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No. 8

MASTER PLAN AND FEASIBILITY STUDY FOR SEWERAGE AND DRAINAGE SYSTEM PROJECT IN ALOR SETAR AND ITS URBAN ENVIRONS MALAYSIA

VOLUME I

SUMMARY REPORT

MARCH 1981

JAPAN INTERNATIONAL COOPERATION AGENCY

MASTER PLAN AND FEASIBILITY STUDY FOR SEWERAGE AND DRAINAGE SYSTEM PROJECT IN ALOR SETAR AND ITS URBAN ENVIRONS MALAYSIA

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PREFACE

In response to a request of the Government of Malaysia, the Japanese Government decided to conduct a survey on a Master Plan and a Feasibility Study on the Sewerage and Drainage System Project in Alor Setar and Its Urban Environs and entrusted the Japan International Cooperation Agency (JICA) with the survey.

The JICA sent to Alor Setar, Kedah State a Preliminary survey team headed by Mr. Mamoru KASHIWAYA on December 1978. Based upon the findings of the team, another survey team headed by Mr. Akira SAITA was sent three times during the period from February, 1979 to February, 1981.

The team had discussions with the officials concerned of the Government of Malaysia in conducting the survey. After the team returned to Japan, further studies were made and the present report has been prepared.

I hope that this report will serve for the development of the Project and contribute to the promotion of friendly relations between our two countries.

I wish to express my deep appreciation to the officials concerned of the Government of Malaysia for their close cooperation extended to the team.

March, 1981

Keisuke Arita

Keisuke Arita
President
Japan International Cooperation Agency

SUMMARY
ON
MASTER PLAN AND FEASIBILITY STUDY
FOR
SEWERAGE AND DRAINAGE SYSTEM PROJECT
IN
ALOR SETAR AND ITS URBAN ENVIRONS
MALAYSIA

Guide to the Reports

The Reports consist of the following,

VOLUME I	:	SUMMARY
VOLUME II	:	SEWERAGE MASTER PLAN REPORT
VOLUME III	:	DRAINAGE MASTER PLAN REPORT
VOLUME IV	:	SEWERAGE FEASIBILITY STUDY REPORT
VOLUME V	:	DRAINAGE FEASIBILITY STUDY REPORT
VOLUME VI	:	INSTITUTIONAL STUDY REPORT
VOLUME VII	:	APPENDICES (FOR VOLUME II)
VOLUME VIII	:	DRAWINGS (FOR VOLUME II, IV & V)

VOLUME I - SUMMARY REPORT

ORDER OF PRESENTATION

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LIST OF ABBREVIATIONS

ACP	- Asbestos cement pipe
ASTM	- American Society for Testing Materials
BOD	- Biochemical oxygen demand (3-day, 30 degrees C)
CRCP	- Centrifugally cast reinforced concrete pipe
DE	- Department of Environment, Ministry of Science, Technology and Environment
DID	- Drainage and Irrigation Department, Ministry of Agriculture and Fisheries
DO	- Dissolved oxygen
DWF	- Dry weather flow
EHEU	- Environmental Health and Engineering Unit, Ministry of Health
EPU	- Economic Planning Unit, Prime Minister's Office
ft	- feet
FTCP	- Federal Town and Country Planning
g/cap	- grammes per capita
g/day	- grammes per day
gal	- Imperial gallons
gal/cap	- gallons per capita
gal/day	- gallons per day
GDP	- Gross Domestic Product
GSD	- Federal Geological Survey Department
ha	- hectares
hr	- hours
IBRD	- International Bank for Reconstruction and Development
IMF	- International Monetary Fund
kg	- kilogrammes
km	- kilometres
l/day	- litres per day
l/day/cap	- litres per day per capita
l/sec	- litres per second
m	- metres
m^2	- square metres
m^3	- cubic metres

LIST OF ABBREVIATIONS (Continued)

MADA	- Muda Agricultural Development Authority
mg/l	- milligrames per litre
mil	- miles
MLG	- Ministry of Local Government
mm	- millimetres
MPKS	- Majlis Perbandaran Kota Setar (Municipal Council Kota Setar)
MPN	- Most probable number
MS	- Meteorological Station
MSWL	- Mean Sea Water Level
NEB (LLN)	- National Electricity Board (Lembaga Letrik Negara)
p/ha	- persons per hectare
pH	- Hydrogen iron potential
ppm	- parts per million
PVCP	- poly Vinyl chloride pipe
PWD (JKR)	- Public Works Department, Ministry of Works and Utilities (Jabatan Kerja Raya)
RCP	- Reinforced concrete pipe
SDID	- State Drainage and Irrigation Department
SEDC	- State Economic Development Corporation
SEPU	- State Economic Planning Unit
SLO	- State Land Office
SMHD	- State Medical and Health Services Department
SS	- Suspended solids
STCP	- State Town and Country Planning
VCP	- Vitrified clay pipe
WHO	- World Health Organization
yr	- years

CONVERSION FACTORS

Multiply imperial unit by figures in multiplier column to obtain metric (SI) equivalent; multiply metric (SI) unit by reciprocal to obtain imperial equivalent.

Imperial Unit	Multiplier	Metric unit	Reciprocal
acre	0.4047	hectare (ha)	2.471
ft	0.3048	m	3.281
ft/s	0.3048	m/s	3.281
ft^2	0.0929	m^2	10.76
ft^3	0.02832	m^3	35.31
ft^3/s (cusec)	0.02832	m^3/s (cumec)	35.31
gal	4.546	litre	0.220
gal	0.004546	m3	220
hp	0.7457	kW	1.341
in	25.40	mm	0.03937
lb	0.4536	kg	2.205
lb/ft^2	4.881	kg/m^2	0.2049
lb/ft^3	16.03	kg/m^3	0.06243
mile	1.609	km	0.6214
$mile^2$	2.589	km^2	0.3862
ton	1.016	tonne	0.9842
yd	0.9144	m	1.094
yd^2	0.8361	m^2	1.196
yd^3	0.7646	m^3	1.308

PART I
INTRODUCTION

1. Introduction

1.1 Project Background

In 1978, the Government of Malaysia requested the Government of Japan to cooperate in developing a programme to establish a comprehensive planning of sewerage and drainage system for Alor Setar and its urban environs in Kedah State, Malaysia, as effective measures for the improvement in the general sanitation and public health conditions with due consideration on socioeconomic and environmental situation in the Area.

In response to the request of the Government of Malaysia, the Government of Japan decided to cooperate with the Project and the Japan International Cooperation Agency (JICA), an agency of the Government of Japan for implementation of assistance projects, has dispatched the preliminary survey team to Malaysia in October 1978 to perform a preliminary field reconnaissance and discuss on substance of the proposed Project. Based on the result of preliminary findings and agreement, JICA has undertaken the Project starting February 1979.

The Project for sewerage and drainage are carried out in two phases, namely Master Plan and Feasibility Study. The Master Plan Study was undertaken from February to October 1979 and Feasibility Study was from November 1979 to June 1980, and draft report was submitted to the Government of Malaysia in each occasion for comments. The final report presented herewith is the revised version on Master Plan and Feasibility Study based on such comment.

On Malaysian side, the Government of Malaysia has established Steering and Technical committees during a course of Project.

1.2 Purpose and Scope of Study

The purpose of the study for Alor Setar and it's urban environs is;

(a) to develop a comprehensive Master Plan for the solution of sewerage and drainage problems in order to meet both immediate and future requirement.

(b) to establish a technically sound and economically feasible implementation programme for sewerage and drainage construction including time schedule and financial proposal for the first phase area selected based on the Master Plan, taking the order of implementation priority of every facilities into account.

(c) to recommend the proper organization to perform the planning, designing, construction, operation, of the sewerage and drainage systems together with consideration on proper management and administration as well as legislative provision, which may be required for the activities of the organization recommended.

(d) to transfer technology through in-service training at Project site, and visiting existing and constructing sewerage and drainage facilities in Japan.

The reports presented for the Project consist of the following:

Volume I	:	Summary Report
II	:	Sewerage Master Plan Report
III	:	Drainage Master Plan Report
IV	:	Sewerage Feasibility Study Report
V	:	Drainage Feasibility Study Report
VI	:	Institutional Study Report
VII	:	Appendices (for Volume II)
VIII	:	Drawing (for Volumes II, IV & V)

(The study conducted was on the basis of 1979 data and the Reports above referred reflects them accordingly.)

