MALAYSIA

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

VOLUME VI DRAINAGE

MASTER PLAN

NOVEMBER 1982

JAPAN INTERNATIONAL COOPERATION AGENCY

MALAYSIA

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

VOLUME VI DRAINAGE

MASTER PLAN

NOVEMBER 1982

JAPAN INTERNATIONAL COOPERATION AGENCY

This Master Plan and Feasibility Study consists of eight volumes:

I	Sewerage Summary Report
II	Sewerage Master Plan
III	Sewerage Feasibility Study
IV	Sewerage Appendices
V	Drainage Summary Report
VI	Drainage Master Plan
VII	Drainage Feasibility Study
VIII	Drainage Appendices

TABLE OF CONTENTS

LIST OF TABLES

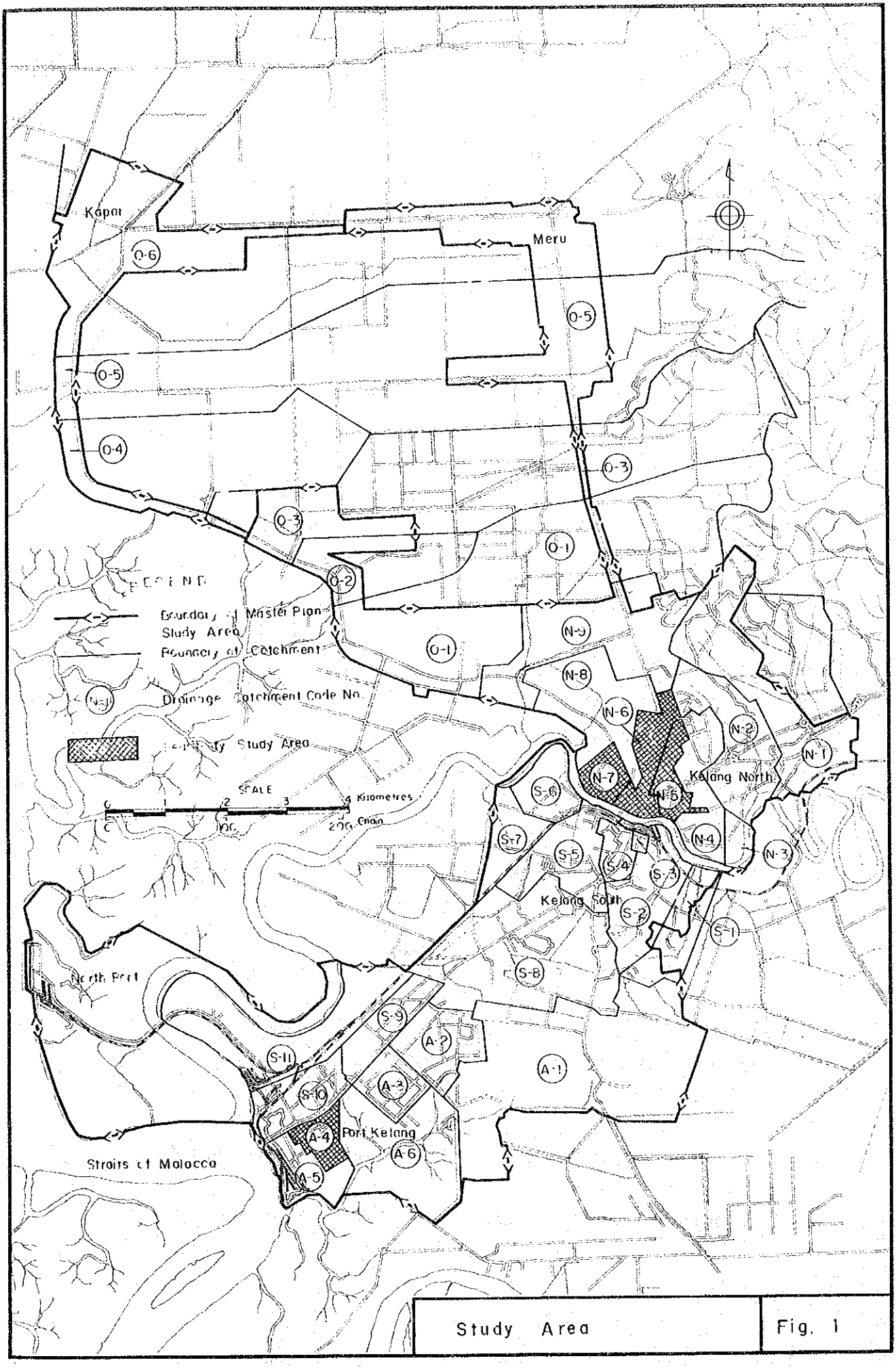
LIST OF FIGURES

LIST OF ABBREVIATIONS

AC	Asbestos Cement
BOD	Biochemical Oxygen Demand
DID	Drainage and Irrigation Department, Ministry of Agriculture and Fisheries
F.C.	Foreign Currency
F.M.P.	Fourth Malaysia Plan
Fig.	Figure
GDP	Gross Domestic Product
ha	hectares
HDPE	High Density Polyethlene
hr	hours
Jalan	Road
JICA	Japan International Cooperation Agency
JKR	Public Works Department
Jln.	Jalan, Road
JT	Jambatan Telecom
Kg.	Kampung
km	kilometers
KTM	Malayan Railway
L.C.	Local Currency
LLN	National Electric Board
Lrg.	Lorong
m	meters
m^2	square meters
m^3	cubic meters

MPK	Kelang Municipality (Majlis Perbandaran Kelang)
M$	Malaysian Dollars
O & M	Operation and Maintenance
PVC	Polyvinyl Chloride
R.L.	Reduced Level
SEDC (PKNS)	State Economic Development Corporation
SS	Suspended Solids
TCP	Town and Country Planning
VC	Vitrified Clay
WWD	Waterworks Department

OUTLINE



Study Area

Fig. 1

OUTLINE

1. The Project Area

The land area in which the Project Area is located covers a total area of 7,669 ha, which includes the entire Kelang Municipality area and its various environs. In addition, the area outside the Project Area from which stormwater discharges into the Project Area is also considered a contributing area in calculating stormwater runoff for the drainage system planning. This contributing area is estimated to be 16,623 ha. However, neither the North Port area of 810 ha which comprises an independent drainage area for which reconstruction work is already being conducted, nor the Kelang River surface area of 231 ha are included in the Master Plan. Hence, the total area concerned in this study is 23,251 ha. Of this, 6,628 ha is within the Project Area. (Ref.: Fig. 1.)

2. Flooding and Existing Drainage System

The condition of the Project Area and the existing drainage system which causes frequent inundation and consequent inconvenience and damages for the residents are as follows:

1) The Area is flat and low with ground elevation generally ranging from R.L. +2.0 m to 4.0 m.

2) The Area is greatly affected by tide, with river or tidal levels fluctuating from R.L. -2.4 m to 3.0 m.

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

4) Bunds are also insufficient and inadequate.

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

3. Population Projection and Land Use Plan

Since no documents on Municipality city planning or land use plan were available on which to base the drainage scheme, population projection up to the year 2000 and land use plan have been worked out by the Study Team. As a result, urbanized population in 2000 is forecasted to be 500,000. Taking into account the development trends and desirable population density in each land use area, it is considered that the extent of the Project Area is considered insufficient to accommodate all urbanized population. Therefore, the urban area in the year 2000 will extend outside of the Project Area. Out of the total population of 500,000, about 380,000 is considered to be inhabiting the Project Area and the remaining 120,000 to be in the surrounding outer areas.

4. Design Basis

Design criteria used herein are basically in accordance with those in DID's "Planning and Design Procedure No.1, Urban Drainage Design Standards and Procedures for Peninsular Malaysia".

As all drains are emptied into the Kelang River, Aur River or the sea, analysis of the Kelang River was conducted briefly to determine the water level which is an essential part of planning drainage facilities.

The result shows that when a mean high water springs at Port Kelang of +2.06 m is used, the water level in the Project Area is R.L. +2.1 m to +2.3 m, which is about the same as the sea level of R.L. +2.06 m.

5. Proposed Drainage System

The necessity for drainage system improvement is obvious by a mere look at the flooded areas and the existing drainage system itself. Furthermore, the necessity is expected to become more urgent, as further development in the Project Area is accelerated, resulting in a tendency of the drainage system to deteriorate.

On the recognition of these findings and comparison of alternatives, this Drainage Master Plan is proposed herewith.

The basic consideration is to consolidate the existing drainage system with the proposed system; that is to make it a part of the proposed system. The study revealed this to be feasible; namely, the proposed catchments, hence their routes are also identical to the existing routes.

The Project Area is divided into 32 catchments. In 26 of the catchments, the gravity flow drainage system is proposed, including two catchments where it would be feasible after completion of land reclamation. Another proposed drainage system is based on the use of retention ponds in the downstream in six catchments to store stormwater during periods when the water level of the receiving water body is higher than that of the drain.

The proposed facilities include renovation of the 107 km-long trunk drains, mainly made of concrete and 11,530 m-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.

6. Construction Cost

The total construction cost of the proposed trunk drains, retention ponds, bunds, tidal gates and telemeter system are estimated to be M$292 million.

Table 1. Construction Cost

Item	Cost (M$ million at 1981 Price Level)	
A. Construction		
Trunk Drains	167	
Tidal Gates (Including Telemeter System)	6	
Retention Ponds	4	
Bunds	1	
Sub-Total		178
B. Engineering Fees		28
C. Contingency Cost		42
D. Land Acquisition Cost		44
Total		292

7. Implementation Priorities

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).

8. Implemention Program

Completion of drainage facilities in the total 32 catchments (6,628 ha) is financially difficult. Furthermore, flood-prone areas exist here and there all over the Project Area. Hence, as a first step toward completion of the drainage system for the Project Area, as many areas as possible should be relieved from flooding. Therefore, for example, highest high water level of R.L. +3.0 m is not adopted but mean high water springs of R.L. +2.1 m for drainage design, and implementation of small drains is excluded.

Therefore, 16-ranked catchments out of 32 are proposed to be implemented by the year 2000.

Table 2. Implementation Schedule

	Catchment	Area (ha)	Project Cost (M$ million) (At 1981 Price Level)
Phase 1 (1983-1990)	1. A-4 catchment	52.5	2.5
	2. N-6 catchment	72.3	5.2
	3. N-7 catchment	48.2	2.3
	4. N-5 catchment	69.5	3.2
	Total	242.5	13.4*
Phase 2 (1991-1995)	5. A-3 catchment	106.9	7.5
	6. S-7 catchment	110.8	3.3
	7. S-8 catchment	539.2	27.6
	8. S-10 catchment	144.6	12.9
	Total	901.5	52.1*
Phase 3 (1996-2000)	9. S-5 catchment	156.1	10.7
	10. A-2 catchment	133.6	7.6
	11. S-9 catchment	120.5	10.8
	12. N-8 catchment	255.0	9.5
	13. S-3 catchment	11.8	0.8
	14. N-1 catchment	372.7	23.4
	15. S-6 catchment	96.7	8.4
	16. N-3 catchment	25.5	1.3
	Total	1,171.9	72.5
Grant Total (1983-2000)		2,315.9	138.0

Note: * Including cost of telemeter system

9. Financial Plan

Financial analysis is conducted for the purpose of exploring the sources for financing the drainage project and determining a reasonable charge for beneficiaries in order to make the drainage system viable.

The available financial sources are (1) Loan from the Federal Government, (2) Grant from the Federal/State Government, (3) Developers' contribution, (4) Property surcharge tax for the drainage service, and (5) MPK's general revenues.

Thus, the following financial plan is proposed:

1) About 61 percent (M$85 million) of the construction cost to be financed by Federal Government loan.

