FEASIBILITY STUDY
FOR
SEWERAGE AND DRAINAGE PROJECT
BUTTERWORTH/BUKIT MERTAJAM METROPOLITAN AREA
MALAYSIA

VOLUME I

SUMMARY REPORT

FEBRUARY 1979

JAPAN INTERNATIONAL COOPERATION AGENCY

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PREFACE

In response to a request of the Government of Malaysia, the Government of Japan decided to conduct a study on the sewerage and drainage system project in Butterworth/Bukit Mertajam Metropolitan Area, Penang, and the Japan International Cooperation Agency (JICA), the official agency responsible for the technical cooperation programme of the Government of Japan, conducted the study.

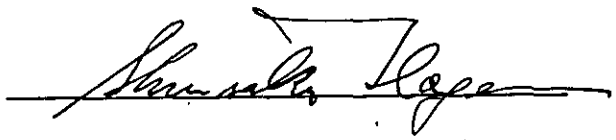
The Government of Malaysia decided to make the environmental protection and life environment improvement programme as part of important policy objective of the Third Malaysia Plan commenced in 1976, and requested the Government of Japan to make the study of the project.

JICA sent a preliminary survey team to Malaysia in May 1976. Based on the result thereof, JICA conducted a Master Plan Study from October 1976 through June 1978 and submitted the Final Report on the Master Plan Study to the Government of Malaysia. In parallel with this, JICA conducted a Feasibility Study on the first priority area identified in the Master Plan and completed the present report.

I hope that this report will contribute to the planning and construction of sewerage and drainage facilities not only in the project area but also in the whole Malaysia, and at the same time serve to strengthen the friendly relations between our two countries.

I wish to express my heartfelt appreciation to the Malaysian Authorities and officials concerned for their cooperation and hospitality extended to the teams dispatched by JICA.

February, 1979



Shinsaku Hogen
President
of
Japan International Cooperation Agency

FEASIBILITY STUDY
FOR
SEWERAGE AND DRAINAGE PROJECT
BUTTERWORTH AND BUKIT MERTAJAM METROPOLITAN AREA

MALAYSIA

VOLUME I - SUMMARY REPORT

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List of Abbreviations

EHEU	-	Environmental Health and Engineering Unit, Ministry of Health
DE	-	Department of Environment, Ministry of Science and Technology
EPU	-	Economic Planning Unit, State and Federal Governments
ED	-	Engineering Department, MPSP
PWD	-	Public Works Department, State and Federal Governments
DID	-	Drainage and Irrigation Department, State and Federal Governments
PDC	-	Penang Development Corporation
PWA	-	Penang Water Authority
TCP	-	Town and Country Planning, Penang
MPSP	-	Municipal Council Province Wellesley
MPPP	-	Municipal Council Penang Island
WHO	-	World Health Organization
IBRD	-	International Bank for Reconstruction and Development
ADB	-	Asian Development Bank
OECF	-	Overseas Economic Cooperation Fund, Japanese Government

I INTRODUCTION

1.1 Project Background

In 1976 the Government of Malaysia requested the Government of Japan to co-operate in developing a programme to establish a comprehensive planning of sewerage and drainage systems for the Butterworth/Bukit Mertajam Metropolitan Area in Penang State, Malaysia, as a vital step towards improvement in the general sanitation and public health conditions with due considerations on socioeconomic and environmental situation in the Area as a whole.

In response to the request from the Government of Malaysia, the Government of Japan decided to co-operate with the project and the Japan International Cooperation Agency (JICA), an agency responsible for implementation of technical co-operation programmes of the Government of Japan, sent a preliminary survey team to Malaysia from May through June 1976, to perform a preliminary field reconnaissance and to discuss with the Government of Malaysia on the implementation of studies for the programme. On the basis of the results of the preliminary survey, JICA undertook studies for planning of sewerage and drainage project since October 1976.

The task of the project for sewerage and drainage master plan was undertaken during the period from 1976 through 1978, and a final report on master plan covering the whole Metropolitan Area was submitted in May 1978 to the Government of Malaysia.

Based on the findings and recommendations of the master plan report, and with due considerations on basic requirement of the Government of Malaysia, the feasibility study was undertaken from September 1977 through June 1978 as the second step of the project.

The Government of Malaysia has established both Steering and Technical Committees during the course of implementation of the project. It also provided the counterpart personnel for technology transfer and certain services and facilities to the project at the time of field survey in the area by the study team.

1.2 Purpose and Scope of Work

The objective of this feasibility study is to provide the Government of Malaysia with sewerage and drainage plan in an economical and orderly manner with socially compatible approach

for the collection and disposal of wastewater and stormwater in the selected areas of Butterworth/Bukit Mertajam Metropolitan Area. The substance of the study is therefore expected to enable the Government to make decision on magnitude of investment, implementation schedule and operation and maintenance of the proposed project.

The activities carried out under this study include; (a) discussions with the members of MPSP, Penang State and Federal Government, (b) transfer of technical knowledge to the counterpart personnel, and (c) preparation of reports in Tokyo, including alternative studies to select the most desirable plan for the area, preliminary engineering design, and studies on organization, management and legislation.

The areas covered by the feasibility study are Butterworth Zones Nos. 1, 2, 3 and 4; Bukit Mertajam Zone No. 3; and Seberang Jaya Zones Nos. 1 and 2 for the sewage works; and Sub-basins Nos. 2-2, 2-3, 2-4, 2-5, 2-7, 2-12 and part of 2-1, 2-10, 2-11, 2-13 and 2-14 in Basin II; and all Sub-basins in Basin IV for the drainage works, as illustrated in Figures 1, 2 and 3.

1.3 Reports and Documents Prepared

A number of reports were prepared and submitted to the Government of Malaysia during the period of the study, either in the form of interim or draft, covering all the work performed under the study. Results of the investigations and studies together with recommendations are presented in the following reports:

Volume I	Summary Report
Volume II	Sewerage System
Volume III	Drainage System
Volume IV	Institutional Study
Volume V	Preliminary Engineering Drawings and Maps

II SEWERAGE SYSTEM

2.1 Study Area

The Study Area for sewerage system feasibility study comprises seven sewerage zones namely, (1) Butterworth zones Nos. 1, 2, 3 and 4, (2) Bukit Mertejam zone No. 3, and (3) Seberang Jaya zones Nos. 1 and 2, with a total area of 3,255 ha (8,040 acres) excluding the areas of water courses such as the Prai, Juru and Derhaka rivers. Area and population by each sewerage zone are shown in Table 1 and locations of the sewerage zone are illustrated in Figures 1 and 2.

2.2 Studies and Investigations

A comprehensive study was carried out for the Study Area, covering identification of problems involved and viable implementation programme of the sewerage system to be provided in the first stage programme for over six years. The major work undertaken in the study are summarized in the following:

- Field surveys and investigations to select sewer routes and locations of pumping stations and treatment facilities, including preparation of alternative plans for the analysis of investment requirements for the first stage programme.

- Test borings at selected points of the possible construction sites for sewers and treatment facilities.

- Topographic survey of ground surface elevations and cross sections and invert elevations of the existing major drains.

- Investigations on the existing sewerage system to obtain data concerning sewage flow rates, infiltration and sewage qualities.

- Evaluation of investment requirements for the first stage programme, including selection of the priority areas for immediate construction, alternative plans and related costs for construction and operation and maintenance of the facilities.

- Development of the design criteria for the first stage programme.

- Studies on organizational, managerial, legal and financial considerations.

- Financial analysis of the proposed sewerage system for the first stage programme.

2.3 Findings and Study Results

The following findings and results of studies have been obtained under the present feasibility study:

- There is at present no adequate modern sewerage system in the area except for a part of the Seberang Jaya sewerage district, zone No. 2, where a sewerage scheme has been undertaken by PDC. Most of the domestic sewage and industrial wastewater from the area are discharged directly into nearby drains or other available waterways.

- There are two types of human excreta disposal systems functioning in the area, one is septic tank system and the other bucket system. After passing through septic tanks, the effluent is discharged into nearby water courses while the sludge is generally removed by vacuum lorries and transmitted to open lands for disposal. In the case of the bucket system, excreta is collected from time to time and transported to the designated dumping places where the excreta is buried in the ground.

- At present, approximately 20 per cent of the area is served by the septic tank system and the remaining part by either cesspool or bucket system.

- The discharge of most of the domestic wastewater without treatment is a cause of water pollution in rivers and drains and is eventually contaminating the beaches and offshore marine waters. Such conditions have resulted in adverse environmental effects creating odour and aesthetic problems in many parts of the area. If no immediate action is taken to alleviate the wastewater burden on the water courses, it is evident that the pollution will become more serious in the future.

- Present population in the area as of 1976 is 156,300 which has been estimated on the basis of the land use pattern as defined in the master plan.

- On the basis of the presently available data, populations of the area for the years 1985, 1990 and 2000 have been estimated at 208,000, 233,800 and 300,700 respectively. The estimations have been made on the assumption that the annual population growth rates for the years from 1976 through 1985 would be 5.5 per cent and 3.4 per cent for the years from 1986 through 2000. Estimated population distribution in each of the sewerage zone is presented in Table 1.

- Per capita average sewage flow rates in residential and commercial areas in the year 1976 have been estimated to be 180 l/day/cap (40 gal/day/cap) and 415 l/day/cap (91 gal/day/cap) respectively, with the average BOD of 200 mg/l.

- Industrial wastewater survey conducted at the selected 104 representative factories of the area indicated that the total wastewater produced in 1976 was 6,280 m^3/day (1.38 MGD) with BOD production of 1,167 kg/day (2,573 lb/day).

- Design flow rates for the years 1990 and 2000 have been projected, including domestic sewage, industrial wastewater and extraneous water, as summarized in Table 2.

- Studies and investigations have led to the conclusion that stabilization pond system would be the most suitable process to treat the sewage. It was also found that aerated lagoon process would have to be applied in some of the ponds in the future to meet the requirement by the ever-increasing sewage flow rate. These are discussed in detail in Chapter 8 of Volume II.

2.4 Design Bases

Design bases to be applied for the sewage works design and planning in the first stage programme have been developed. Major elements are as follows:

- The Manning equation should be used for sewer designs.

