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MALAYSIA

MASTER PLAN AND FEASIBILITY STUDY FOR SEWERAGE AND DRAINAGE SYSTEM PROJECT IN KELANG, PORT KELANG AND ITS ENVIRONS

VOLUME V DRAINAGE

SUMMARY REPORT

NOVEMBER 1982

JAPAN INTERNATIONAL COOPERATION AGENCY

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PREFACE

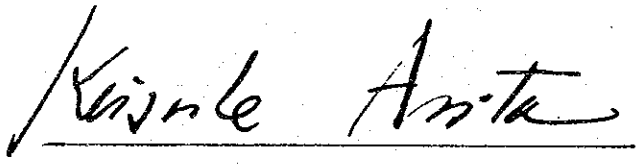
In response to a request of the Government of Malaysia, the Japanese Government decided to conduct a survey on the Sewerage and Drainage System Project in Kelang, Port Kelang and Its Environs and entrusted the survey to the Japan International Cooperation Agency (JICA). The JICA sent to Malaysia a survey team headed by Mr. Hajime Yamada of Tokyo Engineering Consultants Co., Ltd., from March to June and from September to December, 1981.

The team had discussions with the officials concerned of the Government of Malaysia and conducted a field survey in the Kelang and Port Kelang area, Selangor State, Malaysia. After the team returned to Japan, further studies were made and the present report has been prepared.

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

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

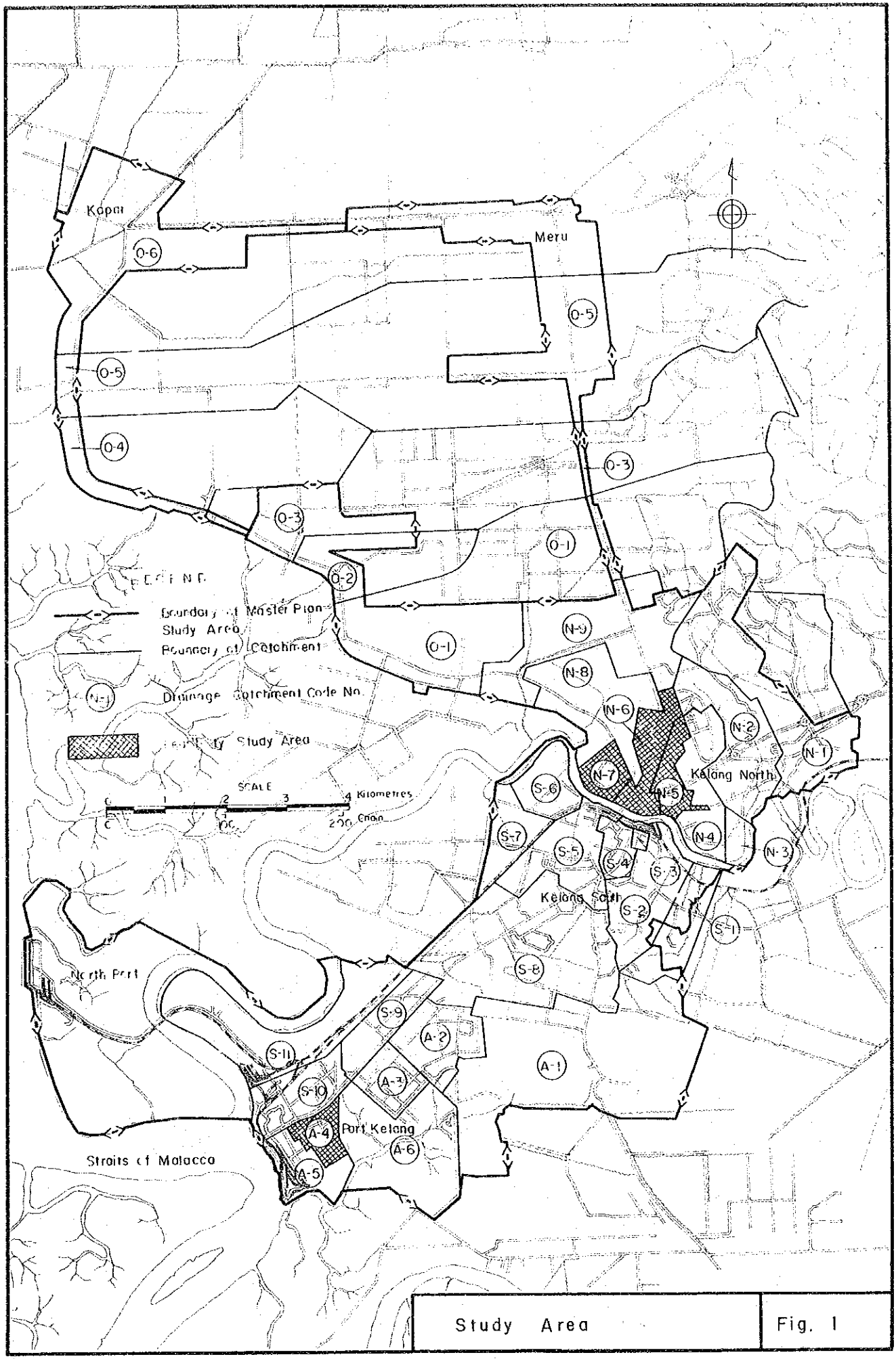
November, 1982



Keisuke Arita

President

Japan International Cooperation Agency



Study Area

Fig. 1

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1. Introduction

In view of the deteriorating conditions of sanitation and environmental pollution in Kelang Muncipality and its environs, in the midst of its various rapidly burgeoning development, the urgent necessity for implementing the sewerage and drainage system project is self-evident.

A sanitary sewerage system *per se* for the collection and disposal of both domestic and industrial wastewater is non-existent in the modern sense of the term. What passes for it is mainly direct discharge of wastewater into open drains or watercourses from septic tanks and shops or factories. Also, the frequent floods that bring damage and disrupt the daily lives of the inhabitants are basically caused by the old and dilapidated drainage system presently serving the municipality and its outlying areas.

