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MALAYSIA

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

VOLUME III SEWERAGE

FEASIBILITY STUDY

NOVEMBER 1982

JAPAN INTERNATIONAL COOPERATION AGENCY

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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

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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

OUTLINE

1. Project Area

Project Area for the Feasibility Study, selected as the First Phase area in the Master Plan forms a part of Kelang North Sewerage District, Zone-1, and its area is 385 ha. Present population of 20,000 (1980) is expected to increase to 36,000 by the year 2000.

2. First Phase Project

Sewerage facilities proposed to be constructed during the First Phase up to the year 1990 include the following:

1) Trunk sewers (diameter 375 - 1,200 mm, total length 6,660 m)
2) Branch and lateral sewers (diameter 225 - 450 mm, total length 56,985 m)
3) Kg. Kuantan intermediate pumping station
4) Connaught wastewater treatment plant, including three series of stabilization ponds

Preliminary engineering design for these facilities was conducted, and the construction, operation and maintenance costs were estimated based on the design. Also, implementation program up to the target year of 1990 was developed, taking into account the starting year of 1983 and necessary preparatory works, such as land acquisition and detail engineering design. As shown in Table 1., the first two years (1983-84) are allocated for preparatory works, and actual construction works will begin from 1985 for a six-year period up to 1990. According to the implementation program, project cost by each year was estimated as shown in Table 2. All costs are based on the 1981 price with annual escalation rate of 6.5 percent. Construction cost of about M$41 million increases to about M$56 million by escalation factor.

Table 1. First Phase Implementation Schedule

Item	First Phase Program							
	1983	1984	1985	1986	1987	1988	1989	1990
I Preparatory Works								
Land Acquisition		▨						
Detailed Design	▨							
Tender Documents		▨						
Tender Invitation, Evaluation and Contract Award		▨						
II Sewer Collection System								
1) Trunk Sewers			▨	▨				
2) Branch and Lateral Sewers								
Unit-1 (56 ha)					▨	▨		
Unit-2 (59 ha)						▨	▨	
Unit-3 (86 ha)				▨	▨			
Unit-4 (56 ha)			▨					
Unit-5 (81 ha)							▨	▨
3) Kg. Kuantan Pumping Station								
Civil Works					▨	▨		
Mech. & Electrical Works						▨		
III Connaught WTP								
Civil Works				▨	▨			
Architectural Works						▨		
Mech. & Electrical Works						▨		

Table 2. Total Cost of Construction and Operation/Maintenance

Year	Construction Cost			Operation and Maintenance Cost	Total
	L.C.	F.C.	Sub-total		
1983	2,558	1,119	3,677	171	3,848
1984	4,146 (24,699)*	-	4,146	183	4,329
1985	6,546	3,376	9,922	233	10,155
1986	10,446	5,490	15,936	249	16,185
1987	8,566	3,128	11,694	288	11,982
1988	4,354	4,103	8,457	457	8,914
1989	688	164	852	930	1,782
1990	721	555	1,276	1,028	2,304
1991	-	-	-	1,131	1,131
1992	-	-	-	1,239	1,239
1993	-	-	-	1,326	1,326
1994	-	-	-	1,426	1,426
1995	-	-	-	1,528	1,528
Total	38,025 (58,578)*	17,935	55,960		

Note: L.C. represents local currency portion and F.C. represents foreign currency portion.

( )* Cost in case total land required up to 2000 is purchased in the First Phase.

3. Financial Plan

According to the study of financial planning in the Master Plan, financial projections for the Feasibility Study are examined.

The following financial plan is recommended as the best plan:

1) The foreign currency of the construction cost (M$18 million) is to be financed by loan from a foreign lending agency.

2) The local currency of the construction cost (M$36 million), excluding the land acquisition cost is to be financed by loan from the Federal Government.

3) The land acquisition cost required in the First Phase (M$4 million) is to be met by a grant by the Federal and/or State Government.

4) A 70 percent sewerage surcharge rate on the water bill and a 3 percent sewerage surcharge tax rate of the property assessment are to be imposed on the beneficiaries.

5) Kelang Municipality is to bear the financial burden of M$2.6 million up to 1995 for the proposed sewerage system.

4. Institutional Organization and Legal Aspect

4.1. Expansion of the Engineering Department

Kelang Municipality organization is modified, based on the enlargement of the Engineering Department. The main features of the new organization are as follows:

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

2) The current Work Shop unit of the Sewer and Drain Section is to be set up as independent section.

3) An accounting system, separated from the Municipality's general revenues and expenditures, is to be incorporated in the new organization.

4) The required staff is 11 in the initial year of 1983 and 26 in 1990 at the end of the First Phase (excluding laborers).

4.2. Legal Aspect

There are no legal problems in implementing the sewerage project under existing laws and regulations.

5. Project Evaluation

Provision of the sewerage system benefits directly or indirectly the served population. As for the quantifiable benefits, the operation costs of about M$0.8 million for desludging septic tanks and night soil collection and disposal are saved after completion of the First Phase program. Benefits such as environmental improvement are unquantifiable but significant.

In Malaysia, the household income level has considerably increased in the last ten years. As income increases, what once seemed tolerable comes to be considered intolerable. This indicates a higher civil minimization level is required in Malaysia. Therefore, the desirability for sewerage service is expected to increase and come to be considered necessary.

CHAPTER 1

INTRODUCTION

CHAPTER 1 INTRODUCTION

1.1. Background

As presented in Vol. II: Sewerage Master Plan, the Sewerage Master Plan Study covers 7,669 ha, including the Kelang Municipal Council area and various surrounding areas. For planning purposes, this area has been divided into eleven (11) sewerage zones, and each sewerage zone has been further divided into sub-zones, to identify topographic and local development conditions, in order to determine system requirements and priorities for implementation.

On the basis of the above, a study to determine magnitude of investments and implementation priorities was conducted, and an implementation program in three (3) phases up to the year 2000 with special emphasis on the First Phase Program was proposed. Accordingly, it was considered appropriate to give top priority to Zone 1, sub-zone 1 in Kelang North area according to a rating assessment. Approximately M$41 million at 1981 price level would be required for the first phase investment by the Malaysian Government covering approximately up to the year 1990, taking into account various factors, including economic background and financial capability of the local government, for which further detailed analysis is to be carried out in the Feasibility Study. The proposed first priority area covers 338 ha with present population (1980) of 20,000, with projected population (2000) of 36,000. (Ref. to Fig. 1.1.)