- A minimum size of public sewers shall be 225 mm (9 in.) in dia., but 150 mm (6 in.) in dia. for house connexion pipes.

- Sewers up to 300 mm (12 in.) in dia. should normally be of VCP with compression type joints. Sewers 375 mm (15 in.) in dia. or larger should be of centrifugally-cast reinforced

concrete pipe and pressure sewers up to 600 mm (24 in.) in dia. be of asbestos-cement pipe and 700 mm (28 in.) or larger be of steel pipe.

- All sewers should be designed to maintain a mean flow velocity of not less than 0.6 m/sec (2 ft/sec), but not exceed 3.0 m/sec (9 ft/sec) when flowing full.

- Earth covering of sewer pipes is not to be less than one metre (3.3 ft) unless special protection measures against the expected load are considered.

- Maximum manhole spacings are from 100 to 150 m (328 - 492 ft) depending upon the sizes of sewer, with internal sizes of 1,200 mm to 1,800 mm (47 - 70 in.)

- Types of pumping station are circular for small capacity and rectangular for large capacity, both without grit chamber but with coarse bar screens prior to the pump well.

- Initial pump capacity should be adequate to meet the condition in the year 1990 with at least two units of pump equipment. Submersible non-clogging pumps are recommended for all pumping stations because of their easiness in operation and maintenance and also low construction cost of pumping station structures.

- Sewage treatment shall be of stabilization pond process consisting of sedimentation cell, primary pond and maturation pond. Both for primary pond and maturation pond, multiple units should be provided.

Details of the design criteria are described in Chapter 6 of Volume II.

2.5 Preliminary Engineering Study for Entire Study Area

Various sewerage facilities that would be established throughout the entire Study Area under the proposed sewerage programme are shown in Figures 1 and 2. Area and population by sub-zone, and the proposed sewerage facilities by government contribution are shown in Tables 1 and 3 respectively. The elements of the preliminary engineering of the system are discussed in the following:

- Layout of the sewerage facilities has been prepared basically following the proposed division of the Study Area into sewerage zones and sub-zones in the Master Plan, with some minor modifications to reflect the recent development of the area.

- One of the most important factors to be considered in preparing sewerage layout is the selection of sites for stabilization ponds. Thus the emphasis is given to finding the suitable locations of the ponds and the possibility of acquiring enough space for the ponds well in advance.

- Sewer routes have been selected based on the results of site investigations and comparative studies on the possible routes, including analysis on the relationship between costs of sewers and pumping stations and the depth, as discussed in Section 7.4 et seq. of Chapter 7, Volume II.

- Evaluation was made on the large scale housing development schemes now underway by private developers, and the result of which was also well taken in layout planning so that the sewerage systems in the schemes would be integrated in the regional sewerage plan.

- The recommended sanitary sewerage system of physical facilities, developed after considering numerous alternatives, encompasses; (a) trunk, main, submain, branch and lateral sewers of totally 107,360 m (66.7 miles) long, ranging from 225 mm to 900 mm in diameter, (b) 14 pumping stations with capacities ranging from 1.9 m^3/min to 37.4 m^3/min, and (c) four waste stabilization ponds with capacities ranging from 13,192 m^3/day (2.9 MGD) to 33,874 m^3/day (7.5 MGD).

2.6 Proposed First Stage Programme

In determining the priority and reasonable magnitude of the investment for sewerage implementation during the first stage programme, a careful consideration is given to both technical and financial aspects.

As the first step, each of the 20 sewerage sub-zones is evaluated by rating system to determine the priority order of the construction. The rating system applied for the assessment includes such major elements of importance as (a) population density, (b) extent of urbanization, (c) waste loading produced, (d) sewage flow rate, and (e) availability of excreta disposal system. The evaluation indicates that the sewerage implementation is most urgently required in the eight sewerage sub-zones

namely; Butterworth district zone 1, sub-zones A and B; Butterworth district zone 3, sub-zones A and B; Butterworth district zone 4, sub-zone A; Bukit Mertajam district, zone 3, sub-zones A and B; and Seberang Jaya district zone 1, sub-zone A.

In order to select the most appropriate magnitude of the first stage investment, seven alternative combinations of the selected eight high priority sewerage sub-zones have been set, and each of the alternatives is analysed in terms of costs and possible revenues. The selected alternative combinations are;

Alternative I - combination of BW1-A, BW1-B, BW3-A, BW3-B, BM4-A, BM3-A, BM3-B and SJ1-A.

Alternative II - combination of BW1-A, BW1-B, BW3-B, BW4-A, BM3-A and BM3-B.

Alternative III - combination of BW1-A, BW1-B, BW3-A, BW3-B, BW4-A and BM3-A.

Alternative IV - combination of BW1-A, BW1-B, BW3-A, BW3-B, BW4-A and BM3-B.

Alternative V - combination of BW1-A, BW1-B, BW3-A, BW3-B, BM3-A and BM3-B.

Alternative VI - combination of BW1-A, BW1-B, BW3-A, BM3-A and BM3-B.

Alternative VII - combination of BW1-A, BW1-B, BW3-A, BW3-B and BM3-B.

The results of the alternative study indicate that Alternative V is superior to other six alternative combinations in terms of its revenue, financing schedules and the scale of the initial investment requirements. Thus, Alternative V is selected as the acceptable sewerage system for the first stage programme. These analyses are described in detail in Section 9.3, Chapter 9 of Volume II.

The selected sewerage system for the first stage programme will cover a total area of 1,066 ha (2,633 acres) with a total population of 84,000 in the year 1985. The required facilities for the programme are summarized in Table 4 and illustrated in Figures 1 and 2.

2.7 Construction Schedule and Costs for the First Stage Programme

A construction schedule of the sewerage facilities for the first stage programme is proposed to be completed in the five years of the project, covering the six high priority sewerage sub-zones. The programme is scheduled to commence in the fiscal year 1980 and to complete by the end of 1985 fiscal year.

Estimated construction cost for the programme, including engineering and contingencies, is M$28,878,000 at 1977 price levels as shown in Table 5. Annual operation and maintenance costs for the proposed system are estimated for the years from 1980 through 1990, as summarized in Table 6. These are discussed in Section 9.4, Chapter 9 of Volume II.

2.8 Financial Planning for the First Stage Programme

(a) Required Capital Costs

For implementation of the sewerage construction for the first stage programme from 1980 through 1985 as enumerated above, a total cost of M$28,878,000 at 1977 price levels (M$37,749,000 at escalated price) will be required. As developers are assumed to be responsible for constructing the sewerage facilities in the development areas and also individual household owners are responsible for house connexion and plumbing, such costs are excluded from the construction cost of the programme.

(b) Sources of Fund

The combined loans from international lending agencies (foreign loan) and Federal Government (local loan) are assumed to finance both foreign and local currency portions of the project cost. Because the foreign currency component of the project cost is significantly small accounting for only 21 per cent of the total cost, alternative financial projections are attempted on the assumption that the above international lending agencies would not limit the loan to the foreign currency portion only but extend a loan to a part of the local currency portion, when local currency is not sufficiently available and particularly when local procurement is done for those of foreign origin. The alternative financial projection, therefore, incorporates the foreign exchange component equivalent arbitrarily to approximately 40 percent of the total project cost.

The operating revenues are projected mainly by sewerage service charge and supplementary allocation from MPSP's general rate fund to cover the operation and maintenance expenses (O/M costs) and debt service payment (amortization of interest and principal of loan). The sewerage charge is set at 70 per cent of existing water bill for the first three years from 1983 through 1985 and 90 per cent from 1986 thereafter for domestic and trade (commercial and industrial) wastewaters.

The charge per unit volume for trade wastewaters is expected to be twice of domestic wastewater due to the current water billing system in that the charge for trade water supply is twice of domestic water supply rate.

Such sewerage charge as determined is well within the prospective users' ability to pay. As the total required cost is difficult to be met only by the sewerage charge, the allocation from the municipal rate fund is considered to supplement the operation revenues on the justification that the benefits to be derived from the sewerage service are not only to the direct users of the system but wider community at large.

(c) Financial Feasibility

As discussed in Chapter 10 of Volume II, four sets of alternative financial schemes have been considered on the basis of the different loan components. In the analysis, it is assumed that three loan components will be available for the project, namely (1) Foreign loan from IBRD or ADB, at 8 per cent interest rate and 20 equal annual repayment after 6-year grace period, (2) Foreign loan from Overseas Economic Cooperation Fund (OECF) of Japan, at 4 per cent interest rate and 14 equal annual repayment after 6-year grace period, and (3) Federal Government loan, at 6 per cent interest rate and 30 equal annual repayment after 6-year grace period. The four alternatives are as follows:

	Foreign Loan (IBRD or ADB)	Foreign Loan (OECF)	Local Loan (Federal Gov't)
Alt. 1	7,918 (21%)	-	29,831 (79%)
Alt. 2	-	7,918 (21%)	29,831 (79%)
Alt. 3	15,100 (40%)	-	22,649 (60%)
Alt. 4	-	15,100 (40%)	22,649 (60%)

The financial projections for the above four alternatives are made in the form of Income Statement, Cash Flow Statement and

Balance Sheet, as presented in Tables 10.7 to 10.18, Chapter 10 of Volume II. A comparison of the four alternatives, as summarized in Table 10.21 of Volume II, is undertaken and Alternative 2 is recommended because it requires the minimum allocation from MPSP's general rate fund and makes a scheme financially feasible.

2.9 Benefits of the Proposed Programme

Significant benefits to public health and sanitation, both direct and indirect, can be derived from the proposed sewerage system in the first stage programme. All anticipated benefits are evaluated on the basis of either quantifiable or non-quantifiable benefits. Since these benefits are not fully quantifiable, non-quantifiable benefits become important in the overall justification of the programme.

Evaluation of the major benefits includes abatement of productivity losses due to water-borne diseases, control of water pollution by other means and reduction of the expenditure on the facilities such as septic tank and bucket systems. In the study, however, it is not possible to evaluate overall benefits in terms of benefit-cost ratio, internal rate of return, or net benefit, hence no such normal techniques of B/C analysis are applied.