1.3 Study Area

1.3.1 Sewerage

(1) Master Plan

The Study Area is shown in Fugure 1.1 with a total area of 3,300 ha (8,154 acres), modifying the original Study Area in the Terms of Reference, by adding the Southern Mergong Industrial Area (near the tidal barrage, 43 ha) which has been under preparation for construction, and the low cost housing area located at northern portion of the Northern Mergong Industrial Area (46 ha). The Study Area also includes 125 ha (309 acres) of Kuala Kedah area.

(2) Feasibility Study

The Feasibility Study Area of 187 ha (462 acres), as agreed with Government agencies concerned in Malaysia, comprises most (80 percent) of the existing commercial and institutional area including both state and federal buildings and the most densely populated portion of residential area in Alor Setar town, as shown in Figure 1.1.

The Study Area lies both sides of the railway; one portion of area to the west of the railway is surrounded by Jl. Telok Wan Jah, the Sg. Anak Bukit and Sg. Kedah, and another portion of the area lies to the east of the railway along Jl. Langgar and Jl. Tanjong Bendahara, forming flat terrain ranging from 1.5 m to 2.0 m above MSWL, except the limited areas along the Sg. Raja and Sg. Derga, both of the areas being declining from 0.3 m to 0.5 m from upstream to downstream of the rivers.

By interpretation of the boring results performed for this Study and existing soil survey data obtained, it is considered justifiable to assume that the Study Area have almost uniform layer of silty

clay to 20 m (22 yd) underground from surface and of sand stone further down. The ground water table in the Study Area measures 1.2 m (3.9 ft) to 1.3 m (4.3 ft) from the surface.

1.3.2 Drainage

(1) Master Plan

For the purpose of drainage Master Plan Study, it is agreed to limit to Kuala Kedah town only, since the study for the rest of Alor Setar and it's urban environs have already been undertaken by SDID.

The delineation of the specific Study Area has been identified and agreed with government officials concerned to be 125 ha (309 acres) approximately, which is identical to the area for sewerage study for Kuala Kedah, as shown in Figure 1.2. Additionally approximately 104 ha (261 acres) of tributary outside the Study Area is considered as it contributes its storm runoff to the urban drainage within the Study Area.

(2) Feasibility Study

As determined by the scope of work agreed between both of the Governments, the area for drainage Feasibility Study is not the one for Drainage Master Plan, but the area identical to that for Sewerage Feasibility Study presented in Figure 1.2 covering an area of 187 ha (462 acres). According to the delineation made in the Master Plan by SDID, this area is composed of the nimor catchment 'X3', and a part of minor catchment 'Y1' and Sungai Raja catchment as shown in figure 5.1.

The basic idea in identifying the Study Area for Feasibility Study is, to cover the area necessary for alleviation of the existing flood problems in the urbanized area, which lies within the center of Alor Setar town and to cover the area which can be effectively improved by provision of both sewerage and drainage facilities concurrently in the First Phase programme.

Based on the topographic conditions of the area, approximately 170 ha (420 acres) of tributary outside of the Study Area is further considered for calculating the drain capacities because the tributary contributes its storm runoff to the Study Area. Hence, the total area concerned for this drainage feasibility study under this Project is approximately 357 ha (882 acres) as shown in Figure 1.2.

1.4 Present Condition of the Study Area

(i) As of 1979, some 139,600 people resides within the Study Area comprizing approximately 3,300 ha (8,154 acres). During the last decade, the area has experienced a rapid growth of population together with expanded commercial and industrial activities, and is expected to further continue its growth.

(ii) There is at present no comprehensive sanitary sewerage system in the area, except for small scale communal sewage disposal systems in some of new housing areas. Most of sullage water and commercial wastewater are indiscriminately discharged directly into near-by drain or other available watercourse, and human excreta from houses are disposed of either through septic tank or conservancy system (bucket system). As of 1979, there are approximately 25,400 households in the Study Area, of which 1,770 households are served by communal septic tank for excreta disposal. Most of the effluents from the septic tanks generally find their way into the watercourses, thus resulting in gross pollution and septicity of receiving watercourses, especially during dry season. In rainy season, on the other hand, the bulk of stagnated waste loads in the watercourses are flushed out into the main watercourses with resulting overload beyong self-purification capacity of them. (Refer to Section 8,Chapter 3, Volume II)

The rivers become increasingly polluted while flowing through the built-up areas in the city. The Sg. Anak Bukit; for example, is significantly polluted by the waste loads from the houses, shops and industries, depleting DO level less than 3 mg/l in some portions. Also in many portions of drains, expecially within the built-up areas where flow is low during dry season, water is grossly polluted. These rivers and drains are further degraded beyong acceptable level in the succeeding years by the rapid growth of population if no proper pollution control measure is taken to alleviate the wastewater burden to the watercourses. (Refer to Section 9, Chapter 3, Volume II)

(iii) Both Alor Setar and Kuala Kedah towns have been currently experienced with the flood problems, since no adequate drainage system exists except the limited areas with smaller drainage facilities in the towns as a whole. Generally, the existing drainage system consists of natural and piecemeal-improved watercourses with meandering alignment of various widths and depths. Most of these drains are heavily silted and in many cases inadequate to accommodate heavy rain storm, thus causing frequent flooding in many places throughout the town. Further, due to the ongoing rapid development, numerous swamps and paddy fields now functioning as reservoirs for controlling floods are demolishing. Therefore, significant increase of the peak discharge of stormwater runoff shall consequently be resulted in the future, and flooding will be more significant in the area, if adequate drainage system is provided. (Refer to Chapter 2, Volume III)