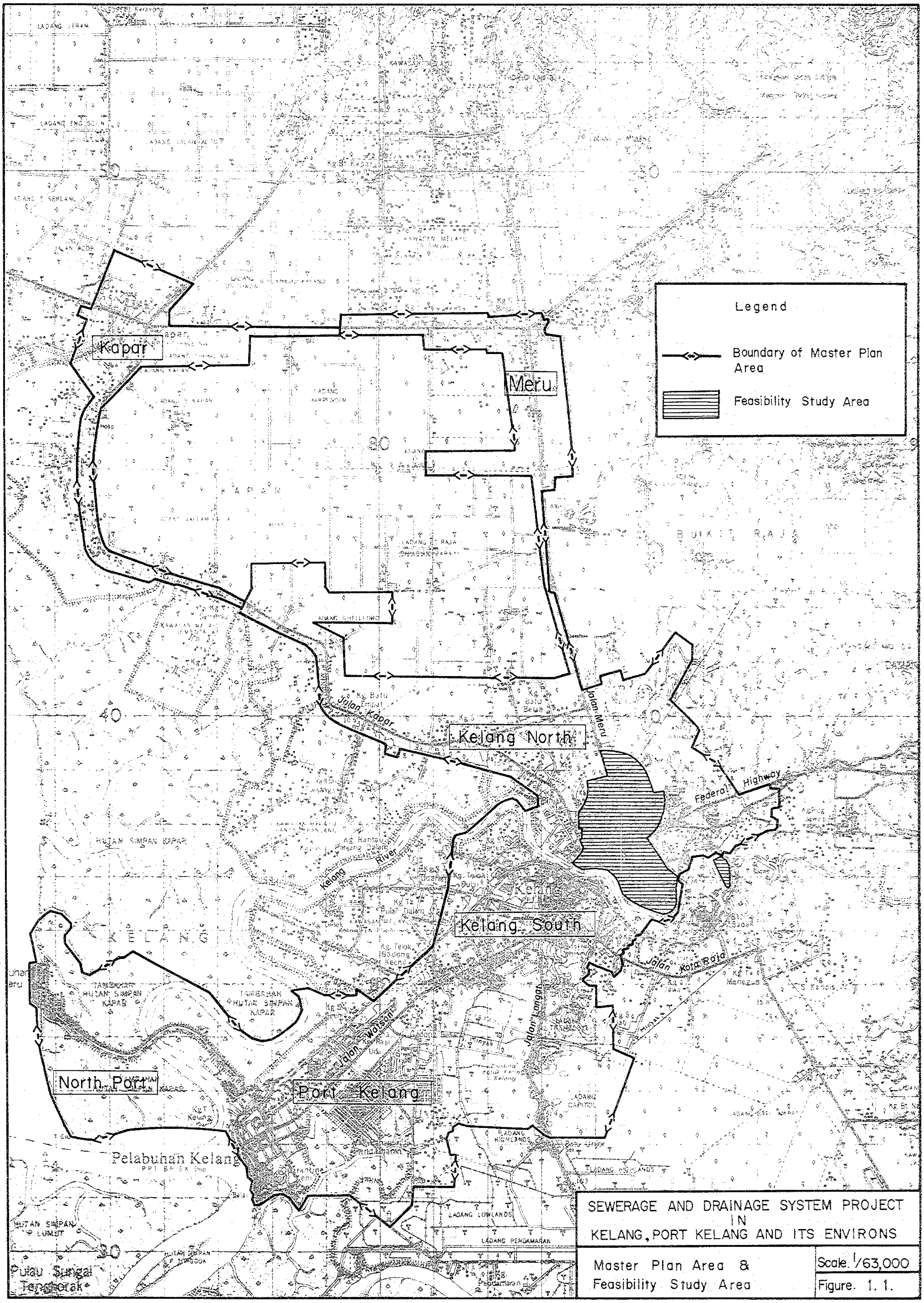
1.2. Feasibility Study

On the basis of the foregoing background, the Feasibility Study is undertaken exclusively for the area identified for the First Phase program, pursuant to the basic plan recommended in the Master Plan Report.

The Feasibility Study presented herewith includes a review of the data collected during the Master Plan study and collection of necessary additional supporting engineering and financial data by means of various surveys and site investigations in connection with the area as identified for the First Phase Program. In the surveys and investigations, levelling the routes of trunk and branch sewers and interviews with 70 households for the purpose of reinforcing the data on peoples' willingness-to-pay were included. Measuring existing main drains and investigation of underground structures, such as telecom cables, electric cable and water supply pipes were also carried out.

To finance the First Phase program cost, optimal financial plan is carefully considered by financial analysis of conceivable alternative strategies. Possible bilateral and/or multilateral international financial resources are taken into consideration in the alternative studies, together with those of the Federal Government of Malaysia. Also, the financial capability of the Kelang Municipality is carefully analyzed to determine financial viability of the Project.

Various individual studies inclusive of study on pipe materials and design drawings of the sewerage facilities are also undertaken and are presented in the Chapter 5 and Appendix K, Vol. IV.



SEWERAGE AND DRAINAGE SYSTEM PROJECT IN KELANG, PORT KELANG AND ITS ENVIRONS

Master Plan Area & Feasibility Study Area	Scale 1/63,000
	Figure. 1.1.

CHAPTER 2

FEASIBILITY STUDY AREA

CHAPTER 2 FEASIBILITY STUDY AREA

2.1. The Study Area

Further field reconnaissance was carried out for the Feasibility Study Area at Zone 1, sub-zone 1 of Kelang North. Development plans showing the proposed road layout were collected from the Engineering Department of the Kelang Municipality. As a result of these investigations, detailed map for sewerage facilities planning was made by the Study Team which is shown in Fig. 2.1.

The Study Area of 338 ha is located on the right bank of the Kelang River and forms the eastern portion of the Kelang Municipality area. One of the major three commercial areas in Kelang is included in the Area where the three major roads - the Federal Highway, Jalan Meru and Jalan Kapar - become confluent.

Surrounding the rapidly growing commercial area are developed low-density residential areas. A number of housing developments have been or are now being carried out in the remaining part of the Area. These recently developed residential areas are provided with sufficient road network system. Service lateral sewers can be installed in the back lane located between the rear of the houses on both sides.

Some *Kampung* areas are scattered in the southeast portion of the Area. Vacant areas also exist, scattered in some of the southeast portion, as well as in the north portion of the Area. However, plans for housing and various other purposes have already been made in these areas so that they are likely to be developed in the very near future.