The results of the evaluation of benefits indicate that the provision of sewerage system is fully justified for the benefits of individual household, commercial enterprise and community environment. If no sewerage system is provided in the area, sanitary conditions, which are already deplorable in many areas in the city, will become progressively worse. Details of benefits are described in Chapter 11, Volume II.

Table 1 Area and Population by Sub-zone

Sewerage Zone	Sub-zone	Area (ha)	Population Year 1976	Population Year 2000
BW 1	BW1-A	164	21,800	26,400
	BW1-B	42	1,200	3,200
	BW1-C	160	13,200	20,160
	Sub-total	366	36,200	49,760
BW 2	BW2	120	0	14,400
BW 3	BW3-A	116	10,300	13,920
	BW3-B	221	6,850	8,880
	BW3-C	95	8,350	10,920
	Sub-total	432	25,500	33,720
BW 4	BW4-A	172	14,150	20,280
	BW4-B	279	13,600	22,500
	Sub-total	451	27,750	42,780
SJ 1	SJ1-A	243	14,450	27,720
	SJ1-B	76	800	9,360
	SJ1-C	54	600	3,470
	Sub-total	373	15,850	40,550
SJ 2	SJ 2	400	3,600	37,090
BM 3	BM3-A	172	17,300	19,977
	BM3-B	292	14,610	30,320
	BM3-C	96	2,740	5,120
	BM3-D	57	400	2,280
	BM3-E	249	12,340	11,674
	BM3-F	107	0	9,172
	BM3-G	45	0	3,857
	Sub-total	1,018	47,390	82,400
	Total	3,160	156,290	300,700

Note: (1) Land area required for waste stabilization ponds (about 95 ha) is not included.

(2) For locations of sub-zones, see Figures 1 and 2.

Table 2 Design Sewage Flow Rates

Type of Wastewater	Classification of Area	Year 1990	Year 2000
1. Residential		208 l/d/c	230 l/d/c
2. Commercial		441 l/d/c	460 l/d/c
3. Industrial	BW.1 (1)	15.76 m^3/d/ha	17.02 m^3/d/ha
	BW.2	-	-
	BW.3	43.23 -"-	55.55 -"-
	BW.4	315.67 -"-	315.67 -"-
	SJ.1	37.50 -"-	46.25 -"-
	SJ.2	56.58 -"-	57.32 -"-
	BM.3 (2)	349.00 -"-	394.00 -"-
4. Extraneous	High pop. density area, from 85.7 to 200 person/ha.	9 m^3/d/ha	
	Low pop. density area, incl. industrial area.	5 m^3/d/ha	

Note: (1) In this zone no industries are planned to settle in the future.

(2) Industrial wastewater discharge from a single factory.

Table 3 Summary of Proposed Sewerage Facilities by the Government's Contribution in the Study Area

Component \ Sewerage Zone	BW Zone 1	BW Zone 3	BW Zone 4	SJ Zone 1	BM Zone 3
1. Sewer					
a. Total Length of Sewer	17,560 m	21,985 m	20,150 m	8,895 m	38,770 m
b. Size of Sewer	225 to 900 mm diam	225 to 750 mm diam	225 to 600 mm diam	225 to 750 mm diam	225 to 900 mm diam
2. Pumping Station	a) Kampung Bengali	a) Permatang Tengah	a) Kampung Simpah	a) Chai Leng Park	a) Sungai Ara
	Capacity 4.8 m^3/min.	Capacity 14.2 m^3/min.	Capacity 13.2 m^3/min.	Capacity 11.0 m^3/min.	Capacity 3.6 m^3/min.
	3 pumps	3 pumps	4 pumps	4 pumps	3 pumps
	b) Chain Ferry	b) Mak Mandin	b) Bagan Lalang	b) Kampung Selut	b) Betek
	30.7 m^3/min.	17.4 m^3/min.	12.8 m^3/min.	18.9 m^3/min.	2.5 m^3/min.
	5 pumps	4 pumps	4 pumps	4 pumps	3 pumps
	c) Sungai Nyor	c) Soon Corporation		c) Kim Sar Garden	c) Sungai Rambai
	2.0 m^3/min.	1.1 m^3/min.		1.9 m^3/min.	37.4 m^3/min.
	2 pumps	2 pumps		2 pumps	6 pumps
3. Waste Stabilization Pond					
a. Design Flow (daily average flow)	18,575 m^3/d	(*) 33,874 m^3/d		13,192 m^3/d	28,119 m^3/d
b. Area Required for Pond	14 ha	37 ha		12 ha	32 ha
c. Number of Pond Unit	2 units	12 units		3 units	8 units

Note: (*) Single waste stabilization pond for BW zones 3 and 4.

Table 4 Summary of Proposed Sewerage Facilities by the Government Contribution for the First Stage Programme

Component \ Sewerage Zone	BW Zone 1 (BW1-A & BW1-B)	BW Zone 3 (BW3-A & BW3-B)	BM Zone 3 (BM3-A & BM3-B)
1. Sewer			
a. Total Length of Sewer	11,905 m	16,795 m	26,440 m
b. Size of Sewer	225 to 900 mm dia.	225 to 750 mm dia.	225 to 900 mm dia.
2. Pumping Station	a) Kampung Bengali Capacity 4.1 m^3/min 3 pumps b) Chain Ferry 21.3 m^3/min 4 pumps c) Sungai Nyor 1.6 m^3/min 2 pumps	a) Permatang Tengah Capacity 6.6 m^3/min 2 pumps b) Mak Mandin 13.6 m^3/min 3 pumps c) Soon Corporation 1.1 m^3/min 2 pumps	a) Betek 0.7 m^3/min 2 pumps b) Sungai Rambai 23.1 m^3/min 4 pumps
3. Waste Stabilization Pond			
a. Design Flow (daily average flow)	10,103 m^3/d	12,677 m^3/d	14,023 m^3/d
b. Area Required for Pond (*)	14 ha	37 ha	32 ha
c. Number of Pond Units Required	2 units	3 units	4 units

Note: (*) Required land area for the condition in the year 2000.

Table 5 Disbursement Programme for the First Stage Programme (at 1977 prices)

(Unit: M$1,000)

	1980		1981		1982		1983		1984		1985		Total	
	L	F	L	F	L	F	L	F	L	F	L	F	L	F
Sewers	-	-	2,142	378	2,213	390	2,419	427	1,120	198	1,980	349	9,784	1,742
Pumping Station:														
Mech. & Electrical Equipment	-	-	104	242	19	44	68	160	52	122	63	146	306	714
Civil Works	-	-	515	129	81	20	170	42	393	98	172	43	1,331	332
Waste Stabilization Pond:														
Civil Works	-	-	-	-	973	243	1,316	329	-	-	1,007	252	3,296	824
Cleaning Machine		-	-	-	-	-	-	232	-	-	-	102	-	334
Land	4,123	-	-	-	-	-	-	-	-	-	-	-	4,123	-
Sub-Total	4,123	-	2,761	749	3,285	697	3,973	1,190	1,565	418	3,222	892	18,930	3,946
Consulting Services:														
Engineering Design	469	469	-	-	-	-	-	-	-	-	-	-	469	469
Supervision	-	-	70	105	80	120	103	155	40	60	82	123	375	563
Physical Contingencies	94	94	566	171	673	163	815	269	321	96	661	203	3,130	996
Total Project Cost (End, 1977 price)	4,686	563	3,397	1,025	4,039	980	4,891	1,614	1,926	574	3,965	1,218	22,904	5,974
Escalation Factors (a)	1.158		1.216		1.276		1.340		1.407		1.477			
Total Project Cost (Escalated Price)	5,426	652	4,131	1,246	5,154	1,250	6,554	2,163	2,710	808	5,856	1,799	29,831	7,918
	6,078		5,377		6,404		8,717		3,518		7,655		37,749	

L : Local Currency
F : Foreign Currency
(a): 5% per annum for total cost

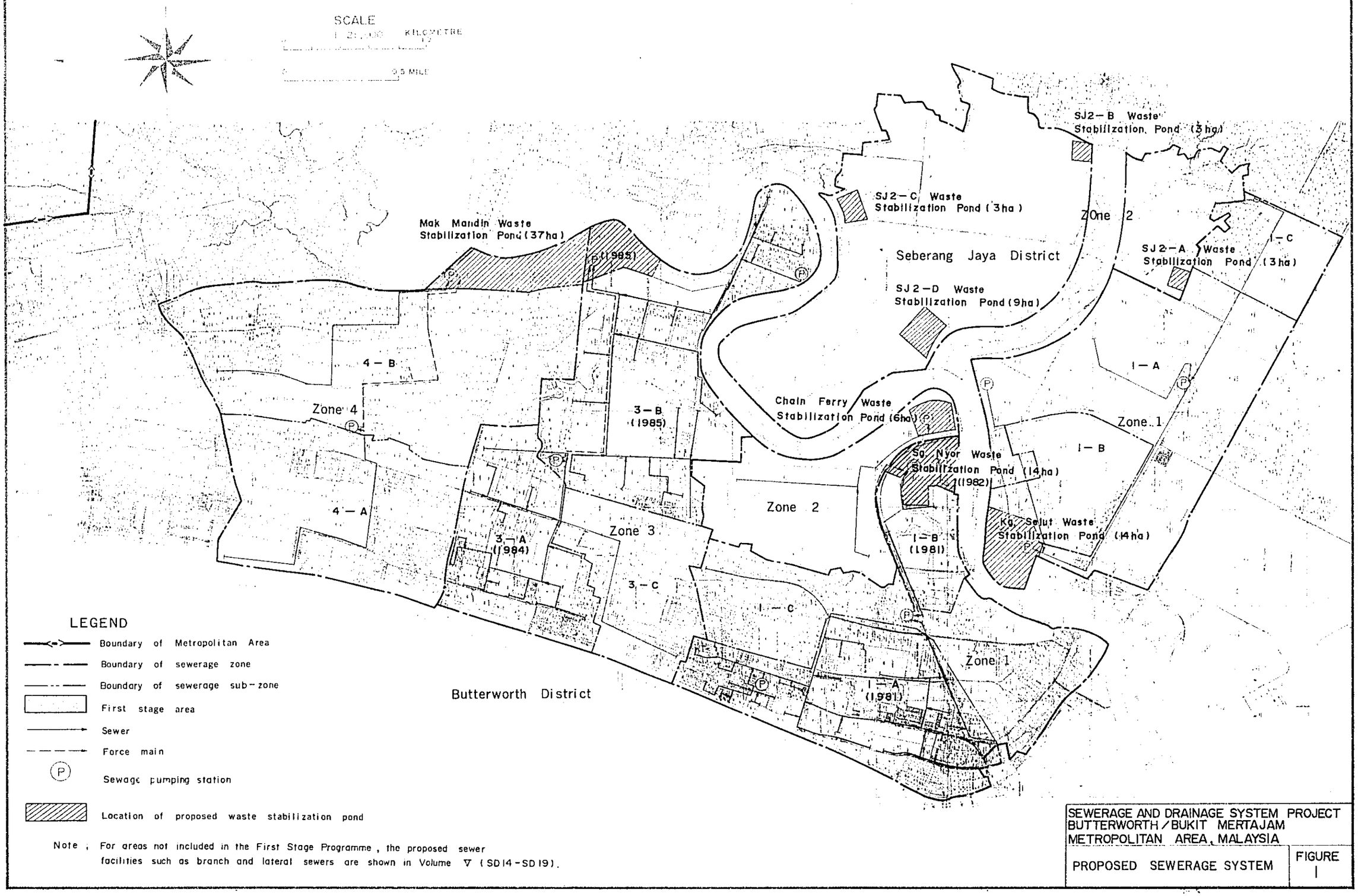
Table 6 Annual Operation and Maintenance Costs (at 1977 prices)