In order to stem this debilitating condition and provide an appropriate and modern situation in alignment with the advances being made according to the Fourth Malaysia Plan, the establishment of the sewerage system and renovation and modernization of the existing draiange system are proposed.

The proposal for the project is in the form of a Master Plan, which provides the essential groundwork for a comprehensive, long-range plan up to the year 2000. This is followed by a Feasibility Study of a carefully-selected First Priority area for appropriate investigation and analysis of the actual viability of the project. Both Master Plan and Feasibility Study are conducted separately for the sewerage and drainage systems, although the two systems have an interrelationship of working in tandem, although separately, toward the same goal of improving the environment and easing or relieving the Project Area from the losses and hardships caused by flooding.

This report represents the culmination of the Scope of Work as agreed by the governments of Malaysia and Japan, from all aspects of engineering, finance and management.

2. Drainage Master Plan

2.1. The Project Area

The Project Area of the Drainage Master Plan is situated to the west of the State of Selangor and covers a total area of 7,669 ha, which includes the entire Kelang Municipality area and its various environs.

The Kelang Municipality, which is a royal town of the State of Selangor, is located at the mouth of the Kelang River about 40 km west of the federal capital of Kuala Lumpur.

The Project Area is comprised of Kelang North, Kelang South, Port Kelang, Kapar and Meru. Kapar and Meru are small independent urban centers. The central parts of Kelang North, Kelang South and Port Kelang are commercial areas, and the surrounding areas are allotted for residential purpose. The major industrial area is alloted in the North Port area.

Kelang Municipality has a population of 196,209 (1980), making it the fifth largest city in Malaysia. Its average population density is approximately 30 persons/ha, while that excluding Kapar, Meru and the remaining swampy areas is over 50 persons/ha.

The State of Selangor, in which Kelang Municipality is located, is one of the most economically advanced states, which generates a third of the entire national GDP. A third of the State GDP comes from the manufacturing sector, while only 8 percent comes from agriculture, compared with over 20 percent for the whole of Malaysia. The belt along the Kelang River from Port Kelang through Kelang South, Kelang North to Kuala Lumpur has become the most economically vital zone in the country. Kelang, which faces the entrance of not only this belt but also the entire nation, is the site of Malaysia's international and largest port.

2.2. Flooding and Existing Drainage System

The condition of the Project Area which causes frequent inundations and consequent inconvenience and damages for the Project Area residents results from the following conditions:

1) Its flat and low topography, with ground elevation generally ranging from R.L. +2.0 m to 4.0 m.

2) The great effect of tides, with river or tidal levels fluctuating from R.L. -2.4 m to 3.0 m.

3) The inadequate watertightness of the tidal gates, located at each outlet of the trunk drains.

4) The insufficient and inadequate bunds.

5) The insufficient capacity of the trunk drains which is considerably lower than the estimated stormwater discharge.

As a result, the Project Area suffers from tide-caused flooding because of items 3) and 4) and stormwater flooding due to item 5).

There are as many as 52 flood-prone areas all over the Project Area, totalling 653 ha in area and affecting 30,000 persons (1980).

2.3. Planning Basis

The main purpose of the Drainage Master Plan is to provide complete relief from flooding by the year 2000. Essential elements considered for this purpose are land use, design storm recurrence intervals, and the Kelang River and sea water level.

Stormwater discharge varies, depending on land use pattern. For example, peak stormwater discharge based on which drainage facilities are designed, generally increases with growth in urbanization, since a larger amount of rainfall would flow immediately from the non-absorbent paved roads and larger number of roofs into the drains.

Hence, land use plan and population projection which determines the required land use area, were worked out up to the year 2000 by the Study Team. According to this, the average value of runoff coefficient, which affects the size of drainage facilities and which is determined according to land use pattern, increases from 0.45 to 0.55; i.e., by 20 percent, by the year 2000.

Design storm recurrence intervals, which is one of the major elements to be considered in design of drainage facilities, is from 5 to 10 years for urban drainage. This is lower than that for rivers, because failure of river facilities, such as bunds, results in considerable damage, including even casualties, while the effect of failure of urban drainage facilities is less drastic, such as inconvenience to inhabitants. Furthermore, as an urban drainage system consists mainly of a large number of small drain networks, an urban drainage system with high flood recurrence intervals would become impracticable.

The value of the design storm recurrence intervals in Japan varies from 5 to 10 years according to the size of the town, based on benefits to be derived and incurring cost. In Malaysia, design storm recurrence interval as determined and recommended for the sake of national conformity by DID is 2 years for residential area and 5 years for commercial and industrial areas. Hence, these figures are adopted as the basis for the Master Plan.

Kelang River and sea water level is another major element for design of drainage facilities. As all drains empty into the Kelang River, Aur River or the sea, the size of all drainage facilities is dominated by the water level. The water level of both the Kelang and Aur River is practically the same as that of the sea, fluctuating from R.L.-2.8 m to +3.0 m.

It would be ideal to design drains to be emptied even during the highest water level of R.L.+3.0 m. However, this would involve a tremendous amount not only of funds but also of time required to complete the drainage system since a large number of pumps would become unavoidable, considering the low topography of the Project Area.

Since flood-prone areas exist here and there all over the Project Area, the first step toward completion of the drainage system over the Project Area, would be to provide means of relieving as many areas as possible from flooding. Therefore, R.L. +3.0 m is not adopted for the Master Plan; instead, the commonly used mean high water springs is adopted for the Master Plan. In addition, frequency of flood water level, which occurs twice a day, exceeds mean high water springs of R.L. +2.06 m one time out of seven As a result, there is little chance of high-intensity rainfall coinciding with high water level.

2.4. Proposed Drainage System

Basically, improvement and expansion of the existing channel capacity is considered, by utilizing the existing facilities to the maximum extent possible, for the sake of economy and efficient implementation. Hence, the proposed 32 catchments are mainly in accordance with the existing catchments, with the exception of S-5 catchment, where the upstream basin, bordered by the railway line and Federal Highway, is incorporated in S-8 catchment.