SCALE
1: 60,000

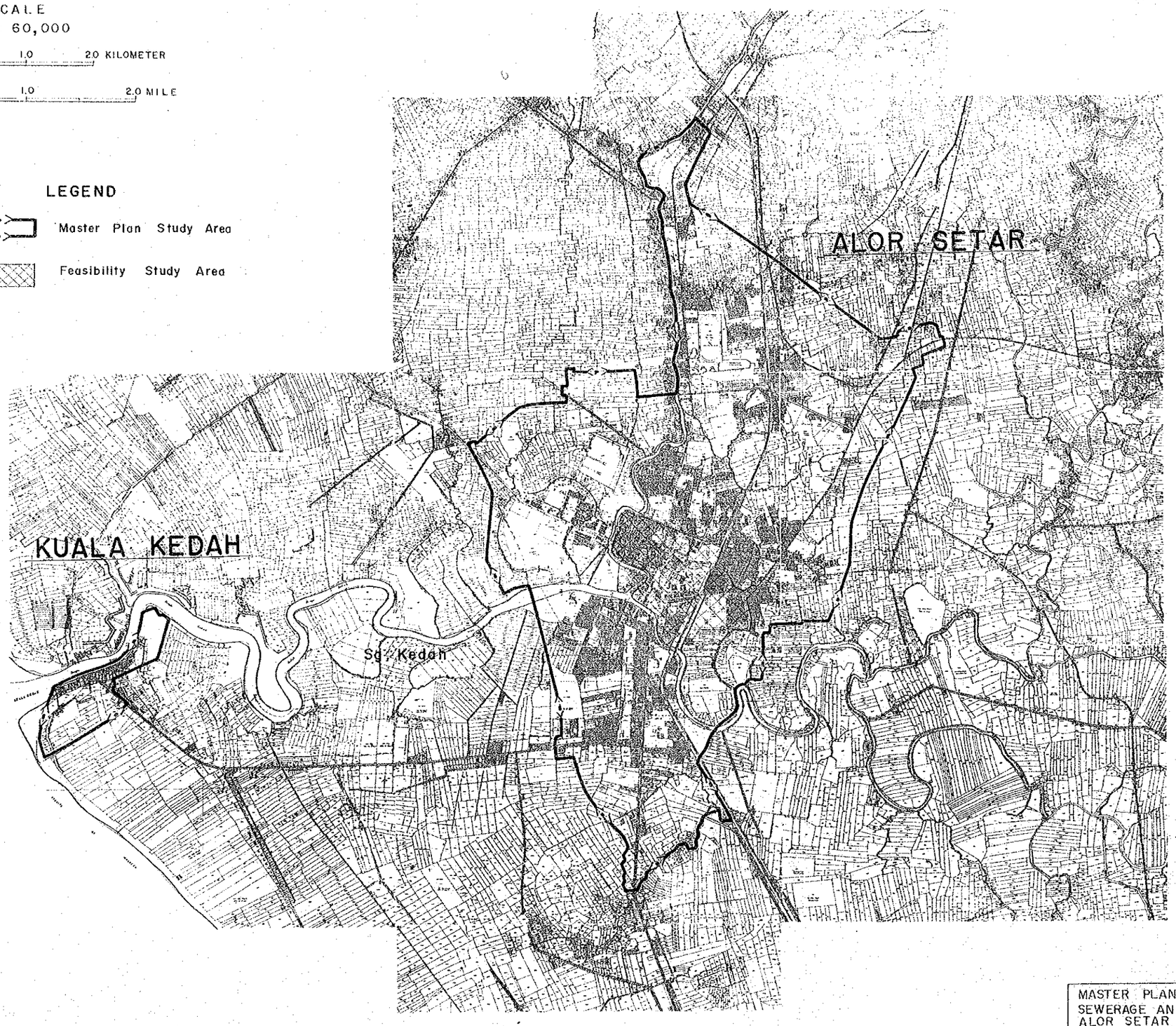
0 1.0 2.0 KILOMETER

0 1.0 2.0 MILE

LEGEND

Master Plan Study Area

Feasibility Study Area



MASTER PLAN AND FEASIBILITY STUDY FOR SEWERAGE AND DRAINAGE SYSTEM PROJECT IN ALOR SETAR AND ITS URBAN ENVIRONS

SEWERAGE STUDY AREA

FIGURE 1·1

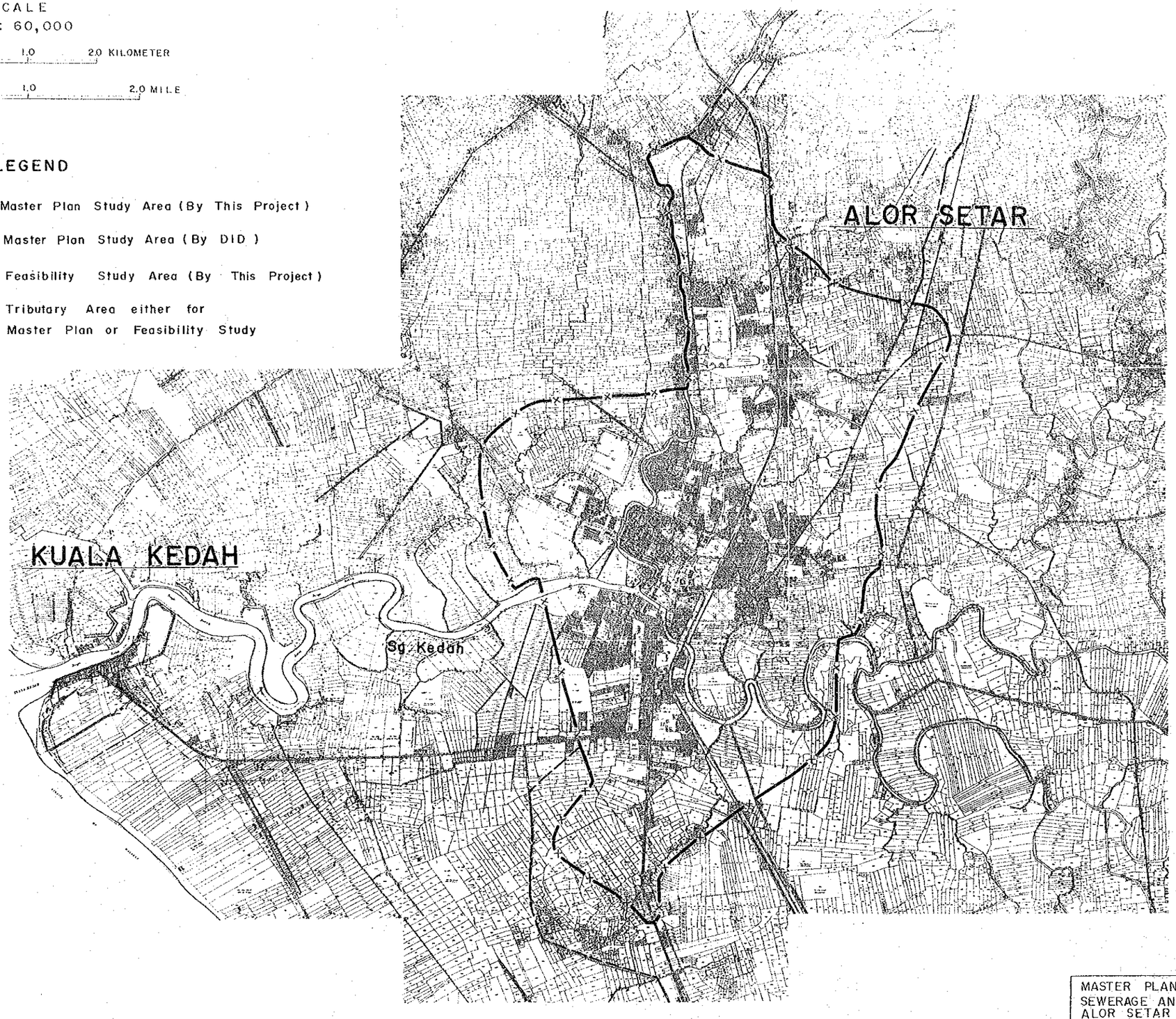
SCALE
1: 60,000

0 1.0 2.0 KILOMETER

0 1.0 2.0 MILE

LEGEND

- Master Plan Study Area (By This Project)
- Master Plan Study Area (By DID)
- Feasibility Study Area (By This Project)
- Tributary Area either for Master Plan or Feasibility Study



MASTER PLAN AND FEASIBILITY STUDY FOR SEWERAGE AND DRAINAGE SYSTEM PROJECT IN ALOR SETAR AND ITS URBAN ENVIRONS

DRAINAGE STUDY AREA

FIGURE 1 · 2

PART II
SEWERAGE MASTER PLAN

2. Sewerage Master Plan

2.1 Basic Consideration

As the result of the various studies and investigations, the basic components for Master Plan are summarized hereinafter:

- On the basis of the existing land use of the Study Area a 2000-year land use plan is made in consultation with STCP as resulted in Table 2.1 and Figure 2.1. (Refer to Section 3, Chapter 4, Volume II)

Table 2.1 Land Use Plan in the Year 2000

Land Use	Area (ha)	Prorated Ratio(%)
Residential Area	2,521.0 (1,228.0)	76.4
Commercial Area	174.9 (80.0)	5.3
Institutional Area	32.0 (32.0)	1.0
Industrial Area	207.0 (46.5)	6.3
Open Space, Vacant Land, Public Land	64.0 (40.0)	1.9
School	159.0 (140.5)	4.8
Mosque, Temple	33.0 (33.0)	1.0
River, Railway	110.0 (110.0)	3.3
Agricultural Area	0 (1,290.0)	0.0
Total	3,300.0 (3,300.0)	100.0

Note: Figures in parentheses indicate the land use areas in the year 1979.

- based on the 1970 population census of 100,439, present population in the Study Area including Kuala Kedah area is estimated to be 139,600 on the assumption that overall annual growth rate, composite of natural and social growth rates, is assumed to be 3.5% between 1970 and 1975, and 4.0% between 1975 and 1979.

  Population projection for future key years between 1980 and 2000 is then made assuming 4% annual growth rate, taking into account of the population forecast in the previous studies such as "The Kedah-Perlis Development Study" (Economic Consultants Limited, England), "Preliminary Study for Sewerage Project in Alor Setar and its Urban Environs" (EHEU) and "Urban Sewerage Survey" (WHO) as shown in Table 2.2. (Refer to Section 4, Chapter 4, Volume II)

Table 2.2 Population Project in the Study Area up to the year 2000

Year	Population	Annual Growth Rate (%)
1980	145,200	
1985	176,700	
1990	215,000	4.0
1995	261,600	
2000	318,300	

- Based on present population density and it's evaluation, the 2000-year population estimated as 318,300 persons is distributed in the area by types of future land use. The 2000-year population density are set out by eight categories of future land use patterns, and further, residential and industrial areas are divided into three and two types respectively by the characteristics of each area, as shown in Table 2.3. (Refer to Section 4, Chapter 4, Volume II)

Table 2.3 Population Distribution by Land Use in the Years 1979 and 2000

Land Use		Area (ha)	Population Density(**) (Persons/ha)	Population
Residential Area			(53.5)	(99,700)
A		1,863.6	120	223,632
			(7.3)	(4,150)
B		566.0	70	39,620
				(3,650)
C (*)		91.4		5,648
	Sub-total	2,521.0	-	(107,500) 268,900
Commercial Area		174.0	(162.6) 200	(28,300) 34,800
Institutional Area		32.0	(0) 0	(0) 0
Industrial Area			(20.5)	(3,000)
A (North Mergong)		146.0	100	14,600
				(***800)
B (South Mergong, Kuala Kedah)		61.0	0	0
	Sub-total	207.0	-	(3,800) 14,600
School		159.0	0	0
Park		64.0	0	0
Mosque, Temple		33.0	0	0
River, Railway		110.0	0	0
Total		3,300	(42.3) 96.5	(139,600) 318,300

Note (*): Residential Area A: "Urbanized and/or urbanizing area" consisting of the Municipal Councial Area promulgated in 1974.