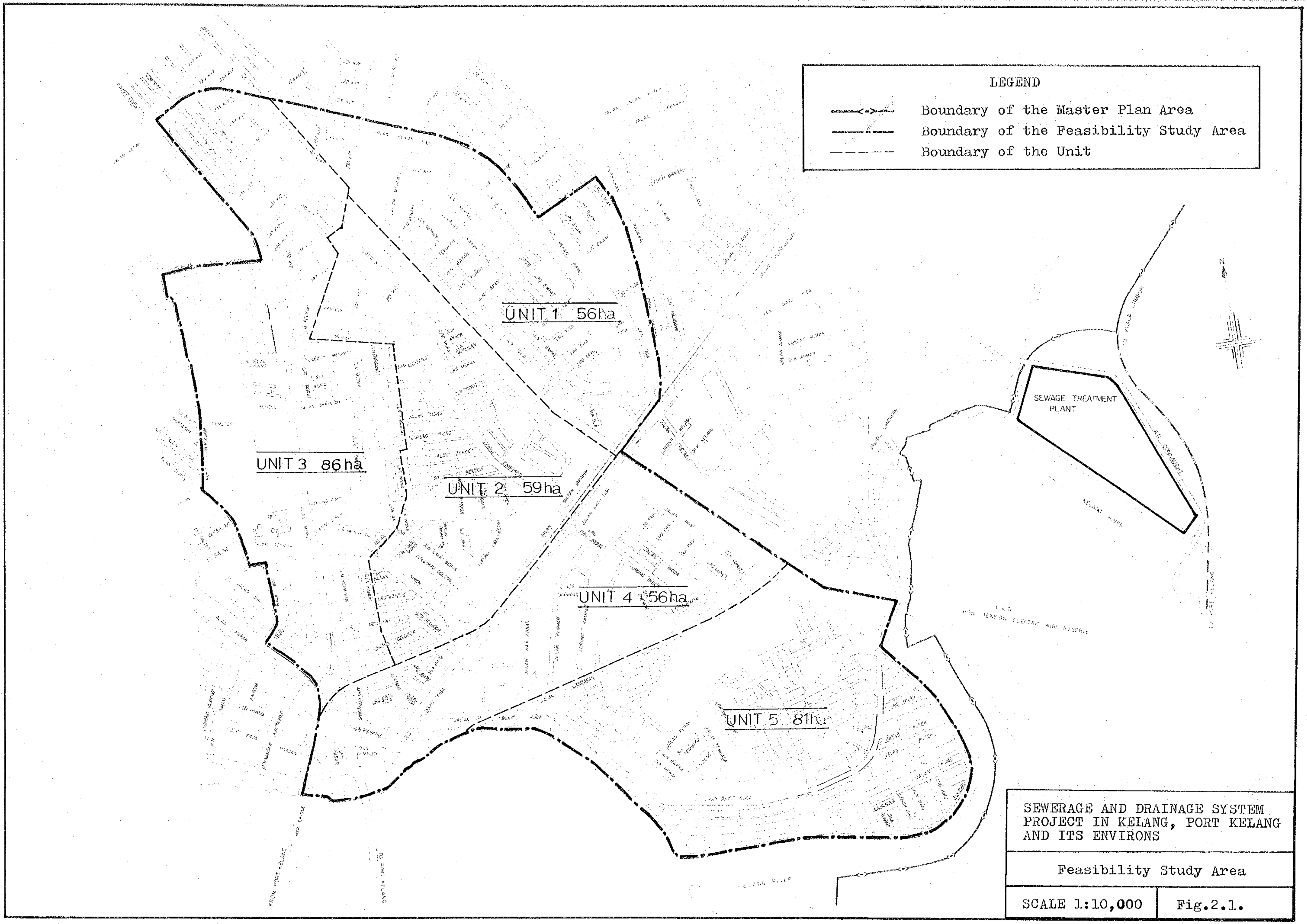
2.2. Sewerage Unit

In order to determine the implementation schedule, the Sewerage Feasibility Study Area is identified by sewerage units, according to topographic condition and existing and proposed road layout plans. The Federal Highway connecting Kuala Lumpur and Kelang through the east-west direction will divide the Area, for the purpose of sewerage unit consideration, because of heavy traffic conditions causing difficulty in installing sewer crossings.

The Area north of the Federal Highway is divided into three units (units 1 to 3 from east to west). Unit-1 consists of a residential area which is separated from Unit-2 by a narrow depression running along the high-tension power line. Unit-3 is located along Jalan Meru, separated from Unit-2 by a small rise.

The area south of the Federal Highway is divided into two units by Jalan Landasan, since sewers in the northern part (Unit-4) are naturally intercepted by this road, but sewers in the southern part (Unit-5) naturally flow toward Jalan Bukit Kuda.

These five units and their hectares are shown in the following Fig. 2.1.



SEWERAGE AND DRAINAGE SYSTEM PROJECT IN KELANG, PORT KELANG AND ITS ENVIRONS

Feasibility Study Area

SCALE 1:10,000 | Fig.2.1.

CHAPTER 3

LAND USE PLAN AND POPULATION PROJECTION

CHAPTER 3 LAND USE PLAN AND POPULATION PROJECTION

Based on the land use plan and population projection proposed in the Master Plan, a detailed plan and projection for the Feasibility Study Area are worked out. Supplementary information currently considered by the TCP, Selangor State, were collected through the Kelang Municipality. Discussions with the consultants conducting the city planning for Kelang Municipality were held and suggestions received from them. Subsequent adjustments and modifications therefore are made as a result of information obtained during the field survey period.

3.1. Existing Land Use

Present land use in the Area is grouped into seven categories; namely, residential, commercial, industrial, vacant area, open space, school area and L.L.N. reserve, in which vacant area is defined as an area which is not used for any purpose or an area which is now under development and open space as parks, sport fields and cemeteries.

Present land use is shown in Fig. 3.1 on the last page of this chapter. Hectares of each category in the Feasibility Study Area is presented in Table 3.1.

Table 3.1. Existing Land Use (1980)

Land Use	Area	
	(Hectare)	(Percentage)
Residential	193	57.1
Commercial	20	5.9
Industrial	1	0.3
Vacant	71	21.0
Open Space	16	4.8
School	22	6.5
L.L.N. Reserve	15	4.4
Total	338	100.0

3.2. Conceptual Plan

Conceptual plan for the Study Areas is developed to clarify future development policy. Structural components of the conceptual plan are shown in Fig. 3.2 and their descriptions are as follows:

1) Main Axis

The urban axis connecting Kuala Lumpur, Kelang South and Port Kelang, composed of regional commercial and institutional facilities, is the main axis, as stated in the Master Plan Report, for the regional activities extending beyond the Project Area.

2) Sub-Axes

The sub-axes, which are composed of schools, open space and daily shopping centers, form the main axes for daily life in the Study Area.