A comparative study of the retention pond and pump conducted in S-6, S-9, S-10, A-4 and A-5 catchments, where impounded water cannot be emptied by gravity during high tide, reveals that a downstream retention pond is preferable to using a pump. Despite the possible difficulty of acquiring enormous land space for retention ponds, especially in S-10 and A-5 catchments, the retention pond system is proposed.

Landfilling is proposed in S-11 and A-6 catchments. These catchments, which are now swamps, are expected to be developed under PKNS management, as in the case of the North Port area, into industrial areas. It is proposed that the landfilling be conducted simultaneously with the drainage system renovation when these catchments are developed.

While downstream retention pond and landfilling help prevent inundation during high water stages, another alternative is to decrease stormwater discharge, by means of an upstream retention pond and/or diversion channels, in the case of N-6 and S-5 catchments.

However, comparative studies revealed the upstream retention pond to be unfeasible, whereas the diversion channel was found to be feasible for S-5 catchment but not for N-6 catchment. However, the downstream route for N-6 catchment is shifted west of the Federal Highway for ease of construction.

Of the 32 catchments, the gravity flow drainage system is proposed in 26, including S-11 and A-6 catchments. Another drainage system is based on the use of downstream retention ponds in six catchments; namely, S-5, S-6, S-9, S-10, A-4 and A-5 catchments.

The proposed drainage facilities include renovation of the 107 km-long trunk drains and 11,530 meter-long bunds, construction of five retention ponds for six catchments, replacement of 26 tidal gates, and installation of telemeter inspection system for the tidal gates.

2.5. Construction Cost

The total construction cost is estimated to be M$292 million at 1981 price level, of which M$173 million (or 58 percent) is for trunk drains, M$44 million for land acquisition, M$28 million for engineering fees, M$42 million for contingency cost, and M$4 million and M$1 million for retention ponds and bunds respectively.

This sum might be considered to be high, compared with that in other towns. This is because the proposed drains are made mainly of rectangular reinforced concrete due to the developed condition of the town.

N-5 1	U 1.4x1.4 1.5 155	N-5 7	U 2.8x2.8 0.9 60	N-6 6	U 1.3x1.3 1.0 175	N-6 12	U 2.1x2.1 1.9 295	N-7 3	U 1.6x1.6 1.1 20	N-7 7	U 1.7x1.7 0.6 360
N-5 2	U 2.0x2.0 1.0 400	N-6 1	U 1.5x1.5 1.0 120	N-6 7	U 1.6x1.6 0.8 205	N-6 13	U 2.4x2.4 1.9 85	N-7 4	U 1.9x1.9 0.9 180	N-7 8	U 2.1x2.1 0.6 240
N-5 3	U 2.3x2.3 0.9 400	N-6 2	U 1.5x1.5 1.2 160	N-6 8	U 1.7x1.7 1.1 230	N-7 1	U 1.2x1.2 1.0 125	N-7 5	U 2.1x2.1 0.8 220	N-7 9	U 2.9x2.9 0.6 20
N-5 4	U 2.4x2.4 0.9 75	N-6 3	U 1.7x1.7 1.0 625	N-6 9	U 1.8x1.8 1.1 320	N-7 2	U 1.4x1.4 1.2 25	N-7 6	U 0.8x0.8 1.6 265		
N-5 5	U 2.6x2.6 0.8 170	N-6 4	U 1.8x1.8 1.0 340	N-6 10	U 2.1x2.1 1.9 125						
N-5 6	U 2.7x2.7 0.8 165	N-6 5	U 1.3x1.3 1.0 270	N-6 11	U 2.1x2.1 1.9 35						

A-4 1	U 1.1x1.1 0.9 190	A-4 5	U 2.4x2.4 Jal 0.6 35	A-4 9	U 2.7x2.7 0.5 60
A-4 2	U 1.5x1.5 0.8 235	A-4 6	U 1.6x1.6 0.4 365	A-4 10	U 2.9x2.9 0.5 20
A-4 3	U 2.0x2.0 0.6 50	A-4 7	U 1.7x1.7 0.5 60		
A-4 4	U 2.2x2.2 0.6 255	A-4 8	U 1.7x1.7 0.6 305		

LEGEND

- Boundary of Project Area
- Boundary of Catchment
- Boundary of Sub-Catchment
- Proposed Drain
- R — Retention Pond
- Tide Gate
- (A-1 / 1) — Name of Drain and Name of Sub-Catchment
- U 14.0 / 10.0 x 2.0 — Shape and Size (m)
- 0.5 — Slope (‰ = 1/1000)
- 490 — Length (m)

Where

- U 14.0 / 10.0 x 2.0 : Masonary Drain, upper width = 14.0 m, bottom width 10.0 m, depth = 2.0 m
- U 4.5 x 2.0 : Reinforced Concrete, width = 4.5 m, depth = 2.0 m

Scale One Centimetre to 0.5 Kilometre

Scale One Centimetre to 0.5 Chain

N-5 1	U1.4x1.4 1.5 155	N-5 7	U2.8x2.8 0.9 60	N-6 6	U1.3x1.3 1.0 175	N-6 12	U2.1x2.1 1.9 295	N-7 3	U1.6x1.6 1 20	N-7 7	U1.7x1.7 0.6 360
N-5 2	U2.0x2.0 1.0 400	N-6 1	U1.5x1.5 1.0 120	N-6 7	U1.6x1.6 0.8 205	N-6 13	U2.4x2.4 1.9 85	N-7 4	U1.9x1.9 0.9 180	N-7 8	U2.1x2.1 0.6 240
N-5 3	U2.3x2.3 0.9 400	N-6 2	U1.5x1.5 1.2 160	N-6 8	U1.7x1.7 1.1 230	N-7 1	U1.2x1.2 1.0 125	N-7 5	U2.1x2.1 0.8 220	N-7 9	U2.9x2.9 0.6 20
N-5 4	U2.4x2.4 0.9 75	N-6 3	U1.7x1.7 1.0 625	N-6 9	U1.8x1.8 1.1 320	N-7 2	U1.4x1.4 1.2 25	N-7 6	U0.8x0.8 1.6 265		
N-5 5	U2.6x2.6 0.8 170	N-6 4	U1.8x1.8 1.0 340	N-6 10	U2.1x2.1 1.9 125						
N-5 6	U2.7x2.7 0.8 165	N-6 5	U1.3x1.3 1.0 270	N-6 11	U2.1x2.1 1.9 35						