2) The remaining construction cost (M$54 million) to be financed by Federal and/or State Government grant. However, the grant amount differs phase by phase, as follows:

   First Phase: No grant
   Second Phase: Grant for 1/3 of the construction cost
   Third Phase: Grant for 1/2 of the construction cost

3) A 3 percent property surcharge tax for the drainage service to be imposed on all property within the MPK area.

4) A developer's fee of M$3,000 per acre is to be imposed on new developments.

10. Institutional Organization

Enlargement of the Engineering Department is proposed, based on a review at each governmental level -- Federal, State and Kelang Municipality -- of the respective existing organizational units engaged in drainage activities.

The main features of the new organization are as follows:

1) In the existing Sewer & Drain Section, three units are to be newly set up: Design Unit, Construction Unit, and Operation & Maintenance Unit.

2) The current Work Shop Unit of the Sewer & Drain Section is to be made an independent section.

3) The total required staff (excluding the labor pool) is to be as follows: 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 and thereafter.

At present, a shortage of qualified and trained engineers deters Kelang Municipality from undertaking the urban drainage work. Thus, it is recommended that MPK recruit drainage staff to be initially assigned temporarily to SDID for execution of the First Phase work, and later to be transferred back to MPK for subsequent work on the basis of their training at SDID.

11. Benefits and Effects

The proposed drainage system will bring about such benefits as: (1) reduction of flood damage, (2) improvement of environment, and (3) increase in land value. It is expected to provide relief from flooding for 653.4 ha of flood-prone areas and 30,000 persons by the year 2000. Also, the recent rise in the level of living standard has wrought a definite change in the general concept of sanitation, health, and aesthetic sense; what once seemed tolerable has come to be regarded as being intolerable. Judging from the average increase in income of the people in Malaysia during the past decade, the environmental improvement expected to result from the proposed drainage system is considered of significant importance from the viewpoint of quality of daily life. Furthermore, the increase in land value expected from the drainage system will, in turn, bring additional revenue to Kelang Municipality.

CHAPTER 1

INTRODUCTION

CHAPTER 1 INTRODUCTION

1.1. Background

The economy of Malaysia has made remarkable progress in the past decade, which is apparent in its highly sustained GDP growth, its large investment share in GDP and its rapid, stable growth in the manufacturing sector.

The State of Selangor, which occupies only 2.5 percent of the total area of the country has about 18 percent of the total population and generates one-third of the total GDP in Malaysia including the Federal Territory.

Kelang Municipality is in the State of Selangor and is connected with the Federal capital of Kuala Lumpur at a distance of about 40 km by a direct highway route. The belt along this highway from Kuala Lumpur to Kelang Municipality called "Kelang Valley" is the most vital and economically advanced area in the State of Selangor and is expected to be continuously developed during the immediate future.

Kelang Municipality, located at the mouth of the Kelang River facing the Straits of Malacca is considered to be the gateway to this vital "Kelang Valley" belt. Port Kelang including North Port, the largest trading port in Malaysia, serves as a trigger for further continuous development of this vital belt, and is expected to increase its function even more. Furthermore, Kelang Municipality has rapidly been increasing various social and economic aspects of its activities to become a vital stronghold of the area due to its proximity and ease of commutation up to Kuala Lumpur.

The foregoing are factors which ensure the rapid future industrialization and urbanization of Kelang Municipality.

However, the sanitary conditions prevailing in Kelang Municipality can only be termed as being very poor. Its urban drains and streams,

which are presently used for both sewerage and drainage purposes, are badly polluted and their maintenance is not satisfactory, providing a possible source of health hazards through disease vectors, vermins and industrial waste. If appropriate sanitary control measures are not set up soon, future industrialization and urbanization of the Municipality are expected to further increase problems of sanitation and pollution. The conditions are obviously in need of improvement.

In addition to the above sanitary conditions, Kelang Municipality has been suffering from problem of flooding due to its topographic conditions. Most of the areas lies on very flat and low land, compared with the water level of the Kelang River which flows through Kelang Municipality into the Straits of Malacca. During heavy rainfalls and high sea tides, flooding occurs in the lower parts of the Municipality. Since future development within and around the Municipality is expected to increase the rate of rainfall runoff, it is evident that the flooding areas will be expanded with consequent problems and/or damage to industry, commerce and human daily life. These conditions may in turn serve as bottlenecks for future industrialization and urbanization of Kelang Municipality.

Taking the above-mentioned conditions into account, the necessity and urgency of establishing an effective plan of implementing both sewerage and drainage systems for Kelang Municipality was recognized, and the Government of Malaysia requested the assistance in the form of technical cooperation by the Government of Japan to conduct a study for a long range Master Plan to be followed by a Feasibility Study on priority areas according to urgency of the needs.

In response to the above request, the Government of Japan agreed to offer the services of a Japanese team of experts for the study and transfer of knowledge to counterpart personnel appointed by the Government of Malaysia, in accordance with laws and regulations in force in Japan. The Japan International Cooperation Agency (JICA), the official agency responsible for implementation of technical cooperation programs sponsored by the Government of Japan, is in charge of this study.

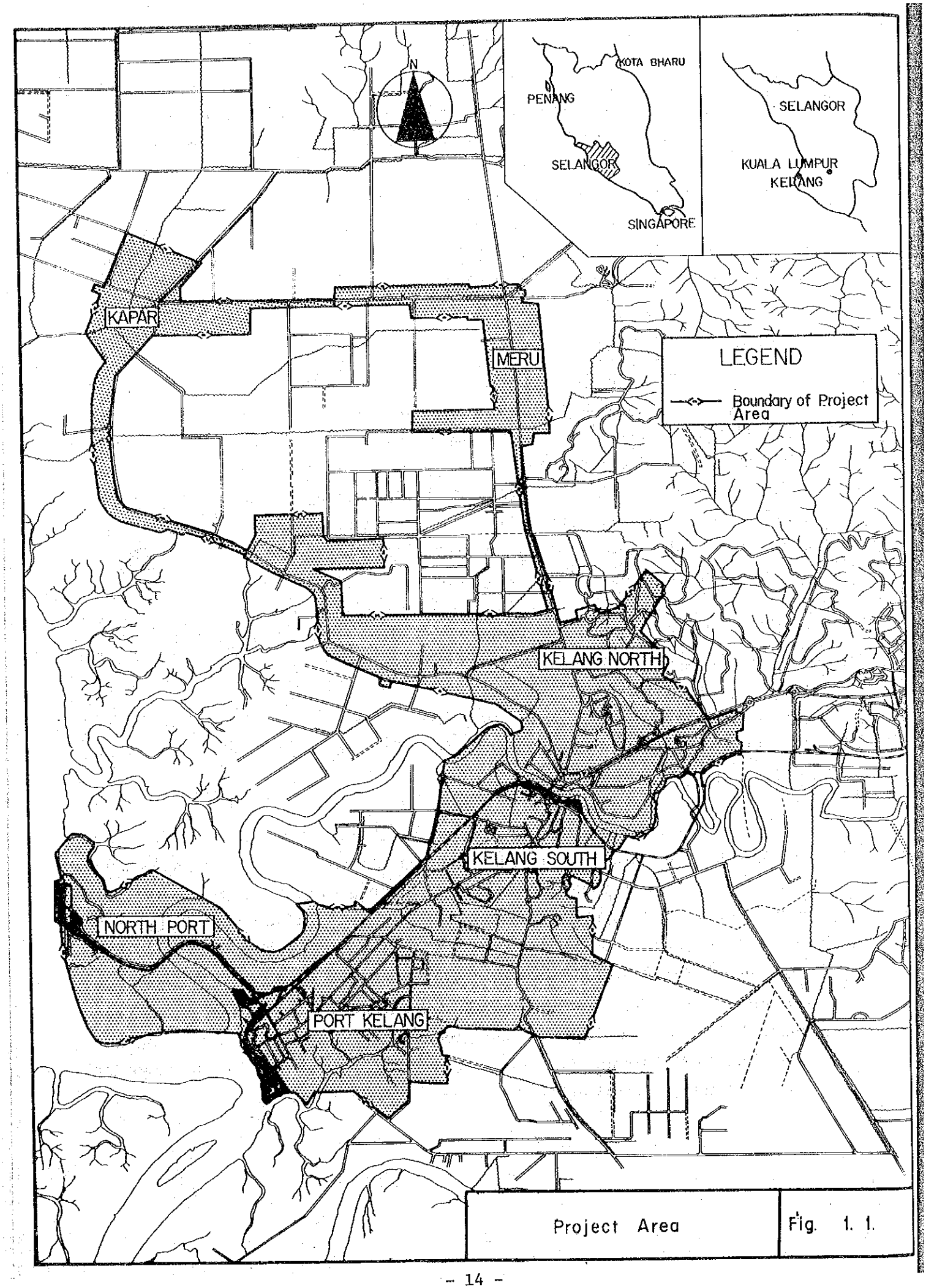
For the above purpose, a Japanese Supervisory Committee was set up in Tokyo in March 1981 and the joint firms of Tokyo Engineering Consultants Co., Ltd. and Central Consultant Inc. were retained by JICA to form the Study Team under the supervision of the Japanese Supervisory Committee. Technical and Steering Committees of the Government of Malaysia were also set up in Kuala Lumpur in order to deal with the progress of its studies and substance of its reports.

1.2. Definition of the Project

Before commencing the Study, the Scope of Work for the Project was officially agreed by both the Governments of Malaysia and of Japan. The Project consists of preparing a Master Plan up to the year 2000 for both sewerage and drainage systems including all aspects of engineering and managerial matters normally required for a comprehensive long-range plan, and a Feasibility Study on the first priority area with sufficient details on engineering plan, cost estimates and financing consideration.

The area for the Project was determined based on the above agreement. Total area of the Project Area is 7,669 ha. as shown in Fig. 1.1. For the purpose of planning, total Project Area is expected to be divided into smaller areas to identify urgency of the work, based on which phasing schedule for implementation will be established with the first phase program for Feasibility Study.

It is expected that following completion of the Master Plan, plans for sewerage and drainage systems covering the Project Area with necessary facilities up to the year 2000 will be established, with approximate cost estimates for implementation which however, will require reviewing and modifying at a later stage, according to succeeding developments. On the other hand, the Feasibility Study, completed in the first phase program for the highest priority area will enable the authorities concerned to proceed detailed design of civil work and procurement of materials and equipment according to the required standard procedure, provided sufficient fund for implementation is committed.



Project Area | Fig. 1. 1.

CHAPTER 2

BACKGROUND INFORMATION FOR THE STUDY

CHAPTER 2 BACKGROUND INFORMATION FOR THE STUDY

2.1. Physical Characteristics of the Project Area

2.1.1. Location

Malaysia consists of West Malaysia (Peninsular Malaysia) and East Malaysia (Sabah and Sarawak), and has thirteen states including Sabah, Sarawak and the Federal Territory. Malaysia's total area is about 330,400 km^2.

West Malaysia is surrounded by the Straits of Malacca to the west, the South China Sea to the east, and the contiguous boundaries of Thailand and Singapore. It lies entirely within the tropics, extending from latitude 1° to 7° north and from longitude 100° to 104° east.

The State of Selangor is located in the western part of West Malaysia and lies from latitude 2.5° to 4.0° north and from longtitude 100.7° to 102.0° east. Its area is about 8,200 km^2, including the Federal Territory, which occupies 2.5 percent of the whole area of Malaysia.

The Project Area of the Master Plan is situated in the western part of the State of Selangor and covers the whole area of the Kelang Municipality and its various environs. The Kelang Municipality is located about 40 km west of the Federal capital of Kuala Lumpur and has a population of 196,209 (1980), which makes Kelang Municipality the fifth largest city in Malaysia.

The Project Area is comprised of Kelang, Port Kelang, Kapar and Meru. From north to south, the Area is about 17 km (10.5 miles) and from east to west about 14 km (8.7 miles), with a total of 7,669 ha. (about 19,000 acres).