Residential Area B: The extended area from 1974 City Council area.

Note (2): (*) Includes such places as Sultan's Palace, Kedah Club, low cost houses, housing area in North Mergong Estate, apartment houses near chinese Temple at Tongkang Yard, and Police Quarters.

(**) Population density is calculated based on gross area.

(***) The present 800 population in the South Mergong area is assumed to become nil in the future moving in the residential area.

(3): Figures shown in parentheses of both Population Density and Population columns indicate for the 1979 condition.

- After considering three alternatives of sewerage collection system, namely (1) combined system collecting sanitary wastewater and rainfall runoff in a closed conduit, (2) separate system collecting sanitary wastewater and rainfall runoff by separate closed conduit, and (3) separate system collecting sanitary wastewater by closed conduit and collecting rainfall runoff by open channel, (3) (a separate system collecting sanitary wastewater by sewer pipe and collecting rainfall runoff by open channel) is recommended, due to it's economical and technical advantages. (Refer to Section 5, Chapter 4, Volume II)

- Taking into consideration of the environmental quality regulations for sewerage and industrial effluent currently being drafted in Malaysia, tentative effluent criteria are proposed as shown in Table 2.4, which are used in proposing sewerage treatment facilities. (Refer to Section 5, Chapter 4, Volume II)

Table 2.4 Tentatively Recommended Effluent Quality Criteria from Sewage Treatment Facilities

Parameter	Unit	Value	Remarks
BOD	mg/l	50	3 days at 30°C
Coliforms	N/ml	1,000	MPN

- To select the most appropriate treatment method in the Study Area, three methods, namely stabilization pond process, aerated lagoon process and oxidation ditch process are selected and compared each other in the technical and economical view points. The result of above study indicates that the stabilization pond process will be the most economical system in the Study Area in case flow rates are below 30,000 m^3/day with availability of land required and aerated lagoon process will be the most economical in case flow rates becomes 30,000 m^3/day or above with less requirement of land compared to the case of stabilization pond process. (Refer Section 5, Chapter 4, Volume II)

- Future Wastewater quantity and quality for each of the areas categorized in future land use is estimated, as shown in Table 2.5, based on JKR's data, and analysis of wastewater sampled and various available studies in sewerage plans undertaken in Malaysia and other Asian countries. In the case of industrial area, amount of wastewater generated in the three areas, namely North Mergong, South Mergong and Kuala Kedah, is estimated separately due to different characteristics of wastewater. In addition, the general hospital, the prison and schools are also estimated separately due to the substantial size of the land each of them occupying. (Refer to Section 4, Chapter 5, Volume II)

Table 2.5 Wastewater Quantities and Qualities in the Year 2000

Area	Wastewater Quantity	Wastewater Quality BOD (mg/l)	SS (mg/l)
Residential Area	230 l/cap/day (2.76-16.1 m^3/ha/day)	200	200
Commercial Area	460 l/cap/day (92 m^3/ha/day)	200	200
Institutional Area	23 l/cap/day (8.6 m^3/ha/day)	200	200
Industrial Area			
(1) North Mergong	19.2 m^3/ha/day	60	100
(2) South Mergong	33.9 m^3/ha/day	280	270
(3) Kuala Kedah	111.4 m^3/ha/day	2,000	500
Schools	11.5 m^3/daytime cap/day	200	200
General Hospital	500 m^3/day	200	200
Prison	110 m^3/day	200	200

- The joint treatment including domestic and industrial wastes is recommended from the view point of economy and engineering. In most of sewerage zones exclusive of Kuala Kedah zone, effect of industrial wastewaters to the treatment facilities in terms of quantity is negligible, the volume involved is far less that of domestic wastewaters. It is, however, required that grease and oil is removed by installing oil trap before discharging into the public sewers for protection of a conduit system and adequate maintenance of treatment facilities. Also at Kuala Kedah industrial area where large fish processing industries are to be established, it is proposed that each factory is required to install pretreatment facility for reduction of wastewater quality, which is not only advantageous for protecting sewerage facilities but also for recovering low materials for the factory. (Refer to Section 6, Chapter 4, Volume II)

- On the basis of the studies and findings above including population distribution, land use and wastewater flow rate, quantity and quality estimated to be generated from the Study Area are shown in Table 2.6 in terms of daily average flow, (Refer to Section 6, Chapter 4, Volume II)

Table 2.6 Served Population and Estimated Wastewater Quantities and Qualities Generated from Sewerage Sub-zone in the Year 2000

Sewerage Zone	Sewerage Sub-zone	Served Population (persons)	Daily Average Flow (m^3/day)	BOD Concentration (mg/l)	SS Concentration (mg/l)
A	A - 1	29,700	10,020	152	152
(Alor Merah)	A - 2	38,000	11,550	152	152
	Sub-total	67,700	21,570	152	152
B	B - 1	54,200	21,130	175	175
(Kota Setar)	B - 2	40,700	12,030	157	157
	B - 3	11,100	3,220	160	160
	Sub-total	106,000	36,380	168	168
C	C - 1	21,500	5,460	106	128
(Mergong)	C - 2	33,700	11,740	160	161
	Sub-total	55,200	17,200	143	149
D	D - 1	46,500	15,020	168	168
(Penkalan Kundor)	D - 2	30,000	8,710	161	161
	Sub-total	76,500	23,730	166	166
E (Kuala Kedah)	E	12,900	6,140	634 (532)	253 (176)
Total		318,300	15,020	-	-

Note: Figures in parentheses are estimated by assuming 20% (BOD) and 60% (SS) removal rates by pretreatment in the factories.

2.2 Master Plan Proposed

(1) System Layout

For the purpose of developing long range plan for sewerage, whole Study Area is devided into five sewerage zones, namely, Zone A (Alor Merah), Zone B (Kota Setar), Zone C (Mergong), Zone D (Penkalan Kundor), and Zone E (Kuala Kedah), considering geographical, topographical, demographical and other conditions. Out of these five zones, four zones are further devided into ten sub-zones as shown in Figure 2.2 in order to identify the priorities for construction programme. (Refer to Section 2, Chapter 5, Volume II)

Recommended sewerage system layout plan is shown in Figure 2.2. This plan is developed based on the available topographical maps further modifying by the actual ground survey, on the basis of the future urban development planning, population density estimates and other socioeconomic factors. The physical facilities recommended in this plan comprise, (i) system of sanitary main, (ii) pumping stations, and (iii) sewerage treatment facilities in the form of stabilization pond and aerated lagoon, sufficient to comply with the need for the year 2000 for each of the five sewerage zones independently. Priorities of construction within the next 20 years for any part of the system layout as proposed in the Master Plan are also considered and enumerated in the succeeding sections. (Refer to Section 5, Chapter 5, Volume II)

(2) Construction Phasing

To determine the order of priority for implementation, careful consideration has been given for evaluation of each of sub-zones by using assessment factors such as (1) population density, (2) development condition, (3) waste load generation aspect, (4) excreta disposal system, (5) flood condition, and (6) incidence of waterborne diseases.

The results of overall evaluation mentioned above indicate that sub-zone B-1 is given the highest priority for the immediate requirement of implementation, followed by sub-zone D-1, E, C-1 and A-1, in the priority order. These sub-zones are either urbanized and/or urbanizing area. Based on the financial capacity of the Government agencies concerned, reasonable magnitude of capital investment is considered and phases of implementation are recommended as shown Figure 2.3 and Table 2.7. (Refer to Section 9, Chapter 5, Volume II)

Sewerage facilities in the "urbanized and/or urbanizing area" will be provided by the Government contribution, excluding the areas undertaken by developers in this area. In addition, the trunk sewers in the future development and the branch sewers connecting from the trunk sewers to the terminal sewers (provided by developers in the development areas) will be also provided by the Government contribution. The remainder of the sewers, (i.e. branch and lateral sewers in the future development areas and all house connection) will be provided by private contribution.

Table 2.7 Implementation Priority Areas and Estimated Construction Costs in Phases

Phase	Construction Cost (M$1,000 at 1979 Price level)		Sewerage Sub-Zone to be Implemented	Served Area (ha)	Population (Persons in 2000)
	Government Contribution	Private Contribution			
First Phase (1981-1985)	17,136	3,835	A part of B-1	187	25,200
Second Phase (1986-1990)	18,534	6,019	The remaining B-1	272	29,000
			A part of D-1	68	8,900
Third Phase (1991-1995)	21,775	10,338	The remaining D-1	313	37,600
			E	125	12,900
Fourth Phase (1996-2000)	26,713	10,380	C-1	187	21,500
			A-1	385	29,700
Total	84,158	30,572	-	1,537	164,800
	114,730				

Note: In the connection of the cost estimate, average branch and lateral sewer length in urbanized and urbanizing area is estimated at 110 m/ha, while in future development area is 130 m/ha.