A-4 1	U1.1x1.1 0.9 190	A-4 5	U2.4x2.4 Jal 0.6 35	A-4 9	U2.7x2.7 0.5 80
A-4 2	U1.5x1.5 0.8 235	A-4 6	U1.6x1.6 0.4 365	A-4 10	U2.8x2.9 0.5 20
A-4 3	U2.0x2.0 0.6 50	A-4 7	U1.7x1.7 0.5 60		
A-4 4	U2.2x2.2 0.6 255	A-4 8	U1.7x1.7 0.6 305		

Scale One Centimetre to 0.25 of a Kilometre S=1/25,000

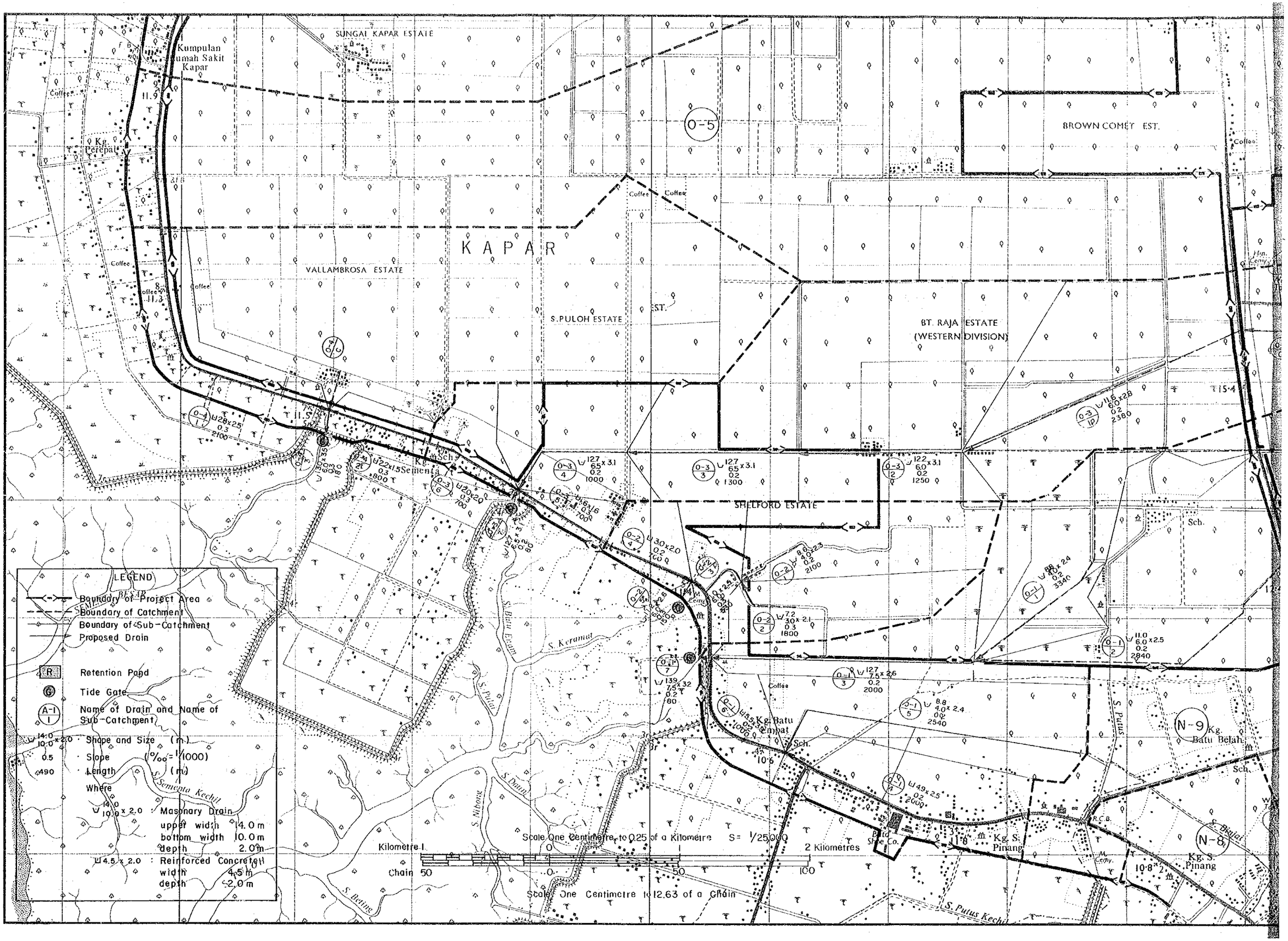
Kilometres 0 2

Chain 50 0 50 100

Scale One Centimetre to 12.63 of a Chain

General Plan of Proposed Drainage System (1)

Fig 2


SUNGAI KAPAR ESTATE
Kumpulan Rumah Sakit Kapar
Kg. Perepat
KAPAR
VALLAMBROSA ESTATE
S.PULOH ESTATE
BROWN COMET EST.
BT. RAJA ESTATE (WESTERN DIVISION)
SHELFORD ESTATE
Kg. Batu Empat
Kg. Batu Belah
Kg. S. Pinang
Coffee
Sch.
S. Sementa Kechil
S. Bilau Besar
S. Keramat
S. Batang
S. Nibong
S. Dalam
S. Putus Kechil
S. Bujal
LEGEND
Boundary of Project Area
Boundary of Catchment
Boundary of Sub-Catchment
Proposed Drain
Retention Pond
Tide Gate
Name of Drain and Name of Sub-Catchment
Shape and Size (m)
Slope (‰ = 1/1000)
Length (m)
Where
Masonary Drain
upper width 14.0 m
bottom width 10.0 m
depth 2.0 m
Reinforced Concrete
width 4.5 m
depth 2.0 m
Scale One Centimetre to 0.25 of a Kilometre S= 1/25,000
Kilometre 1
2 Kilometres
Chain 50
100
Scale One Centimetre to 12.63 of a Chain

BROWN COMET EST.

