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

VOLUME IV

SEWERAGE FEASIBILITY STUDY

MARCH 1981

JAPAN INTERNATIONAL COOPERATION AGENCY

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

ON

MASTER PLAN AND FEASIBILITY STUDY

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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
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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	- Meterological 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	m^3	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

CHAPTER 1
SUMMARY

1. The Feasibility Study Area (hereinafter called as the Study Area) is defined to be 187 ha (462 acres) as the area for First Phase Programme (1981 - 1985) within the boundary of areas for Master Plan Studies already submitted and approved. This Area is decided according to the priority order of five sewerage zones in the Master Plan study areas with due consideration on the estimated magnitude of investment for each of them.

2. The Study Area is composed of approximately 40 percent of sewerage Sub-zone B-1 of the Master Plan as shown in Figure 3.1.

3. Residential and commercial areas dominate the present and future (2000) land uses occupying more than 70 percent of all land uses in the Study Area. However, a part of residential area in 1979 is projected to be converted into commercial area by 2000 and similarly open space and vacant land in 1979 into commercial area by 2000 as shown in Table 4.1 and 4.2.

4. Since the Study Area comprises mostly saturated developed area, the 1979 night-time population of 22,450 are projected to increase slightly by the year 2000 to 25,240, about 13 percent increase during the period of 21 years. However, it should be noted that day-time population in commercial and institutional area and schools are expected to increase significantly with a total population of 40,360 persons in addition to night-time population by the year 2000.

5. Sewerage facilities proposed in the First Phase Programme (1981 - 1985) consist of (1) public sewers (or all sewers excluding house connections) with a total length of 21,970 m varying from diameters 225 mm to 1,050 mm including force main sewer, (2) two intermediate pumping stations (namely Kolam Air and Tanjong Bendahara),

and (3) one treatment facility including those facilities of scum chamber, facultative ponds and maturation ponds. Land acquisition is required for the treatment facility and two sites for the intermediate pumping stations proposed in the First Phase Programme. In addition, land for four treatment facilities for the succeeding phases should preferably be procured together with those for the First Phase in order to avoid difficulty in acquisition and price escalation in the future.

6. The project cost of the First Phase Programme is estimated to be approximately M$17 million including local and foreign currency portions as of 1979 price level, including costs for construction, engineering services for detailed design and supervision, contingency and land acquisition. With annual escalation factor of 8 percent, the total cost estimated for the First Phase Programme is approximately M$23 million. The project cost is proposed to be disbursed each year for the five year First Phase Programme as follows:

(M$1,000)

	1981		1982		1983		1984		1085		Total	
	L	F	L	F	L	F	L	F	L	F	L	F
1979 Price	3,104	638	3,304	721	3,226	1,604	2,104	714	1,408	313	13,146	3,990
	3,742		4,025		4,830		2,818		1,721		17,136	
Escalated Price	4,363		5,071		6,568		4,140		2,731		22,873	

Note: L and F refer to Local and Foreign currency respectively.

7. The financial viability for the implementation of the First Phase Programme is studied based on the estimated capital costs as well as recurrent costs with due consideration on allowance for price escalation to be anticipated at the implementation stage.

The availability of the various sources of funds for the required costs estimated as above are studied including internal generation of revenues as well as external fundings. The charging system for the sewerage use and relevant user's ability to pay for the sewerage services is also studied to raise potential revenue for the project.

The financing plans in nine alternatives have been prepared as follows assuming various components of financing sources to recommend the best alternative plan based on the total project cost estimates of M$22,873,000 with allowance for eacalation.

Alternative I-A : The foreign currency portion of M$5,379,000 is assumed to be financed by the loan of softer terms from bilateral capital sources and local currency portion of M$17,494,000 to be financed by Federal Government loan.

Alternative I-B : The foreign currency portion is increased to M$7,998,000 equivalent to 40% of project cost excluding land acquisition cost, and local currency portion is reduced to M$14,875,000 of above Alternative I-A.

Alternative II-A : The foreign currency portion of M$5,379,000 is assumed to be financed by the loan of ordinary terms from international capital sources and local currency portion of M$17,494,000 to be financed by Federal Government loan.

Alternative II-B : The foreign currency portion is increased to M$7,998,000 equivalent to 40% of project cost excluding land acquisition cost, and local currency portion is reduced to M$14,875,000 of above Alternative II-A.

Alternative III-A : The foreign currency portion of M$5,379,000 is assumed to be financed by the loan of softer terms from bilateral capital sources and local currency portion of M$14,617,000 to be financed by Federal Government loan providing the Federal Government contributes a grant for land acquisition cost of M$2,877,000 approximately 12.6% of the total cost.

Alternative III-B : The foreign currency portion is increased to M$7,998,000 equivalent to 40% of project cost excluding land acquisition cost, and local currency portion is reduced to M$11,998,000 of above Alternative III-A.

Alternative IV-A : The foreign currency portion of M$5,379,000 is assumed to be financed by the loan of ordinary terms from international capital sources and local currency portion of M$14,617,000 to be financed by Federal Government loan providing the Federal Government contributes a grant for land acquisition cost of M$2,877,000, approximately 12.6% of total cost.

Alternative IV-B : The foreign currency portion is increased to M$7,998,000 equivalent to 40% of project cost excluding land acquisition cost, and local currency portion is reduced to M$11,998,000 of above Alternative IV-A.

Alternative V : The total project cost is assumed to be financed by Federal Government providing M$19,996,000 to be financed by Federal Government loan and land acquisition cost of M$2,877,000, approximately 12.6% of total cost to be subsidized by Federal Government.

As a result of comparative study of each alternative the plan incorporating the foreign and local loans with substantial grant elements and the least amount of annual contribution from MPKS has been recommended, which is, inter alia, 1) The project cost amounting to M$7,998,000 is to be financed out of bilateral soft loan with annual interest of 3.25 percent per annum with 30 years repayment after 5 years grace period. 2) A part of local currency portion amounting to M$11,998,000 is to be financed by Federal Government loan with 6 percent interest per annum and 30 years repayment after 5 years grace period. 3) Land acquisition cost amounting M$2,877,000 is to be financed by Federal Government grant.

8. The above stated investment from different financing sources on different conditions are considered viable for MPKS by the projected annual operating income with minimum of contribution from its annual budgetary provision.

9. Implementation of the First Phase Programme is expected to contribute to the benefit of direct and indirect beneficiaries in various fashions, such as, for (1) social welfare: reducing incidence of waterborne disease that, in turn, means saving from

wage loss; improving environmental aesthetics; reducing groundwater contamination, etc., (2) water pollution control, (3) increase of the value of land, (4) inducement of various land developments, and (5) cost saving over sanitation facilities which should be necessary if the sewerage system is not provided.

CHAPTER 2
INTRODUCTION

The Master Plan Report (Volume II) recommends that out of 3,300 ha of the Master Plan study area, 187 ha (462 areas), about two-fifth of sewerage sub-zone B-1, should reasonably be considered as First Phase Area to proceed for construction during the period of 1981 to 1986, and Feasibility Study should be undertaken immediately including preliminary design work.

The project cost for the First Phase Programme is estimated to be in the order of M$15 million government contribution at 1979 price level, with additional M$2 million for land acquisition of treatment facilities for succeeding phase after the First Phase Programme, which makes total of approximately M$23 million by escalated cost with annual rate of 8 percent, which is considered reasonable on the basis of financial background of the conceivable potential sources and ability and willingness to pay of beneficiaries.

Thus, Sewerage Feasibility Study presented herewith includes review of the data collected at the Master Plan stage and collection of necessary additional supporting data by way of various surveys and site investigations with respect to engineering aspect, including, inter alia, leveling the main sewer routes, sampling and anlyzing the wastewater qualities at selected influencial pollutant sources, measuring longitudinal and transversal sections of the major drains and rivers as needed and locating major underground structures.

To finance the First Phase project cost, optimal financial plan is carefully considered by conducting financial analysis over conseivable alternative strategies taking into account of potential bilateral/ multilateral financing sources to support necessary local and foreign currency portions with the view to determine financial viability of the

proposed project on the basis of estimated financial capability of the implementing government agency.

Various individual studies and design drawings of the sewerage facilities are incorporated in the annexes at final pages of the current report.

CHAPTER 3
FEASIBILITY STUDY AREA

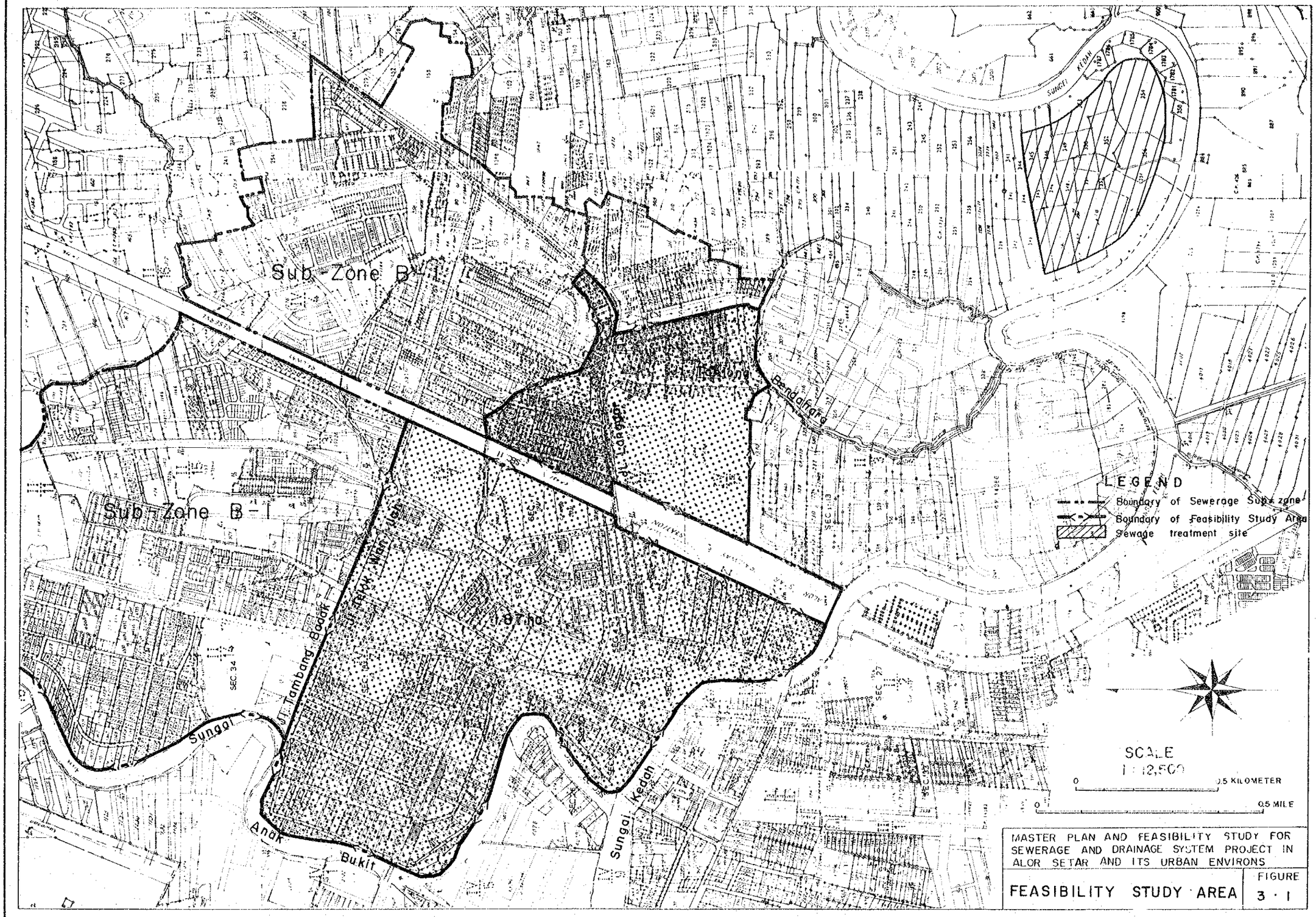
The Study Area of 187 ha (462 acres) comprises most densely populated portion of residential area and most (80 percent) of the existing commercial area and the central portion of the institutional area with both state and federal buildings and MPKS' buildings in Alor Setar. The Feasibility Study Area is shown in Figure 3.1.

The Study Area lies both sides of the railway: one portion of area to the west of the railway is surrounded by the railway, 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 as shown in Figure 3.1, 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 executed under 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 underground from surface and of sandstone further down. The ground water table in the Study Area measures 1.2 m to 1.3 m from the surface.

It is noted that major underground facilities such as water distribution mains and communication cables exist under the proposed trunk sewer routes of Jl. Langgar, Jl. Raja and Jl. Putera as illustrated in Fingure SF-16 of Volume VIII.

FIGURE 3 · 1



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

FEASIBILITY STUDY AREA

FIGURE 3 · 1

CHAPTER 4
LAND USE AND POPULATION

The land uses and population distribution in the Study Area both at present and in the future up to the year 2000 are summarized in this chapter by extracting from the Master Plan Report.

4.1 Land Use

The present land uses in the Area are divided into six categories, namely residential area, commercial area, institutional area, schools, open space and vacant land, and mosque, as shown in Table 4.1 with relative percentages of shares of the land.

