment Board
NESDB	: National Economic and Social Development Board
NHA	: National Housing Authority
NSO	: National Statistic Office, Office of the Prime Minister
PAT	: Port Authority Thailand
PPD	: Policy and Planning Division, Office of Under Secretary of State for BMA
RID	: Royal Irrigation Dept., Ministry of Agriculture
RTSD	: Royal Thai Survey Dept., Ministry of Defence
TOT	: Telephone Organization of Thailand

FD	: Financial Division, Office of Under Secretary of State for BMA
MEA	: Metropolitan Electricity Authority
MOC	: Ministry of Communication
OUSS	: Office of Under Secretary of State for BMA

ANNEX 2

GLOSSARY (Definitions of Terms)

* Activated Sludge Process

A process for achieving biological stabilization of wastewater based on use of activated sludge generated under aerobic conditions maintained by included aeration in a reaction chamber, with the effluent subsequently settled and part of the sludge returned to the reaction chamber.

* Aeration

The bringing about of intimate contact between air and a liquid by one or more of the following methods: (a) spraying the liquid in the air, (b) bubbling air through the liquid, (c) agitating the liquid to promote surface absorption of air.

* Aerated Lagoon

A natural or artificial wastewater treatment pond in which mechanical or diffused-air aeration is used to supplement the oxygen supply.

* Aerobic

Requiring, or not destroyed by, the presence of free elemental oxygen.

* Authority

Bangkok Metropolitan Administration directly responsible for the execution, operation, maintenance and control of public sanitary sewerage system (subject to approval of the Council of Ministers through the Ministry of Interior)

* Biochemical Oxygen Demand

The quantity of oxygen used in the biochemical oxidation of organic matter in specified time, at a specified temperature, and under specified conditions. Abbreviated - BOD.

* Box Culvert

A culvert with a rectangular cross section.

* Branch Sewer

A sewer which receives wastewater from a relatively small area, and discharges into a main sewer serving more than one branch-sewer area.

* Building

A structure having walls and a roof and used or intended to be used for the housing, shelter, enclosure or support of persons, animals or property.

* Cesspool

A partially lined pit or vault forming part of, a connected to, a latrine and from which the liquid leaches into the surrounding soil.

* Coefficient

A numerical quantity, determined by experimental or analytical methods, interposed in a formula which express the relationship between two or more variables to include the effect of special conditions or to correct a theoretical relationship to one found by experiment or actual practice.

* Chlorination

The application of chlorine to water or wastewater, generally for the purpose of disinfection, but frequently for accomplishing other biological or chemical results.

* Coliforms

An important parameter for assessing the level of pollution in receiving waters, based on measuring the concentration of coliform bacteria, which is a rough index of the probable level of contamination by human excreta.

* Collection System

A system of sewers and appurtenances for the collection, transportation, and pumping of sewage and industrial wastes.

* Combined Sewer

A sewer receiving both surface runoff and sanitary and/or industrial wastewater.

* Commercial Area

Areas where commercial activities are dominating such as markets, shopping centers and trade centers.

* Commercial Wastewater

Wastewaters discharged from the commercial areas.

* Contamination

Pollution of potable water by any substance or by water which carries or may carry such substance or organisms, which may be harmful to human health.

* Culvert

A closed conduit for the free passage of surface drainage water under a high-way, railroad, canal, or other embankment.

* Depreciation

The amount which must be charged against profits each year in a series which will equal the original purchase price of a given asset at the end of its useful life expectancy.

* Discount Rate

The compound rate of interest which measures the difference between two values separated by one or more successive periods of time. The rate is applied to the ultimate value to determine the present value of the series at any prior point in time.

* Discharge

As applied to a stream or conduit, the rate of flow, or volume of water flowing in the stream or conduit at a given place and within a given period of time.

* Dissolved Oxygen

The oxygen dissolved in water, wastewater, or other liquid, usually expressed in milligrams per liter, parts per million, or percent of saturation. Abbreviated - DO.

* Domestic Wastewater

Wastewaters discharged from the population in residential and commercial areas (excluding commercial wastes). It may or may not contain ground water, surface water or storm-water. Also called sanitary wastewater.

* Easement or Right-of-way

An acquired legal right for the specific use of land owned by others.

* Effluent

The liquid outflow of any facility producing wastewater or designed to treat, convey, or retain wastewater.

* Estuary

A passage in which the tide meets a river current; especially an arm of the sea at the lower end of a river; a firth.

* Faecal Matter

Matter discharged from the bowels of humans and of animals held in pens or enclosures.

* Flush Toilet

A latrine consisting of a plumbing fixture for the collection and discharge of waste with flushing water.

* Force Main

A pressure pipe joining the pump discharge at a water or waste-water pumping station with a point of gravity flow.