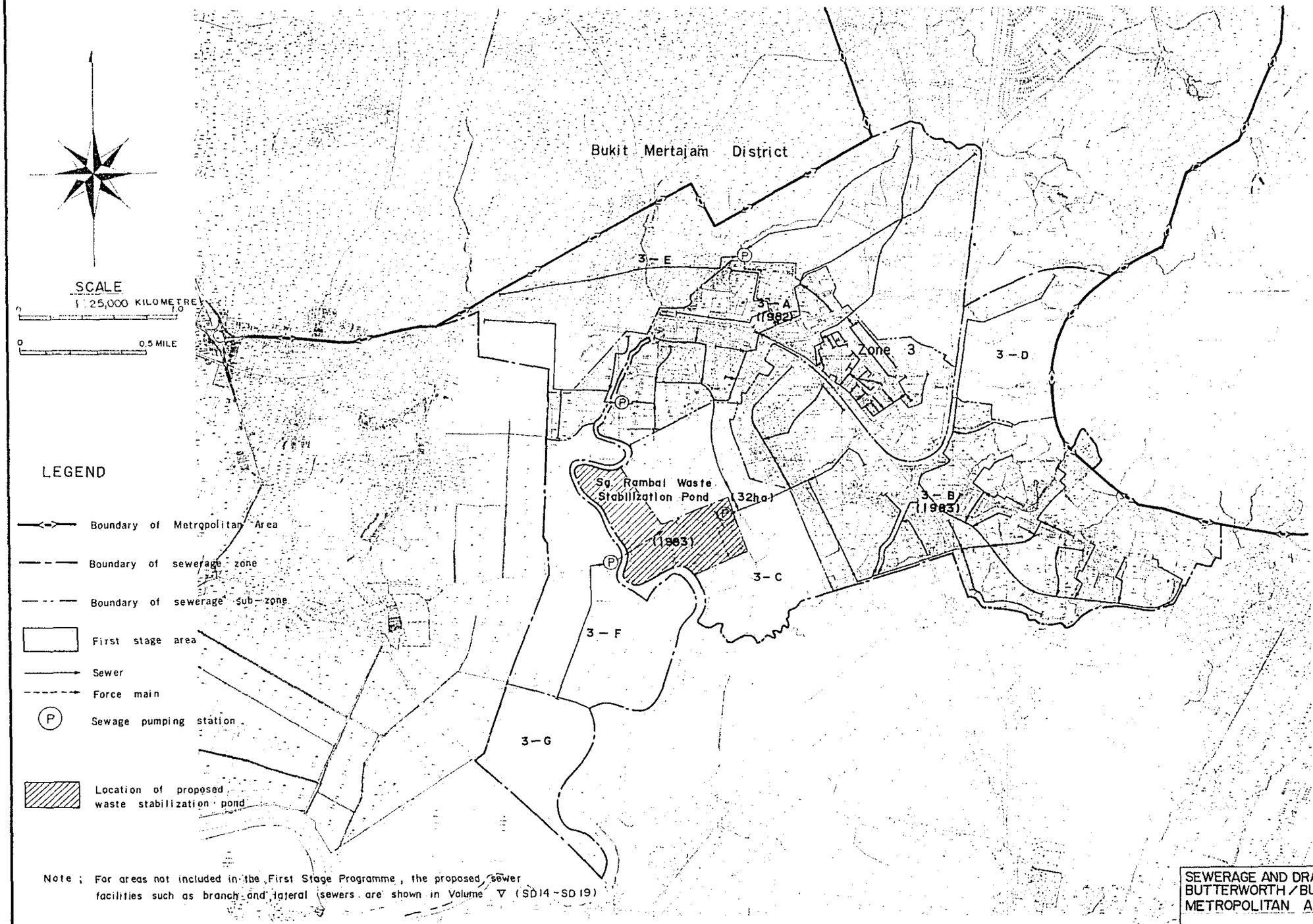
(Unit: M$1,000)

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Payroll (1)	86	153	153	284	355	397	410	410	410	410	410
Maintenance	-	-	-	43	64	101	119	134	134	134	134
Power	-	-	-	26	35	43	53	68	69	70	71
Administration (2)	9	15	15	28	36	40	41	41	41	41	41
Total	95	168	168	381	490	581	623	653	654	655	656

Note: (1) Wages and salaries for the personnel to be employed for the sewage works.

(2) Miscellaneous expenses including those for office supplies and personnel temporarily employed.


SCALE
KILOMETRE
0.5 MILE
SJ2-B Waste Stabilization Pond (3ha)
SJ2-C Waste Stabilization Pond (3ha)
Zone 2
Mak Mandin Waste Stabilization Pond (37ha)
(1985)
Seberang Jaya District
SJ2-D Waste Stabilization Pond (9ha)
SJ2-A Waste Stabilization Pond (3ha)
1-C
1-A
4-B
Zone 4
3-B (1985)
Chain Ferry Waste Stabilization Pond (6ha)
Zone 1
1-B
Sg Nyor Waste Stabilization Pond (14ha) (1982)
Zone 2
4-A
3-A (1984)
Zone 3
3-C
1-B (1981)
Kg Selut Waste Stabilization Pond (14ha)
1-C
1-A (1981)
Zone 1
Butterworth District
LEGEND
Boundary of Metropolitan Area
Boundary of sewerage zone
Boundary of sewerage sub-zone
First stage area
Sewer
Force main
Sewage pumping station
Location of proposed waste stabilization pond
Note , For areas not included in the First Stage Programme , the proposed sewer facilities such as branch and lateral sewers are shown in Volume V (SD14-SD19).
SEWERAGE AND DRAINAGE SYSTEM PROJECT
BUTTERWORTH / BUKIT MERTAJAM METROPOLITAN AREA, MALAYSIA
PROPOSED SEWERAGE SYSTEM
FIGURE 1



SEWERAGE AND DRAINAGE SYSTEM PROJECT
BUTTERWORTH / BUKIT MERTAJAM
METROPOLITAN AREA, MALAYSIA

PROPOSED SEWERAGE SYSTEM — FIGURE 2

III DRAINAGE SYSTEM

3.1 Study Area

The Study Area for drainage system feasibility study covers Bukit Mertajam town with its fringes (a part of Drainage Basin II) and Butterworth town (whole of Drainage Basin IV). In addition, the area outside the Study Area, which discharges stormwater to the Study Area due to the topographic conditions, is considered as the contribution area in calculating stormwater runoffs for the drainage system planning.

The total area for drainage study is 4,671 ha (11,540 acres), comprising 1,932 ha (4,770 acres) in Bukit Mertajam, 1,546 ha (3,820 acres) in Butterworth, and 1,193 ha (2,950 acres) in the contribution area. Details of the drainage study area are described in Table 7.

3.2 Studies and Investigations

For the drainage study, all available information and data have been collected from the various agencies concerned, including topographic and street maps; records of tide levels, expected land use plan, flood prone area, conditions of existing drainage systems; and technical reports and documents on the Juru tide gate and the Prai barrage.

It was necessary to carry out further studies and investigations to supplement the data lacking. These include the following:

- Investigations on the existing drainage facilities, covering layout, type, catchment area boundaries and present conditions.
- Surveys and investigations on ground surface elevations, and sizes and invert elevations of the existing facilities such as major drains, culverts and tide gates.
- Field observations of flood prone areas on their physical and topographic conditions, and the extent of flood damage.
- Reconnaissance on the present land use pattern and available right-of-way.

- Estimation of stormwater quantities on the basis of land uses both at present and in the future, using DID's "Urban Drainage Design Standards and Procedures for Peninsular Malaysia".

- Comparative study on alternative plans to relieve the Study Area from floodings.

- Development of the construction and maintenance programme of the facilities.

- Estimation of construction costs by private contribution.

- Evaluation of the expected benefits of the proposed drainage system.

3.3 Findings and Recommendations

(a) Present Conditions of the Area

Present situations of the area with respect to the topography waterways, drains and flooding are as follows:

- Butterworth area is situated in low-lying and flat coastal plains with ground elevations ranging from less than 1 m (+3.3 ft) at the lowest in southern portion to +3.5 m (+11.5 ft) at the highest in northern portion of the area.

  Butterworth area comprises the hilly lands with steep surface gradient and high ground elevation, and low portion along the Juru River. The ground elevation ranges from +6.0 m (+20.0 ft) or more in the core of the town to 1 m (+3.3 ft) or less in the lower portion.

  The mean high sea water level is +1.10 m (3.6 ft) and the highest recorded level is +1.68 m (+5.5 ft).