In the Project Area, the watercourses are the Kelang River, the Aur River, and the coastal watercourses of the Kapar Besar and Puloh rivers, etc. The Kelang River runs through and around the center of the Project Area and into the Straits of Malacca. The Aur River flows across the southern edge of the Project Area.

2.1.2. Topography and Geology

1) Topography

The Project Area can be divided topographically into two parts, Port Kelang and other areas comprised of Kelang, Kapar and Meru.

Port Kelang has flat terrain, and the elevation is below 3.05 m (10 ft.). Even in residential areas, there are some low lying locations where tide-effected flooding occurs.

Although the other areas are mildly hilly, the terrain is mostly flat with higher elevation compared to the Kelang River. There is a hilly ridge beyond the Project boundary at Meru running from northwest to southeast. This ridge is a watershed for runoff which originates outside the Project Area. At present, some hills in this area are being developed into residential estates. This tendency is expected to continue towards the future, due to the urbanization program in Kelang Municipality. By the year 2000, the target year of the Master Plan, condition of land use in this terrain is expected to be greatly changed.

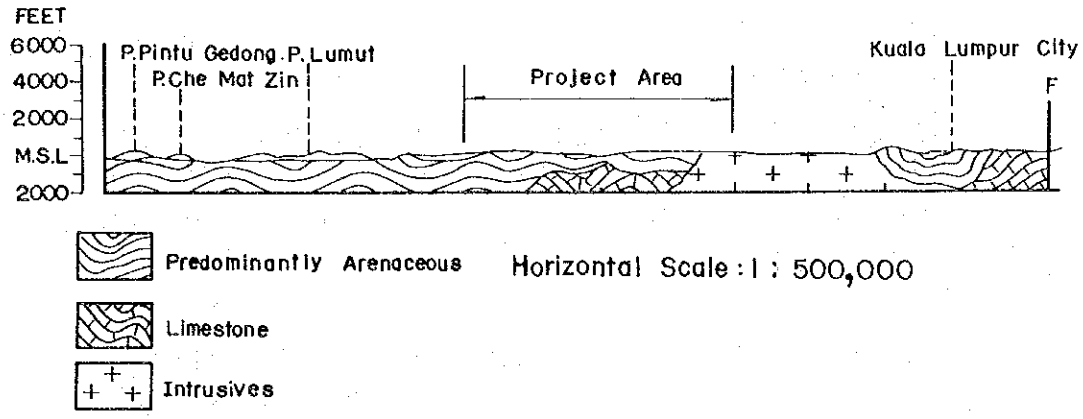
The populated areas are located in Port Kelang, Kelang South and Kelang North. Suburbs are almost totally covered by palm groves.

2) Geology

The geological nature of the western part of the Project Area divided by Jalan Langat, is alluvium of the Quaternary Period and that of the east is quartzite and phyllite of the Permian Carboniferous, or Triassic Period.

The hilly ridge running from north to south at the east side of Jalan Langat is overlain by medium stiff clay with some gravel and is of the quartzite, sandstone, schist and shale groups.

Fig. 2.1. Diagrammatic Section of Geology



Source: Hydrogeological Map of Peninsular Malaysia

The relatively shallow underground in the Project Area seems to be formed by two typical soil layers. The upper layer is silty clay and the lower layer is silty sand, according to boring data from the Aur River and terrain of the Project Area. The elevation of the lower layer, which is considered to be a supporting ground base, seems to gradually rise to the surface eastward toward the Project Area.

According to the "Kelang Sewerage Study" report in 1968, conducted by Proctor & Redfern International Ltd., twenty-one (21) boring tests were carried out up to a depth of 7.6 m (25 ft.), by means of an auger and shell in Port Kelang, Kelang South and North, with the following results:

a) Typically, the soils are soft to very soft clay with ground water level less than 1.5 m (5 ft.) below the surface.

b) The coefficient of cohesion C of clay soils is less than 0.18 kg.cm^2 (375 p.s.f.) by the unconfined compression strength test and these are classified as "very soft."

c) Values by the permeability test show around 3.0×10^{-6} cm per second. This value is a very low permeability consistent with the expected range between a clay and a silty clay.

d) A sulphate content is shown in a range of 98 to 108 ppm. Values of pH vary from 4.5 to 8.5.

e) By the Atterberg Limit test, the natural moisture of six samples out of eight samples is higher than the liquid limit.

f) Compaction testing indicates that substantially improved soil strengths could be obtained by compaction, provided moisture reduction is possible.

Location of the 21 boreholes where the boring tests were conducted are shown in Fig. 2.2. Out of the 21 boreholes, eight points were selected for ground water testing and low pH values were recorded at three points where ground elevation is high. Location of ground water sampling points and those of low pH values, are also shown in Fig. 2.2.

2.1.3. Climate

The climate in the Project Area is typically tropical; in short, hot and humid throughout the year with frequent squalls. No meteorological station exists in the Project Area; however, meteorological data is available at Subang Station (Kuala Lumpur International Airport), located 15 km east of the Area. Data obtained there for the 1968-1980 period are summarized as follows:

24 hrs. mean temp:	26.3°C
Mean daily maximum temp:	32.1°C
Mean daily minimum temp:	22.6°C
Highest maximum temp:	36.0°C
Lowest minimum temp:	18.1°C
24 hrs. mean humidity:	84.0%
Annual average rainfall:	2,300.8 mm/year

Mean number of rainy days: 193 days/year

Winds of strong force (Force 8 or more) are extremely rare.

Rainfall and temperature data are shown in Table 2.1 for reference.

Table 2.1. Record of Mean, Highest and Lowest of Monthly and Annual Rainfall, Raindays and Temperature

	Period	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
Rainfall (mm)														
Mean	1966-1980	177.8	140.8	208.6	297.3	176.0	135.6	114.2	138.4	162.8	269.2	248.5	231.6	2300.8
Highest	1966-1980	370.3	255.5	336.8	469.4	405.6	253.5	242.4	312.2	281.9	496.3	374.7	536.7	2906.7
Year of Highest		1971	1966	1976	1966	1973	1972	1979	1969	1979	1968	1972	1971	1973
Lowest	1966-1980	70.9	87.1	89.4	144.4	49.3	25.7	49.5	36.6	98.8	58.7	91.2	100.3	1800.8
Year of Lowest		1974	1976	1972	1977	1979	1978	1976	1972	1976	1974	1971	1977	1974
Number of Raindays														
Mean	1966-1980	13	13	16	20	15	13	12	14	15	21	21	19	193
Highest	1966-1980	22	18	24	26	23	17	19	21	22	26	26	23	210
Year of Highest		1967	1966	1978	1973 1980	Sev.	1976 1977	1980	1969 1971	1975	1968	1972	Sev.	1980
Lowest	1966-1980	5	6	6	10	7	6	7	8	11	17	18	13	177
Year of Lowest		1972	1968	1972	1977	1976	1970 1978	1967	1974	1969	Sev.	1968 1973	1977	1972
Temperature (°C)														
24 Hr. Mean	1968-1980	25.9	26.3	26.6	26.8	27.0	26.7	26.4	26.4	26.2	26.2	25.9	25.8	26.3
Mean Daily Max.	1968-1980	31.9	32.8	33.0	32.8	32.7	32.3	31.9	32.0	31.8	31.7	31.2	31.2	32.1
Mean Daily Min.	1968-1980	21.8	21,9	22.4	23.1	23.3	22.9	22.5	22.5	22.6	22.7	22.8	22.3	22.6
Highest Max.	1968-1980	34.7	35.5	36.0	35.6	35.1	35.0	34.5	35.0	34.8	34.6	34.0	33.8	36.0
Year of Highest Max.		1979	1970	1970	1969	1979	1978	1976	1972	1969 1979	1979	1979	1977	1970
Lowest Min.	1968-1980	18.6	18.1	18.7	21.2	21.0	20.0	20.0	20.0	20.5	20.2	20.6	20.0	18.1
Year of Lowest Min.		1979	1968 1977	1968	1971	1976	1976	1976	1976	1976	1978	Sev.	1975	1968 1977

Notes: Station: Kuala Lumpur International Airport (Subang)
Latitude: 03°07'N
Longitude: 101°33'E
Ht. above M.S.L.: 16.5 m