* Gradient

The rate of change of any characteristic per unit of length or scope. The terms is usually applied to such terms as elevation, velocity, pressure.

* Head

The height of the free surface of fluid above any point in a hydraulic system; a measure of the pressure or force exerted by the fluid.

* House Connection

The pipe carrying wastewater from the building to a public sewer. Also called Building Sewer and House Sewer.

* Hydraulic Gradient

The slope of the hydraulic grade line; the rate of change of pressure head; the ratio of the loss in the sum of the pressure head and position head to the flow distance. For open channels, it is the slope of the water surface and is frequently considered barallel to the invert. For closed conduits under pressure, it is the slope of the line jointing the elevations to which water would rise in pipes freely vented and under atmospheric pressure. A positive slope is usually one which drops in the direction of flow.

* Industrial Wastes

The liquid wastes from industrial processes, as distinct from domestic or sanitary wastes.

* Infiltration

(1) The flow or movement of water through the interstices or pores of a soil or other porous medium. (2) The quantity of groundwater that leaks into a pipe through joints, porous walls, or breaks. (3) The entrance of water from the ground into a gallery. (4) The absorption of liquid by the soil, either as it falls as precipitation or from a stream flowing over the surface.

* Infrastructure

The basic structures and facilities upon which the economic activities of a community or region are dependent, such as roads, railways, school systems, water and power supply and other public utilities. Sometimes referred to as Social Overhead Capital.

* Inlet

(1) A surface connection to a drain pipe. (2) A structure at the diversion end of a conduit. (3) The upstream end of any structure through which water may flow. (4) A form of connection between the surface of the ground and a drain or sewer for the admission of surface or storm water. (5) An intake.

* Invert

The floor, bottom, or lowest portion of the internal cross section of a closed conduit. Used particularly with reference to aqueducts, sewers, tunnels, and drains. Originally, it referred to the inverted arch which was used to from the bottom of a masonry-lined sewer.

* Land Use

The culture of the land surface; which affects the social and economic conditions of a region and which determines the amount and character of the runoff and erosion. Existing or zoned economic use of land, such as residential, industrial, farm, commercial.

* Lateral Sewer

A sewer that discharges into a branch or other sewer and has no other common sewer tributary to it.

* Latrine

A structure or device for the collection and accumulation, leaching or discharge of human faecal matter and urine.

* Main Sewer

A sewer that receives many tributary branches and serves a large territory. Also called Trunk Sewer. In small systems, a sewer to which one or more branch sewers are tributary.

* Manhole

An opening in sewer provided for the purpose of permitting a man to enter or leave the sewer.

* Modified Aeration

A modification of the activated sludge process in which a shortened period of aeration is used with a reduced quantity of suspended solids in the mixed liquor.

* Private Sanitary Sewerage System

A sanitary sewerage system owned and directly controlled otherwise than by a public authority or not available for public use.

* Private Sewer

A pipe carrying wastes from one or more buildings to the boundary of the permises.

* Privy

A structure enclosing a latrine.

* Primary Treatment

(1) The first major (some times the only) treatment in wastewater treatment works, usually sedimentation. (2) The removal of a substantial amount of suspended matter but little colloidal and no dissolved matter.

* Public Sanitary Sewer

A conduit for the conveyance of sanitary sewage and forming part of a public sanitary sewerage system.

* Public Sanitary Sewerage System

A sanitary sewerage system owned or directly controlled by a public authority and available for public use.

* Public Sewer

Any sewer intended for public use installed and controlled by the Authority.

* Pumping Station

A wastewater pumping station that lifts the wastewater to a higher elevation when the continuance of the sewer at reasonable slopes would involve excessive depths of trench, or that raises wastewater from areas too low to drain into available sewers. These stations may be equipped with pneumatic ejectors, centrifugal pumps, or other pumps.

* Nightsoil

Faecal matter and urine accumulated on premises.

* Open Channel

Any natural or artificial waterway or conduit in which water flows with its surface exposed to the outside atmosphere.

* Outlet

Downstream opening or discharge end of pipe, culvert or canal.

* Oxidation Ditch

A kind of biological wastewater treatment process, in which biological oxidation of organic material is effected by artificially accelerated transfer of oxygen to the water from air.

* Plumbing Fixture

An installed receptable which is supplied with water or receives or discharges water or waterborne waste.

* Pollution

The introduction into water of harmful or objectionable material in sufficient amout to be detectable.

* Premises

A unit of land owned or occupied by any person, organization, private or government agency, government or other legal entity, including all buildings and other structures thereon.

* Residential Area

Areas including dwellings, business buildings, institutions and also neighbourhood shops, but dominated by dwellings.

* Rotating Disc

A kind of biological wastewater treatment process, in which a fixed-film microbial layer on rotating media is used.