- Butterworth area is drained to the sea or the Prai River without noticeable problems. Bukit Mertajam discharges its stormwater to the upper reach of the Juru River in which the water level is controlled by the Juru tide gate. The gate raises the water level of the river upstream of the gate when heavy storm occurs, which may cause some problems in the future.

- Existing drainage system consists of open channels, either lined or unlined, tide gates and outfall pipes. There are many swamps functioning as reservoir which cuts the peak flow rate and alleviate floods downstream. These swamps have been reclaimed gradually by urban development.

- The Study Area is predominantly rural in character except in the core part of the town and in new housing scheme areas, thus resulting in low runoff coefficient throughout the area. Existing drains can normally cope with the reduced discharge, however, there are many flood prone areas in the area because of the insufficient provision of tertiary drains and lacking maintenance work for the facilities.

- Local floodings are caused in the areas wherein the ground elevation is lower than the high tide level (+1.7 m or 5.5 ft) which is too high to permit drain by gravity to the rivers.

- Existing road side drains are generally in good condition to handle the stormwater, while major drains (monsoon drains) and culverts are not satisfactorily maintained. Presently, no proper cleaning equipment for drains are provided. If appropriate maintenance measures are taken, the condition will be significantly improved.

(b) Study Results and Conclusions

On the basis of the results of investigations and studies carried out under the present study, the following conclusions have been drawn:

- Because stormwater runoff will increase gradually as the urbanization of the area proceeds, the carrying capacity of the existing drains should be increased in the future. Thus the existing drains except small road side ditches have to be enlarged and lined to increase their capacity to cope with the increased runoff.

- Entire Study Area can be drained to the nearby waterways by gravity, if properly planned and designed. It may be technically feasible to provide gravitational drainage system in the area.

- Land filling is preferable for the presently undeveloped areas. Existing low-lying and builtup urban areas, with the ground elevations lower than the highest recorded sea water level, should be protected by tide gates from flooding due to backing-up of the high sea water levels.

- The right-of-way required for the proposed drainage system is still available within the Study Area. The recommended reserves for drains (Refer to Chapter 4 of Volume III) have to be set aside from urban development.

- It is necessary to provide suitable measuring equipment for collection of data concerning rainfall and conditions of rivers and drains.

- Elimination of floods in the areas where development schemes are now underway is most urgently required, and these areas are to be included in the first stage programme.

- Butterworth area will be divided into several independent sub-drainage basins in the drainage system planning. The areas between Butterworth beach and Jalang Raja Uda, which have been drained to the Prai River by a monsoon drain (named "Butterworth drain A" in the present study), are to be divided into three sub-basins. Two of which, situated in the northern portion of the areas, are rapidly developing by new housing schemes, while the remaining southern portion is unlikely to develop for the time being because most of its developable land is occupied by kampungs with high population density and no urgent development schemes are considered at this stage. For these reasons, the two sub-basins in the northern portion of the areas are to be drained directly to the sea through a new diversion channel so as to relieve the southern portion of the areas from the down flow of stormwater from the upper reach.

  The drainage facilities for these areas are to be designed using the runoff coefficient of 0.65 because these areas are expected to develop fully by the year 2000.

  The drainage system thus planned will enable the capital investment to expend in more efficient manner by concentrating the construction in the northern portion but deferring the investment for the southern portion.

- For both Mak Mandin industrial estate and the agricultural and swampy areas north of the estate, a diversion channel

will be provided. The stormwater from upper reach will be directly discharged to the Prai River so that the industrial estate will be relieved from flooding. Since the upper reach is unlikely to be developed fully by the year 2000, the drainage facilities in these undeveloped areas are to be designed using a runoff coefficient of 0.5. However, drain reserves to be set aside will be determined for all drains on the basis of the coefficient of 0.5 which is for the ultimate land use for this sub-basin.

- In the rest of Butterworth area, the existing drainage system should be enlarged to meet the requirement by the expected development of the area.

- The right bank areas of the Juru River in Bukit Mertajam, wherein development is now underway, can be relieved from flooding if the stormwater is discharged to the downstream of the Juru River tide gate.

- In the low-lying undeveloped areas, land filling is considered to be most effective means to prevent flooding because these areas are expected to be developed by different private developers. The recommended ground elevation for the reclamation is +2.3 m (+7.5 ft) above mean sea water level in Bukit Mertajam and +2.0 m (+6.6 ft) in Butterworth (Refer to Chapter 4, Volume III).

- Provision of tide gate will be an effective means to protect low-lying and builtup areas with ground elevations lower than the highest recorded sea water level (+1.7 m or 5.5 ft) from the flood due to the backing-up of the sea water.

3.4 Design Bases

As described in Chapter 3 of Volume III, the work carried out under the present study is basically in accordance with DID Planning and Design Procedures No. 1 "Urban Drainage Design Standards and Procedures for Peninsular Malaysia". The bases of the design include the following:

- All drainage facilities are designed for the initial storm (2 and 5-year return periods). Rainfall intensity-duration-frequency curves developed by DID for Georgetown have been applied for the design, in the forms;

$$I_2 = \frac{6,720}{t + 32}$$

$$I_5 = \frac{8,070}{t + 30}$$

where

I_2 = 2-year frequency rainfall intensity, mm/hr

I_5 = 5-year frequency rainfall intensity, mm/hr

t = time of concentration, minutes

The average frequencies of rainfall occurrence applied for drainage design are set for various land uses as follows;

Land Use	Frequency (yr)
Residential	2
Commercial	5
Industrial	5

- Width of reserve land space for individual trunk and principle infrastructural drains have been determined by the land use pattern in the year 2000, using an average runoff coefficient of 0.65.

- Sizes of facilities have been determined by runoff coefficients estimated for the different land use patterns in the year 2000, as shown in the following;

Land Use	Runoff Coefficient
Residential - densely inhabited	0.65
" - sparsely inhabited	0.35
Commercial	0.85
Industrial	0.50
Mountainous	0.50

- All levels indicated in the present report are on the basis of Malaysian Survey Ordnance Datum.

- Design tailwater is determined by adopting "Mean High Water Tide Level" (+1.1 m or 3.5 ft).

- The maximum tide level recorded is "Highest Recorded Sea Level" (+1.7 m or +5.5 ft).

- Discharge from the large agricultural areas is estimated on the assumption that the areas will function as the detention basin and cut off the peak flow rate to the downstream. The discharge from the areas is computed by the rational method using a runoff coefficient of 0.35 and a rainfall intensity of the 2-year return period.

3.5 Preliminary Engineering Study for Entire Study Area

(a) Evaluation of Existing Drainage System

Information and engineering data were gathered through reconnaissance and field survey and also from the government agencies concerned. On the basis of the results of survey and consultation with the government agencies, each of the drainage basins is evaluated and the flood problems and drainage requirements are identified.

In Butterworth area, it is found that the some counter measures should be taken immediately, including (1) alleviation of the present flood problems at the earliest possible date by an immediate improvement scheme, which in turn would be integrated into the over-all drainage system, and (2) establishment of a drainage programme to meet the expected requirements due to the future urbanization in the area.

Currently housing development programme is underway along the Juru River, and swamps are being reclaimed in Bukit Mertajam area. Consequently, as the programme proceeds the river water level will rise and flood problems will become more intense. This situation has to be improved by the appropriate drainage plan in the area.

(b) Alternative Studies on Drainage System

In order to select the most suitable route of main drains for the Study Area, possible alternative routes of the drains are selected and studied on their advantages and disadvantages. The alternative studies include (1) diversion of upstream drain to the sea, (2) separation of some portion from existing tributary, (3)

short cutting of drain, (4) improvement of tide gate, (5) enlargement of existing drain, and (6) land reclamation.

(c) Proposed Drainage System

The proposed drainage system, developed on the basis of the preliminary engineering design, includes various stormwater drainage facilities, comprising open channels, bridges, culverts, tide gates and outfalls. The elements of the proposed system are as follows:

- The system is gravitational without pumping station. The major portion of the drains, especially those in Butterworth area, have flat invert slopes owing mainly to the topographic conditions of the area with gentle ground surface gradient and low ground elevation.

- The channels consist of trunk drains for the catchment area of 40 ha (100 acres) or more and infrastructural drains covering the area of less than 40 ha. The major portion of the existing trunk and infrasturctural drains are to be integrated as a part of the new drainage system after being enlarged and lined.

- Different types of channels are recommended for the system depending upon the conditions of construction sites and the drainage basins. They include trapezoidal rubble wall, rectangular retaining wall with reinforced concrete, rectangular conduits with reinforced concrete and V-shaped concrete channels. For bridges, culverts, tide gates and outfalls, same standards as those being used for the existing drainage system are recommended. Details of these facilities are described in Chapter 3 and Chapter 4 of Volume III.

- Construction of the drainage system is classified into two parts according to the responsibilities for the construction, one for the government contribution and the other for the private contribution. It is assumed that the government will provide all trunk drains together with bridges and culverts, outfall facilities, tide gates and infrastructural drains, to serve builtup areas. The drainage system within the areas still undeveloped are the private developers' responsibility.

- The construction cost of the drainage system, covering the entire Study Area of 3,480 ha (8,600 acres) of which about 2000 ha (4,940 acres) by private contribution, is estimated at approximately M$90 million including about M$8 million for land acquisition. About 26 per cent of the total cost is for trunk drains with an average per hectare cost of M$26,000.

Details of the preliminary engineering design and the proposed drainage system are described in Chapters 4 and 5 of Volume III, and also illustrated in Figures DD-19 and DD-20 of Volume V.

(d) Implementation Schedule

The elements of the works for the proposed drainage system are arranged in accordance with the order of priority for implementation, and then three alternative groups of drainage facilities are identified with cost for comparative analysis. These include:

- Alternative 1 : Facilities to meet the minimum requirement for improvement, including alleviation of the present flood problems by the drains in urban development scheme areas in Butterworth town at a cost of about M$4 million.

- Alternative 2 : Alternative 1 plus upgrading of BWE and SEA.A drain systems at a total cost of about M$6.4 million.

- Alternative 3 : Alternative 2 plus upgrading of BWC drain system at a total cost of about M$9.1 million.