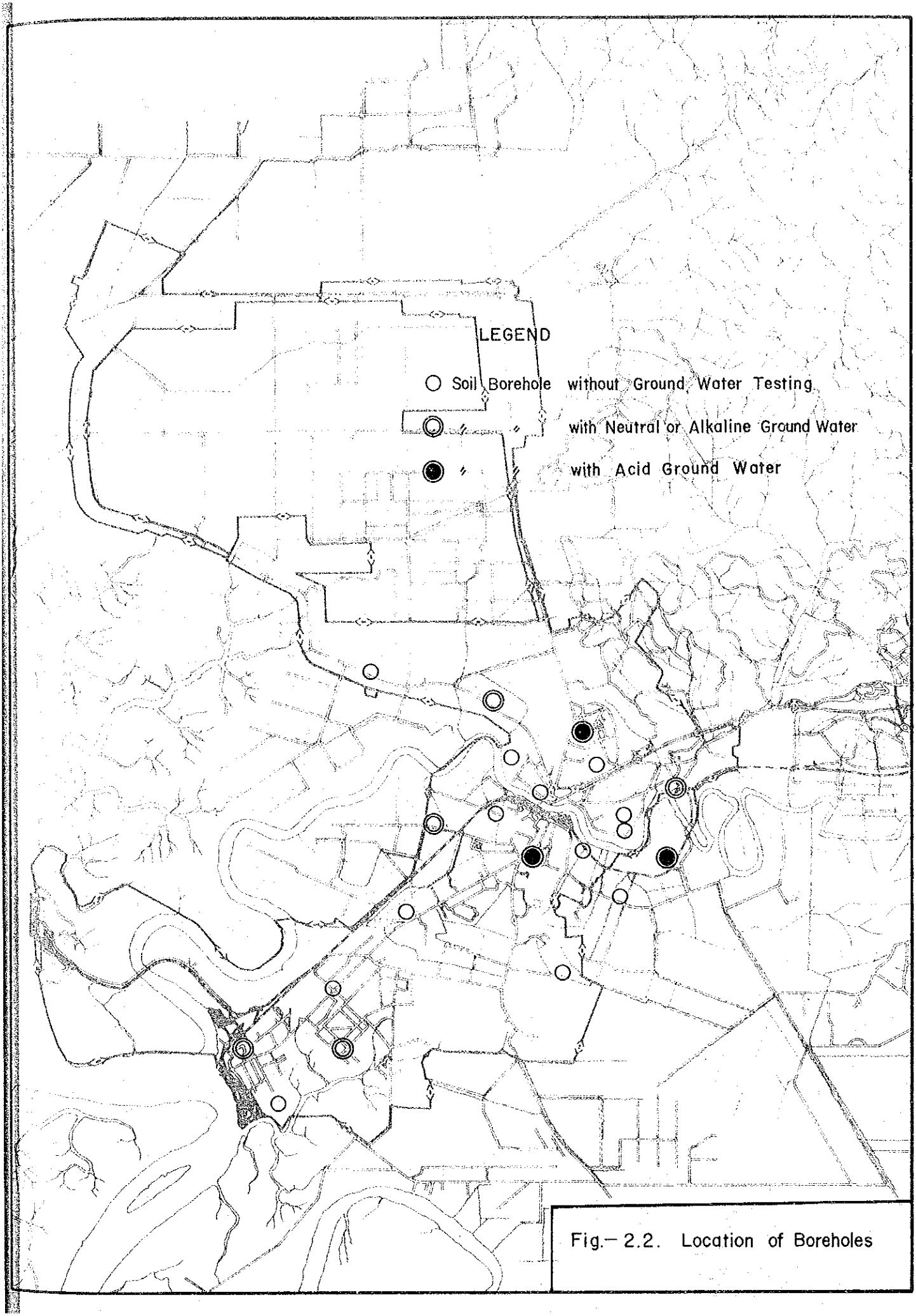


Fig.– 2.2. Location of Boreholes

2.2 Socio-Economic Conditions

2.2.1. Population and Urbanization

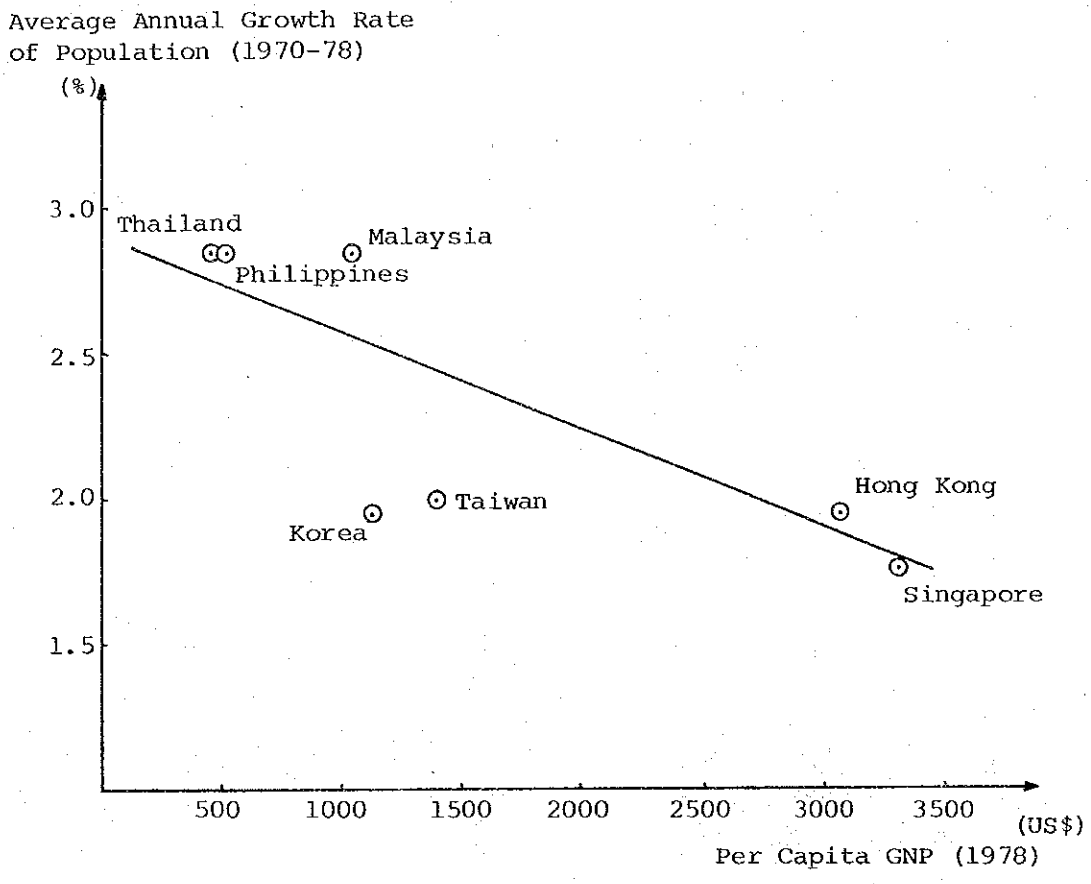
According to the Fourth Malaysia Plan (FMP), the total 10.8 million population of Malaysia in 1970 increased to an estimated 14.3 million in 1980, with an average annual growth rate of 2.8 percent. This growth rate is almost the same as that of middle-income countries in Asia, such as Thailand (2.7 percent) and the Philippines (2.7 percent).

As seen in the following Fig. 2.3, the population growth rate is, in general, related to the per capita income level. It can be empirically said that the more industrialized a nation, the less its growth rate. Therefore, the population growth rate in Malaysia is expected to decrease in the future as increased participation by the industrial sector in the economy is clearly foreseen.

According to the same source of information, the population of the country is estimated to increase from 14.3 million in 1980 to about 16.2 million by 1985, growing at an average annual rate of 2.6 percent. The population of Peninsular Malaysia is expected to increase at an average rate of 2.4 percent per annum, which is lower than the growth rate of 3.2 percent per annum estimated for Sabah and Sarawak.

The urban population growth rate in the last decade was 4.6 percent per annum. In absolute terms, urban population increased from 2.6 million in 1970 to about 4.1 million in 1980 in Peninsular Malaysia. This means that about 29 percent of the total population lived in urban areas in 1970, compared to 35 percent in 1980.

Fig. 2.3. Population Growth Rate and Per Capita Income Level



Source: World Development Report, W.B., 1980.

For reference, the urban population growth in Japan from 1950 to 1960 was 6.7 percent per annum while the growth rate of the real per capita GNP during the same period recorded 8 percent per annum. As the economy of Malaysia is expected to sustain its remarkable progress, its urban population growth rate will remain high throughout the 1980s. The FMP predicts the growth of the urban population in Peninsular Malaysia at an average rate of 4.1 percent per annum from 4.1 million in 1980 to an estimated 5.1 million by 1985. As a result, the proportion of urban population is expected to increase from 35 percent to 38 percent during the FMP period. The predicted high rate of urbanization is attributable to Malaysia's expected economic growth, particularly in the industrial sectors

and rural-urban migration, bringing the real per capita GNP to increase accordingly.

2.2.2. The Economy of Malaysia

In the past decade of the Second and Third Malaysia Plan periods (1970-80), the economy of the country achieved remarkable progress. It was indeed a period of high economic growth, which brought a great structural change the Malaysian economy had never experienced before. The per capita gross domestic product(GDP) in real terms during this decade increased by 4.9 percent per annum (about 60 percent increase in 10 years). The per capita gross national product (GNP) at the current price in 1980 reached approximately M$3,630.

The share of GDP in the agriculture, forestry and fishery sectors decreased from 30.8 percent in 1970 to 22.2 percent in 1980, while that of the manufacturing sector increased from 13.4 percent to 20.5 percent in the same period. The growth in total investment of the economy in the past decade was so vital that the share in GDP increased from 17.8 percent in 1970 to 26.5 percent in 1980, among which private investment was double that of public investment.

Active progress in the manufacturing sector, supported by (a) availability of domestic and foreign capital, (b) abundant labor force, (c) stable growth in the primary sector and (d) well-established managerial ability, proved to be sufficiently strong during the "Energy crises" period from 1973 onwards, which had serious ill effects on both developed and developing countries.

The above-mentioned three indicators; i.e., sustained growth in GDP, in large investment share in GDP and stable and rapid growth in the manufacturing sector, prove that the Malaysian economy has already entered the stage of modern economic growth which the Japanese economy experienced in the 1960s.

The New Economic Policy (NEP) launched at the inauguration of the Second Malaysia Plan in 1970 had as its fundamental goals the eradication of poverty by raising income levels and increasing opportunities for all Malaysians, and re-ordering of society to correct economic imbalance so as to reduce and eventually eliminate the identification of any particular group with economic activities.

Concerning income growth, the NEP provided satisfactory results in the past decade. However, equitable distribution of the achievement seems to be of concern to the Government. Poverty in urban areas still remain in the shadow of skyscrapers, and the gap in productivity between urban and rural areas is increasing.

The NEP's goals remain to be pursued during the current FMP (1981-85). Particularly, it seems to place major concern on equitable distribution of income among peoples as well as regions.

It is natural that the striking performance in the 1970s and further availability of resources in the Malaysian economy make FMP challenging. The FMP advocates the increase of the GDP in real terms to 7.9 percent per annum which is 0.1 percent higher than the rate achieved in the 1970s. (Ref.: Table 2.3.)

The position of balance of payments continued to be favorable during the 1970s. Particularly the trade balance recorded a remarkable surplus of M$21,954 million during 1976-80 compared to a surplus of M$4,088 million during 1971-75. The strong growth in trade surplus resulted from, in particular, an increase in the export value of crude petroleum and manufactured goods. A better position in trade balance and a substantial inflow of official and private capitals enabled the country to accumulate about M$6,702 million during 1976-80. Thus, the external reserves of the national bank reached an estimated M$10,304 million at the end of 1980. This level of external reserves is equivalent to 5.5 months of imports at the 1980 level. The debt service ratios to GNP and exports of goods/services were 4.6 percent and 8.8 percent respectively in 1978, compared to 1.7 percent and 3.6 percent in 1970. These figures indicate that although the position in debt service ratios was greater during the past decade, it is not at a critical level.

Table 2.2. Balance of Payments, Malaysia (1971-80)

(Unit: M$ million)

		Cumulative		
		1971-75 (Actual)	1976-80 (Estimate)	1971-80 (Estimate)
	Export of goods	35,962	97,282	133,244
-	Import of goods	31,874	75,328	107,202
=	Trade balance	+4,088	+21,954	+26,042
+	Balance on services	-6,457	-16,632	-23,089
+	Net transfers	-628	-487	-1,115
=	Balance on current account	-2,997	+4,835	+1,838
+	Official long-term capital	+2,327	+2,789	+5,113
+	Corporate investment	+3,282	+6,911	+10,193
+	Commercial credit	+119	-158	-39
+	Private financial capital	+339	-2,285	-1,946
+	Errors and omissions	-1,279	-5,537	-6,816
=	Overall balance	+1,791	+6,552	+8,343
+	SDR allocation	+121	+150	+271
=	Net change in external reserves (increase-/decrease+)	-1,912	-6,702	-8,614

Source: FMP

2.2.3. The Economy of the State of Selangor

The economy of Selangor, excluding the Federal Territory, has attained an overall high level, especially in its manufacturing and tertiary sectors during the past decade. Its rapid economic progress, as shown in the table below, has made it the richest state in Malaysia, with a per capita GDP nearly double the national average. Its GDP represents approximately one-third of the total national GDP.

Year	Per Capita GDP	GDP
1971	M$2,153	M$3,826 million
1980	M$2,655	M$4,144 million

One-third of its GDP comes from the manufacturing sector, while only 8 percent comes from agriculture. A substantial output of this manufacturing sector accrues from industries located in the Kelang Valley, and accounts for 37 percent of the nation's total output. Thus, this belt along the Kelang River from Port Kelang to Kuala Lumpur has become the most economically vital zone in the country.

The future economic growth of Selangor is expected to continue experiencing high levels of GDP and per capita GDP throughout the next decade. The GDP of the state is projected to grow at 7.4 percent per annum from 1980 to 1985 and at 9.0 percent per annum from 1985 to 1990, leading to M$5,934 million GDP and M$9,148 million GDP respectively (all figures are presented at 1970 price level). On the other hand, the per capita GDP is projected to reach M$3,100 in 1985 and M$3,972 in 1990, which are approximately 1.33 times higher for 1985 and 1.27 times higher for 1990 than the projected national average.

Particularly, the future growth of the economy of Selangor is expected to stem from the increasing establishment of high-technology industries, such as the production of medical, electrical and telecommunications equipment, as well as the expansion of service activities related to programs aimed at strengthening the role of Selangor as the growth center for Peninsular Malaysia.

The following Table 2.3 gives the economic condition of Selangor State, compared with those of the country as a whole.