Future land uses in the Area are projected as shown in Table 4.2 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 to be involved would be similar to the present status of the area bounded by Jl. Telok Wan Jah, Sg. Raja, Sg. Derga and railway in the Study Area.

4.2 Population

Using the results of projections as presented in the Master Plan, the population of the Study Area both in 1979 and 2000 are estimated to be 22,450 and 25,240 respectively. The estimated average population densities per ha in both 1979 and 2000 are approximately 120 persons and 135 persons respectively as shown in Table 4.3 and 4.4.

The projected population of the Study Area in 2000 does not show significant increase after 1979, because the present population has been almost under 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 4.5.

Table 4.1 Land Uses in 1979

Land Use	Area (ha)	Prorated Ratio (%)
Residential Area	78.2	41
Commercial Area	55.9	30
Institutional Area	12.2	7
Schools	30.7	16
Open Space and Vacant Land	8.5	5
Mosque	1.5	1
Total	187.0	100

Table 4.2 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 4.3 Population in 1979

Land Use	Population (Persons)	Population Density (Persons/ha)
Residential Area*	11,690	149.5
Commercial Area	10,200	182.5
Institutional Area	-	-
Schools	560	18.2
Open Space and Vacant Land	-	-
Mosque	-	-
Total	22,450	120

Note: * includes Residential Area (A) and (C) and a portion of Commercial Area in Table 4.4.

Table 4.4 Population in 2000 (to be used for design purpose)

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

Note: (1) Figures in parentheses indicate day-time population.

(2) * Residential Area is classified into (A) through (C) according to population density (refer to Table 4.3 of Section 4 in Chapter 4, Master Plan Report)

(3) ** Night-time population is considered nil.

Table 4.4 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

CHAPTER 5
DESIGN BASIS

The design criteria necessary for the purpose of preliminary engineering design are summarized in this chapter with necessary additional input onto the criteria in the Master Plan.

5.1 Design Flow Rates

Design flow rates to be used in the preliminary engineering design are summarized in Table 5.1-1, and similarly design flows in Table 5.1-2. (Refer to the Master Plan for detail).

Table 5.1-1 Design Flow Rates

Item		In the Year 1990	In the Year 2000
Wastewater	Residential area	208 l/d.cap	230 l/d.cap
	Commercial area	441 l/d.cap ($88.2 m^3$/d.ha)	460 l/d.cap ($92 m^3$/d.ha)
	Institutional area	23 l/d.cap ($8.6 m^3$/d.ha)	
	Schools	8.5 l/d.cap	11.5 l/d.cap
Extraneous water	Residential area	$6.3 m^3$/d.ha	
	Commercial area	$4.5 m^3$/d.ha	

Note: Industrial area is not included in the Study Area.

Table 5.1-2 Design Flows

(m^3/day)

Item	In the Year 1990	In the Year 2000
Residential Area	1,734	1,343
Commercial Area	6,053	8,924
Institutional Area	177	276
Schools	216	326
Extraneous Water	982	982
Total	9,162	11,851

Note: Refer to Appendix D, Volume VII for detail.

5.2 Sewerage Facilities

5.2.1 Sewers

Sewers are designed on the basis of the design criteria as summarized in the following:

(a) Manning's Formula:

$$V = \frac{1}{n} \cdot R^{\frac{2}{3}} \cdot S^{\frac{1}{2}}$$

where

V = velocity of flow in m/sec

n = coefficient of roughness, 0.013 for new sewers and 0.015 for existing sewers

R = hydraulic radius in m

S = slope

(b) Peak Flow Rate:

$$M = \frac{5}{P^{\frac{1}{7}}}$$

where

M = peaking factor, ratio of peak flow to average flow

P = design population in thousand

(c) Sewer Materials:

- VCP for the sizes up to 300 mm in dia.
- CRCP for sizes 375 mm in dia. or more
- ACP for the pressure pipe up to 600 mm in dia.
- Steel pipe for the pressure pipe of 700 mm in dia. or more

(d) Maximum Design Velocity for All Pipes: 3.0 m/sec (10 ft/sec)

(e) Minimum Design Velocity:

- for VCP 0.6 m/sec (2 ft/sec)
- for other cement-bonded pipes 0.75 m/sec (2.5 ft/sec)

(f) Minimum Size of Public Sewer: 225 mm

(g) Maximum Manhole Spacing:

- 100 m (328 ft) for the sizes up to 600 mm in dia.
- 150 m (492 ft) for the sizes 675 mm in dia. or more

(h) Minimum Earth Covering of Public Sewer 1 m (3.3 ft)

5.2.2 Pumping Stations

Following major elements are considered for the proper design of pumping stations:

(a) Design Flow

The design of pumping stations shall be based on the peak flow of the sewage, unless lower rate of flow for design is justified. All pipes and conduits shall also be designed to carry the expected peak flow plus some allowance for the ground-water infiltration and unavoidable surface-water contributions.

Enough storage capacity shall be provided in wet wells, where automatic controls and variable speed drivers are not furnished to match pumping rates exactly with inflow.

(b) Type of Pump

A study was made to select (1) type of pump (i.e., screw, centrifugal, or submersible related to grit chamber and pump well type), and (2) structural shape for pumping station (i.e., circular or rectangular type).

The study supports to employ submersible pumps for the two pumping stations (i.e., P_1 and P_5, refer to Figure 6.1) of insitu concrete cast rectangular type as studied in Annex 8.

(c) Grit Removal Units and Screen Devices

It is proposed that no grit removal units are provided for pumping stations. However, manual coarse bar screens (100 mm clearance between the screen bars) shall be provided in front of the pump wet well.

(d) Ventilation and Prevention of Odour and Noise

Pumping stations shall be enclosed in a rigid structure to prevent the diffusion of odour and noise to the nearby dwellers. Also, a suitable ventilation device shall be provided for all stations to ventilate the screen room and other necessary sections of the station required for operation and inspection purposes.

(e) Pump Capacity

Although the structure of pumping stations shall be constructed for the year 2000, initial installation of pumps shall be adequate to meet the 1990 flow condition to avoid excessive investment.

Two units of pumps including one stand-by shall be provided initially, then additional units shall be installed in proportion to the increasing flows according to the construction phases.

(f) Pump Drive

In selecting a type of pump drive, a careful consideration is given on the frequency of electrical power suspension and its duration in addition to cost comparison between electric motor and diesel engine. The study indicates that the use of electricity is more economical and dependable than diesel engine or other source of power. Further, electricity has been currently used in Malaysia, which makes the use of electric motor more practical as prime mover for all sewage pumps.

5.2.3 Treatment and Disposal System

By evaluating various types of treatment processes for both technical and economical viewpoints, stabilization pond process has been recommended as the most desirable process for treating the sewage as far as the land space is available. However, the stabilization pond process should be modified to aerated langoon process when the pond is overloaded in a successive stages.

A unit of stabilization pond proposed consists of facultative pond and maturation pond in series. Further, a scum chamber provided in front of facultative ponds in parallel to remove scum prior to biological reaction in the succeeding series of ponds.

The design of treatment units shall be based on the average rate of sewage flow per 24 hours except where significant deviation from normal diurnal flow patterns are expected. For pipes and conduits, peak flow rate shall be considered in determining the capacity.

Application rates for the stabilization pond design components are summarized in Table 5.2.

Table 5.2 Design Basis for Stabilization Pond

	Design Component	Application Rate
1.	Scum Chamber	
	Detention time	5 min
	Depth	1.0 - 1.5 m
2.	Facultative Pond	
	Surface BOD loading	300 kg/day.ha (268 lb/day.acre)
	Depth	1.5 m
3.	Maturation Pond	
	Detention time	3 days
	Depth	1.5 m
4.	Expected Effluent Quality	
	BOD_3	50 mg/l (max.)
	Coliforms	1,000 N/ml

5.3 Materials and Methods of Construction

5.3.1 Construction Materials

(a) Structural Materials

Most construction materials for the sewerage system are available in Malaysia except the equipment required for pumping stations and treatment facilities such as large types of pumps, electric and control facilities, gates, aerators, flow meters, etc.

Laterite and gravel suitable for concrete aggregate are available in adequate quantities in Kedah State. Portland cement is also manufactured in Perlis State, conforming to internationally acceptable standards, suitable for construction of sewerage facilities, such as pressure and non-pressure concrete pipes and civil and building works for pumping stations and treatment facilities.

Since most of the sewerage structures are subject to sulfide attack, high-quality sulphate-resisting Portland cement specified as Type II in ASTM, is recommended for under-ground structural works. The actual specification of concrete mixes and strengths is a matter to be decided during final design. However, in view of the importance of preventing not only structural failure but ground-water infiltration, all concrete for sewerage works should be dense and properly cured to obtain the full advantage of quality control.

(b) Pipe Materials

Pipes currently available in Malaysia are limited both in sizes and materials. Vitrified clay pipe less than 300 mm size are available and the quality is totally suitable for sewerage use. Both asbestos

cement pipes and PVC pipes are manufactured in Malaysia in limited sizes conforming to internationally accepted standards.

For the selection of sewer materials, careful consideration should be given to the corrosion problem by sulfide buildup in sewers. Because of the expected high temperatures and relatively high BOD of the wastes, the sulfide problem can be expected to be serious. Preference is, therefore, given to use of corrosion resistant materials such as vitrified clay pipe, in order that the sewers to be installed will indeed have a useful life for longer period as desired, on the basis of an economic study among various kinds of pipes for different materials and pipe sizes as discussed in Appendix I of Volume VII.

In view of the above study results and availability of pipes in different materials, the use of the following pipes for sewerage construction is proposed:

1) Sanitary sewers of 300 mm or less in diameter should be of vitrified clay pipe.

2) Sanitary sewers from 375 mm and more in diameter should be of centrifugally cast reinforced concrete pipe with 12 mm thick high alumina cement mortar lining.

3) Pressure sewers of up to 600 mm in diameter should be of ACP.

4) Pressure sewers of 700 mm and more in diameter should be of steel pipe.

(c) Sewer Bedding Materials

All sewer pipes are bedded either in a monolithic cradle of plain concrete or crushed stone or gravel, having a minimum thickness of

60 mm for 150 mm diameter service connection pipes under the pipe barrel. The concrete cradle should have a height as indicated in Figure SF-15, Volume VIII having width at least equal to or more than the outside diameter of the pipe barrel.

Granular materials are recommended as bed material for vitrified clay pipes, and CRC pipes up to 525 mm, in lieu of shaping the trench bottom. The granular bedding material, in addition to providing firm uniform support for the pipes, can frequently stabilize the trench bottom. The pipe bedding material must remain firm and not permit displacement of the pipes, either during pipe laying and backfilling or after completion of construction.

For large sewer pipes of 600 mm or more, the use of well graded crushed stones is recommended, because these stones will generally provide the most satisfactory pipe bedding when compacted thoroughly and properly placed, to provide uniform support for the pipe barrel and to completely fill all voids under and around the pipes.

In many cases sewer bedding materials depend on the various conditions such as soil condition and the expected loads, etc. There will be cases which require pipe casing to protect the body of pipes, especially when laid shallow.

(d) Manhole Materials

The manhole frame and cover should normally be made of cast iron, having adequate strength to support superimposed loads, with a minimum diameter of 600 mm. Ventilation vents may be provided over the cover. However, for manholes at depressed areas subject to flooding, such vents should not be provided to avoid undesirable entry of stormwater and sand and grit.

Manhole materials include brick, precast concrete cone and cast-in-place concrete. The concrete cone may be furnished to reduce the diameter of manhole at the top to accommodate the frame and cover. For the vertical portion of wall (barrel), cast-in-place concrete or brick may be used, depending upon the depth of manholes or soil conditions.

5.3.2 Construction Methods

(a) Sewer Construction Methods

The critical factors to construct sewers are (a) trench bedding, (b) backfill, and (c) proper joining of pipes. It is also necessary to consider minimum interference to the residents and traffic in the vicinity of the construction area together with the minimum risk to the workmen. The following factors should be considered for laying sewers by open-trench excavation method.

(i) Trench Dimensions

The width of the trench to be excavated should be kept to a minimum considering the pipe diameter, trench bracing, and working room required for placing, joining, and backfilling of the pipes.

(ii) Excavation

To minimize surface restoration work, a trench excavated should be as narrow as possible. To limit interference to the traffic in narrow roadways or highly congested down-town areas, the excavated material should be removed to storage area, and returned later for backfilling, and excavation should be undertaken prior to immediate installation of the pipes. It is advisable to limit the maximum length of open trench to 100 m in open areas and 30 to 40 m in developed areas.

(iii) Pipe Bedding, Bracing, and Sheeting

In most of the Study Area, the soil may primarily be sandy silt and/or clay, and high water table may be encountered.

In sand and clay soils, no lateral bracing will be required for 2 to 3 m depth vertical walls and for 3 to 4 m back-sloped walls. In the areas of primarily silty soil, extra tight bracing will be required for the different depth of excavation. For deep excavation in soft clay soil, special precaution is required against heaving to be caused by the low shear strength in wet condition by using trench sheet driving deep into the ground. This problem may be overcome by driving the sheet piles.

(iv) Dewatering

For most of the areas in the Study Area, removal of ground water from the excavated trench will be required. Dewatering can be handled by sump pumps at the lower end of the trench where the ground water table is manageable by the pumps, while application of well-point method may be necessary, when the soil is sandy with high ground water table and excessive water is encountered.