BT. RAJA ESTATE
(WESTERN DIVISION)

SHELFORD ESTATE

BT. RAJA EST.
(EASTERN DIVISION)

NORTH HUMMOCK EST.

BT. RAJA

Kg. Batu Lampat

Kg. Batu Belah

Kg. S. Pinang

Kg. S. Pinang

Water Tower

Water Tower

Hosp.

Sch.

Coffee

S. Putus

S. Putus Kechil

S. Bujal

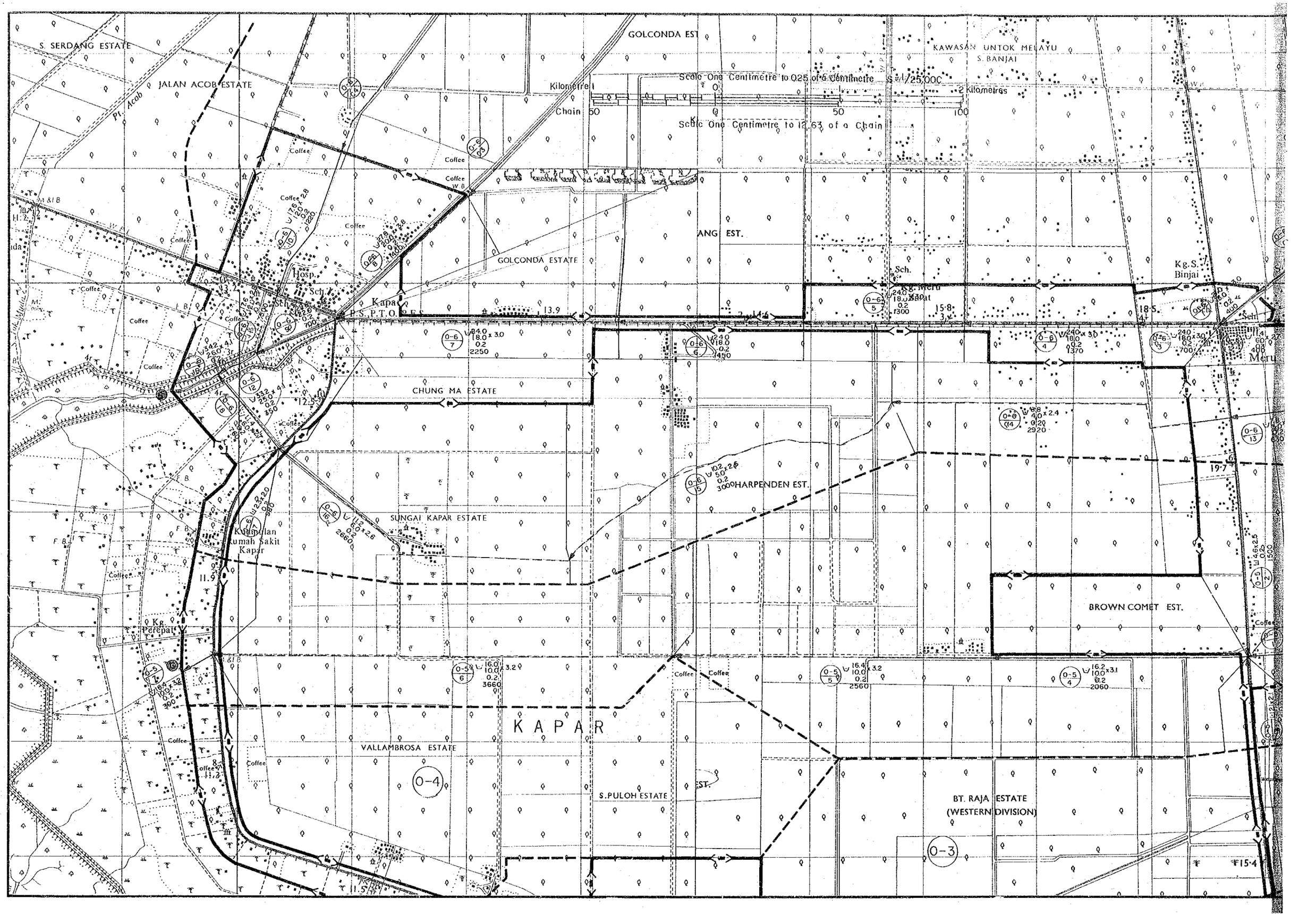
One Centimetre to 0.25 of a Kilometre S= 1/25,000

2 Kilometres

One Centimetre to 12.63 of a Chain

General Plan of
Proposed Drainage System (2)

Fig. 3


S. SERDANG ESTATE
JALAN ACOB ESTATE
Pt. Acob
GOLCONDA EST
KAWASAN UNTOK MELAYU
S. BANJAI
Scale One Centimetre to 025 of a Centimetre
1/25,000
2 Kilometres
Kilometre 1
Chain 50
0
50
100
Scale One Centimetre to 12.63 of a Chain
GOLCONDA ESTATE
ANG EST.
Hosp.
Sch.
Kapar
P.S.P.T.O.
Sch.
Kg. Meru
Kapar
Kg.S. Binjai
Meru
CHUNG MA ESTATE
HARPENDEN EST.
SUNGAI KAPAR ESTATE
Kumpulan Rumah Sakit Kapar
Kg. Perepat
BROWN COMET EST.
K A P A R
VALLAMBROSA ESTATE
S.PULOH ESTATE
BT. RAJA ESTATE
(WESTERN DIVISION)
Coffee
0-4
0-3

GOLCONDA EST

KAWASAN UNTOK MELAYU
S. BANJAI

Scale One Centimetre to 025 of a Centimetre = 1/25,000
0 1 2 Kilometres
50 0 50 100
Scale One Centimetre to 12.63 of a Chain

ANG EST.