Table 2.3. Economy of Selangor State: GDP of Sector Origin

(The Selangor State excludes the Federal Territory) (Unit: M$ million at 1970 price level)

Sector	State of Selangor (including F.G.)								Malaysia							
	1971		1980		1985		1990		1971		1980		1985		1990	
	Value	(%)	Value	(%)	Value	(%)	Value	(%)	Value	(%)	Value	(%)	Value	(%)	Value	(%)
Agriculture	419	(11.3)	611	(7.7)	636	(6.1)	682	(4.5)	3,852	(30.5)	5,809	(22.9)	6,720	(18.3)	8,193	(14.9)
Mining & Quarrying	198	(5.3)	153	(1.9)	146	(1.4)	115	(0.8)	834	(6.6)	1,214	(4.8)	1,607	(4.4)	1,863	(3.4)
Manufacturing	940	(25.3)	2,462	(31.2)	3,563	(34.0)	5,559	(37.0)	1,858	(14.7)	5,374	(21.2)	9,040	(24.6)	15,121	(27.6)
Construction	242	(6.5)	492	(6.2)	646	(6.2)	947	(6.3)	541	(4.3)	1,186	(4.7)	1,824	(5.0)	2,938	(5.4)
Utilities	76	(2.0)	219	(2.8)	284	(2.7)	396	(2.6)	238	(1.9)	592	(2.3)	953	(2.6)	1,500	(2.7)
Transport, Storage & Communication	196	(5.3)	722	(9.1)	905	(8.6)	1,263	(8.4)	632	(5.0)	1,696	(6.7)	2,492	(6.8)	3,834	(7.0)
Wholesale, Retail, Trade, Hotel & Restaurant	715	(19.2)	1,261	(16.0)	1,725	(16.5)	2,464	(16.4)	1,717	(13.6)	3,295	(13.0)	4,841	(13.2)	7,279	(13.3)
Finance, Insurance, Estate & Business Services	299	(8.0)	662	(8.4)	835	(8.0)	1,150	(7.7)	1,126	(8.9)	2,155	(8.5)	3,079	(8.4)	4,629	(8.4)
Gov't Service	509	(13.7)	1,033	(13.1)	1,373	(13.1)	1,920	(12.8)	1,466	(11.6)	3,398	(13.4)	5,228	(14.2)	8,044	(14.7)
Others	128	(3.4)	279	(3.5)	365	(3.5)	527	(3.5)	354	(2.8)	657	(2.6)	948	(2.6)	1,459	(2.7)
Total	3,722	(100.0)	7,894	(100.0)	10,478	(100.0)	15,023	(100.0)	12,618	(100.0)	25,376	(100.0)	36,732	(100.0)	54,860	(100.0)
Share of Selangor (%)	29.5		31.1		28.5		27.4									
Area (km^2)	8,196	(2.5% of the total area)							330,434							
Population (1,000)	1,777	(16.0)	2,559*	(17.9)	3,087	(19.1)	3,656	(20.0)	11,104		14,261		16,180		18,261	
Population Density (person/km^2)	216		312		377		446		33.6		43.2		50.0		55.3	
GDP at Purchasers' Value	3,826		4,144		5,934		9,148		13,016		26,188		37,824		56,760	
Per Capita GDP	2,153		2,655		3,100		3,972		1,172		1,836		2,338		3,129	
Ratio to Malaysia	1.84		1.45		1.33		1.27		1.0		1.0		1.6		1.0	

Source: Fourth Malaysia Plan

Note: * This figure is revised to be 2,405, according to the latest source, the 1980 Census.

2.3. Population and Land Use

2.3.1. Population

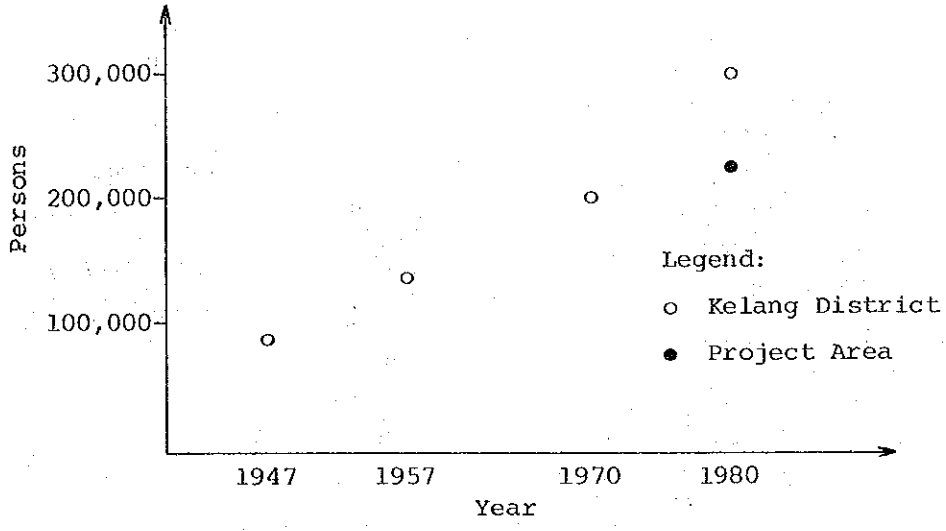
1) Population Trend

Population trend in the Project Area can be observed through results of four censues conducted in 1947, 1957, 1970 and 1980 in Malaysia.

Since various small suburbs are included in the Project Area, in additon to the entire Municipality area, the Project Area does not geographically coincide either with the State adminstrative area of Kelang District, which is larger than the Project Area, or with the Kelang Municipality area. Thus the Project Area population for the census years, 1947, 1957 and 1970 could not be obtained. However, population in the Kelang District for all of the census years and that in the Porject Area in the 1980 census were available to provide, as shown in Fig. 2.4, a graphic view of the population trend.

Since the Kelang Municipality area is the only urban area and the remaining areas consist of *Kampung* and agricultural areas, population increase in the Kelang District during the 33-year period from 1947 to 1980 is considered to have occurred in the Municipality area. Preliminary field count summaries of the 1980 census revealed the population in the Kelang District (which was 89,000 in 1947) and in the Project Area to be 284,941 and 205,630 respectively. The annual population growth rate of the years between 1970 and 1980 was 3.7 persent, which is larger than the annual growth rate of 2.4 percent for Peninsular Malaysia and samller than the rate of 4.0 percent for the State of Selangor.

Fig. 2.4. Population Trend



2) Population Distribution in 1980

The population figure of each *Kawasan* for the year 1980, taken from the preliminary field count summaries, is shown in Fig. 2.5 below. The figure illustrates that the population is concentrated in Port Kelang, Kelang North and Kelang South.

3) Population Density in 1980

The population density of each *kawasan* in 1980 is shown in the following Fig. 2.6, which shows that Port Kelang is the most densely populated area with *kawasan* #13 having the highest density of 100 persons/ha, including the squatter population. On the other hand, Kapar and Meru are observed to be among the least densely populated areas, with population density of approximately 10 persons/ha. The contrast in the various population densities with the average population density of the Project Area of approximately 30 persons/ha should be noted.

Fig. 2.5. Project Area Population Distribution in 1980

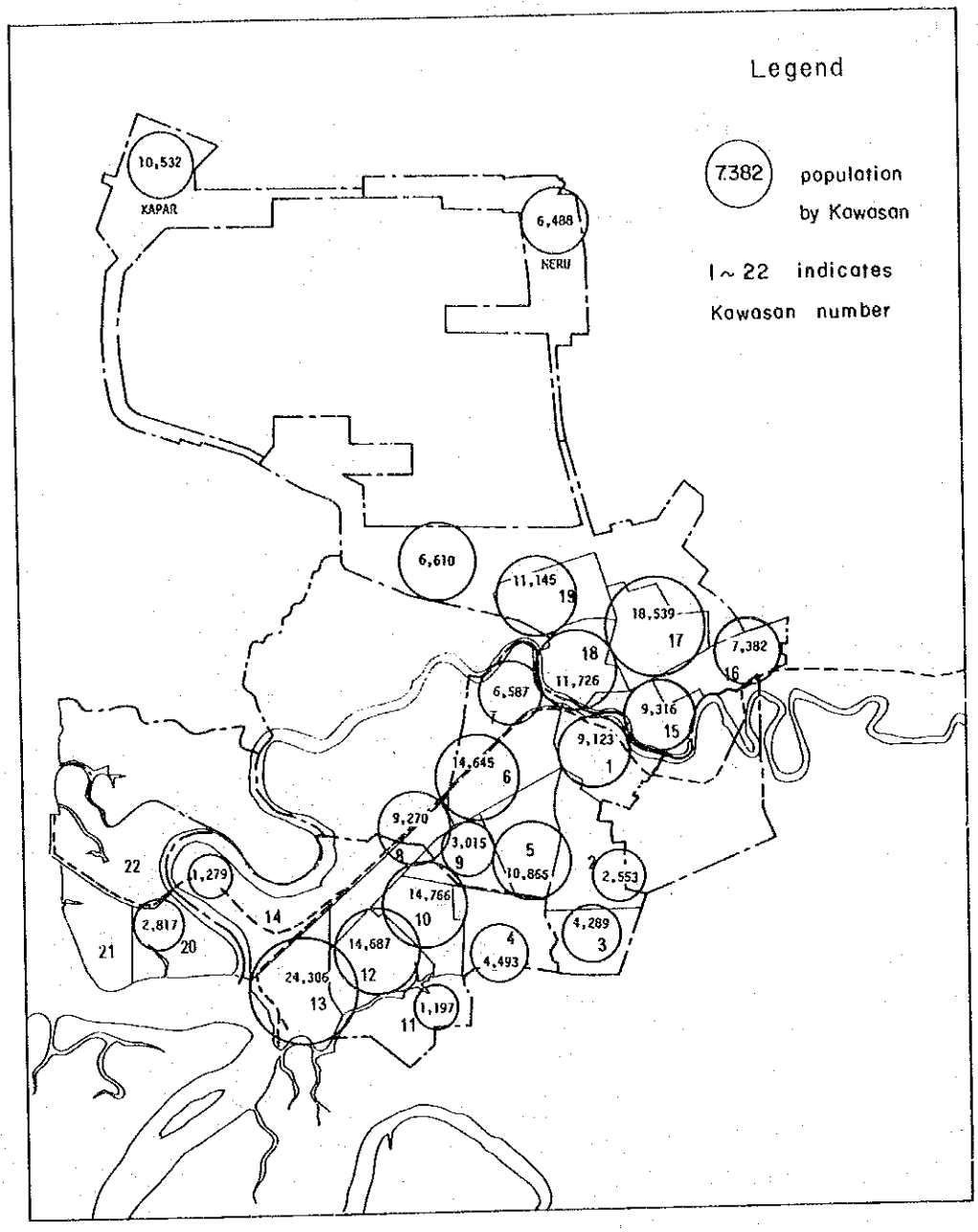
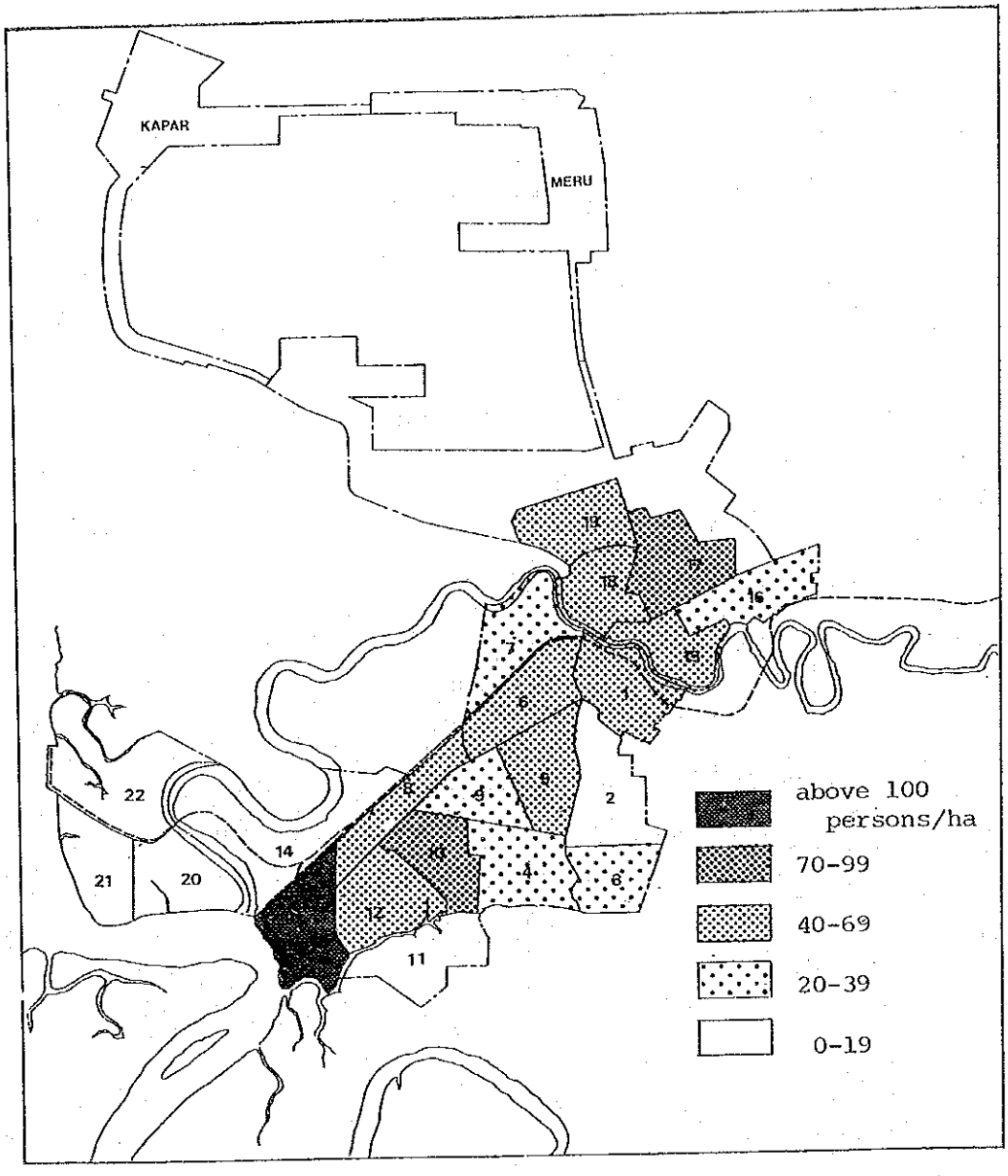