(v) Backfilling

For normal conditions, the bottom layer should be extended to 30 cm above the crown of the pipes. Laterite layer shall be used but shall not contain large stones, roots, or lumps of clay. Subsequent filling of trenches and around manholes should be built up by layers, each of which is not exceeding 15 to 25 cm and also unformily and throughly compacted.

(b) Construction of Pumping Station

Pumping stations and screening units will require a foundation extending approximately 15 m below the existing ground surface (see Figures SF-23 of Volume VIII). This construction may pose particular problems because of high water table and the type of soil at the sites. The normal method of excavation, using sheet pilling, will not be practicable for application at some sites with deep foundations, even with a series of well-points or sumps for drainage.

(c) Construction of Stabilization Pond

Despite its simplicity in nature, the stabilization pond should be constructed properly in order to ensure economy and durability as well as satisfactory performance. Major considerations to be given on the structural design of the pond are described in the following:

(i) Shape of Pond

The shape of the ponds shall have no narrow and elongated portions. In principle, rectangular pond with a length not exceeding three times the width is proposed to be most desirable. Also, concerns of the pond shall be rounded to minimize accumulation of floating materials.

(ii) Embankments

The area where the embankments are to be constructed should be completely cleared. Embankments should be constructed of impervious materials to the extent possible and sufficiently compact to form a stable structure. The embankment top width is to be 6 to 8 m (19.7 to 26.2 ft). The inner and outer slopes of the embankment should not

be steeper than one horizontal to one vertical. The embankment is pitched with rubble stones from the top of the embankment down to the bottom of the pond. The top width of the dike should also be paved to -nsure the access and passage of maintenance vehicles. Minimum free-board is considered to be 0.5 m.

(iii) Pond Bottom

The pond bottom should be made as level as possible at all points. The soil formation at the bottom should be impervious to avoid percolation or seepage of the contents. Therefore, although compacted subsoil at the bottom after removing porous topsoil may increase the water-holding capacity to some extent, the pond bottom should be replaced by well compacted clay or other suitable impervious materials. Further, vinyl sheet may be used to cover the bank and a part of the pond bottom extended about 10 m from the bottom edge.

(iv) Inlet and Outlet Arrangement

Each inlet and outlet shall be provided to each pond. The inlet shall always be submerged so as to allow the incoming sewage flow towards the bottom rather than the surface to avoid odour nuisance and ensure better mixing of the incoming flow with the pond contents. The important precaution to be taken in providing the inlet arrangement is to ensure that the incoming sewage is not directed towards the outlet, thus avoiding short-circuiting. Therefore, the relative location of the inlet and outlet is important. The proposed intervals between the inlet and outlet are to be more than 10 m (33 ft).

(v) Miscellaneous

The pond area should be enclosed with a suitable fence to preclude livestock and discourage trespassing. A vehicle access gate of sufficient width to accommodate the maintenance and operational equipment shall be provided. Open space around the pond is seeded by a low perennial spreading grass which is suitable for growing around stabilization pond sites. Care should be given to landscaping the treatment site, providing buffer zone between the facilities and site boundary, to prevent noise and odour problems.

CHAPTER 6
ENGINEERING CONSIDERATION FOR PROPOSED SEWERAGE SYSTEM

6.1 Sewerage System Layout Plan

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 Project. 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 discussed in the following section.

Alternative study for sewage conveyance facilities are carried out to supplement the master plan study as discussed in Annex 2. This study indicates that Alternative 3, (to pump up the incoming sewage at P5 and convey it by pressure to the treatment facility site by two barrels of force main sewers of equal size. The intergrated 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.

The proposed layout plan for sewage system is shown in Fig. 6.1.

6.2 Proposed Sewerage Facilities with Preliminary Engineering Design

Preliminary engineering design is worked out for the recommended sewerage facilities as described in section 6.1 and Figure 6.1 above for use of the construction cost estimates and the subsequent detailed designing.

The preliminary engineering design includes only for the First Phase sewerage facilities to be provided by the Government. Individual house connections are therefore to be considered later at the time of implementation of services to the beneficiaries.

6.2.1 Sewers

The design of sanitary sewers is based on separate system excluding stormwater. All wastewater discharged from residential, commercial and institutional areas are conveyed to the waste stabilization pond by the proposed separate sewers (Stormwater will be dealt with by a drainage system to be provided separately from the sanitary sewers).

The proposed sanitary sewers are designed based on the estimated ultimate waste flows including extraneous water such as ground water infiltration.

The required capacities of sewers is determined by applying the design basis as discussed in Chapter 5. Figure SF-17 of Volume VIII shows the proposed alignment of the sewers including trunk sewers, and branch and lateral sewers. The plans and profiles for the proposed sewers are also shown in Figure SF-18 through SF-22 of Volume VIII. These figures incorporate the sewer diameter, sewer slope, sewer length, flow direction, location of manholes, boundaries of sewerage zone and sub-zone, and tributaries of sewerage zone and sub-zone, and contributary areas for each sewer. The computation for sewer design is shown in the tables in Annex 7.

Table 6.1 Sewer Length and Number of Manholes by Sewer Size and Depth Proposed by the First Phase Construction Programme

Pipe Dia. (mm)	Average Depth of Sewer (m)	Pipe Length (m)	No. of Manholes Required
225	2.0	11,495	173
	3.0	2,420	38
300	2.0	150	5
	3.0	505	6
	4.0	80	2
375	4.0	900	12
	5.0	690	10
450	4.0	170	3
	5.0	950	13
	6.0	55	1
525	6.0	250	4
600	7.0	80	1
675	7.0	285	4
750	6.0	265	3
	7.0	470	6
900	3.0	110	1
	5.0	365	3
	6.0	700	6
	8.0	10	1
1,050	7.0	400	5
600*	2.0	1,620	-
Total		21,970	297

Note: *: Force main sewer

Table 6.1 shows the proposed sewer diameters, length, average excavation depth, and number of manholes to be installed by the First Phase Programme.

6.2.2 Pumping Stations

Two pumping stations are required for the proposed sewerage system for the First Phase Programme. These pumping stations are designed based on the design basis described in Chapter 5. Though structures of pumping stations are designed to meet the requirement in the year 2000, pump equipment is provided to handle the 1990 sewage flow, in order to avoid an excessive investment.

The proposed shape of pump well is rectangular as shown in Figure SF-23 of Volume VIII. With the provision of coarse bar screens of 100 mm (4 in.) clearance between the screen bars, the screening will be removed manually and carried out by a truck to the disposal site. No grit chamber is provided.

Submersible non-clog pump is proposed due to the advantages of (1) easiness in inspection, operation and maintenance, (2) smaller required floor space than conventional pump, and (3) lower operation cost than other types as studies in Annex 8. Also, a wide range of the size is available in local market from 100 mm to 500 mm in diameter with long experience in operation.

The design flows of the two pumping stations and outline specifications of the pumps provided in the First Phase Programme for the years 1990 and 2000 are shown in Table 6.2 and 6.3 respectively. Proposed plans of these pumping stations are presented in Figure SF-23 of Volume VIII.

Table 6.2 Design Flows of Pumping Stations

Name	The Year 1990		The Year 2000
	Daily Average Flow (m^3/day)	Peak Flow (m^3/min)	Peak Flow (m^3/min)
Kolam Air	6,630*	13.4*	28.6
Tanjong Bendahara	9,200*	17.4*	56.8

Note: (*) The year 1990 sewage flows indicate only from the First Phase Programme Area, while the year 2000 flows indicate from the entire sewerage sub-zone B-1 for Kolam Air pumping station, and from the entire sewerage zone B for Tanjong Bendahara pumping station.

Table 6.3 Outline Specifications for Pumps

Name of Pumping Station	Total Design Head (m)	1990-Year Flow		2000-Year Flow		Pump Type
		Pump Capacity Per Unit (m^3/min)	No. of Pumps Required (*)	Pump Capacity Per Unit (m^3/min)	No. of Pumps Required (*)	
Kolam Air	10	6.7	3	9.6	4	Sub-mersible
Tanjong Bendahara	26	8.7	3	14.5	5	Sub-mersible

Note: (1) (*) includes one stand-by.

(2) Kolam Air pumping station requires land space of 630 m^2, while Tanjong Bendahara pumping station requires 1,600 m^2 for the year 2000.

6.2.3 Treatment Facilities

As discussed in the Master Plan Report and in section 5.2.3, waste stabilization pond process is applied until the need arises in the future

for modification of facilities. The treatment facilities consist of scum chambers, facultative ponds and maturation ponds. These are conveniently located close to the Sg. Kedah to discharge the effluent to the river.

Under the preliminary engineering design purpose, the waste stabilization ponds are designed for a capacity of 11,850 m^3/day which is expected from the First Phase Area by the year 2000, using the design criteria developed in Chapter 5.

The land space required for the treatment facilities for sewarage zone B is estimated to be 22.5 ha. Stabilization pond system is used until the ponds are overloaded. Then, considering economy including all expenses such as for land acquisition, construction, operation and maintenance, the stabilization pond system is converted into aerated lagoon system by changing the maturation ponds (1.5 meter depth) and facultative ponds (1.5 meter depth in Figure 6.2) into aerated lagoons (3.0 meter depth) and maturation ponds (1.5 meter depth) respectively as shown in Figure 6.3.

Based on the 2000-year design flow and BOD loadings in the First Phase Programme Area, which are estimated to be 11,850 m^3/day and 2,054 kg/day respectively, surface area and land space required by the stabilization ponds is illustrated in Figures 6.2, 6.3 and SF-25 of volume VIII. The sewage flow generated in the First Phase Programme Area will be treated by the units of Nos. 1, 2, 3, 4 and 5.

Table 6.4 Surface Area and Land Space Required by Waste Stabilization Pond for the 2000 Year Condition in the First Phase Programme Area

Item	Surface Area Required	Land Space Required (ha)
Facultative Pond	7.27	14.5
Maturation Pond	2.63	

Note: Available land area of the stabilization pond is 22.5 ha for the sewerage zone B.

6.2.4 Laboratory Equipment

The influent and effluent of the stabilization pond should be recorded quantitatively and qualitatively by the frequency as suggested in Section 6.6 of Chapter 5, Master Plan Report. In addition, to monitor the effectiveness of the First Phase sewerage system as well as the progress of the water pollution of the Sg. Anak Bukit and Sg. Kedah, water qualities should be analyzed as to BOD and DO levels at least once in every month at the four sampling points (a, b, e_2 , and d) as shown in Figure L-10, Appendix L of Volume VII.

Approximately 60 m^2 laboratory will be provided in the Kota Setar treatment site in the First Phase to effectively accommodate necessary laboratory equipment for the 2000-year condition. However, equipment to be provided in the First Phase should be limited to the minimum to be needed until the end of the Second Phase (1990). The equipment should include for testing of pH, DO, BOD, SS, coliforms and oil/grease as recommended in Table 6.5, not including the equipment for testing of nitrogen, phosphorus and heavy metals awaiting for future consideration.

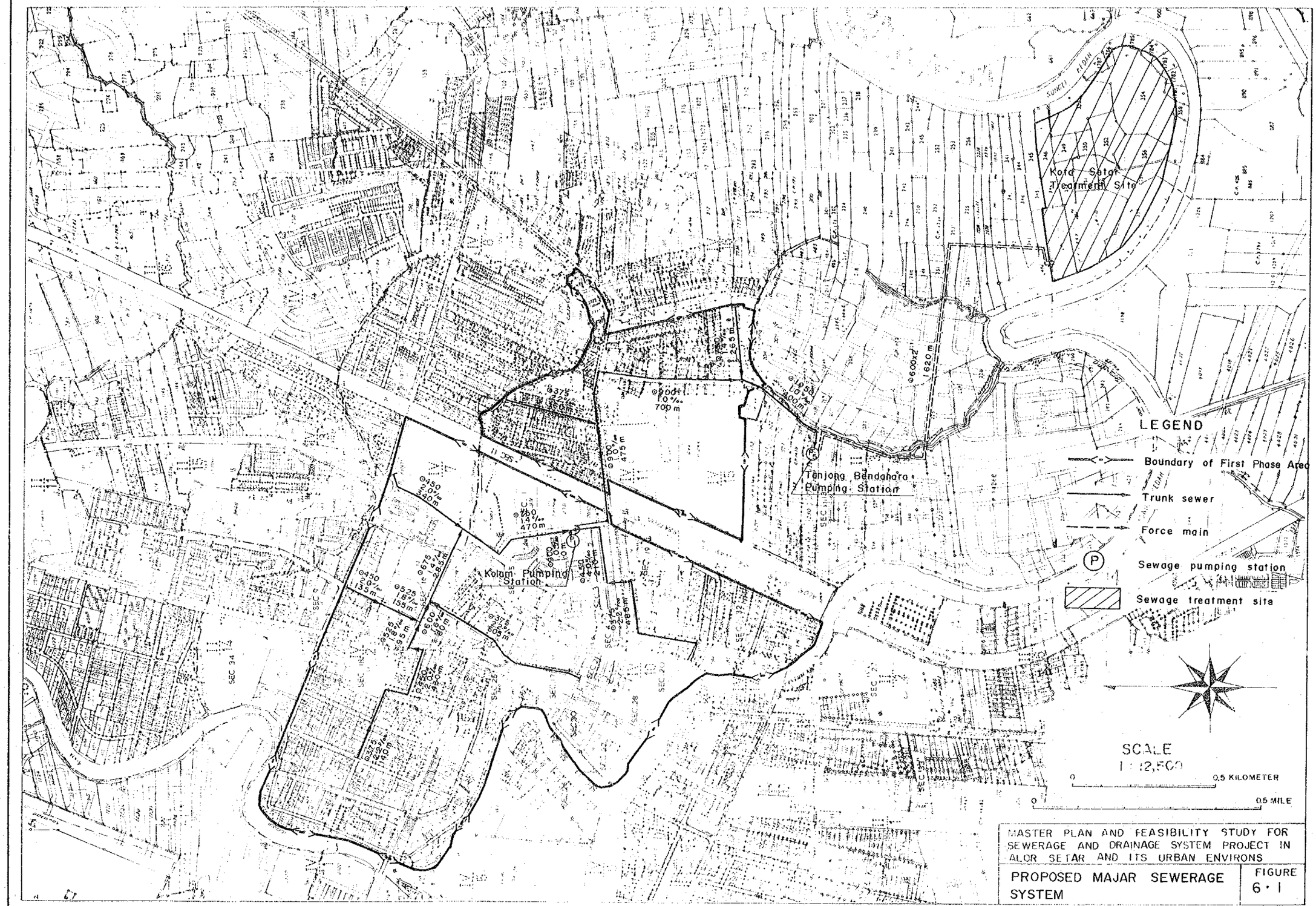
Table 6.5 Laboratory Equipment to be provided by the First Phase Programme