Alternatives 2 and 3 assume that the drainage system is required only when the housing development schemes are implemented. Although at present exact schedule for development of the areas has not been fully decided yet, if the scheme is undertaken the flood damage will become more serious in BWE than in BWC because of its high population density. Alternative 1 is not sufficient to meet the requirements by the urban development in the foreseeable future. Alternative 3 covers BWC drain system which is less imminent than other drains.

In view of the above situations, Alternative 2 is considered to be superior to other alternatives and the magnitude of the cost

is reasonable as the first stage programme. It is therefore recommended that Alternative 2 be implemented as the first stage programme. Details of implementation schedule are discussed in Subsection 5.3.2, Chapter 5, Volume III.

3.6 Proposed First Stage Programme

The first stage programme for the drainage system proposes a six-year implementation period starting in 1980 and ending in 1985, including one year for design in 1980. The programme has been sequenced into a series of stages of construction, each containing a number of different facilities, as tabulated in Table 8.

The total construction cost of the proposed first stage drainage programme is estimated at M$6,403,000 at 1977 price levels, including engineering and supervision services, and contingencies expended over the six-year period.

The additional operation and maintenance cost required for the proposed system is approximately M$600 to 800 per year, including depreciation and labour costs for cleaning of facilities and others.

Although there is a potential requirement for foreign currency to procure some locally available equipment and materials of the foreign origin, the amount of such cost is negligibly small. The estimated construction cost has, therefore, been represented totally in local currency.

The amount of the capital cost and recurrent expenditure is considered not substantial, and it may be reasonable to assume that the financial requirement for the first stage programme is within the financial capacity of the responsible government.

The plan of the proposed drainage facilities is shown in Figure 3 and the related expenditures by year are also shown in Table 8. For further details, see Chapter 5 of Volume III.

3.7 Benefits of the Proposed Programme

Various types of benefit will be derived from the implementation of the recommended drainage programme. The anticipated benefits include the prevention of the occurrence of flood damage, improvement of comfort and convenience of the individual and community, and the decrease of swampy areas and mosquito breeding.

Although most of the benefits are not fully quantifiable, there will be high social benefits together with the environmental improvement of the areas. The benefits evaluation is discussed in Chapter 6 of Volume III.

Table 7 Study Area for Drainage System

Drainage Basin II (Bukit Mertajam)			Drainage Basin IV (Butterworth)		
Name of drainage system	Served area by drainage system (ha)	Contributing area from outside Study Area (ha)	Name of drainage system	Served area by drainage system (ha)	Contributing area from outside Study Area (ha)
TANAN DRAIN	234.5	41.3	BUTTERWORTH DRAIN A-A	101.5	0
SUNGAI ARA	402.4	16.7			
PAYA DRAIN	78.4	16.3	BUTTERWORTH DRAIN A-B	153.7	0
BUKIT MERTAJAM DRAIN	122.4	4.8	BUTTERWORTH DRAIN A-C	201.6	0
SUNGAI RAMBAI	99.4	499.0	BUTTERWORTH DRAIN B	222.6	32.8
SUNGAI PASIR	399.6	29.5			
SUNGAI PEKAN BHARU	168.0	49.7	BUTTERWORTH DRAIN C-A	181.8	0
BUKIT KECHIL DRAIN (A)	74.9	0	BUTTERWORTH DRAIN C-B	229.1	0
BUKIT KECHIL DRAIN (B)	77.1	0	BUTTERWORTH DRAIN D	28.7	0
PMTG KEBUN SIREN DRAIN	42.9	503.0	BUTTERWORTH DRAIN E	81.3	0
BUKIT TENGAH DRAIN	176.2	0	SEA DRAIN-A	30.1	0
			SEA DRAIN-B	15.5	0
STP AREA	56.0	0	SEA DRAIN-C	11.3	0
			SEA DRAIN-D	18.9	0
			SEA DRAIN-E	33.4	0
			PRR-A	23.7	0
			PRR-B	12.6	0
			Direct Discharge to Sea or River	200.2	0
Total	1,931.8	1,160.3	Total	1,546.0	32.8
			Grand Total	3,477.8 ha (8,590 acres)	1,193.1 ha (2,947 acres)

Table 8 Construction Costs of the First Stage Programme by Year

(Unit: M$1,000)

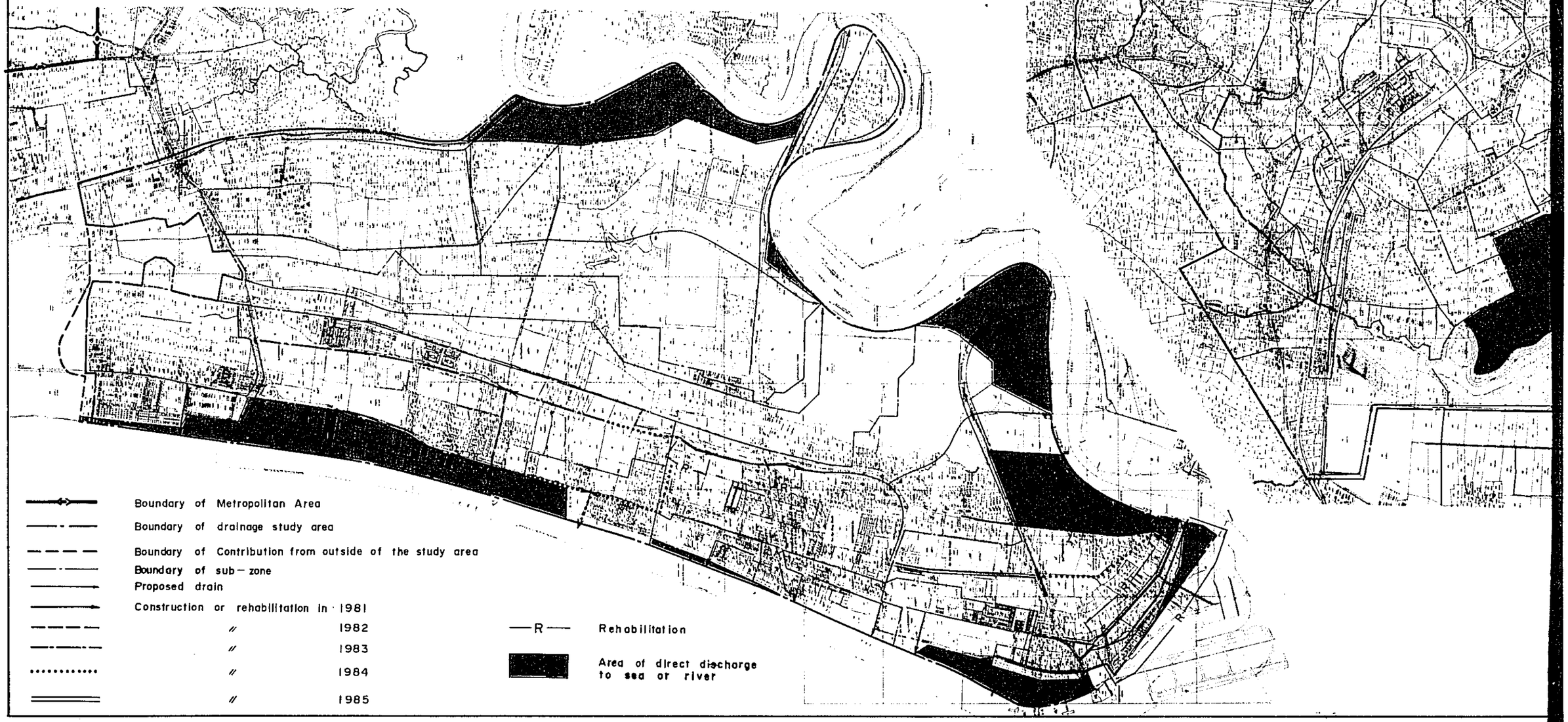
1980		1981		1982		1983		1984		1985		Total
Description	Cost	Description	Cost	Description	Cost	Description	Cost	Description	Cost	Description	Cost	
Engineering Design	231	Construction of: bridge at, BWA.C-8 ARA-11 RAM-3,5(drain) box culvert at, BWA.C-3 Rehabilitation of: BWA.C-1,3 BWD-2,3,4 BWE-8b,8c,8d	241 203 227 37 6 7 9	Construction of: drain, BWA.B-5,6,7 bridge at, BWA.B-7 Rehabilitation of: drain, ARA-9,10,11	460 235 322	Construction of: drain, BWA.B-1,2,3,4 BWA.B-5c,5b	608 233	Construction of: drain, BWE-5,6,7,8 BWA.A-1,2,3 3b	532 166	Construction of: drain, BWE-1,2,3,4	570	
Construction Cost	-		730		1,017		841		698		570	3,856
Contingencies	-		146		204		169		140		114	773
Engineering Fee	231		44		61		51		42		34	463
Sub Total	231		920		1,282		1,061		880		718	5,092
Land Cost	-		214		75		224		265		385	1,163
Cost for Equipment	-		100		12		36		-		-	148
Grand Total (End '77 Price)	231		1,234		1,369		1,321		1,145		1,103	6,403
Escalation Factors(*)	1,158		1.216		1.276		1.340		1.407		1.477	-
Grand Total (Escalated Price)	267		1,501		1,747		1,770		1,611		1,629	8,525

(*) Escalated at 5% per annum .