Fig. 2.6. Population Density in 1980



2.3.2. Land Use

1) Existing Land Use

The present situation regarding land use of the Project Area is that the area surrounding the commercial centers of Kelang North, Kelang South and Port Kelang are allotted for residential purpose. The major industrial area is allocated in the North Port area, with some industrial areas also included in Kelang North and Port Kelang. The agricultural areas, chiefly palms oil estates, cover the area between North Port and Kelang South.

The existing land use situation of the Project Area is shown in Fig. 2.7, while details of the areas earmarked for various categories of land use are given in Table 2.4.

Table 2.4. Existing Land Use (1980)

Land Use	Area (Hectare)	(Percentage)
Residential	1,600	20.9
Commercial	60	0.8
Industrial	700	9.1
Port Area	160	2.1
Institutional/Government	230	3.0
Open Space/Agriculture/ Vacant Land	4,919	64.1
Total	7,669	100.0

Source: Interim Development Control Planning Study, 1981, Selangor State.

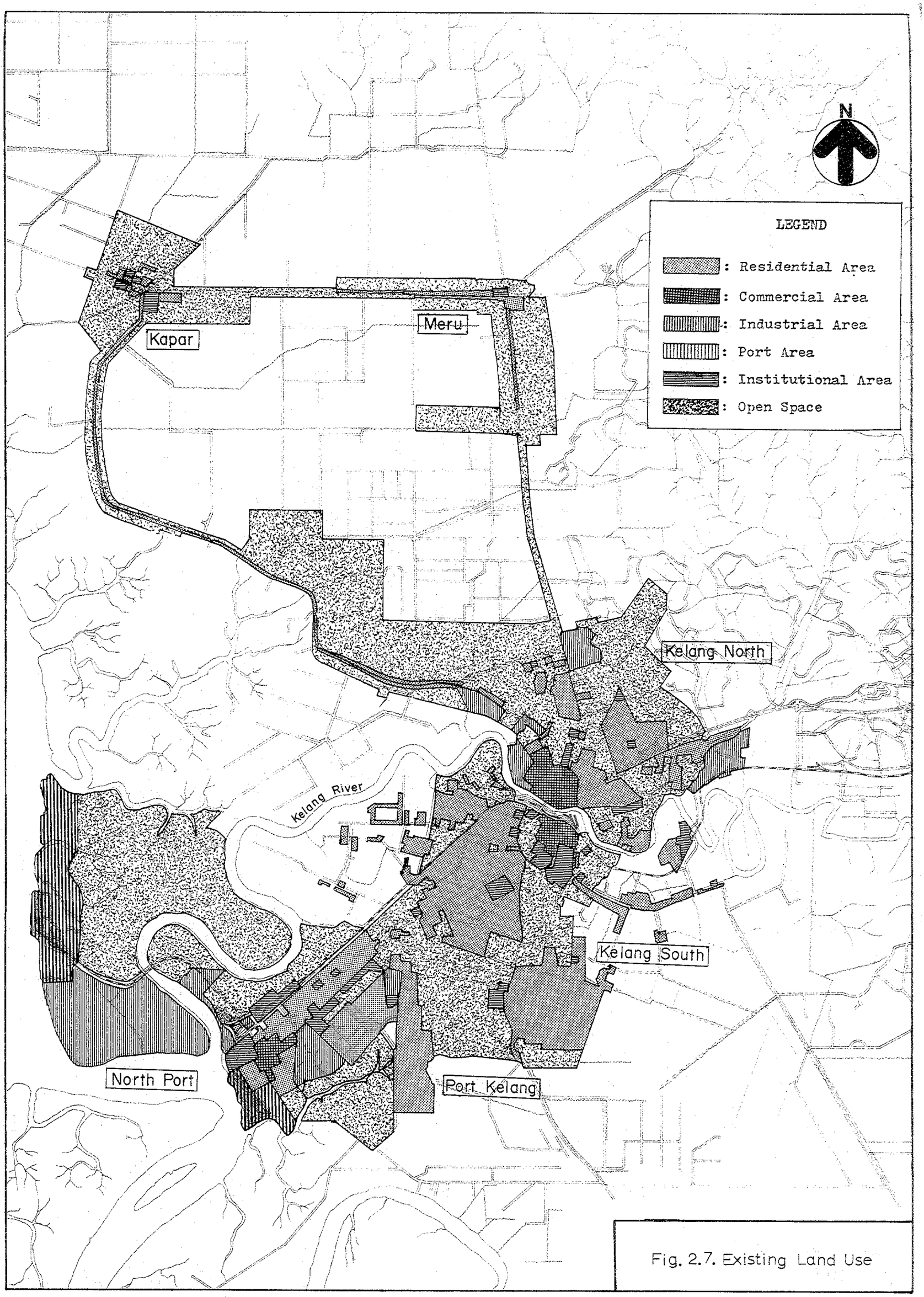


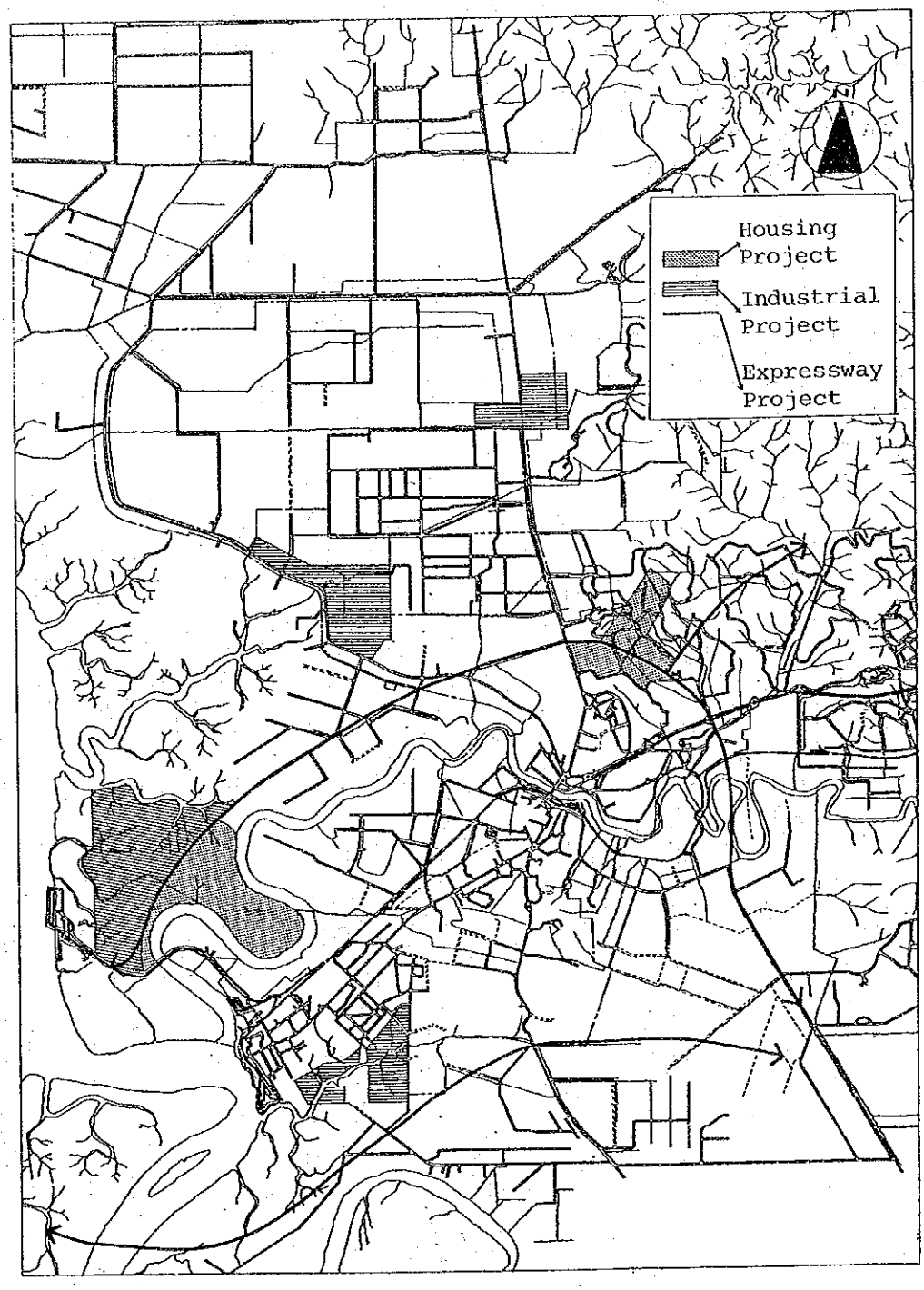
Fig. 2.7. Existing Land Use

2) Development Projects

The sites for the planned industrial, housing and road projects are shown in the following Fig. 2.8. According to this figure, the industrial projects are concentrated in North Port and the main housing projects are located in Kelang North.

As for road construction projects in the Project Area, the North Expressway is currently under construction, and the proposed South Expressway will connect Federal Highway and the New Port, which will be constructed at Pulau Lumut. These expressway projects are shown in Fig. 2.8.

Fig. 2.8. Main Development Projects



2.4. Existing River and Drainage System

2.4.1. River System

The largest river in the Project Area, the Kelang River starts from the mountainous border of the State of Pahang, and flows westward through Kuala Lumpur and Petaling Jaya to the sea. Its route through the Project Area goes through the center of Kelang, then to the north of Port Kelang. The river is affected by tidal waves throughout the Project Area and to a considerable distance upstream to the Puchong Weir. Most of the drains in the Project Area empty into the river.