	Name of Equipment	Quantity
1.	Analytical Balance	1
2.	Incubator (BOD)	1
3.	Incubator (microbiological)	1
4.	Microscope	1
5.	Oven	1
6.	pH Meter	1
7.	Pump (vacuum-pressure)	1
8.	Refrigerator (large and small)	2
9.	Sterilizer	1
10.	Still	1
11.	Water Bath	1
12.	Others* (such as BOD bottle, DO bottole, buret, titrate flask, buld pipettee, etc.)	10 each

Note: (1) * The articles needed for analyses should be supplemented as expendable in the future.

(2) Layout plan for laboratory will be provided during detailed design stage.

FIGURE 6 · 1

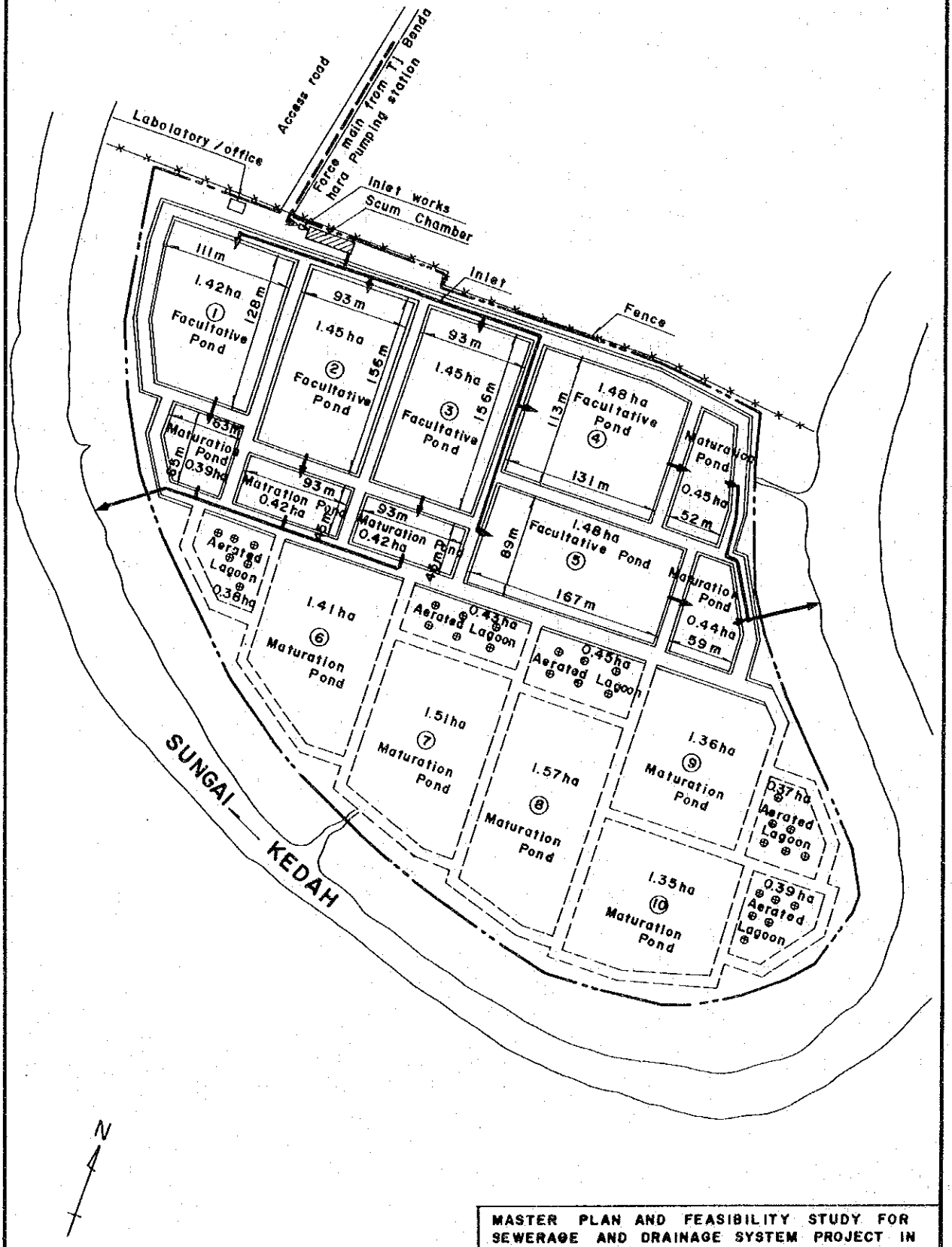


MASTER PLAN AND FEASIBILITY STUDY FOR SEWERAGE AND DRAINAGE SYSTEM PROJECT IN ALOR SETAR AND ITS URBAN ENVIRONS

PROPOSED MAJAR SEWERAGE SYSTEM

FIGURE 6 · 1

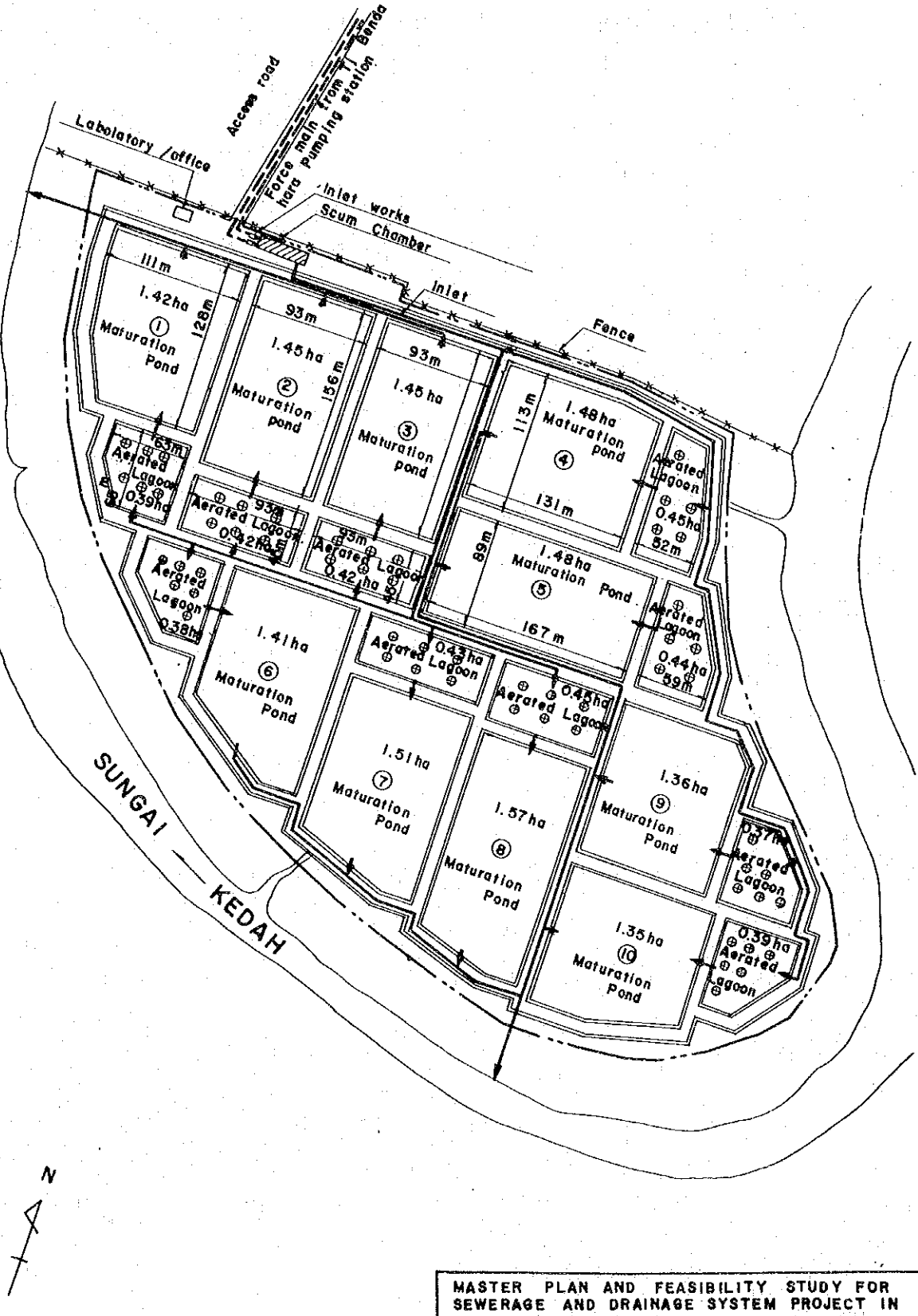
FIGURE 6·2



MASTER PLAN AND FEASIBILITY STUDY FOR SEWERAGE AND DRAINAGE SYSTEM PROJECT IN ALOR SETA AND ITS URBA ENVIRONS

PLAN FOR WASTE STABILIZATION POND PROPOSED IN THE FIRST PHASE	FIGURE 6·2

FIGURE 6·3



MASTER PLAN AND FEASIBILITY STUDY FOR SEWERAGE AND DRAINAGE SYSTEM PROJECT IN ALOR SETA AND ITS URBA ENVIRONS

MODIFIED PLAN OF WASTE STABILIZATION POND IN FIG,6·2 FOR THE FINAL PHASE

FIGURE 6·3

CHAPTER 7
COST ESTIMATES AND CAPITAL INVESTMENT SCHEDULE FOR THE FIRST PHASE PROGRAMME

This chapter describes cost estimating procedures of the sewerage facilities, implementation schedule for the First Phase Programme and estimated construction costs for the proposed sewerage facilities.

7.1 Cost Estimates

7.1.1 Procedure for Estimating Construction Costs

The basic unit costs for sewerage facilities presented in this subsection are extracted from Appendix G of Volume VII.

Materials for structures of pipe bedding, pumping station and treatment facility are generally available in Malaysia, except for mechanical equipments of these facilities. The materials are available in the local market include reinforcing bars, timber, sand and gravel for concrete, vitrified clay pipe and centrifugally cast reinforced concrete pipe of 1,800 mm (71 in.) in diameter or less.

Construction costs for the facilities are defined as the sum of all expenditures required to bring the project to completion. The expenditures for the civil works, installation of the equipment, contractor's profits and overhead, and all related construction works are included in the cost.

(a) Average Construction Costs for Sewers

Since the trench excavation method is proposed for all sewer constructions as discussed in Chapter 5, sheet piling may be needed

depending on the soil conditions and sewer depth. In the majority of the locations, the soil will be primarily soft clay and sand, and the high ground water table will be encountered, based on the data in Figure SF-24 of Volume VIII. In those areas tight sheeting and bracing will be normally required if the depth is 2.0 meters or deeper. Therefore, these are considered for the costing of sewer construction.

The average gravity sewer construction costs in terms of per meter have been estimated by varying pipe sizes and excavation depths as shown in Table 7.1, taking into account the costs for excavation, sheeting, dewatering, reinforcing, restoration of paving as needed, together with contractor's profits and overhead. Similarly, the average pressure sewer construction costs are shown in Table 7.2. Construction costs for varying sizes of manholes and depths are also shown in Table 7.3.

Table 7.1 Gravity Sewer Construction Costs by Size and Depth

(M$/m of pipe length at 1979 price level)

Pipe Dia. (mm)	Depth of Excavation (m)						
	2.0	3.0	4.0	5.0	6.0	7.0	8.0
225	148	176	202	453	562	-	-
300	197	225	251	251	610	-	-
375	169	197	224	474	587	611	-
450	200	230	257	509	620	650	-
525	224	250	283	537	653	681	-
600	254	288	318	580	693	735	875
675	308	345	378	645	762	811	957
750	334	372	405	675	792	845	995
900	413	455	491	769	891	955	1,119
1,050	496	543	582	868	994	1,068	1,246
1,200	555	608	650	942	1,072	1,157	1,346
1,350	662	717	761	1,060	1,193	1,286	1,484
1,500	755	815	862	1,169	1,305	1,402	1,620

Table 7.2 Pressure Sewer Construction Costs by Size

(M$/m of pipe length at 1979 price level)

Pipe Dia. (mm)	225	300	375	450	525	600	700	800	900
Construction Cost	97	114	135	166	206	253	445	557	666

Note: (1) Pipe material from 225 mm to 600 mm dia. is Asbestos-cement pipe and from 700 mm to 900 mm dia. is Steel pipe.