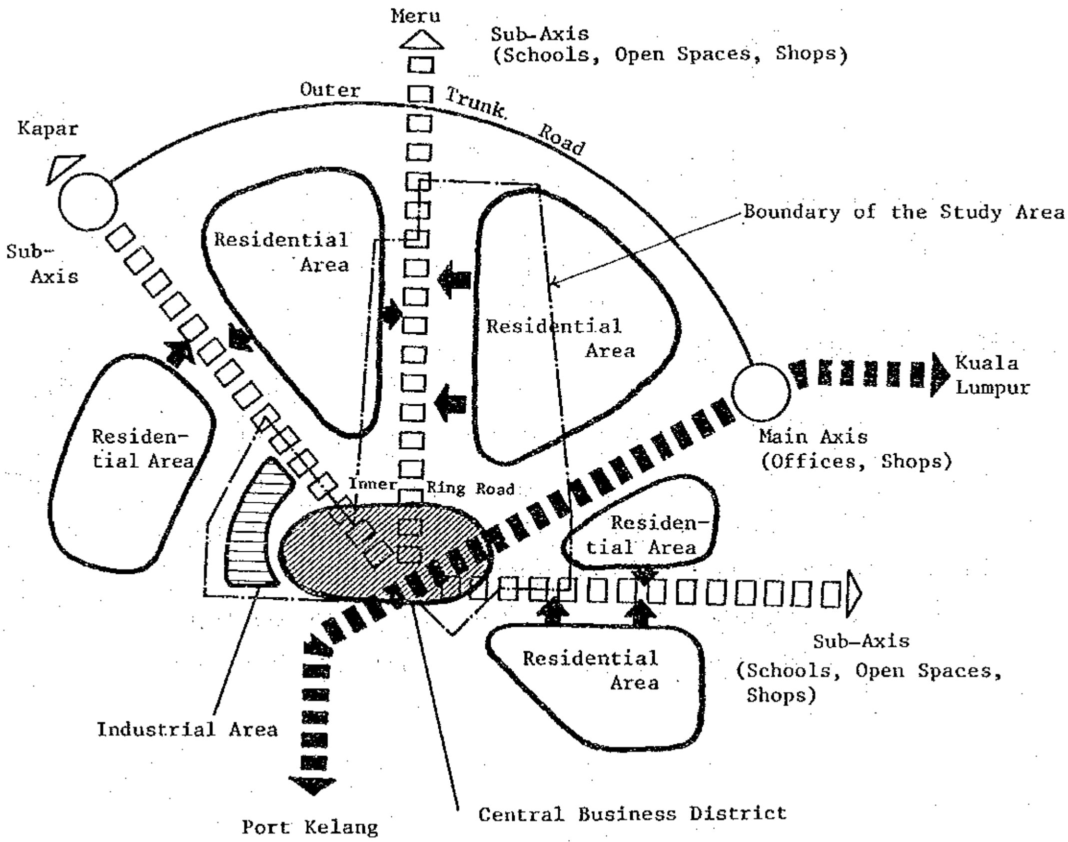
3) Inner Ring Road

The inner ring road surrounding the central business district (C.B.D.) functions as a boundary separating the commercial and residential areas, and also relieves traffic congestion in the central area.

4) Outer Trunk Road

The outer trunk road surrounding the Project Area functions as a boundary separating the high-density and medium- or low-density residential areas. It also helps relieve traffic congestion in the central business district.

Fig. 3.2. Conceptual Plan



3.3. Population Projection

Present (1980) and future (2000) population are estimated in the Master Plan. Based on the estimation, population projection up to the year 2000 is reviewed and confirmed for the Sewerage Feasibility Study Area. Logarithmic function is considered to be the most representative for estimating population in the Area, taking into account development conditions. The result is presented in the following Table 3.2.

Table 3.2. Population Projection

Year	Population
1980	20,000
1985	24,400
1990	28,500
1995	32,300
2000	36,000

3.4. Land Use Plan in the Year 2000

Land use plan in the year 2000 is developed using projected land use and other various planning parameters projected in the Master Plan such as population density for each land use category, number of persons in a household, etc. Development in the category of vacant area is fully taken into consideration, and the foregoing conceptual plan is used as a guide for allocating each category of land. The results are shown in Fig. 3.3 and Table 3.3.

Table 3.3. Land Use Plan (2000)

Land Use	Area	
	(Hectare)	(Percentage)
Residential	210	62.1
Commercial	57	16.9
Industrial	-	-
Open Space	29	8.6
School	22	6.5
L.L.N. Reserve	20	5.9
Total	338	100.0