1) Kelang River Flow

The DID maintains flow records at a few gauging stations upstream from the Puchong Weir where tides are not expected to have any effect on the river. The flood discharge at the town of Kelang was estimated as follows by using specific flood discharges based on results of the National Water Resources Study. (Ref: Section 4.2.)

Flood Discharge (m^3/sec)	Return Period (year)
690	100
610	50
360	5
260	2

2) Kelang River Water Level

The tidal level which affects the water level of the Kelang River is shown below:

Table 2.5. Tidal Level at Port Kelang

Lowest Astronomical Tide	R.L. -2.84 m
Mean Low Water Springs	R.L. -2.04 m
Mean Low Water Neaps	R.L. -0.44 m
Mean Sea Level	R.L. +0.16 m
Mean High Water Neaps	R.L. +0.86 m
Mean High Water Springs	R.L. +2.06 m

Source: Tide Tables, Malaysia and Sigapore, 1981.

2.4.2. Background of the Drainage System

The existing drainage system was constructed some 30 to 40 years ago by the Public Works Department of the State Government of Selangor which was responsible for drainage work at the time. Since then, no major changes have been made to keep pace with the rapid development of the town, except for the Kelang North Drainage Scheme in the early '60s by the Council itself. At that time, 4,800 m of main drains and three tidal gates were constructed at a cost of about M$1 million.

Later in the early '70s, the Council completed and adopted its own Master Drainage Scheme. Another milestone in the development of Kelang's drainage system was laid when the Council established the policy requiring main drainage contribution from all new developments. However, the amount the Council could afford yearly was less than M$1 million, which was hardly sufficient for any major improvement work.

On January 1, 1977, when the Kelang Municipal Council was instituted under the Local Government Act, 1976, its status was upgraded from a district council to that of a municipal council, with more administrative independence and financial autonomy as the Local Authority for Kelang Municipality.

The Urban Drainage Scheme planned in 1978 in collaboration with the State Government indicates the following conclusions:

. That the existing drainage system was far outdated.
. That failure to make improvements in the system would create a great problem.
. That a detailed study of the whole area would be necessary.
. That it would cost M$20 million to undertake the initial improvement program to provide relief to badly flooded areas.

Following this study, the urban drainage scheme was undertaken by the State Government, with responsibility for maintenance taken over by the Municipality, where it still remains.

At present, the State Government is planning interim measures for improvement of the urban drainage system with a budget of some M$20 million. This plan is described in Table 2.6.

2.4.3. Existing Drainage System

The existing drainage system for the Municipality consists of approximately 13 km of river bund, 32 tidal gates, 130 km of main drains, and a network of internal drains handling the flow from all the areas in the town center, the housing estates, residential areas and the surrounding agricultural areas.

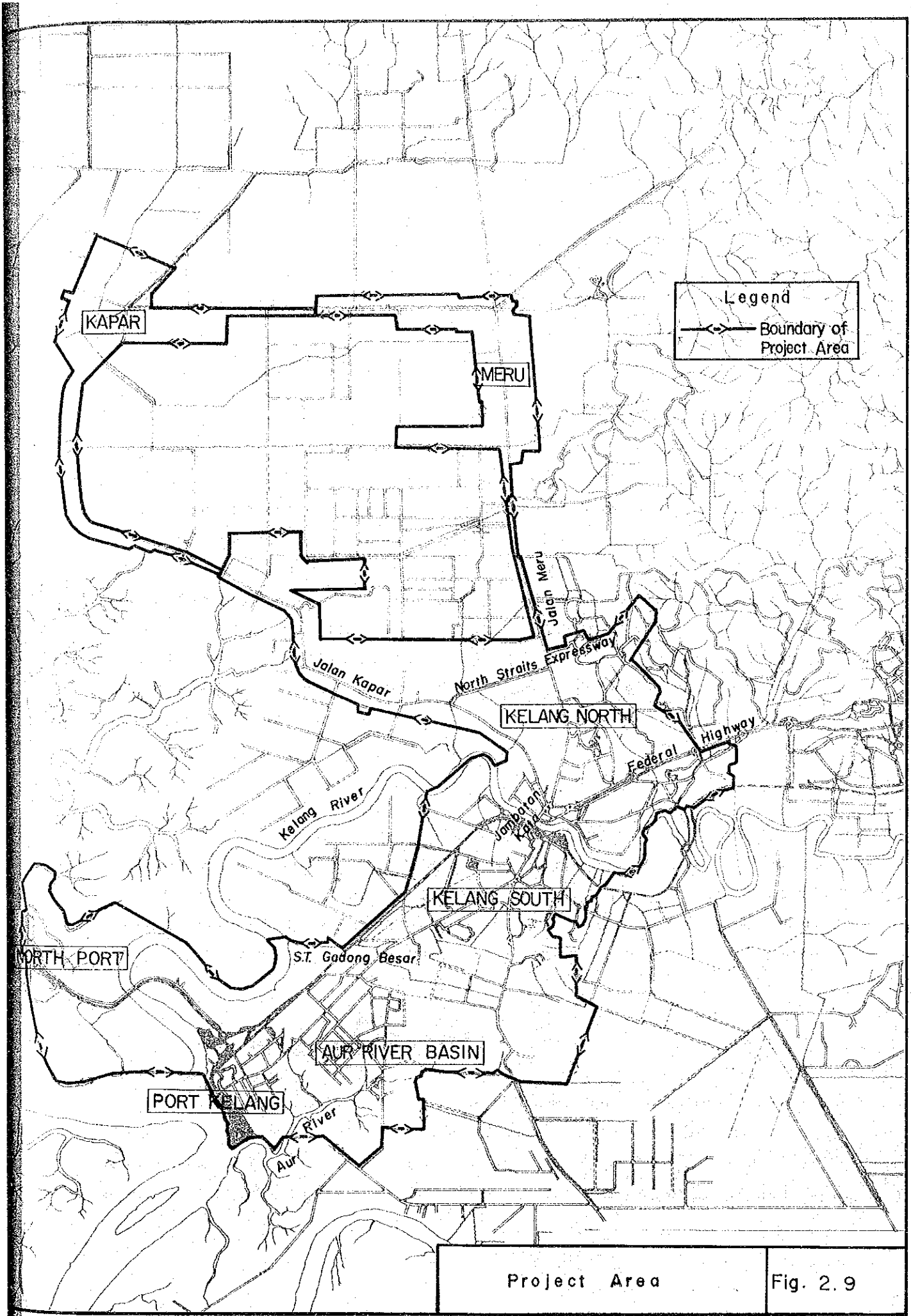
Considering the fact that the existing drainage system was constructed some 30 to 40 years ago, when the urban areas were considerably smaller and that there has been rapid and widespread urbanization, which is expected to continue, the improvement undertaken after the initial construction will be totally inadequate to cope with the increased need.

The present drainage system can be divided into three sectors; namely, the Kelang River basin, Aur River basin, and Kapar and Meru areas. (Ref.: Fig. 2.9.) Furthermore, each drainage basin group is divided into some 10 catchments, with the drain routes each wending its way to a point nearest to a river, due to the flatness of terrain.

Table 2.6. State Government Plan for the Kelang Drainage System Interim Measures

(Unit: M$1,000)

Item	Amount	-1980	1981	1982	1983	1984	1985	1981-1985	1986-
1. Bund	1,000	-	-	-	200	200	200	600	400
2. Tidal Gate	2,500	561	483	400	300	300	17	1,500	439
3. Open Channel									
(a) Concrete	7,000	411	788	500	600	600	512	3,000	3,589
(b) Earth	1,000	-	-	100	100	-	-	200	800
4. Bridge and Culvert (Crossing Rail)	3,000	-	-	200	200	100	-	500	2,500
5. Bridge and Culvert (Crossing Road)	2,500	-	-	200	150	50	-	400	2,100
6. Survey	500	-	260	40	-	-	-	300	200
7. Land Acquisition	2,500	-	469	560	471	-	-	1,500	1,000
Total	20,000	972	2,000	2,000	2,021	1,250	729	8,000	11,028



Project Area

Fig. 2.9

1) Area

a) The Kelang River Basin Sector

This sector is defined as the area where drains flow into the Kelang River. It is divided into three subsectors: Kelang North (north of the River), Kelang South (south of the River), and the North Port.

i) Kelang North Sub-Sector

This sub-sector includes most of the densely developed town area, comprised of multi-story buildings, markets and shops, which are close to the river, and the housing area further but within a 5-kilometer radius from the river. This area is protected from tidal inundation by a bund approximately 5 km long. There are 12 tidal gates installed along the bund, of which five are 0.9 m diameter; three, 1.8 x 1.8 m; two, 0.6 m diameter and another two, 1.5 m x 1.2 m. Stormwater and wastewater are carried down to these gates by 10 main drains, into which flow a multitude of small drains from the developed areas. Flow from agricultural land is also channelled through these drains which were originally constructed for agricultural development.

ii) North Port Sub-Sector

Apart from the Kelang North area, there is another area through which drainage flows to the Kelang River; namely, the North Port area. Formerly a swampy and undeveloped area, it has become and independent drainage basin, with some parts developed and others in the process of development, including open channels, retention ponds and land reclamation.

iii) Kelang South Sub-Sector

This area, south of the Kelang River, has almost the same system of bunds, gates and drains as that in the Kelang North Sub-Sector, while the town area itself is less dense. There are some 15 tidal gates in this area, most of which are old and small. Tidal inundation is prevented in

this area by a stretch of bund starting from a point close to Jambatan Kota and following the Kelang River up to Gadong Besar River. The rest of the area east of the bridge has no bund, depending largely on the railway line, which is built on raised ground for protection. About 10 main drains carry the storm and wasterwater from the town and neighboring housing areas to the several tidal gates along the railway line. Some valuable land lie unprotected between the railway line and the river bank.

b) The Aur River Basin

The 8-kilometer-long Aur River, which flows directly into the sea, receives drainage in the downstream from the Port Kelang area but functions as a drain in the upstream area of this basin. There are several tidal gates and a bund which runs mainly along the Aur River.

The upstream area has been developed or is in the process of development into housing estates from palm oil and rubber plantations. In conjunction with this development, improvement of the river has commenced, consisting of realignment and enlargement of the river and construction of a retention pond, based on planning for both residential and plantation areas. However, as future land use planning up to 2000 calls for the area to be completely residential, adjustment has to be made accordingly.

c) Kapar and Meru Areas

Kapar and Meru areas north of the planned North Kelang Straits Expressway are included in the Project Area. Being separately developed for agricultural purpose, their drains flow across the Project Area directly into the sea. Therefore, almost all of these drains are maintained by DID.

2) Facilities

a) Bunds

There are about 13 km of bunds in the Project Area; however, some areas have none, such as in Kelang South, where the railway line is serving the purpose.

The condition of the bund in central Kelang North is fairly satisfactory, partly because the land has been filled and raised to the required level for buildings. Those in the surrounding area of the central Kelang North, however, are generally small and require widening and heightening.

The bund in Kelang South is definitely in bad condition, with one part destroyed by a high spring tide sometime ago, but only temporarily repaired by the Municipality.

The bund in Port Kelang is also in urgent need of widening and heightening to prevent recurrence of damage or even destruction, which has been of serious concern to the residents of the area.

b) Gates

Of the 32 tidal gates, several are of recent construction, but most are 30 to 40 years old. These gates were originally constructed for discharging water from the developed areas, as well as agricultural land, which have been further developed. As a result, the size of the gates are now inadequate. It is probable that their design at the time of construction provided for an increase in capacity for a 10-year period, but that allowance for 20 to 30 years was evidently unforeseen.