SCALE 1: 25.000

0 1.0 KILOMETRE

0 0.5 MILE



Boundary of Metropolitan Area

Boundary of drainage study area

Boundary of Contribution from outside of the study area

Boundary of sub – zone

Proposed drain

Construction or rehabilitation in 1981

// 1982

// 1983

// 1984

// 1985

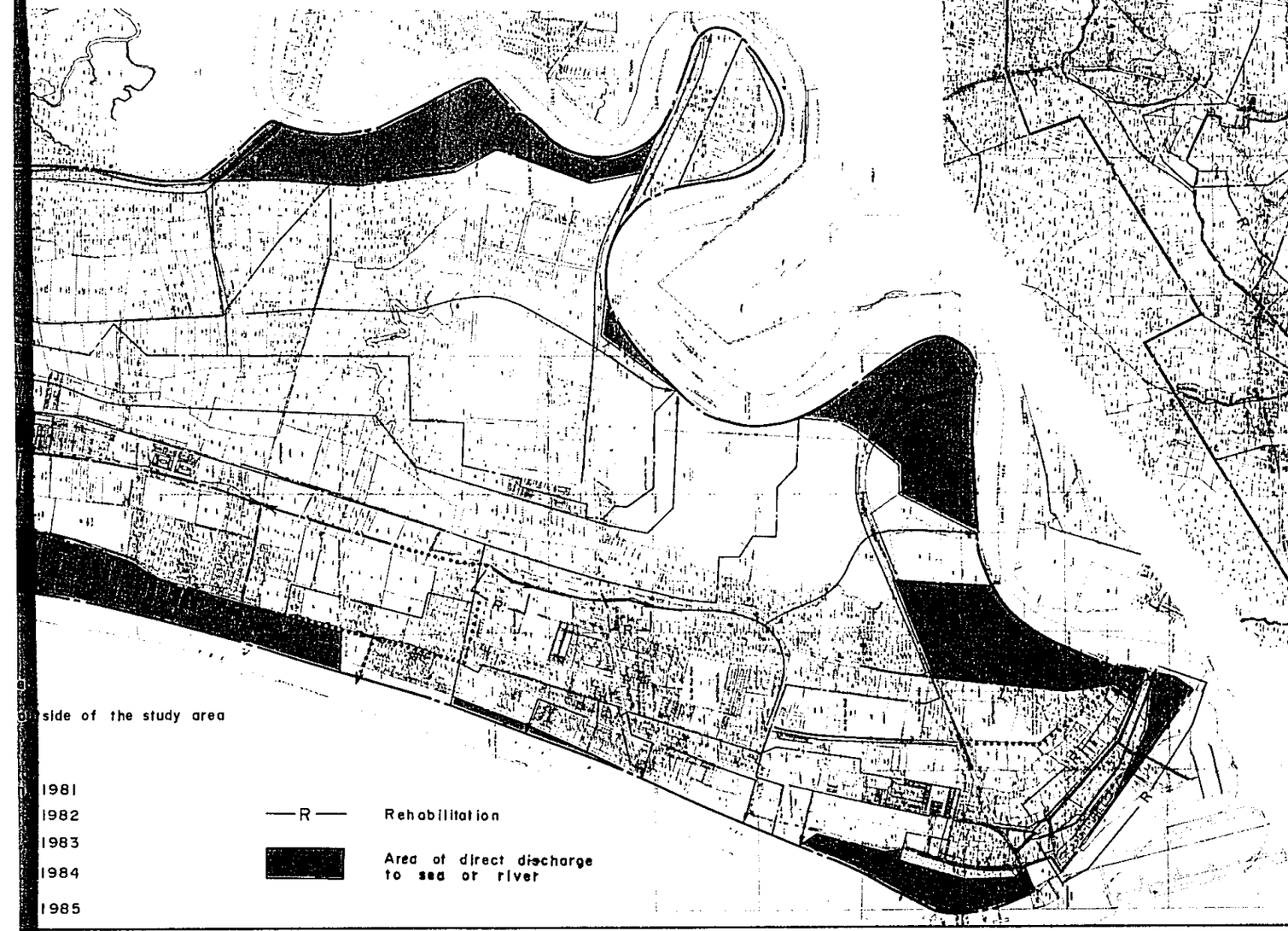
—R— Rehabilitation

Area of direct discharge to sea or river

SCALE 1 : 25.000

1.0 KILOMETRE

0.5 MILE

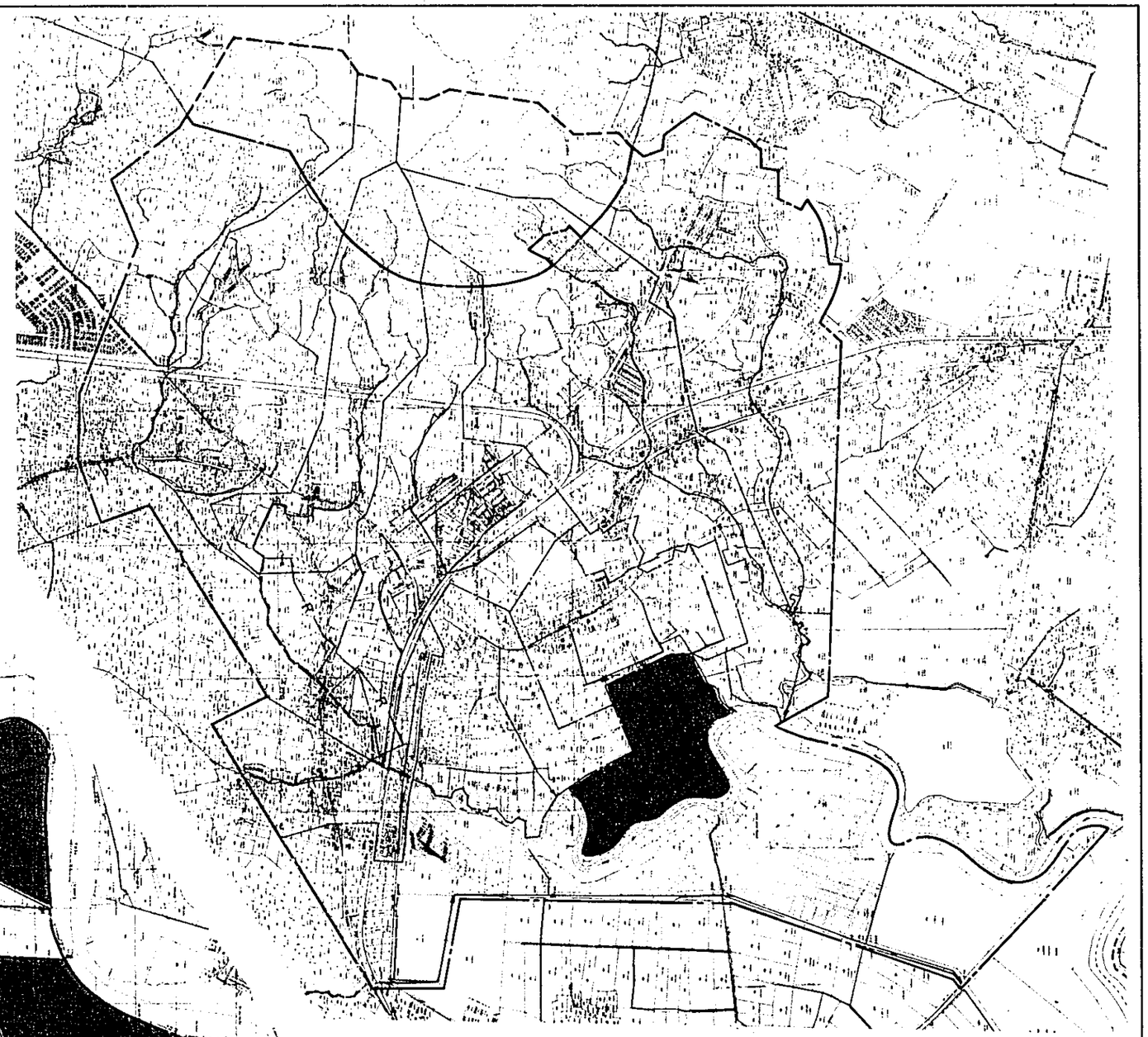


side of the study area

1981
1982
1983
1984
1985

—R— Rehabilitation

Area of direct discharge to sea or river



SEWERAGE AND DRAINAGE SYSTEM PROJECT
BUTTERWORTH / BUKIT MERTAJAM
METROPOLITAN AREA, MALAYSIA

PROPOSED SEWERAGE SYSTEM | FIGURE 3

IV INSTITUTIONAL STUDIES

4.1 Purpose of the Studies

The institutional studies have been undertaken throughout the course of the feasibility study mainly on the basis of the preliminary considerations given in the Master Plan Report, for the purpose of projecting the most suitable organizational set-up with technical capabilities and efficient operation based on functional and economical management. The studies cover the review and evaluation of the existing practice and consideration of the alternative plans together with the necessary legislation provisions.

4.2 Findings

Review of agencies and their respective fields of responsibilities has been undertaken so as to get a clear concept of general relationship among the agencies, their scope of work, organization, jurisdiction and general procedure of policy making in the implementation and management of sewerage and drainage operations. The agencies reviewed are:

- Environmental Health and Engineering Unit, Ministry of Health.
- Department of Environment, Ministry of Science, Technology and Environment.
- Ministry of Local Government and Federal Territory;
- Economic Planning Unit.
- Public Works Department.
- Drainage and Irrigation Department.
- Sewerage Department, City Hall, Kuala Lumpur.
- Municipal Council Penang Island.
- Penang Water Authority.

- Municipal Council Province Wellesley.

On the basis of the results of the above studies, three alternatives are selected for further study to identify the most appropriate organization to be set up for the project. The alternatives considered are:

- Alternative 1 : Creation of a new regional organization by expanding the Engineering Department of Municipal Council Penang Island (MPPP), as Penang Sewerage and Drainage Authority.

- Alternative 2 : Establishment of Penang Water Supply, Sewerage and Drainage Authority.

- Alternative 3 : Expansion and modification of the existing Engineering Department, Municipal Council Province Wellesley (MPSP).

The existing regulations and by-laws pertinent to the proposed sewerage and drainage services are reviewed. Laws and regulations, which are the basis of governing such sewerage and drainage systems, are:

- The Municipal Ordinance.
- Local Government Act, 1976
- The Street, Drainage and Building Act, 1974.
- Town and Country Planning Act, 1976.
- The Environmental Quality Act, 1974.

4.3 Recommendations

Results of the evaluation of three alternative organization arrangements have indicated that Alternative 3, i.e., expansion and modification of existing Engineering Department of MPSP, is the most feasible one at the present stage.

Saving for initial effort and fund required to put a new organization, availability of personnel required, economies in operation and maintenance and administration by co-ordination with

other departments of MPSP and sufficient provision of existing legislation to effect the proposed new organization are major factors that would support this alternative. Therefore, the Engineering Department of MPSP is recommended to be fully responsible for the improvement and operation of the sewerage and drainage systems of the project by expanding its organization with addition of sufficient staff and provision with adequate financial support.