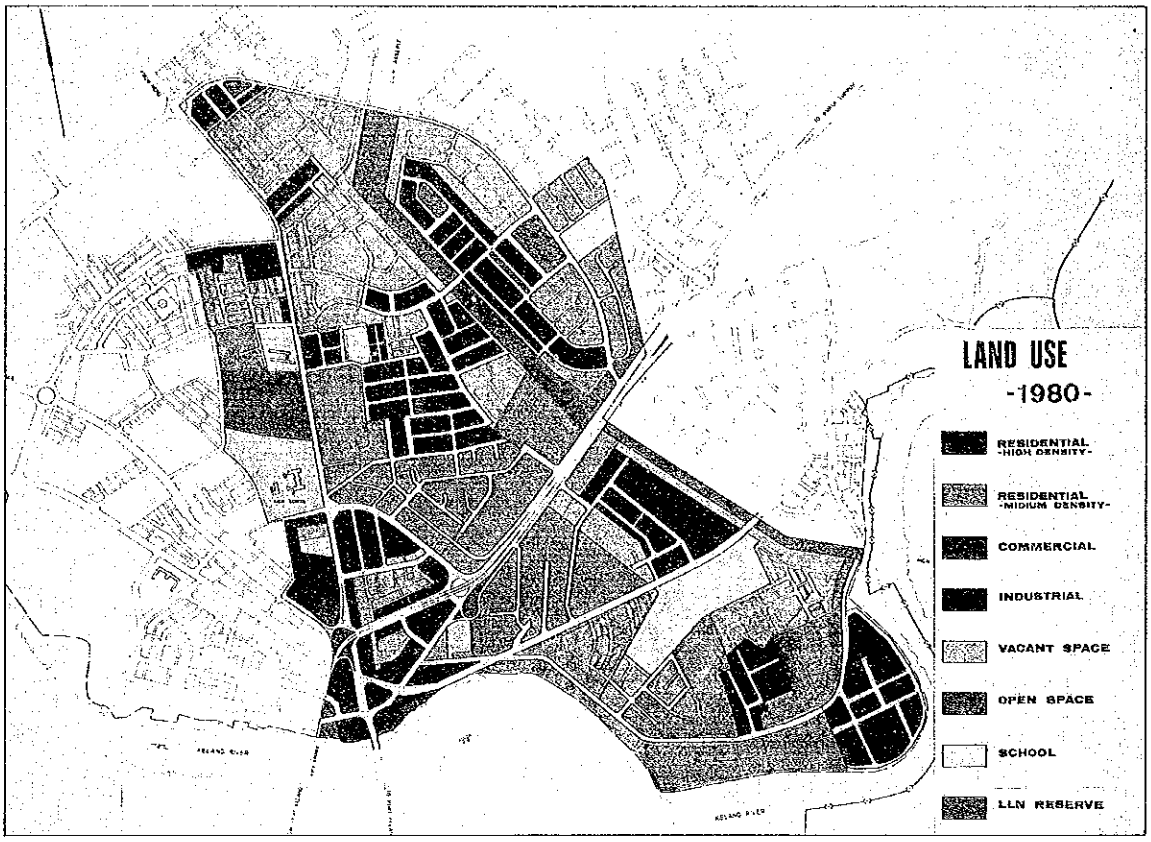


Fig. 3.1. Existing Land Use

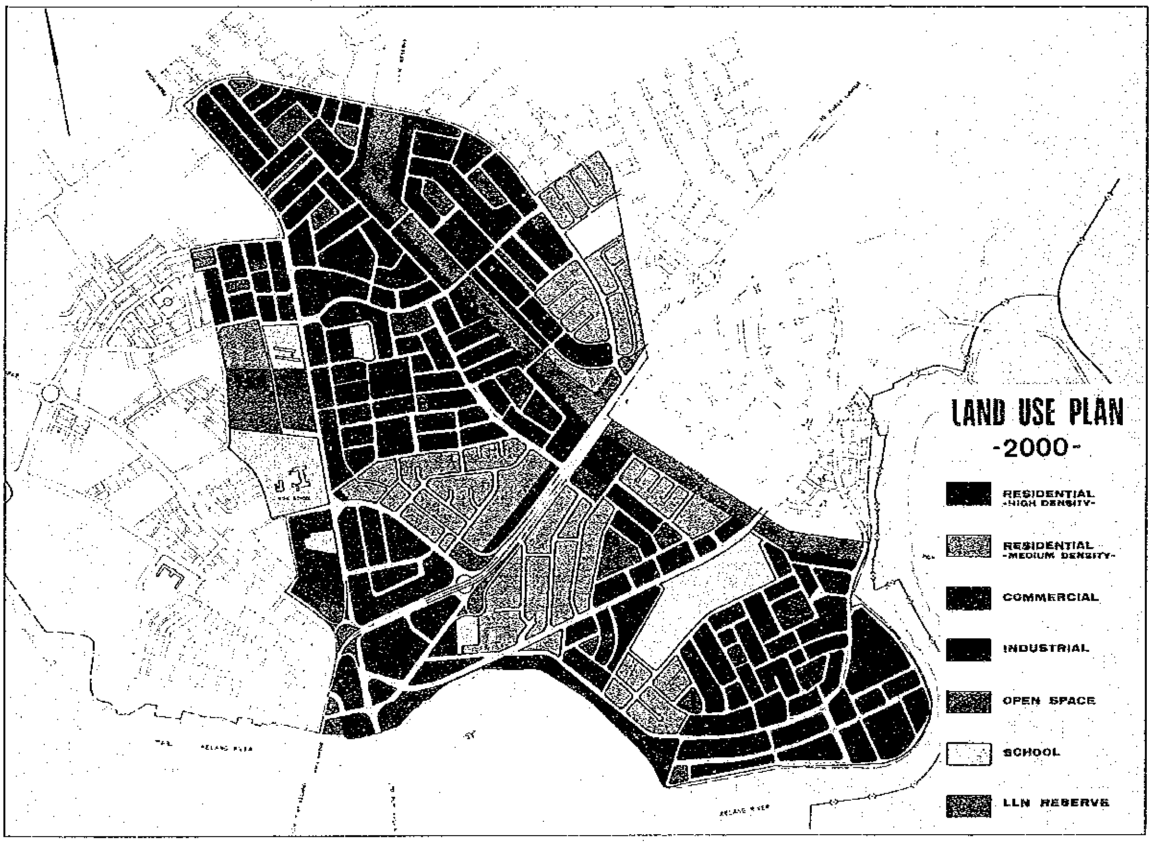


Fig. 3.3. Land Use Plan in 2000

CHAPTER 4

DESIGN BASIS

CHAPTER 4 DESIGN BASIS

Various studies and discussions have already been made in the Master Plan Report as the basis of design consideration including quantity and quality of wastewater, design criteria and materials and construction methods. Therefore, the content of this chapter is mainly a summary of those in the Master Plan together with additional supplementary explanations. Actual applications of these design basis are indicated in Chapter 5 of the present Report.

4.1. Quantity and Quality of Wastewater

4.1.1. Quantity of Wastewater

There are three categories of sewage according to the source of origin; namely, domestic wastewater, industrial wastewater and infiltration. Quantity of domestic wastewater which is generated from the private residences and various other kinds of buildings is estimated based on the per-capita wastewater flow rate. Per-capita wastewater flow rates for both residential and employed population presented in the Master Plan are as follows:

Table 4.1. Per-Capita Wastewater Flow Rates

Year	Per-Capita Wastewater Flow Rate (ℓ/cap/day)
1980	210
1990	240
1995	250
2000	260

In general, the estimated quantity of industrial wastewater is based on the size of the industrial area and unit flow rate of wastewater. In the Feasibility Study Area, no industrial area is expected to be developed, according to future land use plan. Therefore, industrial wastewater is negligible.

Quantity of infiltration is calculated using the unit flow rate of 7 m^3/ha/day presented in the Master Plan.

Wastewater quantities in the Area according to each sewerage unit and category are presented in Table 4.2.

Table 4.2. Area, Population and Wastewater Quantities

	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Total
Area (ha)	56.0	59.0	86.0	56.0	81.0	338.0
Population (person)	5,808	7,614	8,128	5,763	8,687	36,000
Employed Population (person)	73	2,282	10,228	4,299	967	17,849
Domestic Wastewater (m^3/day)	1,500	2,573	4,773	2,616	2,510	14,000
Industrial Wastewater (m^2/day)	–	–	–	–	–	–
Infiltration (m^3/day)	309	388	508	327	491	2,023
Total Wastewater (m^3/day)	1,837	2,961	5,281	2,943	3,001	16,023

4.1.2. Quality of Wastewater

The nature of domestic sewage is estimated on the basis of field survey results carried out in the two selected housing areas in the course of the Master Plan Study. Both BOD and SS concentration are estimated to be 200 mg/ℓ. The industrial wastewater characteristics are discussed and BOD and SS loads are also calculated in the Master Plan. However, no industrial wastewater is expected to be generated in the Study Area and therefore not included in the present Report.

Amount of waste load and average concentration of wastewater to be treated are shown in Table 4.3.

Table 4.3. Waste Load and Average Concentration

Wastewater (m^3/day)	BOD Load (kg/day)	BOD Concentration (mg/ℓ)	SS Load (kg/day)	SS Concentration (mg/ℓ)
16,023	2,800	175	2,800	175

4.2. Design Criteria

4.2.1. Sewers

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

1) Flow Friction Formula

Manning's formula:

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

Where,

V : Velocity of flow, in, m/sec

n : Roughness coefficient, 0.013

R : Hydraulic radius, in m

S : Slope

2) Peak Flow Rate

Domestic wastewater:

$$Md = \frac{5}{P^{1/7}}$$

where,

Md : Peak flow rate

P : Design Population (Unit: 1,000)

Industrial wastewater : 2

Infiltration : 1

3) Minimum and Maximum Velocity

Minimum velocity : 0.6 m/sec

Maximum velocity : 3.0 m/sec

4) Minimum Size of Sewer

For all public sewers : 225 mm

5) Depth of Sewers

The depth of earth covering public sewer pipes shall not be less than 1.0 m.