* Roughness Coefficient

A factor, in the Chezy, Darcy-Weisbach, Hazen-Willams, Kutter, Manning, and other formulas for computing the average velocity of flow of water in the conduit or channel, which represents the effect or roughness of the confining material on the energy losses in the flowing water.

* Sanitary Sewer

A sewer which carries liquid and water-carried wastes from sanitary conveniences of residences, commercial buildings, industrial plants, and institutions, together with quantities of ground, storm and surface water which are not admitted intentionally.

* Sanitary Sewerage System (or wastewater system)

A system of enclosed conduits and appurtenances for the collection and conveyance of wastewater together with any associated structures, equipment and other facilities for wastewater treatment and the disposal of wastewater effluent.

* Sanitary Wastewater

(1) Domestic wastewater with storm and surface water excluded. (2) Wastewater discharging from the sanitary conveniences of dwellings (including apartment houses and hotels), office buildings, industrial plants, or institutions. (3) The water supply of a community after it has been used and discharge into a sewer. Also called sanitary sewage.

* Secondary Treatment

The treatment of wastewater by biological or chemical methods after primary treatment by sedimentation.

* Separate System

A system of sewers and drains in which sanitary wastewater and storm-water are carried in separate conduits.

* Septic Tank

A settling tank in which settled sludge is in immediate contact with the wastewater flowing through the tank and the organic solids are decomposed by anaerobic bacterial action.

* Sewage

The spent water of a community. Term now being replaced in technical usage by the preferable term wastewater.

* Sewage Works

All-inclusive term for wastewater collection, pumping, treatment, and disposal facilities. Term declining in use.

* Sewage Treatment Works

An arrangement of devices and structures for treating wastewater, industrial wastewaters, and sludges; sometimes used synonymously with "waste treatment plant", "wastewater treatment plant", "water pollution control plant", "water renovation plant", "water reclamation plant", etc.

* Sewer

A pipe or conduit that carries wastewater or storm-water drainage.

* Sewerage

System of piping, with appurtenances, for collecting and conveying wastewater from source to discharge. Term declining in use.

* Sewerage System

The structure, equipment, and processes required to collect, convey, treat, and dispose of domestic and industrial wastes.

* Sinking Fund

A fund established by periodic installments to provide for the retirement of the principal of term bonds and of other bonds specified to be retired from sinking funds.

* Stabilization Pond

A type of oxidation pond in which biological oxidation of organic matter is effected by natural or artificially accelerated transfer of oxygen to the water from air.

* Storm Drain (storm channel or ditch)

An open channel for collecting and/or conveying water, groundwater, subsurface water, or unpolluted water from any source. Such drains may be lined, partially lined, or unlined, as required by external factors such as soil condition, velocity of flow, and others.

* Storm Sewer

A sewer that carries storm water and surface water, street wash and other wash waters, or drainage but excludes domestic wastewater and industrial wastes. Also called storm drain.

* Storm Water

The excess water running off from the surface of a drainage area during or immediately after a period of rain. It is that portion of the rainfall and resulting surface flow that is excess of that which can be absorbed through the infiltration capacity of the surface of the area.

* Sub-main Sewer

A sewer into which the wastewater from two or more lateral sewers is discharged and which subsequently discharges into a main, a trunk, or other collector.

* Sullage

Any household waste liquids discharged from any bath, shower, lavatory, basin, floor gully, laundries or sink (not being a slop sink) but excludes faecal water and urine.

* Tidal River

A river in which flow and water surface elevation are affected by the tides. Such effect usually occurs in the lower stretch near the mouth, where the gradient is very flat. In some streams, the effect may extend a hundred or more kilometers upstream from the mouth.

* Unpolluted Water

Water whose quality is equal or better than the effluent criteria, or water that would not be benefited by discharge to the sanitary sewer and wastewater treatment facilities provided.

* Urine

Matter discharged from the bladders of humans and of animals held in pens or enclosures.

* Useful Life Expectancy

The period of time during which a piece of equipment a building or other physical asset is expected to render the service or perform the function for which it is intended, at an acceptable level of efficiency, with ordinary maintenance and under operating conditions expected in the given situation. Technical and financial planning assumes that the asset will have to be replaced at the end of its expected useful life.

* Vault Latrine

A latrine in which human faeces and urine are accumulated in a lined pit or vault for intermittent removal as nightsoil.

* Watercourse

A natural or artificial channel for the continuous or intermittent passage of water, including stream, rivers, lakes, ponds, bays, estuaries, and oceans.

* Wastewater

The spent water of a community. From the standpoint of source, it may be a combination of the liquid and watercarried wastes from residences, commercial buildings, industrial plants, and institutions, together with any groundwater, surface water, and storm-water that may be present. In recent years, the word wastewater has taken precedence over the word sewage.

* Yard Piping

The piping extension from the building drain to the appropriate service connection of the sewerage system.

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