Kg. Meru Baharat

Kg. S.7 Binjai

S. Binjai

W.P.L.

Sch.

Meru

ENG HENG EST.

Coffee

Haji Sharifi

Cemy.

Chr. Cemy.

S. Bakot

S. Pasir

HARPENDEN EST.

BROWN COMET EST.

NORTH HUMMOCK EST.

Water Tower

Hosp.

Sch.

Br. Tumpah

BT. RAJA

S.PULOH ESTATE

BT. RAJA ESTATE
(WESTERN DIVISION)

0-3

LEGEND

- Boundary of Project Area
- Boundary of Catchment
- Boundary of Sub-Catchment
- Proposed Drain
- R — Retention Pond
- S — Tide Gate
- (A-1) — Name of Drain and Name of Sub-Catchment
- Shape and Size (m)
- Slope (‰ = 1/1000)
- Length (m)
- Where *Paya Belambong*
  - U 14.0 x 2.0 / 10.0 x 2.0 : Masonary Drain
    - upper width 14.0 m
    - bottom width 10.0 m
    - depth 2.0 m
  - U 4.5 x 2.0 : Reinforced Concrete
    - width 4.5 m
    - depth 2.0 m

General Plan of
Proposed Drainage System (3)

Fig. 4

2.6. Implementation Program

The completion of a drainage system for an area of the size of the proposed Project Area with its large and expanding population is a task of tremendous magnitude. Therefore, it becomes necessary to build the required drainage facilities by phases, according to the urgency of need and benefits to be derived.

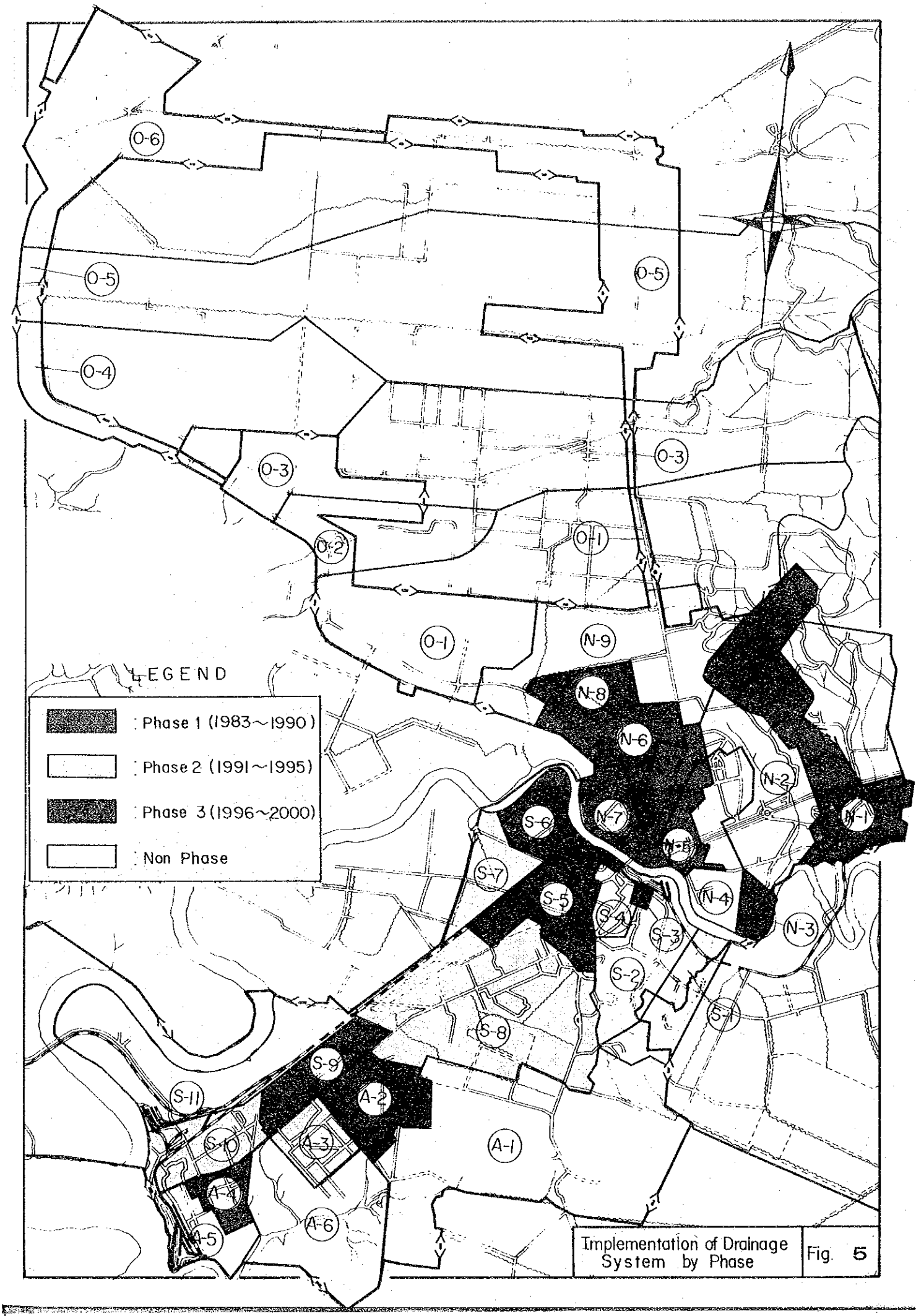
In that sense, each catchment is set up in order of priority, by using an arbitrary rating procedure. Parameters used for this purpose are: (1) population density (both in 1980 and in 2000), (2) flooding condition (both in 1980 and in 2000), (3) land use in 2000 and (4) damage to main roads. The first priority areas are in the center of Kelang North (N-5, N-6 and N-7 catchments) and in the center of Port Kelang (A-4 catchment).

Completion of drainage facilities in the total 32 catchments being financially difficult, drainage systems for 16 ranked catchments at a cost of M$138 million at 1981 price level are planned to be implemented with due financial considerations.