6) Maximum Manhole Spacing

For diameter less than 1,050 mm : 100 m

For diameter 1,050 mm to 1,500 mm : 150 m

For diameter 1,650 mm or more : 200 m

7) Siphons

Velocity in siphons should be designed higher than that in the upper stream sewer by 20 - 30 percent. A multiple-barrel siphon is recommended. The head loss in siphons is calculated based on the following formula:

$$H = i \cdot \ell + 1.5 \frac{V^2}{2g} + \alpha$$

where,

H : Head loss, in m
i : Hydraulic gradient
l : Length of barrel, in m
V : Velocity in barrel, in m/sec
g : Acceleration of gravity, 9.8 m/sec^2
α : Margin, 3 to 5 cm in general

4.2.2. Pumping Station

1) Design Flow

The design of the pumping station is based on the peak flow of the sewage unless special conditions justify the use of a lower rate. All piping and conduits are also designed to carry the expected peak flow, with some allowance for unexpected sewage increases. Enough storage capacities are to be provided in wet wells, especially where automatic controls and variable speed drives are not furnished, to balance pumping rates within the flow rate.

2) Type

Types of pumps suitable for transmitting sewage are considered to be as follows:

a) Submersible pump
b) Centrifugal pump
c) Screw pump

Selection of type depends on the condition of each individual pumping station, such as peak flow, total head, etc. A study is carried out to select the type of pumps recommending submersible pump. (Ref. to Appendix L, Vol. IV)

3) Structure

Provision to facilitate moving pumps and motors shall be considered in designing. Suitable and safe means of access shall be provided for wet and dry wells containing either bar screens or mechanical equipment requiring inspection or maintenance.

4) Pump Capacity

At least two pumps shall be provided for each required station one as a stand-by. The number of pumps is determined on the basis of flow quantities and variation. Where possible, pumps shall have the same capacity and design each other, with interchangeable parts.

5) Pump Drive

In selecting the type of pump drive, careful consideration shall be given to the frequency and duration of electrical power suspension, as well as to cost comparison of an electric motor and a diesel engine. Past experience indicates that the use of motor is generally more economical and reliable than engine.

Furthermore, electricity has been used for years in Malaysia without serious problems. Therefore, it is recommended that the pumps for all pumping stations be driven by electric motor.

6) Ventilation and Prevention of Odour and Noise

Pumping stations shall be enclosed in a concrete structure to prevent the diffusion of odour and noise to nearby residences. Proper ventilation and lighting shall be provided for all stations for the screening room and any other necessary part of the structure.

4.2.3. Treatment Plant

Various types of treatment processes have been evaluated for both technical and economical aspects. As a result, the stabilization pond and aerated lagoon process are recommended by the year 2000, depending on the condition of each treatment plant. The stabilization pond system is recommended for the first stage construction, to be modified to the aerated lagoon system when the pond becomes overloaded in later stages.

A unit of the stabilization pond process consists of a facultative pond and a maturation pond in series. Also, a scum chamber is provided in front of the facultative pond for scum removal prior to biological treatment in the succeeding series of ponds.

Capacity of treatment processing unit shall be determined on the basis of daily average flow rate. All piping conduits and other hydraulic units shall be designed for peak flow.

Standard B parameter limits of effluent in the Third Schedule of "Environmental Quality (Sewage and Industrial Effluents) Regulations, 1979" shall be applied to effluent from the wastewater treatment plant. Parameter limits are shown in Table 4.4.

The main items on which design of treatment facilities is based are tabulated in Tables 4.5 and 4.6.

Table 4.4. Parameter Limits of Standard "B" Effluent

(Environmental Quality [Sewerage and Industrial Effluents] Regulations, 1979)

Parameter		Unit	Limits
1	Temperature	°C	40.0
2	pH Value	-	5.5-9.0
3	BOD at 20°C	mg/ℓ	50.0
4	COD	mg/ℓ	100.0
5	Suspended Solids	mg/ℓ	100.0
6	Mercury	mg/ℓ	0.05
7	Cadmium	mg/ℓ	0.02
8	Chromium, Hexavalent	mg/ℓ	0.05
9	Arsenic	mg/ℓ	0.10
10	Cyanide	mg/ℓ	0.10
11	Lead	mg/ℓ	0.5
12	Chromium, Tribalent	mg/ℓ	1.0
13	Copper	mg/ℓ	1.0
14	Manganese	mg/ℓ	1.0
15	Nickel	mg/ℓ	1.0
16	Tin	mg/ℓ	1.0
17	Zinc	mg/ℓ	1.0
18	Boron	mg/ℓ	4.0
19	Iron (Fe)	mg/ℓ	5.0
20	Phenol	mg/ℓ	1.0
21	Fee Chlorine	mg/ℓ	2.0
22	Sulphide	mg/ℓ	0.5
23	Oil and Grease	mg/ℓ	10.0

Table 4.5. Design Basis of Stabilization Pond

Items	Design Value
Scum Chamber	
Retention Time	= 5 min
Depth	= 1.5 - 2.5 m
Facultative Pond	
Surface BOD Loading	= 320 kg/ha/day
Depth	= 1.5 m - 2.0 m
Maturation Pond	
Retention Time	= 3 days
Depth	= 1.5 m - 2.0 m
Expected Effluent Quality	
BOD	less than 50 mg/ℓ
Fecal Coliform	less than 100,000 N/100 mℓ

Table 4.6. Design Basis of Aerated Lagoon

Items	Design Value
Scum Chamber	
Retention Time	= 5 min
Depth	= 1.5 m
Aerated Lagoon	
Surface BOD Loading	= 1,500 kg/ha/day
Depth	= 3.0 m - 5.0 m
Maturation Pond	
Retention Time	= 3 days
Depth	= 1.5 m - 2.0 m
Expected Effluent Quality	
BOD	less than 50 mg/ℓ
Fecal Coliform	less than 100,000 N/100 mℓ

4.3. Material and Construction Method

4.3.1. General

Presently, most construction materials for sewerage facilities are available in Malaysia, except equipment required for pumping stations and treatment plant, such as large capacity pumps, electric and control devices, aerators, flow meters, etc.

Various kinds of locally manufactured products such as sewer pipes conform to internationally acceptable standards and generally are of acceptable quality. As industrialization continues, new materials suitable for use in sewerage construction are expected to be introduced later.

Investment in the construction sector expanded during the last decade in response to the Malaysian economic plans and development of housing schemes. The investment in architectural construction and civil work accounted for about 40 percent of the total private investment in 1980. This tendency encourages local contractors to develop their capability. Presently, local contractors are capable of carrying out most of the sewerage construction as demonstrated in other areas, such as Kuala Lumpur.

4.3.2. Pipe Materials

Currently, various kinds of pipe materials are locally available in Malaysia. These pipe materials are as follows:

(a) Vitrified clay pipe (VC pipe)
(b) Centrifugally-cast reinforced concrete pipe (concrete pipe)
(c) Asbestos cement pipe (AC pipe)
(d) Polyvinyl chloride pipe (PVC pipe)
(e) Steel pipe
(f) Cast iron pipe
(g) High density polyethylene pipe (HDPE pipe)

There are however size limitations on sizes depending on the materials. As various kinds of sizes are expected to be used in this project, the size limitations should be taken into account.