(2) Earth covering of the sewers are considered to be one meter.

Table 7.3 Manhole Construction Costs by Sewer Size and Depth

(M$/unit at 1979 price level)

Manhole Type	Internal Size (mm)[1]	Excavation Depth (m)						
		2.0	3.0	4.0	5.0	6.0	7.0	8.0
Type I	1,200[2]	1,685	1,864	2,164	2,503	2,778	3,071	3,346
Type II	1,500[3]		2,102	2,548	2,800	3,074	3,368	3,642
Type III	1,800[4]			3,162	3,416	3,689	3,984	4,257

Note: (1) Internal manhole sizes are decided by those of sewers connected to the manholes.

(2) Less than 900 mm sewers are connected.

(3) 900 - 1,200 mm sewers are connected.

(4) 1,200 - 1,500 mm sewers are connected.

(b) Pumping Stations and Treatment Facilities

Both the pumping stations and the stabilization ponds will be constructed by open-trench excavation. The construction costs are estimated on the basis of unit prices for materials and equipment including overhead

of contractor. Major part of the electrical and mechanical equipment is assumed to be imported from such countries as Singapore, Australia, America and Japan.

These costs are estimated based on reasonable assumptions and quotations obtained from reliable manufacturers.

7.1.2 Procedure for Estimating Operation and Maintenance Costs

Procedure for estimating operation and maintenance costs for proposed sewerage system is described in this section for the purpose of feasibility study modiying the study in Appendix G in Volume VII used for master plan stage.

(a) Sewers

The overall operation and maintenance costs have been estimated the First Phase Programme assuming 0.25 percent of the construction cost per annum on the basis of the experience obtained in the similar sewerage system. A high pressure cleaning machine is considered appropriate for cleaning public sewers. The assumptions made for the estimations are as follows:

Frequency of Cleaning		
Public sewers	...	once in every four years
Cleaning Capacity		
Public sewers	...	200 m/day (660 ft/day)
Crew Number		
Public sewers	...	six persons
Useful Life Span of Equipment	...	Ten years

Cost for Spare Parts, Repairing, Overhauling of Equipment	...	5% of equipment cost (per annum)
Work Days and Hours		
Work days	...	250 days per year
Work hours	...	6 hours per day
Salary of Crew	...	M$250 per month

Note: Operation and maintenance cost for house connections is not estimated, as this cost should be incurred privately.

(b) Pumping Stations

Operation and maintenance costs for these facilities are derived from the 1979-year labour and material costs in the Study Area, including power, fuel, lubrication, screenings removal and disposal, and major repairing of equipment.

Inspection and cleaning of the pumps and removal of screenings will be made three times a week at least by two workers. A team of two workers can take care of the two stations in a day.

Annual cost for repairing of civil works and buildings is assumed to be 0.25 percent per annum of the construction cost and 2 percent per annum for electrical and mechanical equipment. Power costs are estimated at M¢8/kwh.

(c) Treatment Facilities

Operation and maintenance required for the stabilization ponds are mainly inspection work. By visual observation, a operator is able to know the general condition of the pond with particular attention to odour

and colour of sewage. In addition, accumulation of floating algae and scum of organic materials will be checked periodically along with the growth of aquatic plants in the ponds. The operator should also inspect the access road, fencing and embankment, and keep them in good condition.

The operation and maintenance of the ponds should be made by the limited number of operators under the operation and maintenance section head, thus reducing the costs significantly. The number of employees required for the proposed stabilization ponds in the First Phase facilities is assumed to be three.

Average salary for each worker is estimated at M$250 per month as of 1979 cost level. Annual cost for repairing of civil works and others is assumed to be 0.25 percent per annum of the construction costs of the ponds.

7.2 Implementation and Disbursement Schedule

7.2.1 Implementation Priority

Considering disbursement schedule of available fund, it seems advisable to identify three Blocks in the Study Area. For the purpose of establishing implementation priority, with due consideration to the geographical condition, Blocks 1, 2 and 3 are recommended as shown in Figure 7.1. Implementation priority of the three blocks, that is, Blocks 1, 2 and 3, in the First Phase Area is determined by evaluating by both technical and economic aspects.

Four major factors are considered for assessing the priority of three blocks, namely by (1) population density, (2) existing condition of land uses, (3) organic generation, and (4) existing condition of excreta disposal system assigning weighted points from one to three for each factor as discussed in Annex 3. The overall evaluated points by block are shown in Table 7.4-1.

Table 7.4-1 Overall Evaluated Points by Block

	Factors	Block 1	Block 2	Block 3
(1)	Population density	1	3	2
(2)	Land uses	1	3	2
(3)	Organic generation	1	3	2
(4)	Existing condition of excreta disposal system	2	1	3
	Total points	5	10	9

Note: Refer to Annex 3 for detail.

Since the revenue/cost ratio differs according to implementation order of the three blocks and revenues to be incurred therefrom, three alternative investment cases are considered as discussed in Annex 3 as concluded in Table 7.4-2.

Table 7.4-2 Revenue/cost Ratio by Case

	Total Present Value for Construction and Operation Costs (M$1,000)	Total Present Value for Revenue (M$1,000)	Revenue/Cost
Case 1	8,352	677	0.081
Case 2	8,540	909	0.106
Case 3	8,845	712	0.080

Referring to both the technical and economic evaluation, it is recommended that the priority should be in the order of Blocks 2, 3 and 1. However, Block 2 will be divided into 2-1 and 2-2 simply for the purpose of equalizing construction work during the First Phase Programme.

7.2.2 Implementation Schedule

Based on the proposed implementation order of the three blocks are above, both implementation schedule and facilities to be provided in the First Phase Programme are worked out as summarized in Tables 7.5 and 7.6 respectively. For the maintenance purpose of the sewerage system, sewer cleaning equipment, trucks and laboratory facilities are also provided in the cost estimates. Land acquisition for all future treatment facilities recommended in the Master Plan is also considered.

Table 7.5 Implementation Schedule for the Proposed Sewerage Facilities in the First Phase Programme

Item	1981	1982	1983	1984	1985
I) Sewage Collection System					
(1) Trunk Sewers (P_1 to stabilization Pond)*					
(2) Branch & Lateral Sewers . Block 1					
. Block 2					
. Block 3					
(3) Kolam Air Pumping Station					
·Civil Works					
.Mech. and Electrical Works					
(4) Tanjong Bendahar 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.

Table 7.6 Proposed Sewerage Facilities in the First Phase Construction Programme

1.	Sewers	
	(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	see Table 6.5
5.	Land Acquisition	
	(1) Treatment sites*	88 ha**
	(2) Pumping station sites	2,230 m^2***

Note: The above proposed sewerage facilities are constructed by the Government Contribution.

* : Includes all treatment site.

** : These area include all treatment sites proposed in the Master Plan, namely 14.7 ha for zone A, 22.5 ha for zone B, 12.4 ha for zone C, 18.8 ha for zone D and 19.6 ha for zone E.

*** : These area include 630 m^2 (Kolam Air Pumping Station) and 1,600 m^2 (Tanjong Bendahara Pumping Station).

7.2.3 Disbursement Schedule for Proposed Sewerage System

The project cost of the sewerage facilities recommended in Table 7.6 is estimated to be approximately M$17 million as of 1979 price level. A period of five years is envisaged from the technical and financial consideration including ability of the potential customers to pay.

Allocation of the costs over the five-year span has been made in Table 7.7, according to the implementation schedule in Table 7.5 and the proposed sewerage facilities as shown in Table 7.6. The first year of the programme (1981) will be needed for detailed design for the facilities proposed and for land acquisition of the pumping stations and five treatment facilities. The following four years are for construction. The cost disbursement schedule for the five-year period from 1981 through 1985 is shown in Table 7.8, taking into account of the following:

(i) Foreign Portion

In estimating the costs for foreign components, it is assumed that all items that are not manufactured in Malaysia will be imported. The items include pumps, engines, valves, metering and controlling devices, and other equipment required for pumping stations and treatment facilities.

(ii) Import Duties

Since the project is undertaken by the Government, it is assumed that no import tax is included in the estimation of the cost for the materials and equipment imported.

(iii) Engineering Costs

Engineering costs for the implementation of the First Phase Programme include the costs for both detailed engineering design and construction supervision services. It is assumed that 15 percent of

the construction costs may be needed for the engineering services, approximately 10 percent is considered to be needed for the detailed design and the remaining 5 percent for the construction supervision services.

(iv) Contingencies

Twenty percent of the estimated construction cost is considered as contingency allowances for the completion of the project safely. This percentage is estimated on the basis of the similar projects experienced elsewhere in Asian countries and also taking various factors in the project area into account.

Based on the consideration in section 7.1.2, Chapter 7, and also the required administrative man-power input shown in Table 2, Volume VI, annual operation and maintenance costs for the years from 1981 through 1991 have been estimated as summarized in Table 7.9.

Table 7.7 Estimated Construction Costs for Proposed Sewerage Facilities in the First Phase Programme (1981 - 1985)

(Unit: M$1,000 at 1979 price level)

Facilities/Activities	Cost for Civil & Architectural Works	Cost for Electrical & Mechanical Equipment	Cost for Land Acquisition	Total
(1) Sewer facilities	6,746	-	-	6,817
(2) Pumping station				
a) Kolam Air	280	443	109(*)	832
b) Tanjong Bendahara	504	635	60(*)	1,199
(3) Wast stabilization pond (Kota Setar)	1,721	-	630(**)	2,351
(4) Cleaning machine	-	150	-	150
(5) Laboratory	38	39	-	77
(6) Land aquisition of other treatment sites	-	-	1,668(**)	1,668
Total	9,289	1,267	2,467	13,023

Note: (1) Land acquisition costs are estimated as follows:

* For pumping station

Kolam Air : $630m^2$ x M$172.58/$m^2$ = M$108,485
Tanjong Bendahara : $1,600m^2$ x M$37.7/$m^2$ = M$60,302

** For treatment site

Zone A (Alor Merah)	: 14.7ha x M$20,000/ha	= M$294,000
Zone B (Kota Setar)	: 22.5ha x M$28,000/ha	= M$630,000
Zone C (Mergong)	: 12.4ha x M$32,000/ha	= M$396,000
Zone D (Penkalan Kundor)	: 18.8ha x M$28,000/ha	= M$256,400
Zone E (Kuala Kedah)	: 19.6ha x M$23,000/ha	= M$450,800
		M$2,298,000

(2) Costs for services on detailed design including tenders and construction supervision together with contingency are not included.

Table 7.8 Disbursement Schedule for the First Phase Programme

(M$1,000 at 1979 price level)

Description	Local Currency						Foreign Currency						Total
	1981	1982	1983	1984	1985	Sub-total	1981	1982	1983	1984	1985	Sub-total	
Sewers	-	2,286	1,424	1,192	895	5,797	-	404	251	210	157	1,022	6,819
Pumping Station													
Civil Works	-	403	224	-	-	627	-	101	56	-	-	157	784
Mech. and Electrical Works	-	-	323	-	-	323	-	-	755	-	-	755	1,078
Waste Stabilization Pond													
Civil Works	-	-	640	486	251	1,377	-	-	160	121	63	344	1,721
Cleaning Machine	-	-	-	-	-	-	-	-	-	150	-	150	150
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
Consulting Services													
Engineering Design	531	-	-	-	-	531	532	-	-	-	-	532	1,063
Supervision	-	64	77	45	27	213	-	96	115	67	41	319	532
Contingencies	106	551	538	351	235	1,781	106	120	267	119	52	664	2,445
Land Acquisition	2,467	-	-	-	-	2,467	-	-	-	-	-	-	2,467
Total	3,104	3,304	3,226	2,104	1,408	13,146	638	721	1,604	714	313	3,990	17,136