The remainder of sewerage sub-zones not considered in the phased Implementation Schedule up to the year 2000 due to the uncertainty of development are shown in Table 2.8 with estimated construction cost at 1979 price level for information only.

Table 2.8 Non-Phased Sewerage Sub-zones with Estimated Construction Cost

(M$1,000 at 1979 price level)

Name of Sub-Zone	Construction Cost		Served Area (ha)	Served Population (persons in 2000)
	Government Contribution	Private Contribution		
A - 2			437	38,000
B - 2			410	40,700
B - 3*	49,093	61,908	68	6,900
C - 2			427	33,700
D - 2			270	30,000
Total	49,093	61,908	1,612	149,300
	111,001			

Note: *Excluding the SEDC development area in Sewerage Sub-zone B-3.

(3) Construction and Recurrent Costs by Phases

The total construction cost (inclusive of contingency, engineering fee and land acquisition cost) for providing sewerage facilities in the sewerage sub-zones to be implemented in the four phases is estimated as M$114.73 million in which M$84.16 million to be the Government contribution and M$30.57 million by private contribution as summarized in Table 2.9 in local and foreign currency portion. It is noted that construction cost for the sewerage facilities by the SEDC's housing development scheme now underway are not included in the cost above. Annual recurrent costs (including operation and maintenance cost plus payroll and administration costs) for sewerage facilities are shown in Table 2.10. (Refer to Section 9, Chapter 5, Volume II)

Table 2.9 Sewerage Construction Costs by Phase
(Government Contribution only)

(M$1,000 at 1979 price level)

Phase	Local Currency	Foreign Currency	Total
First Phase (1981-1985)	13,041	4,095	17,136
Second Phase (1986-1990)	14,740	3,794	18,534
Third Phase (1991-1995)	16,669	5,106	21,775
Fourth Phase (1996-2000)	20,684	6,029	26,713
Total	65,134	19,024	84,158

Table 2.10 Average Annual Recurrent Costs for
Sewerage System by Phase

(M$1,000 at 1979 price level)

Phase	Government Contribution (Operated by MPKS)
First Phase (1981-1985)	367
Second Phase (1986-1990)	665
Third Phase (1991-1995)	1,008
Fourth Phase (1996-2000)	1,415

Note: Recurrent costs for Non-Phased sewerage facilities in Table 2.8 are not included.

(4) Benefits and Justification of the Proposed Programme

Significant benefits to public health of the community can be derived from installation of an adequate sewerage system. The benefits can be grouped into several categories, namely (1) health and sanitation benefits, (2) water pollution control benefits, (3) values added to land, and (4) benefits by reduced expenditure for sanitation facilities. (Refer to Section 10, Chapter 5, Volume II)

- Health and Sanitation Benefit: Based on both the statistic data as to number of water-borne diseases including cholera, typhoid and gastro-entritic diseases in the past two year (1977 and 1978) and a survey on the treatment cost of the patinents, and assuming that approximately 50 percent of the patients attributed to unsatisfactory excreta disposal can be eliminated by the sewerage system, then the quantifiable cost saving by providing the sewerage system in the Study Area is estimated to be over M$1.06 million per year. The reduced number of patinents will accrue an additional indirect benefit, that will save wage loss from disability amounting to over M$170,000 per year.

- Water Pollution Control Benefits: From the current extensive survey of the drains and rivers, most of drains in urbanized area of the Study Area have been polluted and are expected to become much polluted in the future. Rivers will be also polluted by the discharge from the drains. Since these rivers are used for fishing, the reduction of waste loads and improvement of water quality in the drains and rivers are, therefore, a major benefit to be derived from the sewerage system.

- Values Added to Land: Investment for sewerage facilities will have the effect of raising the values of the parcels of land served by the system. These additional land values contribute as a major benefit of the Project, not only contributing to the quality of life of the beneficiaries, but also to contribute as an additional source of revenue for the Government.

- Benefits by reduced expenditure for sanitation facilities: A cost comparative analysis for operation and maintenance made between the existing excreta system (septic tank and bucket) and modern public sewerage system, indicates that the operation and maintenance cost required for sewerage system is lower than those required for the existing sanitary system in terms of per capita burden. In addition, a sewerage system has greater advantage than the existing excreta system in that the former contributes significantly for pollution control of waterways by receiving all kinds of wastewaters and by producing higher quality of effluent.

- Other Benefits: In addition to the quantifiable benefits, unquantifiable benefits will be (1) reduction of discomfort and distress, (2) improvements in environmental aesthetics from elimination of the present sewage odours emanating from drains and sludge accumulation, (3) reduction of groundwater contamination resulting from improved measures for handling sanitary wastes.

- Justification for Project Implementation: On the basis of the results of benefit evaluations for the proposed sewerage system in the Study Area, both tangible and intangible, it is conclused that the Project is definitely justifiable. If no sewerage system were provided in the area, sanitary and environmental conditions, which are already unsatisfactory in many areas of the city, will become progressively worse. Moreover, if this Project is not undertaken at this time, the cost for implementation at later times will become increasingly higher. Thus the accumulated total cost would become substantially higher and would make project implementation more difficult to undertake.

(5) Interim Measures

Since it takes time to complete adequate public sewerage system as proposed in the Master Plan, it becomes necessary to plan and implement interim measures for the purpose of improving sanitary

condition of the city by removing major sources of pollution with the least cost practical approaches through the effort of MPKS. (Refer to Chapter, Volume II)

The measures proposed include the items stated below:

(i) Improvement of Existing Sewerage/Sanitation Facilities for Domestic Wastewaters

Following four components are considered necessary for improvement of domestic waste waters:

- Improvement & repairing of existing communal septic tanks
- Desludging from existing individual septic tanks
- Improvement of existing individual excreta disposal facilities
- Intensification of cleaning activity of drains and ditches

(ii) Improvement of Industrial Facilities

Interim measures on this item should be focussed on the existing major sources of pollution from factories, markets and work shops of the following:

- Installation of a simple ditch with oil trap in the treatment site E for removing oil and materials from seafood processing factories at Kuala Kedah
- Installation of oil traps at Car repairing workshops in Mergong Industrial Area
- Installation of oil trap and sedimentation tank at each public market place relating poultry, fish and meats.

(iii) Measures for New Development Schemes

In addition to the improvement of existing facilities described above, the following measures should also be considered:

- Guidance of sewerage system plan for new housing development
- Guidance of treatment facilities for industrial development scheme
- Continued effort of present practice on environmental sanitation by way of enforcement of Anti-Litter By-law and Gotong-Royong movement.

SCALE
1 : 30,000
0 0.5 1.0 KILOMETERS
0 0.5 1.0 MILE

LEGEND
- Boundary of Study Area
- Commercial and Institutional Area
- Residential Area
- Industrial Area
- Schools
- Mosques, Temples, etc.
- Park Vacant Land and Open Space
- Railway
- River