The pipes selected should be of good quality, durable with necessary strength to resist external load and working pressure in the case of the force main. Special care should be paid to hydrogen sulphide attack under the tropical climate in the Study Area.

Since high groundwater level might be encountered in most places in the Study Area, selection of pipe joint is of importance to prevent groundwater infiltration. As shown in Table 4.7, rubber ring joints or other flexible type of joints are recommended as the most suitable joint.

A study has been carried out to select suitable pipe materials together with joints, taking into account the foregoing and other essential factors. As a result of the study, the following pipe materials depending on type and size of the sewer are recommended as shown in Table 4.7. A Study report is presented in Appendix K, Vol. IV.

Table 4.7. Recommended Pipe Materials

(a) Gravity Sewer

i) Diameter up to 300 mm	VC pipe with either rubber ring joints or other flexible joints
ii) Diameter 375 mm and above	Spigot-and-socket type concrete pipe with rubber ring joints and with high alumina cement mortar lining (up to 600 mm) or PVC lining (675 mm and above)

(b) Force Main

i) Diameter up to 600 mm	Pressure type AC pipe or steel pipe with cement mortar internal lining and bitumen external lining
ii) Diameter 675 mm and above	Steel pipe with the same linings mentioned above

4.3.3. Manhole Materials

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

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

4.3.4. Construction Method

1) Sewer Construction

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

a) Excavation

To economize the construction work, excavators such as backhoe and cramshell should be used. Manual excavation is also required at the trench bottom and where the underground pipes or cables are located. Careful attention should always be paid not to interfere with existing underground structures.

To limit interference with traffic in narrow roadways or highly congested downtown areas, soils excavated should be removed from the area temporarily, and returned later for backfilling. Excavation should be undertaken immediately prior to installation of the pipes for the same reason. It is also advisable to limit the length of open trench to a maximum 100 m in open areas and 30 to 40 m in developed areas.

b) Pipe Bedding, Bracing and Sheeting

According to the soil investigation conducted in the previous sewerage study by Proctor and Redfern in 1968, the soils in the Study Area are classified as soft or very soft silty-clay, and also high water table may be encountered.

The use of timber for sheeting in shallow trenches and steel sheet pile in deep trenches will be required in most parts of the Study Area except for very shallow trenches, taking into account soil and groundwater condition. For deep excavation, special precaution is required against heaving caused by the low shear strength in wet condition. This problem may be overcome by driving sheet piles sufficiently deep in excess of trench depth.

c) Dewatering

For most of the areas in the Study Area, removal of groundwater from the excavated trench will be required. Dewatering can be accomplished by sand pumps at the lower end of the trench in most cases, considering the rather low permeability of the soil.

d) Backfilling

Up to 30 cm above the crown, sand should be laid and carefully compacted. Excavated soil can be used for backfilling above that layer. However, the excavated soil should be dried and large stones, roots, or lumps of clay removed before backfilling. Backfilled soil should also be compacted uniformly and thoroughly.

2) Construction of Pumping Station

Pumping stations require a foundation extending approximately 10 m below the ground surface. To support the structure, concrete piles of 20 - 30 m length will be required, considering the poor soil condition.

3) Construction of Stabilization Pond

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

a) Shape of Pond

The shape of the pond shall be devoid of any narrow or elongated portions. In principle, a rectangular pond with length not exceeding three times the width is considered to be most desirable. Also, corners of the pond shall be rounded to minimize accumulation of floating materials.

b) Embankments

The area where the embankments are to be constructed should be completely cleared. Embankments should be constructed of impervious materials to the extent possible and sufficiently compact to form a stable structure. The top width of the embankment is to be 5 to 6 m. Depending on local conditions, neither the inner nor outer slope of the embankment should be steeper than the ratio of one horizontal to one vertical. The embankment is pitched with rubble stones from the top of the embankment down to the bottom of the pond. The top of the dike should be paved in sufficient width to ensure access and passage of maintenance vehicles. Minimum freeboard is to be 0.5 m.

c) Pond Bottom

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

d) Inlet and Outlet Arrangement

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

e) Miscellaneous

The pond area should be enclosed with a suitable fence to preclude livestock and discourage public trespassing. A vehicle access gate of sufficient width to accommodate maintenance and operational equipment shall be provided. Bypass conduits with valves are provided to enable the pond to be used in any combination when a pond is emptied for repair or other purposes. Care should be given to landscaping the treatment site, providing a buffer zone between the facilities and site boundary.

CHAPTER 5

RECOMMENDED SEWERAGE SYSTEM

CHAPTER 5 RECOMMENDED SEWERAGE SYSTEM

5.1. Trunk Sewer Routes

5.1.1. Alternatives

The following alternatives, some of which are the modifications of trunk sewer routes and location of pumping station as indicated in the Master Plan are considered for planning the most economical sewerage system in the Feasibility Study Area.

Alternative-1 This is the same plan as proposed in the Master Plan. Trunk sewers cross the Federal Highway at two points, one covering Units 1 and 2, and another from Unit 3. There are two pumping stations; namely, Eng Ann (Unit-1) and Kg. Kuantan (Unit-4) pumping stations.

Alternative-2 Trunk sewer crosses the Federal Highway at one point, instead of two points as in Alternative-1. This alternative is considered to avoid sewer crossing of heavy traffic at Federal Highway as much as possible.

Alternative-3 A part of Unit-5 is diverted and connected to the lower reach of the main trunk. The location of the proposed Kg. Kuantan pumping station may have to be changed. This alternative is introduced to investigate the possibility of raising the main trunk in the downstream after the pumping station.

Alternative-4 The trunk sewer from Unit-1 is shifted inside Unit-2, instead of along the Federal Highway, in order to explore the possibility of eliminating Eng Ann pumping station which is required to lift the sewage originating from the lower area in Unit-1.

These alternatives are shown in Fig. 5.1 to Fig 5.4.