Table 7.9 Annual Operation and Maintenance Costs

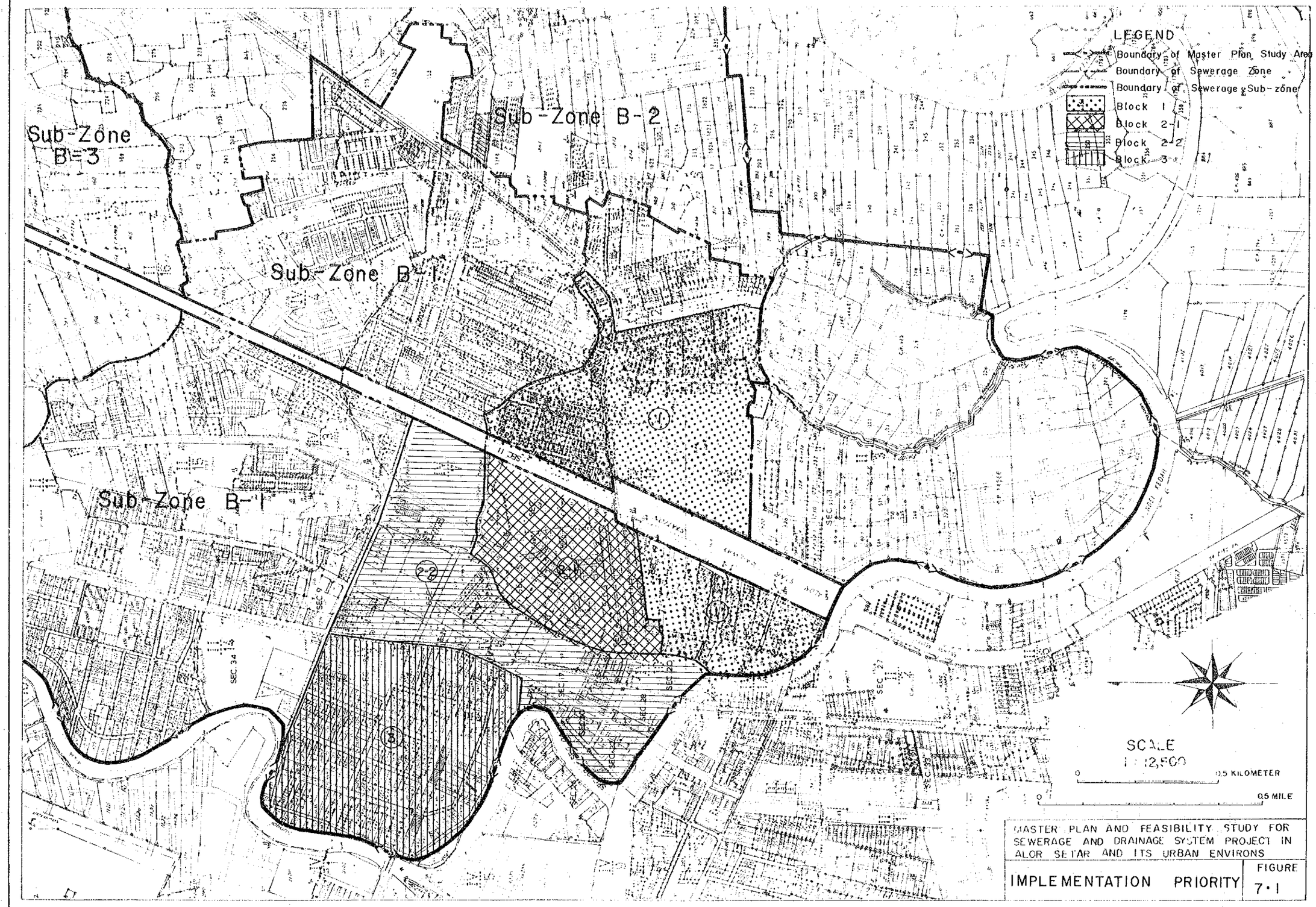
(M$1,000 at 1979 price)

Item	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	-	-	8	35	49	52	52	52	52	52	52
Power	-	-	-	21	35	44	45	46	48	49	50
Administration	17	19	32	32	33	33	33	33	38	39	39
Total	186	205	362	420	449	461	462	463	518	529	530

Note: (a) Wages and salaries for the personnel to be employed for the sewage works, based on the "Schedule of Estimated Staff Requirement", in Table 2, Chapter 2 of Institutional Study (Volume VI).

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

FIGURE 7·1


Sub-Zone B-3
Sub-Zone B-2
Sub-Zone B-1
Sub-Zone B-1
LEGEND
Boundary of Master Plan Study Area
Boundary of Sewerage Zone
Boundary of Sewerage Sub-zone
Block 1
Block 2-1
Block 2-2
Block 3
SCALE
1 : 12,500
0 0.5 KILOMETER
0 0.5 MILE
MASTER PLAN AND FEASIBILITY STUDY FOR SEWERAGE AND DRAINAGE SYSTEM PROJECT IN ALOR SETAR AND ITS URBAN ENVIRONS
IMPLEMENTATION PRIORITY
FIGURE 7·1

CHAPTER 8
FINANCIAL PLAN FOR THE FIRST PHASE PROGRAMME

8.1 Current Financial Situation of Majlis Perbandaran Kota Setar (MPKS)

The Municipal Council of Kota Setar was originally started as Sanitary Board in 1940 to administer the public health and in 1959 it was transformed to Town Board, and Town Council in 1975 with its administrative area of 77.7 km^2 (30 sq. miles). Most recently in 1979 it was upgraded to Municipal Council under the Local Government Act and administrative area was expanded to present 664.1 km^2 (256.51 sq. miles). In the wake of above upgrading the responsibility was also expanded and its financial autonomy has ever since been of great significance.

As there is presently no regular sewerage works undertaken by MPKS except rudimental public sanitary services as night soil collection and disposal as well as desludging of septic tank, it is considered impossible to present information normally required on financial analysis of independent sewerage agency to be responsible for sewerage services. The following description refers, therefore, to general reviews of revenues and expenditures of the public services provided by MPKS. The Table 8.1 shows the summary of the revenue and expenditures of MPKS for the past three years.

The major revenue sources for MPKS is the Rates including contribution in lieu of Rates representing approximately 63% of total revenue as of the year 1978. The Rates are levied on the basis of property value of individual households within the boundary of the Council and such Rates are varied in respective areas. The Rates for household property in the urban built-up area is 24% of the assessed value, the highest in the MPKS's boundary, followed by 13.5% for the property in the area newly developed in 1972 and 8 - 9% for the suburban less developed areas. The average Rates to be levied on the whole property value is about 20% and it is estimated the Rates revenue can be increased up to

Table 8.1 General Revenue and Expenditure Account M$) MPKS (From 1976 to 1978)

	1976	1977	1978
REVENUE			
Rates (Property Assessment)	1,434,265	1,618,448	1,655,507
Contribution in lieu of Rates(*)	162,998	306,696	189,696
License Fee	133,730	141,589	138,663
Government Subsidy		170,608	107,500
Sanitary Service Fee (Night-soil Collection, Septic Tank)	119,494	116,697	102,273
Other General Public Service Fee	546,779	537,797	654,675
Miscellaneous Income	117,609	110,744	99,884
Total Revenue	2,514,875	3,002,579	2,948,198
EXPENDITURE			
Personnel Expenditure (Salary, Wage and Allowance)	1,680,668	2,379,417	2,065,314
Office Supplies and Maintenance	372,206	314,681	439,003
Expenditure for Public Service	237,681	189,273	203,292
Purchase of Machines & Equipments	21,718	58,942	39,999
Miscellaneous Expenditure	3,873	339	748
Total Expenditure	2,316,146	2,942,652	2,748,356
Surplus (Deficit) to General Reserve Fund	198,729	59,927	199,842

Note: (*) Contribution equivalent to rates due from the government and quasi government agencies including State and Federal Government, National Electricity, Malayan Railways, and MADA.

M$ 2 million in the year 1980 assuming the increasing housing development and accruing increase of whole property value up to about M$10 million.

If the benefits of sewerage project are duly reflected to the increase of property value, more revenue can be expected accordingly providing revaluation of property assessment is legally supported. The major expenditures are those related to salary and wages for the employee of the Council. More than half of the personnel expenditures are those for the labourers of about 380 occuyping approximately 73% of total 520 staff of the Council as of the year 1980. These labourers are engaged in the day to day community services mainly for sanitary control programme such as collecting and disposing of night soil and septic tank deposits as well as garbage collection and cleaning of the municipal roads and water ways. The expenditure of such labourers can be reduced significantly if the existing works related to disposal of night soils and septic tank deposits are minimized by the completion of sewerage system.

8.2 Sources of Financing

8.2.1 Sources for Capital Costs

The proposed magnitude of investment to meet the construction for the First Phase Programme of 5 years is approximately M$17 million at 1979 price in the Master Plan Report. On the basis of above magnitude of investment the detailed cost estimation has been made as detailed in the Table 8.3, Project Cost Estimated of the present report.

The foreign currency portion of the total cost is normally assumed to be financed by the loans from the international lending agencies such as International Bank for Reconstruction and Development (IBRD) or the Asian Development Bank (ADB) or bilateral fund sources unless Federal Government purchases and provides foreign currency required as a part of its loan for the project. The local currency part of the construction cost is assumed to be financed by the Federal Government loan.

The terms and conditions of the loans are considered on the basis of current loan practices of international lending agencies as well as Federal Government as described in the subsequent Financial Projection.

Although it is a basic approach to expect a self-supporting operation of the project, such project as sewerage development programme entails a significant amount of capital cost with relatively less generated income. The Federal Government grant to a certain part of the costs including investment for land acquisition is considered necessary under the present financial capability of MPKS in order to help reduce the loan amount and alleviate the difficulty of the debt service payments, thus placing the project on a sound and viable financial basis.

8.2.2 Sources for Operation and Maintenance Costs

The sufficient revenues have to be raised for the satisfactory operation as well as maintenance of the sewerage system constructed. The revenues should be generated in whatever methods to compensate not only the cost related to physical maintenance of the system but also the financial requirement of debt service payments. The policy to raise revenues for the public services should generally based on the principle that those who will receive benefits or convenience from such services should pay the charges or fees in accordance with quantity and quality of services by the methods simple, practicable and equitable.

There are two methods in a broader concept to meet such principle in the sewerage services. The first one is a method to impose a charge on the users of the wastewater disposal system in protection to the use they make of the systems. The second one is a method to distribute the charges to the whole community area including users and nonusers of the systems in accordance with the overall community benefits from the sewerage services. The former is more directly related to the individual users of the systems and normally takes a form to collect the charges based on waste flow contribution. The latter is normally considered to

supplement the revenue sources taking a form of assessment on property based on the justification that each property owner, occupied or unoccupied, and each resident, users or nonusers, receives tangible or intangible benefits such as environmental beautification and land value increases. The following alternative charging methods are, therefore, considered to help select feasible methods taking into account the current practices in some countries in the world including Malaysia.

a) Pedestal Charge

The flat rate is multiplied by the number of water closet (WC) pedestal in the households to calculate the charges on the theory that the waste volume is linked with pedestal. The collection of the charges is administratively easy and has already been practiced in a town in Malaysia, but, it does not appear that the waste discharge is closely related to the pedestal, and, more adequate method should be considered.

b) Fixture-unit Charge

The number of water fixtures, such as faucets, water heaters, air coolers, and flush toilets, are multiplied by flat rate so as to provide the revenue required based on the theory that volume of waste discharge is related to the volume of water consumption, hence to the number of fixtures. However, the households which have many fixtures do not necessarily consume greater amount of water and more rational method should be considered.

c) Per Capita Charge

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

to the numbers of residents. This method is more logical than above two methods in estimating the quantity of waste discharge, however, it has a significant disadvantage in practicability as there is no registration system to confirm the number of residents in the Study Area.

d) Surcharge on Water Consumption

The water rate surcharge is service charge related to water use which is calculated by adding a fixed rate to metered amount of water consumption. This method would appear to be the satisfactory alternative as the volume of waste discharge is closely related to water consumption which is accurately method. There will be certain cases where water consumption is difficult to be measured as consumers draw water from private source (wells). However, the most water in the Study Area is supplied by pipe, and there will be no disadvantage in adopting this method.

Another advantage of this method would be the easiness of collection of charge in case the arrangement is made in combination of billing procedure for water supply. The billing procedure for water supply service is already well established in the State of Kedah including Study Area, and with nominal commission charges JKR may be willing to consider cooperation without services administrative difficulties.

e) Sewerage Benefit Assessment

Special sewerage rate can be levied, in addition to the existing assessment on properties, on the area provided with the sewerage services. Such specific rate can be justifiable because rate revenue can be obtained from the area receiving direct or indirect benefits from the systems while general rate revenue is derived from the wider area including the area with no connection to the sewerage services.

The Local Government Act, 1976 empowers the local municipality in its Sections 128, 130 & 131 to impose sewerage improvement rate at maximum of 5% per annum of the annual value of the property served by sewerage system to meet the costs for construction and maintenance of such sewerage systems.

8.3 Recommended Charging Systems

The selection of the revenue sources as stated above in order to meet the required annual cost including the operating expenditure and debt service payment is therefore undertaken based on the principle that the individuals should contribute towards meeting cost in relation to the benefits they receive from the availability and use of the sewerage services. Those who receive the benefit are not necessarily direct users connected to the sewer but include the owners of properties receiving general benefits of health protection, nuisance elimination, aesthetic enjoyment of waterways and increase of market value of properties. Both the property owners and the users should, therefore, contribute fair share of the cost associated with the construction of the systems as represented in a form of annual repayment of loan required for such constructions, and operation and maintenance cost to ensure continued satisfactory service.

The most appropriate charging method from the direct users shall be to collect surcharge on water consumption of the individual users. This method is particularly considered adequate in the Study Area where all water used is metered. The water rate surcharge can be billed and collected by water supply department of JKR utilizing combined water and sewerage bills and proceeds of the surcharge will be remitted to the agency responsible for sewerage system operation after deduction of agreed fee for JKR's service. A legislative arrangements will be required to add stipulations qualifying the joint billing of water and sewerage charges and cutting off the water supply in case of non-payment of sewerage charge in the existing regulation related to water supply.