This new organization will be responsible for the planning, design, construction, operation and maintenance of the entire system of the Project Area, with administrative assistance and co-ordination of the Departments of MPSP for the services on book keeping and accounting finance and treasury exclusively for sewerage and drainage services.

In the case of drainage service, however, re-allocation of responsibilities among the agencies concerned is considered advisable owing to the existing practice prevailing among the state and MPSP. The recommended re-allocation of responsibilities are as follows:

- DID : Improvement, construction and repair of the structures of trunk drain and catchment basins which cover tributary area of 100 acres or more.

- PWD : Improvement, construction and repair of road side drain on road reserve.

- MPSP: Improvement, construction and repair of the structures of drain and catchment basins which cover tributary area of less than 100 acres. Also, maintenance and operation, including cleaning and desilting of all above mentioned drains existing in the Project Area.

The important factor to be kept in mind by this arrangement is that the costs for improvement and construction of drains should not be too much burden on MPSP. It is clear that considerable investment for such works from MPSP's own financial budget will make MPSP unable to maintain its own responsibility. In case improvement and construction are significant in terms of cost, necessary financial aid from State Government is suggested to be made to the maximum extent possible.

In order to assume full responsibility for improvement and operation of the sewerage and drainage systems for the Project Area as proposed, functional units within the reorganized Engineering Department are recommended taking into account the factors of simplification and economies at the initiation of the systems. The recommended units to be provided are:

- Operation and Maintenance

- Planning and Design

- Construction

- Monitoring and Surveillance

To carry out the required functions, staffing schedule is prepared, estimating the number of staff required for the proposed sewerage and drainage programme for the years 1980 through 1990, with special attention to keep the level of minimum numbers required to the possible extent during the first stage programme (see Table 4.2, Volume IV). Total numbers of personnel required during the first stage and in the year 1990 are as follows:

1980	1981	1982	1983	1984	1985	1990
8	15	15	37	46	52	57

Based on the proposed organizational arrangements, the management system is proposed in order to control efficiently and effectively the system management. The proposed management system to be maintained consists of General Accounting, Budget System, Management Information System, and Billing and Collection System. Since it is intended that the initial cost be minimized in setting up the institution, existing management system should be utilized to the maximum extent. However, the financial records of the sewerage system should better be maintained separately from those of other general public services of MPSP since the system will be better operated independently. It is proposed that Treasury and Finance be in charge of book keeping and accounting for sewerage and drainage services. Billing and collection system does not exist in ED, but this should be added for the purpose of co-ordination of PWA for billing and collection.

The result of review on existing legislation indicates that the laws and regulations now available in Malaysia may cover necessary judicial provision required to control sewerage and drainage undertakings. It is assumed that, for the coming 10-year period, no additional legislation will be needed to expand the powers of sewerage and drainage services beyond those provided in the Street, Drainage and Building Act. However, criteria on water quality discharge, regulations concerning the discharge of trade effluent or industrial wastewater, and in addition, sewerage and sanitary installation by-laws are proposed to be provided at the earliest possible date.

The suggested sewage and drainage works organization chart is shown in Figure 4.

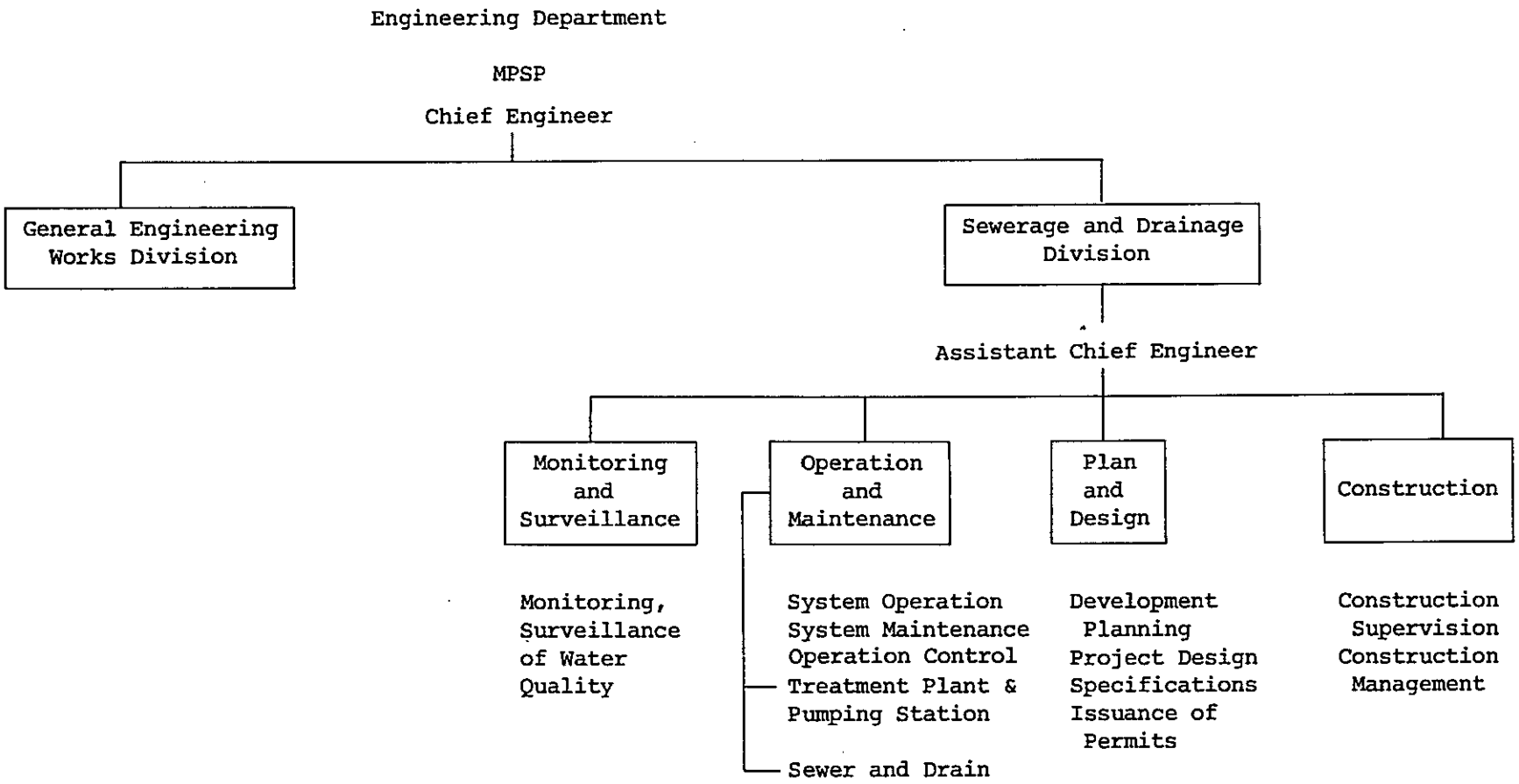


Figure 4 Sewage and Drainage Works Organization Suggested Functional Unit

ANNEX

PROJECT ORGANIZATION

ANNEX

PROJECT ORGANIZATION

The members of both the Steering and Technical Committees of the Government of Malaysia, the Japanese Supervisory Committee and the Consultants engaged in the Study are as follows:

A. Steering Committee

Mr. Ali Yusof	- Ministry of Local Government (K.L.)
Mr. Bashah bin Nordin	- Representative of E.P.U. (K.L.)
Mr. A. Sekarajasekaran	- Ministry of Health (K.L.)
Mr. Loo Kam Weng	- Municipal Council, P.W.
Mr. Koh Kok Ee	- Public Works Department (Penang)
Mr. Teo Cheng Piau	- Survey Department (Penang)
Mr. Mohd. Zuhuri b. Salleh	- State Government (Penang)
Mr. Fong Chek Sam	- Town and Country Planning (Penang)

Mr. Ali Yusof serves as the Chairman of the Committee.

B. Technical Committee

Mr. A. Sekarajasekaran	- Ministry of Health (K.L.)
Mr. Lum Weng Kee	- Ministry of Health (K.L.)
Mr. Khoo Soo Hock	- Drainage and Irrigation Department (K.L.)
Mr. Azizan b. Ariffin	- Drainage and Irrigation Department (Pg.)
Mr. Choo Ewe Guan	- Municipal Council, P.W.
Mr. Ooi Teik Boon	- Municipal Council, Penang Island

Mr. A. Sekarajasekaran serves as the Chairman of the Committee.

C. Japanese Supervisory Committee

Dr. M. Kashiwaya	- Head, Water Quality Control Division, Public Works Research Institute, Ministry of Construction

Dr. K. Inaba	- Deputy Head, Sewerage Planning Division, Sewerage and Sewage Purification Dept., City Bureau, Ministry of Construction
Mr. H. Sookawa	- Technical Officer, River Basin and Sewerage Division, Sewerage and Sewage Purification Dept., City Bureau, Ministry of Construction
Mr. Y. Nakagawa	- Senior Engineer, Construction Department, Japan Sewage Works Agency
Mr. A. Shinbuchi	- Senior Engineer, Planning Department, Japan Sewage Works Agency

Dr. M. Kashiwaya serves as the Chairman of the Committee.

D. Nihon Suido Consultants (NSC)

Mr. A. Saita	- Project Manager
Mr. S. Kitamura	- Technical Adviser
Mr. T. Tsutsumi	- Technical Adviser
Dr. S. Kojima	- Technical Adviser
Mr. T. Ueno	- Co-Project Manager Site Representative of NSC
Mr. S. Sata	- Senior Engineer
Mr. K. Niwa	- Senior Engineer
Mr. S. Nakatake	- Senior Engineer
Mr. M. Tanaka	- Senior Engineer
Dr. Y. Kyu	- Senior Engineer
Mr. T. Horikawa	- Civil Engineer
Mr. Y. Yamazaki	- Civil Engineer
Mr. Y. Hirau	- Civil Engineer
Mr. T. Tashiro	- Sanitary Engineer
Mr. O. Fujikawa	- Sanitary Engineer
Mr. T. Mizutani	- Chemist
Mr. S. Mukai	- Chemist
Mr. H. Yuasa	- Economist
Mr. Y. Mitsuhashi	- Economist

JICA