Table 1. Implementation Schedule

Phase	Catchment	Area (ha)	Cost
First Phase (1983-1990)	N-5, N-6, N-7 and A-4	242.5 ha	M$13 million
Second Phase (1991-1995)	S-7, S-8, S-10 and A-3	901.5 ha	M$52 million
Third Phase (1996-2000)	N-1, N-3, N-8, S-3, S-5, S-6, S-9 and A-2	1,171.9 ha	M$73 million
Total (1983-2000)		2,315.9 ha	M$138 million

The magnitude of the First Phase has been carefully determined, because of lack of time for reviewing its implementation program, while there would be sufficient leeway for review of the second and third phased programs for consideration of town planning (including land use plan which is revised every five years), available funds, and development in the next five to ten years.



Implementation of Drainage System by Phase | Fig. 5

2.7. Financial Plan

The drainage service system, unlike the sewerage service system, generally cannot be based on a cost recovery mechanism since there are no rational measures for gauging the public's awareness of drainage benefits. This means the executing agency (MPK) for drainage activity cannot expect to recover either the project cost or annual operating and maintenance costs.

Under the Local Government Act, 1976, the local government is empowered to undertake drainage works, which indicates that MPK should have complete responsibility for undertaking necessary drainage works. Judging from its present financial capability, it is very difficult for MPK to completely undertake drainage works. However, it might be necessary to treat the proposed drainage system somewhat on the basis of a self-supporting cost-recovery system. Therefore, financial analysis is conducted for the purpose of exploring means of financing the Project. Proposed financial sources are shown in the following table.

Phase	Construction Cost		Operation and Maintenance Cost, Including Debt Service	
	Loan	Grant	Developer's Contribution	Property Surcharge Tax for Drainage Service
Phase 1 (1983-1990)	100%	0%	M$3,000/acre	max. 3%
Phase 2 (1991-1995)	67%	33%	"	"
Phase 3 (1996-2000)	50%	50%	"	"
Total (1983-1990)	61%	39%	"	"

Beneficiaries of the drainage system should pay for this system in the form of property surcharge tax for the drainage service to cover operation and maintenance cost. A maximum three percent property surcharge tax is proposed from the viewpoint of income distribution based on rates proportionate to the currently applied property tax rate, which constitutes more than 80 percent of MPK's general revenues.

Under the Local Government Act, 1976, MPK could impose a maximum rate of 5 percent property surcharge tax on the property assessment value for drainage and sewerage respectively; however, the proposed 3 percent rate is considered justifiable.

The existing developers' contribution of M$3,000/acre should be allocated for amortization of principal and interest of the loan for the construction cost. Of the construction cost, M$80 million at 1981 price level (61 percent) should be financed by Federal/State Government loan, while the remaining M$54 million should be financed by Federal/State Government grant.

This plan would not require MPK to compensate the deficit for the proposed drainage system.

2.8. Institutional Organization and Legal Aspect

Urban drainage service system is related to the community, a local matter rather than a regional or national matter. The Local Government Act, 1976 empowers local government to undertake drainage works, which makes Kelang Municipality (MPK) the executing agency for the Project Area.

However, its present financial capability and lack of sufficient staff make it very difficult for MPK to completely undertake drainage works for the time being. Hence, in the First Phase (1983-1990), MPK will be assisted by the State DID, which has been conducting the Kelang drainage works at the request of the State Government, although MPK actually holds the responsibility.

The Engineering Department of Kelang Municipality was expanded to conduct the Master Plan and Feasibility Study for the drainage system, as well as sewerage system, under the Sewer and Drain Section, indicating MPK's intention of undertaking drainage activities as well as sewerage, based on the Local Government Act, 1976. However, the existing Sewer and Drain Section is mainly engaged in Work Shop duties. Therefore, it is proposed that the Sewer and Drain Section of the Engineering Department separate the Work Shop duties and devote itself to the sewerage and drainage activities, by setting up the following three Units: 1) Design Unit, 2) Construction Unit, and 3) Operation and Maintenance Unit. This reorganization would provide the advantage of minimizing intitial cost and effort.

The required staff (excluding the labor pool) totals 17 in the initial year of 1983, 28 in 1990 at the end of the First Phase, and 30 in 1995 at completion of the Second Stage program up to the year 2000.

A training program should be considered for those recruited in order to raise their level of qualification/experience for satisfactory performance of their assignment. Drainage engineers recruited by MPK will initially be temporarily assigned to SDID for execution of the 1st Phase work, and will later be transferred back to MPK for subsequent work on the basis of their training at SDID.

Concerning legal aspects of the project implementation, a review of The Local Government Act (1976) and The Street, Drainage and Building Act (1974) and interviews with relevant officials, both in Federal and State agencies, confirm that there are no legal problems in implementing the drainage project under the existing laws and regulations.

2.9. Benefits and Effects

The proposed drainage system is expected to bring about such benefits as 1) reduction of flood damage, 2) improvement of environment, and 3) increase in land value.

1) Reduction of Flood Damage

The benefits to be derived from flood prevention are considered to be equivalent to the amount of flood damage. The proposed drainage system is expected to provide relief from flooding for 653.4 ha of flood-prone areas and 16,230 persons by the year 2000. These benefits by phases are shown in the following table.

Anticipated Benefits from Flood Mitigation

Item \ Phase	Phase I - 1990	Phase II 1991 - 1995	Phase III 1996 - 2000	Total
Flood-prone Area (ha)	87.6	290.7	275.1	653.4
Population In Flood-prone Area (person)	5,600	9,100	15,300	30,000
Households* In Flood-prone Area (Household)	982	1,596	2,684	5,262

* A Household is assumed to be comprised of 5.7 persons.

2) Improvement of Environment

It is expected that the higher the public living standard, the higher the public recognition of environmental quality. Thus the following benefits are expected to result from improvement of the environment.

. Elimination of the present offensive odors emanating from drain and sludge accumulations.

. Decline in risk and incidence of diseases and consequent improvement in health and life span.