As the supplementary revenue to be contributed from residents who will receive general benefits of sewerage services, sewerage benefit assessment as referred above is considered logical. MPKS is recommended to take necessary zoning arrangement to define the areas which will receive benefits from sewerage services in order to justify the levying assessment to the property owners in such areas. The collection of such sewerage tax rates as recommended is desirable to be implemented to the maximum extent possible but it is also necessary to consider eventual difficulties in enforcing the increase of existing rates due mainly to political constraints. The allocation of necessary fund of MPKS should alternatively be considered if the implementation of such rate increase is failed.

General tax rates revenue among the items of revenue of the Municipality is the major source of revenue, as stated earlier, on the rental value of the properties. The nature of the revenue being levies on property values, it may be permissible to consider use of a part of such revenue for sewerage system service in order to make the financial planning viable, even though it may be less equitable as the revenue is obtained from whole municipal area while the benefits of such revenue accrue to only limited area provided with sewerage services. However, such provision of fund derived from the general tax rates may be justified, on the basis of social investment for improvement of general health and sanitation of the community as a whole.

The combination of the above two financing sources, namely, sewerage charges on users and tax rates revenue either from property owners or allocation of fund of MPKS is therefore considered to ensure the best mean on the basis of equitable and practicable consideration taking account of both the user and nonuser beneficiaries.

In order to ensure revenue from the direct users, which will constitute substantial source of financial support, serious consideration should be given to enact regulation in effect to make connection mandatory whenever services are made available within 30 m (100 ft) of

property, and moreover, that the sewerage charge be collected whether connected or not connected. Such arrangement for enforced payment will likely to overcome customers' initial reluctance to avail sewerage services, and expedite the connections, making financial plan workable.

8.4 Ability and Willingness to Pay

The ability and willingness of the potential customers to pay for the benefits of sewerage services are measured to gauge the feasibility of the financial independency. The ability to pay is commonly measured by the ratio of the service charge to the total available income of the potential customers. If the ratio is smaller, the ability to pay is greater and maximum limit of the rates commonly employed for sewerage charge in developing countries is approximately two percent. If proposed charge is under two percent of total household's income, the owners of such household are considered capable of paying the proposed charge.

The willingness to pay is not necessarily consistent with the ability to pay as it depends mainly on the individual's awareness and evaluation of the benefits deriving from the sewerage services, and further individuals have common desire to underestimate their capability to pay the charges. The willingness of the individuals to pay for the sewerage services may not be as explicit as their willingness to pay for other utility services including water supply which provide more visual and evident benefits while benefits of sewerage services are more intangible as represented by general sanitation and aesthetic improvements. The public guidance will be necessary to make the individuals aware of and recognize such benefits as one of the approaches to enhance their willingness to pay.

a) Users' Ability to Pay

A sample survey was conducted in June 1979 for the purpose to gauge the ability of potential users to pay the sewerage charge in connection with household income in selected area representing income level in project area based on the sampling approach. A summary of the survey, showing a distribution of income levels as well as the average household income, is presented in Table 8.2. As indicated in the Table 8.2 the average monthly household income is M$580. The maximum monthly sewerage charge within ability to pay would be M$11.6 based on the normally employed rate of two percent as mentioned in previous paragraph.

b) Users' Willingness to Pay

In the survey to estimate above willingness to pay people living in commercial area and one story attached terrace houses indicated rather high degree of willingness to pay of about M$10/month. Some people, who know the sewerage system that contributes to the improvement of sanitary condition of the community, expressed their positive willingness to cooperate for provision of sewerage system and show higher willingness to pay for sewerage service.

It may be expected that households with existing septic tanks of their own may be initially reluctant to avail of government sewerage services. However, once the sewerage system is operational, tangible improvements in the sanitation of the area will be demonstrated and this should entice more users.

8.5 Financial Projection

The nine sets of loan alternatives are developed, in order to secure the fund for initial investment of work required for the First Phase Programme, based on the projected cost estimates of M$22,873,000

Table 8.2 Household Income Survey (June, 1979)

Salary Scale M$/month	Total	Number of Households by House Type I	II	III	IV	V	VI
101 - 200	9	2	1	1	3	2	
201 - 300	13	1	2	3	3	2	2
301 - 400	11	2	1	3	2	2	1
401 - 500	11	2	1	2	3	2	1
501 - 600	7			1	2	3	1
601 - 700	4	1	1		2		
701 - 800	1			1			
801 - 900	6	1	1	1		3	
901 - 1,000	4				1	2	1
1,001 - 2,000	7	1				2	4
More than 2,000							
Total	73	10	7	12	16	18	10
Average Income (M$)	580	532	460	432	445	685	916
Existing Waste Disposal System		PL, PST	PL, PST	BS, PST	OP, BS	BS, PST	PST

Note: House Type

I : Wooden house in Kampung Area

II : One story attached terrace house

III : Two story attached terrace house

IV : Commercial house

V : Semi-detached house

VI : Terrace house located in newly developed residential area

BS : Bucket System

PL : Pit Latrine

CST : Communal Septic Tank

PST : Private Septic Tank

RL : River Latrine

OP : Oxidation Pond

with escalation, as shown in Table 7.8, with due consideration on potential key factors of funding sources as follows:

Alternative I-A : The foreign currency portion of M$5,379,000 is assumed to be financed by the loan of softer terms from bilateral capital sources and local currency portion of M$17,494,000 to be financed by Federal Government loan.

Alternative I-B : The foreign currency portion is increased to M$7,998,000 equivalent to 40% of project cost excluding land acquisition cost, and local currency portion is reduced to M$14,875,000 of above Alternative I-A.

Alternative II-A : The foreign currency portion of M$5,379,000 is assumed to be financed by the loan of ordinary terms from international capital sources and local currency portion of M$17,494,000 to be financed by Federal Government loan.

Alternative II-B : The foreign currency portion is increased to M$7,998,000 equivalent to 40% of project cost excluding land acquisition cost, and local currency portion is reduced to M$14,875,000 of above Alternative II-A.

Alternative III-A : The foreign currency portion of M$5,379,000 is assumed to be financed by the loan of softer terms from bilateral capital sources and local currency portion of M$14,617,000 to be financed by Federal Government loan providing the Federal Government contributes a grant for land acquisition cost of M$2,877,000 approximately 12.6% of the total cost.

Alternative III-B : The foreign currency portion is increased to M$7,998,000 equivalent to 40% of project cost excluding land acquisition cost, and local currency portion is reduced to M$11,998,000 of above Alternative III-A.

Alternative IV-A : The foreign currency portion of M$5,379,000 is assumed to be financed by the loan of ordinary terms from international capital sources and local currency portion of M$14,617,000 to be financed by Federal Government loan providing the Federal Government contributes a grant for land acquisition cost of M$2,877,000, approximately 12.6% of total cost.

Alternative IV-B : The foreign currency portion is increased to M$7,998,000 equivalent to 40% of project cost excluding land acquisition cost, and local currency portion is reduced to M$11,998,000 of above Alternative IV-A.

Alternative V : The total project cost is assumed to be financed by Federal Government providing M$19,996,000 to be financial by Federal Government loan and land acquisition cost of M$2,877,000, approximately 12.6% of total cost to be subsidized by Federal Government.

With nine sets of loan alternatives described above, further detailed financing plans are developed with the following components in mind in order to find most viable financing schedule with the least financial burden on the part of MPKS.

(1) Fund Requirements

The capital cost for the First Phase Programme from 1981 to 1986 and operation cost from 1981 to 1991 only, for the purpose of determining funding requirement, are summarized in Table 8.3 through 8.5. These cost include the allowance for price escalation of 8 percent per annum on the costs estimated at 1979 prices.

(2) Loans

Assuming that MPKS has not own fund to meet the capital costs of the project, the international as well as domestic loans are considered in accordance with the nature of the required fund.

The loans from the international capital sources as well as bilateral capital sources are assumed to provide funds for foreign currency portion of the project cost while the Federal Government is assumed to furnish more softer loans for the local currency portion of the project costs. As the estimated foreign currency component of the project cost is significantly small equivalent to only 24 percent of total cost, the alternative financial projection is attempted on the assumption that above international lending agencies would not limit the loan to the foreign currency portion only but extend a loan to a part of 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 projections, therefore, incorporate the foreign exchange component equivalent arbitrarily to approximately 40 percent of total project costs excluding land acquisition cost.

The exemplified terms of above international and bilateral loans are assumed from the current lending practice of each lending agency for the development project in Southeast Asian regions including Malaysia. The loan of ordinary terms from international capital source is assumed to be made at 8 percent per annum, 20 equal annual

repayments after 5 years grace period. The loan of softer terms from bilateral capital sources is assumed to be made at 3.25 percent interest per annum, 30 equal annual payments after 5 years grace period. The Federal Government loan is assumed to be made at 6 percent interest per annum and 30 equal annual repayments after 5 years grace period. The Federal Government is alternatively assumed to furnish a grant to meet the land acquisition costs since substantial portion of such land acquisition (approximately two-thirds of total land acquisition) is schemed to meet a potential need and such costs are considered to be linked with social costs. (Ref. Alternatives III-A, III-B, IV-A & IV-B) The disbursement of loans is assumed dictated by annual capital requirement.

The deferred payment of interest in addition to deferred payment of principal during the grace period (construction period) or the loan is assumed to reduce the significant financial burden which the executive agency would otherwise be required to assume. Such interest is recommended to be charged to operation after the grace period when construction is completed and sufficient revenue is generated.

(3) Depreciation

Depreciation allowances are estimated by applying the composite depreciation rate of 2.5% to the completed fixed assets in service. The above description rate is calculated based on the estimated life and the estimated investment for each category of sewerage systems as follows.

Category	Estimated Life	Depreciation Rate (a)	Investment Distribution (b)	(a) x (b)
Sewers, ponds and structures	50 years	2%	88.4%	1.768%
Equipment and machine	15 years	6.7%	11.6%	0.777%
			Composite Rate	2.545% ≒ 2.5%

Table 8.3 Project Cost Estimates

(M$1,000)

Item	1981		1982		1983		1984		1985		1986	
	L	F	L	F	L	F	L	F	L	F	L	F
Sewers	-	-	2,286	404	1,424	251	1,192	210	895	157	5,797	1,022
Pumping Station												
Mech. & Electrical Works	-	-	-	-	323	755	-	-	-	-	323	755
Civil Works	-	-	403	101	224	56	-	-	-	-	627	157
Waste Stabilization Pond												
Civil Works	-	-	-	-	640	160	486	121	251	63	1,377	344
Cleaning Machine	-	-	-	-	-	-	-	150	-	-	-	150
Laboratory	-	-	-	-	-	-	30	47	-	-	30	47
Land	2,467	-	-	-	-	-	-	-	-	-	2,467	-
Sub-total	2,467	-	2,689	505	2,611	1,222	1,708	528	1,146	220	10,621	2,475
Consulting Services												
Engineering Design	531	532	-	-	-	-	-	-	-	-	531	532
Supervision	-	-	64	96	77	115	45	67	27	41	213	319
Physical Contingencies	106	106	551	120	538	267	351	119	235	52	1,781	664
Total Project Cost (End, 1979 price)	3,104	638	3,304	721	3,226	1,604	2,104	714	1,408	313	13,146	3,990
Escalation Factors (a)	1,166		1,260		1,360		1,469		1,587			
Total Project Cost (Escalation Price)	3,619	744	4,163	908	4,387	2,181	3,091	1,049	2,234	497	17,494	5,379
	4,363		5,071		6,568		4,140		2,731		22,873	

Note: F : Foreign Currency
L : Local Currency
(a) : 8% per annum for total cost

Table 8.4 Operation and Maintenance Cost at Escalated Prices (a)

(M$1,000)

Item	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
Payroll (b)	197	234	438	473	527	569	615	664	820	907	980
Maintenance	-	-	11	51	78	89	96	104	112	121	131
Power	-	-	-	31	56	75	83	92	104	114	126
Administration (c)	20	24	44	47	52	57	61	66	82	91	98
Total	217	258	493	602	713	790	855	926	1,118	1,233	1,335

(a) Escalated at 8% per annum from original price of the year 1979.
(b) Wages and salaries for the personnel to be employed for the sewerage works.
(c) Administration expenses include office supplies and other miscellaneous expenses.

Table 8.5 Total Cost of Construction and Operation & Maintenance at Escalated Prices

(M$1,000)

Item	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
Construction	4,354	4,911	5,738	5,045	2,774	-	-	-	-	-	-
Operation & Maintenance	217	258	493	602	713	790	855	926	1,118	1,233	1,335
Total	4,571	5,169	6,231	5,647	3,487	790	855	926	1,118	1,233	1,335

(4) Revenue Projection

Sewerage charge at 70 percent of water bill equivalent to M$0.174/$m^3$ for domestic sewerage rate and M$0.3/$m^3$ for trade waste water rate is assumed from 1984 to 1986 to be collected from all domestic and commercial customers whenever public sewers are made available within 30 m (100 ft) of customers' premises or connections are made.

The average monthly water bill per household in the project area is M$7 and sewerage charge equivalent to 70 percent of water bill will be approximately M$5, approximatelt 0.9 percent of average monthly household income of M$580. The rate of 0.9 percent is well within the ability of the residents to pay the sewerage charge as indicated in detail in previous Section 8.4, Ability and Willingness to Pay. The details are summarised in Table 8.6, Projected Sewerage Charge. The collection of sewerage charge is entrusted to State JKR and the collection fee of 2 percent of collected sewerage charge is assumed to be paid to JKR.