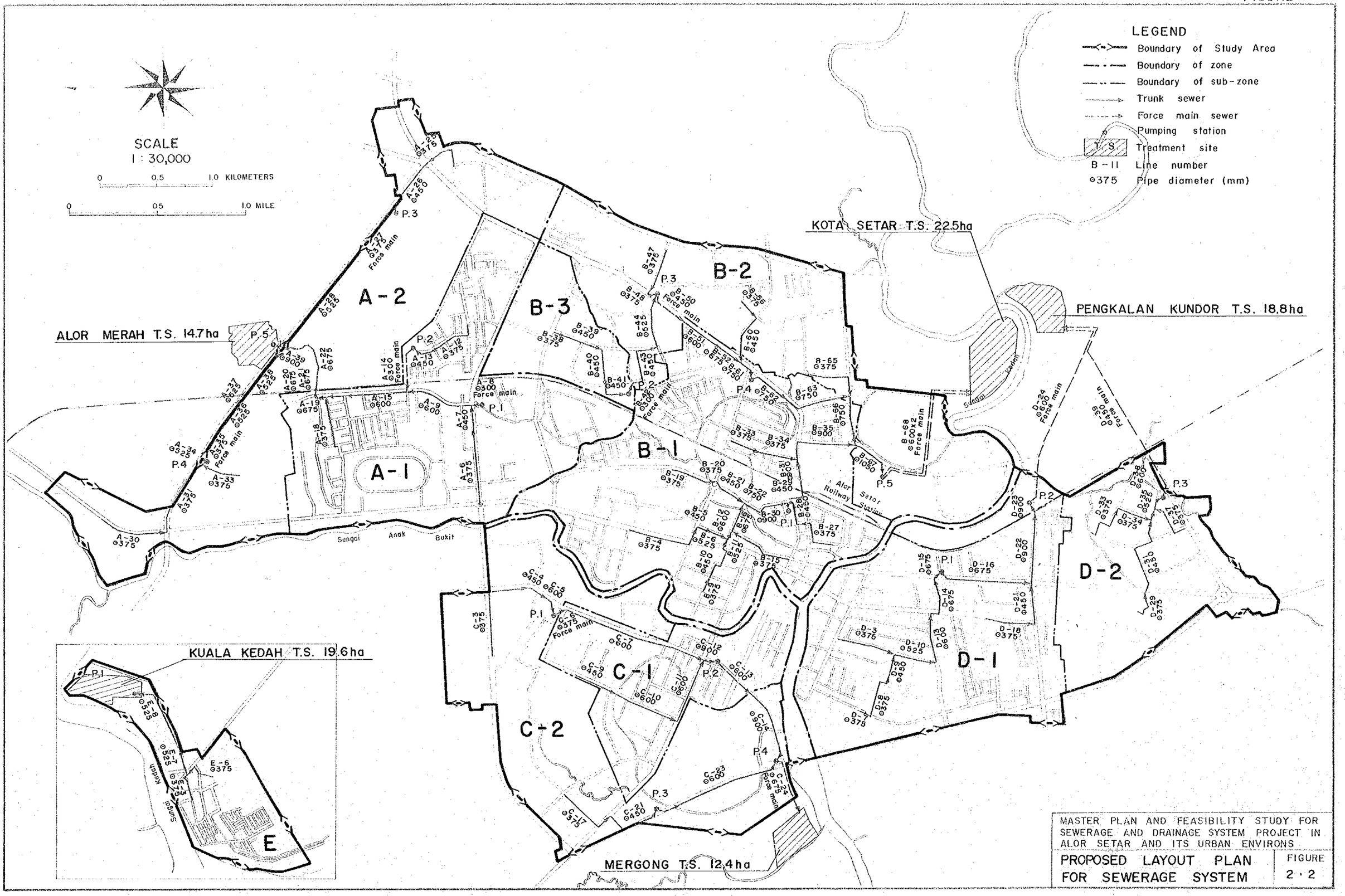
Sungai Anak Bukit
Sungai Kedah
Alor Setar Railway
Alor Setar Station
Sungai Kedah

Note : Refer to Table 2·1

MASTER PLAN AND FEASIBILITY STUDY FOR SEWERAGE AND DRAINAGE SYSTEM PROJECT IN ALOR SETAR AND ITS URBAN ENVIRONS

LAND USE IN 2000

FIGURE 2·1



MASTER PLAN AND FEASIBILITY STUDY FOR SEWERAGE AND DRAINAGE SYSTEM PROJECT IN ALOR SETAR AND ITS URBAN ENVIRONS

PROPOSED LAYOUT PLAN FOR SEWERAGE SYSTEM

FIGURE 2 · 2

SCALE
1 : 30,000
0 0.5 1.0 KILOMETERS
0 0.5 1.0 MILE

LEGEND
- Boundary of Study Area
- Boundary of zone
- Boundary of sub – zone
- 1st Phase
- 2nd Phase
- 3rd Phase
- 4th Phase
- 2nd – 4th Phase
- SEDC Development Area

A
A - 2
B - 3
B - 2
D
B
ALOR MERAH
A - 1
KOTA SETAR
B - 1
Alor Setar Railway Station
Sungai Anak Bukit
C - 2
MERGONG
C - 1
PENGKALAN KUNDOR
D - 1
D - 2
C
KUALA KEDAH
Sungai Kedah
E

MASTER PLAN AND FEASIBILITY STUDY FOR SEWERAGE AND DRAINAGE SYSTEM PROJECT IN ALOR SETAR AND ITS URBAN ENVIRONS

IMPLEMENTATION PROGRAMME | FIGURE 2.3

PART III
DRAINAGE MASTER PLAN

3. Drainage Master Plan

As stated in para 1.3.2, Part I of the present report, the Stuy Area (as shown in Figure 1.2) is limited to Kuala Kedah area, situated in low-lying and flat coastal plains with ground elevation ranging from 1 m to 2.6 m. Consequently, major part of the Study Area, especially regions in fringe of the Sg. Kedah and shore line, are subject to frequent tidal inundation. This is main cause of local flooding in the Study Area. There are still numerous swamps and paddy fields functioning as a reservoir which cut the flow rate and alleviate floods downstream. It is, however, noted that these area will be reclaimed gradually by urban development.

Thus, significant increase of peak discharge of stormwater runoff is expected to affect the urban drainage of the area in the future.

The existing drainage system in the Study Area consists of one major drain and many of secondary and infrastructural drains. The major drain runs from paddy field on the southwest to the Sg. Kedah on the north throughout the urbanized area. This drain is, at present, utilized for both agriculture and urban drainage. Although this drain is basically natural stream with various widths and depths, it can generally accommodate the flow capacities from about 5 m^3/sec to 6 m^3/sec, which is sufficient for the surface runoff for the storm of 2-year frequency under the present ground condition. Presently, the water level of the upstream drain is kept more than 1.3 m for agriculture purpose. This is controlled by the existing gate installed at downstream of the drain.

This Study is to establish the trunk drainage system, while secondary drainage system will be provided by the future study of the Feasibility study. According to the Terms of Reference prepared by Government of Malaysia, it is defined that; (a) Trunk drain shall serve an area of more than approximately 40 ha (100 acres), and (b) Secondary drain shall generally serve an area of between 4 ha (10 acres) and 40 ha (100 acres) approximately.

3.1 Design Criteria

Design criteria for this study, such as runoff formula, rainfall frequency, rainfall intensity, runoff coefficient and time of concentration are determined based on the recommendation in DID's Planning and Design Procedure No. 1 "Urban Drainage Design Standards and Procedure for Peninsular Malaysia".

In addition to the above criteria, the following sea water levels are used for design basis of the drainage study.

HHWL	(highest recorded level, high water spring tide)	SOD + 2.23 m (+7.3 ft)
HWL	(high water level)	" + 1.68 m (+5.5 ft)
MHWL	(mean high water level, spring tide)	" + 1.53 m (+5.0 ft)
LWL	(low water level)	" - 0.46 m (-1.5 ft)

SOD: Survey Ordinance Datum which is the height above mean sea level at Port Swettenham in 1912

Further, the levels to be selected in order to carry out the actual design for determination of the drainage requirement are described below:

(a) For designing the trunk drainage system for the Initial Storm, the tailwater is determined by adopting "High Water Level of +1.68 m (5.5 ft) tide conditions.

(b) For checking the trunk drainage system for the Major Storm, the tailwater is determined by adopting "Mean High Water Level of +1.53 m (5.0 ft) tide condition.

(c) For land filling, ground elevation to be raised is determined by adopting "Highest Recorded Tide Level" of +2.23 m (7.3 ft).

3.2 Master Plan Proposed

(1) System Layout

The proposed drainage basins are delineated basically identical to that of the existing drainage basins divided into four independent basins consisting of one major basin named A and three minor basins named from B1 to B3, as shown in Figure 3.1. Out of these proposed basins, trunk drain is considered only in major basin covering the area of 155 ha, while the minor basins has no provision of the trunk drains, since these basins cover the area of less than 40 ha which is not necessary to provide the trunk drains. Basically, stormwater runoff from the major basin is initially collected by many of smaller drains, and flows into the proposed trunk drain which connects finally to the Sg. Kedah. In the minor basin, collected stormwater by smaller drains flows out directly into either sea or the Sg. Kedah.

Proposed drainage system includes trunk drain and land reclamation for certain area. Proposed trunk drain is approx. 1,700 m length of rubble wall channel with mortar lining on wire net. When development programme is to be implemented in the future, land filling is recommended to be raised to 2.4 m (8 ft) for protection of maximum tide record of 2.2 m (7.3 ft) for development area.

The proposed layout plan of the trunk drain is shown in Figure 3.1. The proposed route of the trunk drain is basically the same as that of the existing natural watercourse, which is identical to that planned by STCP. (Refer Chapter 5, Volume III)

(2) Construction and Maintenance Costs for Proposed Facilities

On the basis of preliminary engineering design and basic costs obtained from relevant Government agencies and private sources, the total construction cost and annual maintenance cost for the proposed trunk drains and smaller drains are estimated to be M$4,453,000 and M$50,900 respectively.