. Decrease in medical expenses.

. Decrease in loss of income through reduced absence from work for health reasons.

3) Increase in Land Value

Land value increase is considered to be a comprehensive representation of the economic benefits to be gained from the drainage system. It is expected to spur the development program and consequent large-scale financial transactions due to improvement in the living environment, and also bring additional revenue to the Municipality through the increased value of private property.

The results of the multivariate analysis show that after completion of the drainage system, the average increase rate of the property assessment value is 1.6 percent; however, in the existing low population density sections of the flood-prone areas, its increase in property assessment value would reach 20.5 percent.

Due to the rapid socio-economic development in Malaysia, mean monthly household income of the lowest income group (40 percent of the population), increased from M$76 in 1970 to M$186 in 1979, according to the Fourth Malaysia Plan. This represents a rise of 145 percent compared with the increase of 66 percent in consumer price index.

With rise in level of living standard, what once seemed tolerable has come to be recognized as being intolerable. Also, along with the rapidly increasing development, flooding has become more serious. Thus, improvement of drainage facilities would undoubtedly contribute greatly to living conditions in Kelang and its environs. Therefore, the construction of the proposed drainage system can be justified.

3. Drainage Feasibility Study

3.1. The Study Area

The Feasibility Study covers those areas of highest priority proposed in the Master Plan for implementation in the First Phase (1983-1990), based on such factors as flooding situation, population density, future development and damage to main roads, consisting of part of Kelang North (N-5, N-6 and N-7 catchments: 190.0 ha) and Port Kelang (A-4 catchment: 52.5 ha).

The Study Area is located in the exact center of the commercial area.

3.2. Proposed Drainage Facilities

Taking into consideration future development of the Project Area up to the year 2000, proposed drainage facilities consist of trunk drains, tidal gates, bunds and telemeter system, which involve the following work:

1) Trunk drains: Widening, deepening and lining existing open channels totalling 7,460 m in length

2) Tidal gates: Replacement of four existing gates, to improve water tightness and capacity

3) Bunds: Construction of bunds totalling 1,980 m in length

4) Telemeter system: Inspection center for 26 tidal gates and telemeter system for four gates.

3.3. Construction Cost

The total construction cost is estimated at M$11.9 million at 1981 price level (M$17.8 million with annual escalation allowance of 6.5 percent in accordance with the Fourth Malaysia Plan).

Of this sum, M$8.7 million (or 73 percent) is for trunk drains, M$0.6 million, M$0.1 million and M$0.3 million are for tidal gates, bunds and telemeter system respectively, M$0.1 million is for land acquisition, while engineering fees and contingency cost are estimated to be M$1.0 million and M$1.1 million respectively.

3.4. Financial Plan

According to the study of financial planning in the Master Plan Report, financial projections are developed on the following basis:

(1) The initial investment for the First Phase work must be financed by Federal Government loan.

(2) Developers' contribution is allocated for amortization of principal and interest for the construction cost.

(3) The required revenue for the operation and maintenance of the drainage system should be raised through appropriate charges against those who will receive benefits from its service.

Under these bases, various financial projections were made in order to determine the most viable financing schedule. In these projections, the drainage surcharge tax rate varies at 1, 2, 3, 4 and 5 percent of annual property value.

Judging from the viewpoint that MPK can bear a maximum burden of about M$5 million up to 1995, a viable financial plan is selected, with a 2 percent drainage surcharge tax rate.

In the proposed financial plan, the entire construction cost of M$17.8 million is furnished by Federal/State Government Loan, the drainage surcharge tax and developers' contribution of M$3,000/acre.

4. Conclusions and Recommendations for Drainage System

(1) In the light of existing conditions and the rapid commercial, housing and industrial developments taking place, the urgent necessity for provision of an improved urban drainage system for the Project Area by renovating the generally antiquated existing system is strongly recognized.

(2) It is technically feasible to improve the urban drainage system and the level of public investment required is considered justified.

(3) The Master Plan strategy for improving drainage facilities should be based on utilizing the existing drainage system to the maximum extent possible, for the sake of economy and efficiency of program implementation.

(4) Trunk drains, retention ponds, tidal gates, bunds and telemeter system for determining whether tidal gates are open or closed in 16 ranked catchments out of 32 should be implemented by the year 2000.

(5) The project cost of implementing the proposed Master Plan is about M$138 million, which will ensure that about 30,000 people and 650 ha will be provided relief from flooding. Developed areas will be provided with an improved urban drainage system.

(6) Due to constraints of financial resources and construction scheduling, the project is divided into three phases as follows: First Phase (1983-1990), Second Phase (1991-1995), and Third Phase (1996-2000). Four catchments are scheduled for implementation in the First Phase (1983-1990), as follows: three in the center of Kelang North, and one in the center of Port Kelang.

The First Phase cost is about M$12 million, which will ensure that about 5,600 people and 90 ha will be provided relief from flooding.

(7) Kelang Municipality should hold the responsibility for improving the urban drainage system; however, in the First Phase (1983-1990), it should be assisted by the State Drainage and Irrigation Department (SDID).

(8) Grant and loan from the Federal/State Government are the fund sources for construction of the drainage system. However, the ratio differs according to phase as follows:

Phase	Loan	Grant
First Phase (1983-1990)	100%	0%
Second Phase (1991-1995)	67%	33%
Third Phase (1996-2000)	50%	50%
Total (1983-2000)	61%	39%

Operation and maintenance cost is furnished by developers' contribution of M$3,000/acre and drainage surcharge tax rate of three percent which is to be newly imposed. However, tax rate in the First Phase is proposed to be 2 percent.

9) In the First Phase (1983-1990), MPK should have the cooperation of the State DID. But from the Second Phase (1991-1995), MPK should bear complete responsibility for the drainage works. The number of required staff (excluding laborers) is 31 in 1983, 28 in 1990, 30 in 1995, up to 2000.

Drainage engineers recruited by MPK will initially be temporarily assigned to State DID for execution of the First Phase work, and will later be returned to MPK for subsequent work on the basis of their training at SDID.