An inspection of all the gates reveals that they are not only grossly undersized to meet present needs but also require various degrees of repair. Furthermore, the drain water level being the same as that in the river, with 0.5 m maximum, watertightness is inadequate in some places during high sea or river stages. Also, the tidal gates are all manually operated and take 0.5 hour for opening and closing.

c) Outlets

Inspection of the existing outlets reveal most of them to be not only undersized but clogged with silt and thick undergrowth. Also, rubbish deposits by people occupying land along the outlets impair and even block some of the outlets.

These outlets exist mainly in Kelang South and Port Kelang, where invaluable land is unfortunately allowed to stay as swamp area, since the tidal gates are installed far from the river, sometimes even near the railway line, instead of near the river.

d) Drains

The approximately 130 km of main drains serve their own respective areas, carrying the flow from numerous small sections or housing areas. Some are fairly large, carrying flow from agricultural land as well.

Some of those drains which were maintained by the Municipality until 1979 were being reconstructed to meet increasing needs. Such improvement work consisted of constructing concrete drains, to provide faster flow with little maintenance. But drains outside the central town have had little or no maintenance or improvement work. Drains built by developers in the housing areas were installed only to satisfy legal requirements and are therefore rudimentary and still lack the necessary outlets to convey the water to the gates.

In most cases, however, the size of the drains remain the same as when built 30 or 40 years ago and yet development has been allowed to flourish, adding greatly to the area requiring urban drainage service, and thus increasing runoff many times over. Furthermore, inspection of the drains reveals that most are not only undersized but not properly maintained, as well as choked with undergrowth and rubbish. Existing dimensions of main drains are tabulated in Table J.1 in Appendix J, Vol. VIII.

2.4.4. Flooding

As Kelang Municipality is situated at the mouth of the Kelang River and its elevation is almost the same as the high water level of the river, flooding (the locations of which are shown in Fig. 2.10) naturally occurs often. However, the depth of flooding generally does not reach more than a few inches throughout the Municipality area, and lasts only a few hours.

1) Tide-Caused Flooding

The Kelang Municipality ground elevation mostly ranges from R.L. +1.5 m to R.L. +4.0 m, the predominant height being from R.L. +1.5 m to +3.0 m. On the other hand, the sea level or Kelang River water level fluctuates from nearly R.L. -2.4 m to a high of +3.0 m. Accordingly, one-third of the area would be submerged under water at high tides, except where there are existing tidal gates and bunds, inadequate as they may be.

Flooding areas due to high tides and low ground elevation are spreading over the seashore areas along the river all over the Kelang. This flooding occurs during high tide even without rainfall, apparently due to the inadequate water tightness of the tidal gates and bunds, as the difference in the drain and river water level is nil or, at most, 0.5 m, if any.

2) Stormwater Flooding

Stormwater flooding from rainfall of high intensity and short duration, is attributable to the inadequate capacity of the infrastructural or trunk drainage system and also as a result of the following:

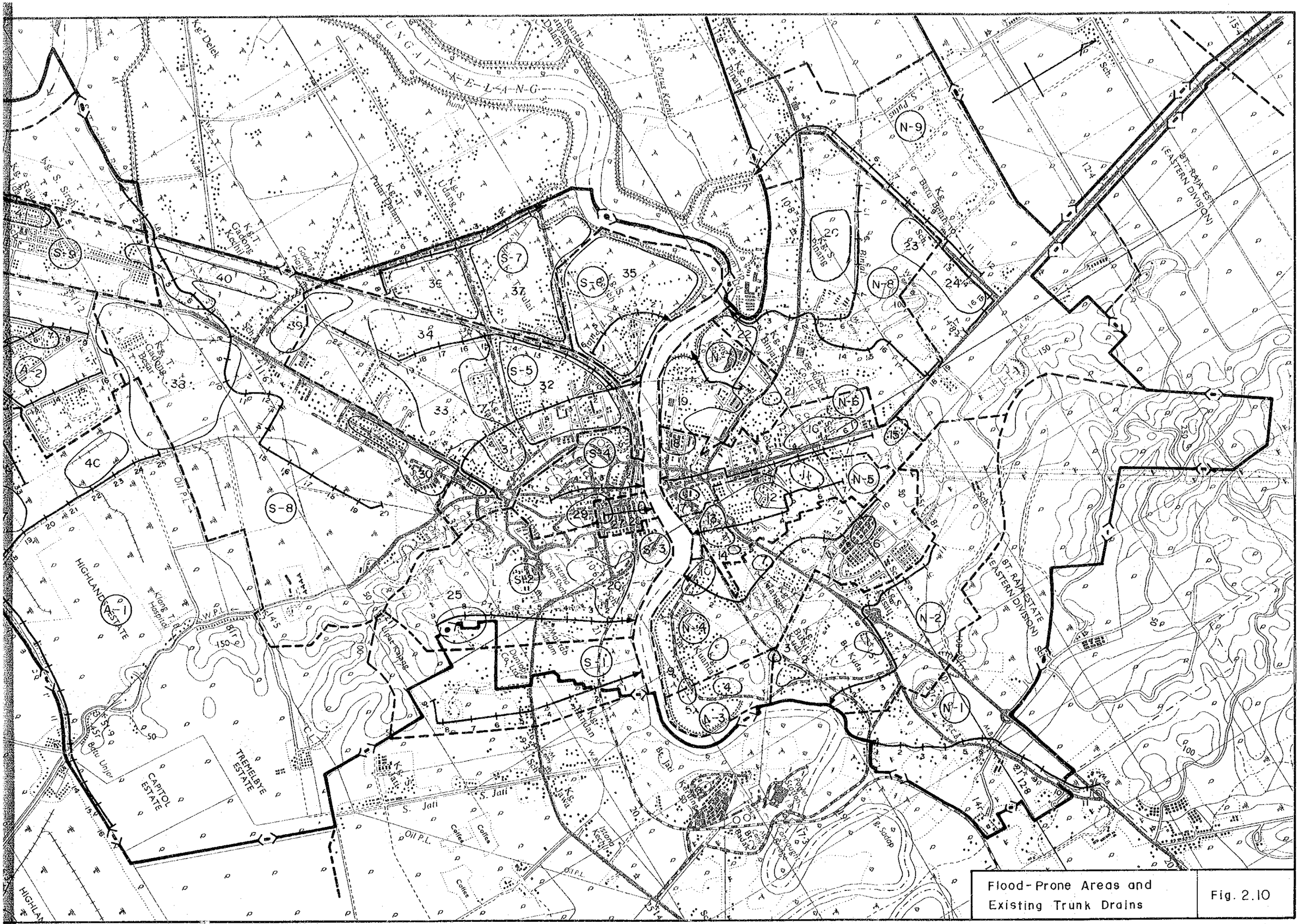
i) Increase in stormwater runoff from upstream development
ii) Flow restriction from downstream construction
iii) Development being permitted in flood-prone areas

Size of flood-prone areas is 870 ha, and population in 1980 and 2000 is about 40,000 and 80,000 respectively as shown in Table 2.8.

Table 2.7. Size and Population in Flood-Prone Areas

Flood-Prone Area No.	Catchment Code No.	Size of Flood-Prone Area (ha)	Population in Flood-Prone Area	
			1980	2000
1	N-2	6.9	400	700
2		5.6	-	600
3		1.4	-	100
4	N-3	2.6	-	400
5		1.1	100	100
6	N-4	7.9	1,000	1,200
7		1.9	200	200
8		1.9	400	600
9		1.1	200	200
10		3.1	-	200
11	N-5	4.5	500	600
12		6.3	800	800
13		6.3	500	500
14		1.1	100	100
15	N-6	2.9	-	400
16		15.3	School	
17		0.9	100	100
18		5.0	300	300
19	N-7	30.7	1,700	2,000
20	N-8	15.0	1,000	1,500
21		1.6	200	200
22		7.0	-	-
23		7.5	300	700
24	N-9	24.3	1,100	2,200
25	S-2	10.2	-	-
26		17.0	400	900
27	S-3	1.5	300	300
28		1.0	100	100
29	S-4	7.5	1,500	1,500
30	S-5	30.0	1,300	3,000
31		9.0	400	1,100
32		47.5	3,100	4,000
33		31.5	1,400	3,900
34		27.1	1,200	3,300
35	S-6	96.7	3,600	8,000
36	S-7	22.8	500	1,300
37		66.4	2,500	5,500
38	S-8	80.2	1,000	10,800
39		13.5	600	1,800
40		33.7	300	4,700
41	S-9	14.5	1,000	1,400
42		16.4	1,100	1,700
43	S-10	3.1	600	600
44		4.8	700	700
45		17.0	-	-
46	A-1	14.6	-	1,500
47		10.6	1,400	1,400
48	A-2	26.2	3,300	3,300
49	A-3	7.4	900	900
50		10.3	1,600	1,600
51	A-4	14.6	600	600
52	A-5	72.3	3,100	3,100
Total		869.3	42,300	82,300

LEGEND
Boundary of Project Area
Boundary of Catchment
Existing Trunk Drain and Point on Cross Section
3 2 1
Flood-Prone Area and No.
1
PORT SWETTENHAM
HIGHLANDS ESTATE
CAPITOL ESTATE
TREMELEYE ESTATE
LOWLANDS ESTATE
PEDAMARAN ESTATE
A-1
A-2
A-3
A-4
A-5
A-6
S-1
S-5
S-7
S-8
S-9
47
40


Flood-Prone Areas and Existing Trunk Drains
Fig. 2.10

CHAPTER 3

POPULATION PROJECTION AND LAND USE PLAN

CHAPTER 3 POPULATION PROJECTION AND LAND USE PLAN

3.1. Population Projection

3.1.1. Kelang District

In order to project the future population in the Project Area up to the year 2000, population in the Kelang District is first estimated. Data from the 1947, 1957, 1970 and 1980 Population Census are used, for which population in West Malaysia, Selangor State and Kelang District are available. However, population in the Project Area requires to be identified from the above data and forecasted because of the difference between Kelang District and the Municipal Council area.

The following four methods (detailed descriptions for each method are presented in Appendix A, Vol. VIII) are adopted to estimate future population:

a) Projection based on annual growth rate
b) Projection based on regression curve
c) Projection based on ratio to West Malaysia population
d) Projection based on ratio to Selangor State population

Results of these projections are summarized in Table 3.1., showing variations in projected population from 560,000 to 590,000 in the year 2000. Taking into account this small deviation in the projections, it is considered reasonable to adopt the median of the four projected figures; i.e., 580,000, as the projected population for the Project.

Table 3.1. Population Projection for the Kelang District

Year	Methods			
	(a)	(b)	(c)	(d)
1980	284,941	284,941	284,941	284,941
1990	410,000	400,000	400,000	410,000
2000	590,000	570,000	560,000	590,000

3.1.2. Urban Area in the Kelang District

Population in the Project Area in 1980 is obtained from preliminary field count summaries of the 1980 Census of the Statistic Department as 205,630, while population of the Kelang District is 284,941, according to the 1980 Census report. This would mean that 79,311 population is distributed outside the Project Area, which is considered to be rural area where population growth is likely to be very slow even in the future. Therefore, it is assumed that there will be no significant change in the rural population of about 80,000 up to the year 2000. Consequently, by subtracting 80,000 out of the projected 580,000 for Kelang District, the rest of the population in the area, which might be termed as Urban Area inclusive of the Project Area, against the above referred rural area is calculated as 330,000 and 500,000 for the years 1990 and 2000 respectively.

Population projection based on the above-mentioned procedure is shown in Table 3.2. up to the year 2000.

Table 3.2. Population Projection in the Urban Area

Unit: persons

Year	Kelang District	Urban Area	Rural Area
1980	284,941	205,630	79,300
1990	410,000	330,000	80,000
2000	580,000	500,000	80,000