The estimated construction cost is divided into two sources of contribution, Government and private. The private contribution is assumed that all smaller drains in undeveloped areas would be provided by private developers. The Government will contribute the costs of proposed trunk drain together with smaller drains required for future improvement in existing built up areas. (Refer to Chapter 7, Volume III)

(3) Note on Implementation of the Proposed Trunk Drain

Because the time schedule for future urban development programme is not definite, the implementation of the proposed trunk drain should be determined carefully. Basically, the implementation of the proposed trunk drain shall be required pursuant to progress of the urban development programme.

Presently, the existing trunk drain, which should be improved as the proposed trunk drain, has sufficient capacity to flow the surface runoff on the present land use condition. Thus no high priority is necessary for immediate implementation of the proposed trunk drain unless the urban development programme is taken up urgently.

In the existing trunk drainage system, there exists the tidal gates which utilize for controlling the water levels in the upstream of the drain, and protecting the backing up of the high tide. The water levels are kept at resonable height to maintains high water level for agricultural purpose.

When urban development programme is practicable, the need for controlling the water level and protecting the backing up of the high tide disappears, because no agricultural area is remaining and land elevations in low-lying areas are expected to be raised by land reclamation to meet the high tide. Therefore, no tidal gate has been proposed in the actual design for the proposed trunk drainage system. However, as long as the agricultural area exist

at the upstream of the proposed trunk drain, which has been considered as a contributing area for calculating the stormwater runoff into the urban drainage, the tidal gate would be still in use.

The above should be kept in mind for implementation of the proposed trunk drain. The priority required for the drainage implementation in the Study Area shall be basically given in developing the smaller drainage system together with the land reclamation in accordance with the development programme. The proposed trunk drain shall be then required to meet the progress of the urbanization. (Refer to Chapter 6, Volume III)

(4) Benefits of the Proposed Drainage System

Proper construction and operation of drainage systems are expected to result in certain types of benefits towards inhabitants of the areas concerned. These benefits include either quantifiable or non-quantifiable benefits as follows:

- Reduction of Flood Damage: In urban area, local flooding will cause considerable nuisance and hardship to those affected, which can be alleviated by proper remedial work on the drainage system. The implementation of such works will result in considerable benefit to the community at large, in terms of public road and private properties becoming flood free, and also, in a more significant and business premises are previously flood prone.

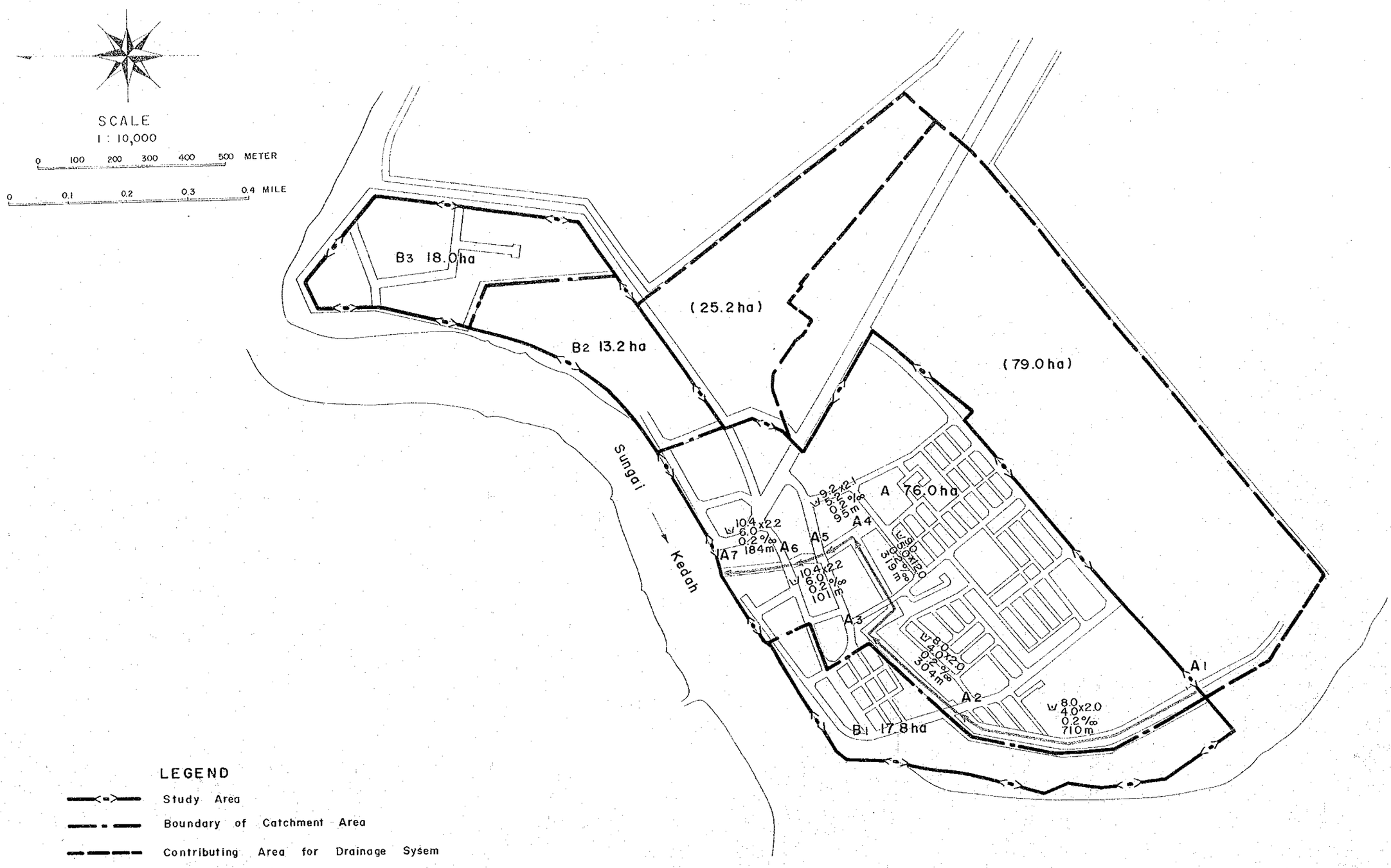
  The quantifiable benefit expected by preventing flooding is equivalent to the amount of damages due to the flood. In the absence of data concerning flood damages, the quantity of benefit is not clear. However, it should be kept in mind that the expenditure to recover flood damage is the recurrent cost upon residents or the municipality and will increase unless flood relief measures are undertaken, whereas initial investment with comparatively small amount of fund for operation and maintenance will be sufficient for prevention of the floodings.

- Improvement of Public Health and Convenience of Community: Benefits under this item can be understood easily when situations in which certain area is flooded and all kinds of waste water including sullage water, human excreta and discharge from industry, are mixed each other spreading coliforms, disease germs and toxic materials.

  It is generally recognized through abundant experiences in the past that after flooding the cases of waterborne disease increase. Together with that of the sewerage system, contribution of the drainage systems to public health improvement can be expected to be very significant, especially in areas where people depend on bucket systems, septic tank and pit privies for disposal of excreta.

- Increase of Land Value: With the provision of infrastructure including drainage system, development programme, for both public and private sectors, will be greatly stimulated and land values increased. The value added to the land tends to increase in proportion to the total investment involved.

  The added land value will be major economic benefit which will stimulate larger scale of financial transaction, and will cuase additional source of taxation for the revenue in favour of the Government agencies concerned. (Refer to Chapter 8, Volume III)



LEGEND

——><——	Study Area
—— · ——	Boundary of Catchment Area
—— — ——	Contributing Area for Drainage Sysem
A · 76.0ha	Catchment Area
——>	Proposed Drain
A1	Point of Drain

MASTER PLAN AND FEASIBILITY STUDY FOR SEWERAGE AND DRAINAGE SYSTEM PROJECT IN ALOR SETAR AND ITS URBAN ENVIRONS

RECOMMENDED LAYOUT PLANNING FOR DRAINAGE SYSTEM

FIGURE 3·1

PART IV
SEWERAGE FEASIBILITY STUDY

4. Feasibility Study for First Phase Programme

Feasibility studies including preliminary design with costings for the area proposed as First Phase implementation of construction in the Master Plan is undertaken on the basis of the following long range projection on land use and population.

4.1 Land Use and Population

- Future land use in the Area are projected as shown in Table 4.1 assuming that a part of the present residential area is converted into commercial area and also the present open and vacant spaces are made into commercial area, in accordance with provisional projection by STCP. These areas involved are bounded by Jl. Telok Wan Jah, Sg. Raja, Sg. Derga and the railway.