The unit rate of sewerage charge is assumed to increase to 90 percent equivalent to M$0.223/$m^3$ and M$0.386/$m^3$ for domestic and trade waste water respectively from 1987 to meet the allowance for assumed escalated prices. Such increase of rate is assumed to be justifiable as the ability of the customers to pay would increase in accordance with general trend of increased wage level as a result of the continuing favourable economic development of the State and the country.

MPKS is also going to impose sewerage tax of 5 percent of annual property value in accordance with provisions of the Local Government Act and the Street, Drainage and Building Act since those who are not directly using facilities would also receive tangible or intangible benefits such as environmental beautification and land value increases.

The allocation of fund is also assumed to be provided from general rates fund of MPKS to supplement to sewerage charge revenue. The amount of such revenue is assumed to meet the minimum requirements to enable the financial plan of each alternative to be viable.

Table 8.6 Projected Sewerage Charges (1982 - 1991)

Item	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
A. Total Population in Master Plan Study Area	157,000	163,300	169,900	176,700	183,800	191,100	198,800	206,700	215,000	223,600
B. Estimated Connected Population			10,100	17,900	23,000	23,200	23,300	23,500	23,600	23,800
C. % of Population Connected			5.9	10.1	12.5	12.1	11.7	11.4	11.0	10.6
D. Estimated Households Connected			1,836	3,255	4,182	4,218	4,236	4,273	4,291	4,327
E. Annual Domestic Water Consumption-Connected Customer in 1,000 m^3			154	525	791	788	786	783	777	772
F. Average Domestic Sewerage Rate in M$/$m^3$ (a)			0.174	0.174	0.174	0.223	0.223	0.223	0.223	0.223
G. Annual Domestic Sewerage Charge (M$1,000)			27	91	138	137	137	136	135	134
H. Annual Trade Water Consumption-Connected Customers in 1,000 m^3			1,180	1,576	1,840	1,931	2,018	2,113	2,209	2,308
I. Average Trade Waste Water Rate in M$/$m^3$ (b)			0.3	0.3	0.3	0.386	0.386	0.386	0.386	0.386
J. Annual Charge for Trade Waste-water (M$1,000)			354	473	552	745	779	816	853	891
K. Estimated Total Sewerage Charge per Annum (M$1,000)			381	564	690	921	954	991	1,026	1,063

Note: (a)F: 70% (1984 - 1986) and 90% (1987 - 1991) of existing domestic water rate
(b)I: 70% (1984 - 1986) and 90% (1987 - 1991) of existing trade water rate

(5) Minimum Requirements for Financial Feasibility

In comparison with other public utility system works, the sewerage works normally entails large capital investment and expensive cost for subsequent operation and maintenance of the completed facilities, while possible sources of revenue to be derived from individual users are less substantial in amount. It is, therefore, difficult to expect a net profit as required normally for the remunerative commercial enterprises.

The revenue should be projected, however, at least to cover operation expenses and debt service payment as the minimum requirement to ensure the viability of the sewerage project, otherwise the project operation would be suspended due to shortage of cash available for operation. In this context the annual revenue for each alternative is schemed to project the cash flow sufficient to cover the annual debt service payment and operation and maintenance expenses with minimum of cash surplus at the ends of the years to cover at least four months' operation and maintenance expenses of the following years.

(6) Other Supporting Requirements

(a) The connections of public sewers with all domestic and commercial properties are assumed to be made as soon as public sewers are made available within 30 m of the properties. The cost for such connections and pertinent plumbing and replumbing would be borne by the property owners and such costs are not included in the financial projections.

(b) The costs for construction of local sewers as well as connections including plumbing and replumbing in the development areas are assumed to be borne by developers and such costs are excluded from the financial projections.

(c) A revolving fund is recommended to be set up to provide loan assistance for customers who would face financial difficulties to pay for the costs of connection, plumbing and replumbing. The loans from such fund are recommended to be made repayable over 6 years including interest of 5 percent per annum. The required amount of such fund will be assessed only after sewers are extended, and therefore, it is not included in the financial projections.

8.6 Evaluation of Alternative Financing Plans

(1) Evaluation Criteria

As indicated in the financing plans, nine alternatives are developed to be on the financially viable base. The amount of required operating revenue in each financing scheme is, therefore, estimated to provide annual cash surplus sufficient, if accumulated, to cover at least four months' operating expenses of the following years. The required amount of such operating revenue are affected by the debt service requirements (payment of interest and principal of loan), and consequently MPKS's contribution to supplement the operating revenue is different in respective alternatives due to the different loan condition as shown in financial statements. Such required contribution from the MPKS may be the vital factor to select an acceptable alternative scheme to suit to the financial capability of MPKS.

There are other factors to assess adequacy of the financing plans of the project such as net income and retained earnings (accumulated net income). The estimated figures of net income indicate that the operating revenues are sufficient enough to cover operating expenses, amortization of loan interest and principal, and the depreciation cost of the plant and facilities. The net loss of income is mainly derived

from the coverage of depreciation cost and should not be construed to invalidate the demonstrated financial feasibility since the annual operating expenses and debt service payment are met by annual operating revenues. The summarised comparison of the alternative plans has been attempted as shown in the following Table 8.7 to help explore the most acceptable alternative.

(2) Conclusion

As shown in Table 8.7, Comparison of Financing Alternative Plans, Alternative III-B will require the least financial contribution from MPKS's allocation fund due to combination of financing loans of softer terms, i.e. lower interest rates and longer repayment period. Assuming that the project implementation is dictated mainly by the MPKS's financial capacity and the least financial burden on MPKS, Alternative III-B appears to be best financial scheme.

It should be noted, however, that all alternative financial schemes inclusive of selected Alternative III-B are based on assumptions for potential combination of loan.

The selected Alternative III-B should, therefore, not be considered exclusive for the proposed Project and other alternatives of different combination of loans as specified in previous Section 8.5, Financial Projection should be considered in compliance with actual needs as exemplified by a case in which the loan from bilateral capital sources can not be effectuated and loan from international capital sources is ensured instead. In such case Alternative IV-B should be considered as the second best alternative financial scheme which requires the least financial contribution from MPKS among those alternatives with loan from international capital sources.

The detailed financial statements for Alternative III-B are presented in the following Tables 8.8 through 8.10. The financing plans for other Alternatives are presented in the Annex 6.

Table 8.7 Comparison of Alternative Financing Plans in Terms of Required Allocation of Fund of MPKS per Annum

(M$1,000)

Alternative	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
Alternative I-A	289	333	520	296	205	805	566	533	546	630	448
Alternative I-B	289	333	520	296	205	752	306	480	493	459	395
Alternative II-A	289	333	520	296	205	1,068	829	796	809	775	711
Alternative II-B	289	333	520	296	205	1,144	905	872	885	851	787
Alternative III-A	289	333	520	296	205	597	358	325	338	304	240
Alternative III-B	289	333	520	296	205	545	306	273	286	223	159
Alternative IV-A	289	333	520	296	205	860	621	588	601	567	503
Alternative IV-B	289	333	520	296	205	937	698	665	696	644	580
Alternative V	289	333	520	296	205	901	466	433	446	412	348

Table 8.8 Project Income Statement, 1981 - 1991 Alternative III-B

(M$1,000)

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
OPERATING REVENUE											
Sewerage Charge	-	-	-	381	564	690	921	954	991	1,026	1,063
Sewerage Tax (a)	-	-	-	-	-	886	974	1,072	1,179	1,297	1,427
Municipality Fund Allocation	289	333	520	296	205	545	306	273	286	223	159
Total Operating Revenue	289	333	520	677	769	2,121	2,201	2,299	2,456	2,456	2,649
OPERATING EXPENSES											
Billing and Collection Fees (b)	-	-	-	8	11	14	18	19	20	21	21
Provision for Bad Debts (c)	-	-	-	4	6	7	9	10	10	10	11
Payroll	197	234	438	473	527	569	615	664	820	907	980
Power	-	-	-	31	56	75	83	92	104	114	126
Maintenance	-	-	11	51	78	89	96	104	112	121	131
Administration	20	24	44	47	52	57	61	66	82	91	98
Total Operating Expenses	217	258	493	614	730	811	882	955	1,148	1,264	1,367
NET OPERATING INCOME	72	75	27	63	35	1,310	1,319	1,344	1,308	1,282	1,282
Depreciation (d)	-	-	-	303	429	499	499	499	499	499	499
Interest	-	-	-	-	-	976	956	944	924	904	892
Net Income (Deficit)	72	75	27	(240)	(394)	(165)	(136)	(99)	(115)	(121)	(109)

Note: (a) Estimated at 5% of "Property Value"
(b) Estimated at 2% of "Sewerage Charge"
(c) Estimated at 1% of "Sewerage Charge"
(d) Composite rate of 2.5% for "Assets in Service" in the following table

Table 8.9 Projected Cash Flow Statement, 1981 - 1991 Alternative III-B

(M$1,000)

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
SOURCES OF FUNDS											
Net Operating Income	72	75	27	63	35	1,310	1,319	1,344	1,308	1,282	1,282
Increase in Account Payable	18	4	19	9	9	7	5	6	16	10	8
Decrease in Current Assets (Less Cash)	-	-	-	-	-	-	-	-	-	-	-
Foreign Loan	1,104	1,352	3,246	1,560	736	-	-	-	-	-	-
Government Loan	382	3,719	3,322	2,580	1,995	-	-	-	-	-	-
Government Contribution (Interest-free Advance)	2,877	-	-	-	-	-	-	-	-	-	-
Total Sources	4,453	5,150	6,614	4,212	2,775	1,317	1,324	1,350	1,324	1,292	1,290
APPLICATION OF FUNDS											
Capital Expenditure	4,363	5,071	6,568	4,140	2,731	-	-	-	-	-	-
Interest											
Foreign Loan	-	-	-	-	-	256	248	248	240	232	232
Government Loan	-	-	-	-	-	720	708	696	684	672	660
Amortization of Principal											
Foreign Loan	-	-	-	-	-	160	168	168	176	184	184
Government Loan	-	-	-	-	-	144	156	168	180	192	204
Total Debt Service	-	-	-	-	-						
Increase in Current Assets (Less Cash)	4	1	5	34	17	13	20	5	6	6	5
Decrease in Current Liabilities	-	-	-	-	-	-	-	-	-	-	-
Total Applications	4,367	5,072	6,573	4,174	2,748	1,293	1,300	1,285	1,286	1,286	1,285
Net Cash Increase (Decrease)	86	78	41	38	27	24	24	65	38	35	34
Cash Available at End of Year (a)	86	164	205	243	270	294	318	383	421	456	490

Note: (a) Estimated at 1/3 of "Operating Expenses" in the previous table

Table 8.10 Project Balance Sheet, 1981 - 1991 Alternative III-B

(M$1,000)

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
ASSETS											
Fixed Assets											
Land	2,877	2,877	2,877	2,877	2,877	2,877	2,877	2,877	2,877	2,877	2,877
Utility Plant in Service	-	-	-	13,125	17,265	19,996	19,996	19,996	19,996	19,996	19,996
Less Accumulative Depreciation	-	-	-	303	732	1,231	1,730	2,229	2,728	3,227	3,726
Net Fixed Assets in Service	-	-	-	15,699	19,410	21,642	21,143	20,644	20,145	19,646	19,147
Construction in Progress	1,486	6,557	13,216	4,140	2,731	-	-	-	-	-	-
Total Fixed Assets	4,363	9,437	16,002	19,839	22,141	21,642	21,143	20,644	20,145	19,646	19,147
Current Assets											
Cash	86	164	205	243	270	294	318	383	421	456	490
Account Receivable (a)	-	-	-	32	47	58	77	80	83	86	89
Inventory (b)	4	5	10	12	14	16	17	19	22	25	27
Total Current Assets	90	169	215	287	331	368	412	482	526	567	606
Total Assets	4,453	9,603	16,217	20,126	22,472	22,010	21,555	21,126	20,671	20,213	19,753
LIABILITIES AND EQUITY											
Long Term Debt											
Foreign Loan	1,104	2,456	5,702	7,262	7,838	7,670	7,502	7,326	7,142	6,958	6,766
Government Loan	382	4,101	7,423	10,003	11,854	11,698	11,530	11,350	11,158	10,954	10,738
Total Long Term Debt	1,486	6,557	13,125	17,265	19,692	19,368	19,032	18,676	18,300	17,912	17,504
Current Liabilities											
Accounts Payable (c)	18	22	41	50	59	66	71	77	93	103	111
Current Debt Maturities	-	-	-	-	304	324	336	356	376	388	408
Total Current Liabilities	18	22	41	50	363	390	407	433	469	491	519
Equity											
Government Capital Contribution	2,877	2,877	2,877	2,877	2,877	2,877	2,877	2,877	2,877	2,877	2,877
Retained Earnings	72	147	174	(66)	(460)	(625)	(761)	(860)	(975)	(1,096)	(1,205)
Total Equity	2,949	3,024	3,051	2,811	2,417	2,252	2,116	2,017	1,902	1,781	1,672
Total Liabilities and Equity	4,453	9,603	16,217	20,126	22,472	22,010	21,555	21,126	20,671	20,213	19,753

Note: (a) Estimated at 1/12 "Sewerage Charges" in the previous table
(b) Estimated at 2% of "Operating Expenses" in the previous table
(c) Estimated at 1/12 of "Operating Expenses" in the previous table