- Using the results of projections as presented in the Master Plan, the population of the Study Area in 2000 is estimated to be 25,240. The estimated average population density per ha in 2000 are approximately 135 persons as shown in Table 4.2.

  The projected population of the Study Area in 2000 does not show significant increase after 1979, because the present population has been almost saturated condition.

  Population of the future key years between 1980 and 1995 have been interpolated by using the 1979 and 2000 populations as shown in Table 4.3.

Table 4.1 Projected Land Uses in 2000

Land Use	Area (ha)	Prorated Ratio (%)
Residential Area (A)	42.2	23
" (c)*	3.4	2
Commercial Area	97.0	51
Institutional Area	12.2	7
Schools	30.7	16
Mosque	1.5	1
Total	187.0	100

Note: * indicates the area occupied by police quarters.

Table 4.2 Population in 2000 (to be used for design purpose)

Land Use	Population (Persons)	Population Density (Persons/ha)
Residential (A)*	5,060	120.0
" (C)*	780	229.4
Commercial Area	19,400	200.0
Institutional Area	- (12,000)	-
Schools**	- (28,360)	-
Mosque**	-	-
Total	25,240 (40,360)	135.0

Note: (1) Figures in parentheses indicate daytime population.
(2) * Residential Area is classified into (A) through (C) according to population density.
(3) ** Night-time population is considered nil.

Table 4.3 Projected Populations for Future Key Years

(Persons)

Land Use \ Year	1979	1980	1985	1990	1995	2000
Residential	11,690	11,420	10,020	8,620	7,240	5,840
Commercial	10,200	10,640	12,830	15,020	17,210	19,400
Total	21,890	22,060	22,850	23,640	24,450	25,240

4.2 Proposed First Phase Facilities

To provide the most economical system layout plan among technically feasible alternatives, studies are executed as to possible routes for sanitary trunk sewers, sites for intermediate pumping stations and treatment facilities in the First Phase area, reflecting the existing local conditions based on the surveys and investigations carried out in the course of this study. Due considerations are also given to the factors such as sewage quantities, connection places, invert elevation of incoming trunk sewers from outside of the First Phase Area.

Major sewerage facilities proposed in the First Phase Programme consist of (1) sewers with a total length of 21,970 m varying from diameter 225 mm to 1,050 mm including force main, (2) two intermediate pumping stations, and (3) treatment facilities as shown in Table 4.4 and Figure 4.1.

Alternative studies for sewage conveyance facilities indicate that the most justifiable alternative from the point of technical soundness and economy of construction would be, to pump up the incoming sewage at P_5 (Tanjong Bendahara Pumping Station) and convey it by pressure to the treatment site by two barrels of force main sewers of equal size. The integrated capacity can meet the 2000-year condition in sewerage zone B. It is recommended to lay single sewer in the first phase to be duplicated in the Second Phase.

In addition to the major sewerage facilities as discussed above, other facilities are required for cleaning of sewers and laboratory test as shown in Table 4.4. Further, land acquisition is required for the treatment facilities of the site and two intermediate pumping stations proposed for the First Phase Programme. It is emphasized that the land for other four treatment facilities for succeeding phases should preferably be procured together with those of the First Phase to avoid difficulty of acquisition and price escalation in the future.

Table 4.4 Proposed Sewerage Facilities and Land Acquisition in the First Phase Construction Programme (by Government contribution)

1.	Sewer	
	(1) Total length of sewer	21,970 m (255 mm to 1,050 mm dia.)
2.	Pumping Stations	
	(1) Kolam Air	Capacity: 13.4 m^3/min, 3 pumps (including 1 stand-by)
	(2) Tanjong Bendahara	Capacity: 17.4 m^3/min, 3 pumps (including 1 stand-by)
3.	Waste Stabilization Pond	
	(1) Design flow (daily average flow)	11,850 m^3/d (5 units)
4.	Others	
	(1) Cleaning machine and truck	1 set
	(2) Laboratory facilities	1 set
5.	Land Acquisition	
	(1) Treatment Sites*	88 ha
	(2) Pumping station sites**	2,230 m^2

Note: * : These include entire areas required in the master plan, namely 14.7 ha (zone A), 22.5 ha (zone B), 12.4 ha (zone C), 18.8 ha (zone D), and 19.6 ha (zone E).

** : These include for Kolam Air and Tajong Bendehara pumping stations in the First Phase construction area only.

4.3 Implementation Programme and It's Disbursement Schedule

(1) Implementation Programme

To establish the most feasible implementation schedule, the Area (part of Sub-zone B-1) is further divided into three blocks (namely blocks 1, 2 and 3) as shown in Figure 4.2, and evaluation is made regarding the order of priority of each block for construction. Thus an implementation schedule is set out as summarized in Table 4.5. (Refer to Chapter 7, Volume IV)

(2) Disbursement Schedule

Based on Tables 4.4 and 4.5, a disbursement schedule is established as shown in Table 4.6. The project cost in the Table includes contingency, land acquisition and escalation factor of 8% per annum. Annual recurrent costs for the proposed programme are estimated in Table 4.7. (Refer to Chapter 7, Volume IV)

Table 4.5 Implementation Schedule for the Proposed Sewerage Facilities in the First Phase Programme (by Government Contribution)

Item	1981	1982	1983	1984	1985
I) Sewage Collection System					
(1) Trunk Sewers (Kolam Air Pumping Station to Kota Setar Treatment Site)*					
(2) Branch & Lateral Sewer .Block 1					
.Block 2					
.Block 3 (Refer to Figure 4.2)					
(3) Kolam Air Pumping Station					
.Civil works					
.Mech. and electrical works					
(4) Tanjong Bendahara Pumping Station					
.Civil works					
.Mech. and electrical works					
II) Waste Stabilization Pond					
III) Other Activities					
(1) Land acquisition					
(2) Others**					
(3) Detailed design					

Note: * includes construction of the access roads from Jl. Tanjong Bendahara to the treatment site.

** includes cleaning equipment, truck, and laboratory facilities.

Tale 4.6 Disbursement Schedule for the First Phase Programme
(Government Contribution only)

(M$1,000 at 1979 price level)

Description	Local Currency						Foreign Currency						
	1981	1982	1983	1984	1985	Sub-Total	1981	1982	1983	1984	1985	Sub-Total	Total
(1) Sewers	-	2,286	1,424	1,192	895	5,797	-	404	251	210	157	1,022	6,819
(2) Pumping station													
. Civil works	-	403	224	-	-	627	-	101	56	-	-	157	784
. Mech. and electrical works	-	-	323	-	-	323	-	-	755	-	-	755	1,078
(3) Waste Stabilization Pond													
. Civil works	-	-	640	486	251	1,377	-	-	160	121	63	344	1,721
(4) Cleaning Machine	-	-	-	-	-	-	-	-	-	150	-	150	150
(5) Laboratory	-	-	-	30	-	30	-	-	-	47	-	47	77
Sub-Total	-	2,689	2,611	1,708	1,146	8,154	-	505	1,222	528	220	2,475	10,629
(6) Consulting Services													
. Engineering design	531	-	-	-	-	531	532	-	-	-	-	532	1,063
. Supervision	-	64	77	45	27	213	-	96	115	67	41	319	532
(7) Contingencies	106	551	538	351	235	1,781	106	120	267	119	52	664	2,445
(8) Land Acquisition	2,467	-	-	-	-	2,467	-	-	-	-	-	-	2,467
Total Project Cost (1979 price)	3,104	3,304	3,226	2,104	1,408	13,146	638	721	1,604	714	313	3,990	17,136
Total Project Cost (Escalated Price)	3,619	4,163	4,387	3,091	2,234	17,494	744	908	2,181	1,049	497	5,379	22,873

Table 4.7 Annual Recurrent Costs

(M$1,000 at 1979 price level)

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
Payroll (a)	169	186	332	332	332	332	332	332	380	389	389
Maintenance (b)	-	-	8	35	49	52	52	52	52	52	52
Power	-	-	-	21	35	44	45	46	48	49	50
Administration (c)	17	19	32	32	33	33	33	33	38	39	39
Total Cost (1979 Price)	186	205	362	420	449	461	462	463	518	529	530
Total Escalated Cost (8% per annum)	217	258	493	602	713	790	855	926	1,118	1,233	1,335

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

(b) Maintenance cost includes costs for the purchase of chemicals for laboratory tests, machine oil, and costs for cleaning equipments, repair and overhauling, etc.

(c) Administration expenses include office supplies and other miscellaneous expenses.