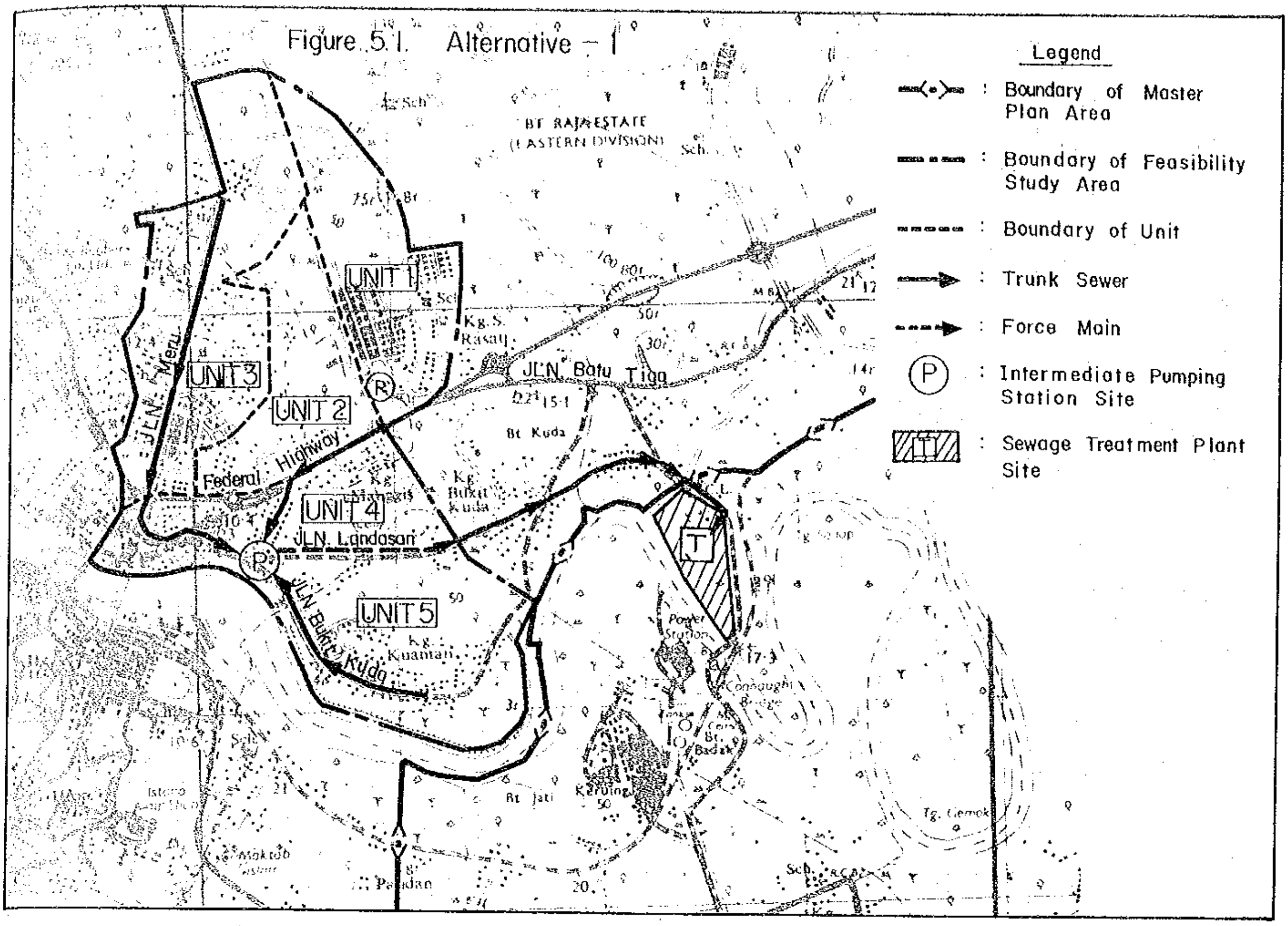


Figure. 5.1. Alternative - 1

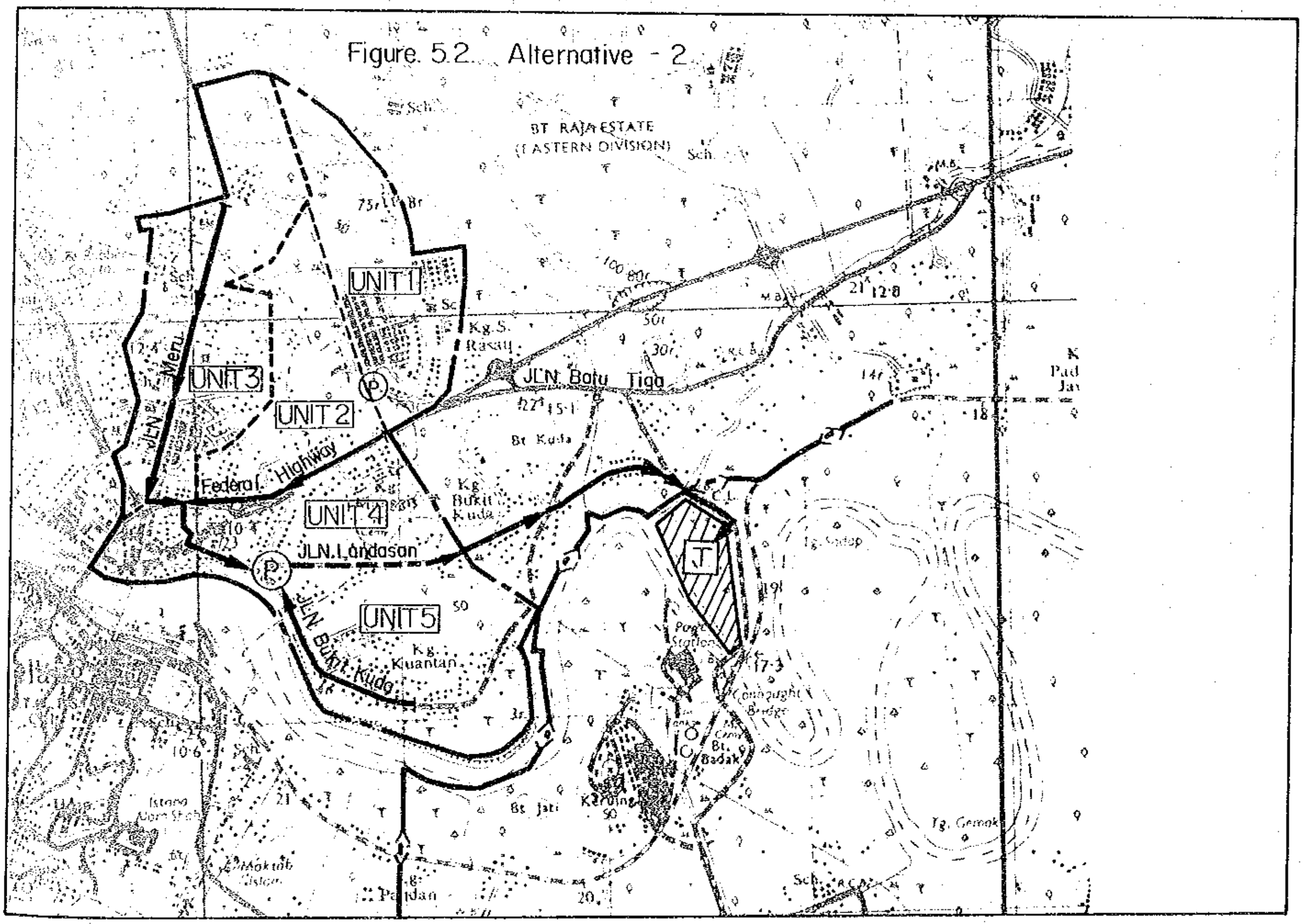


Figure. 5.2. Alternative - 2

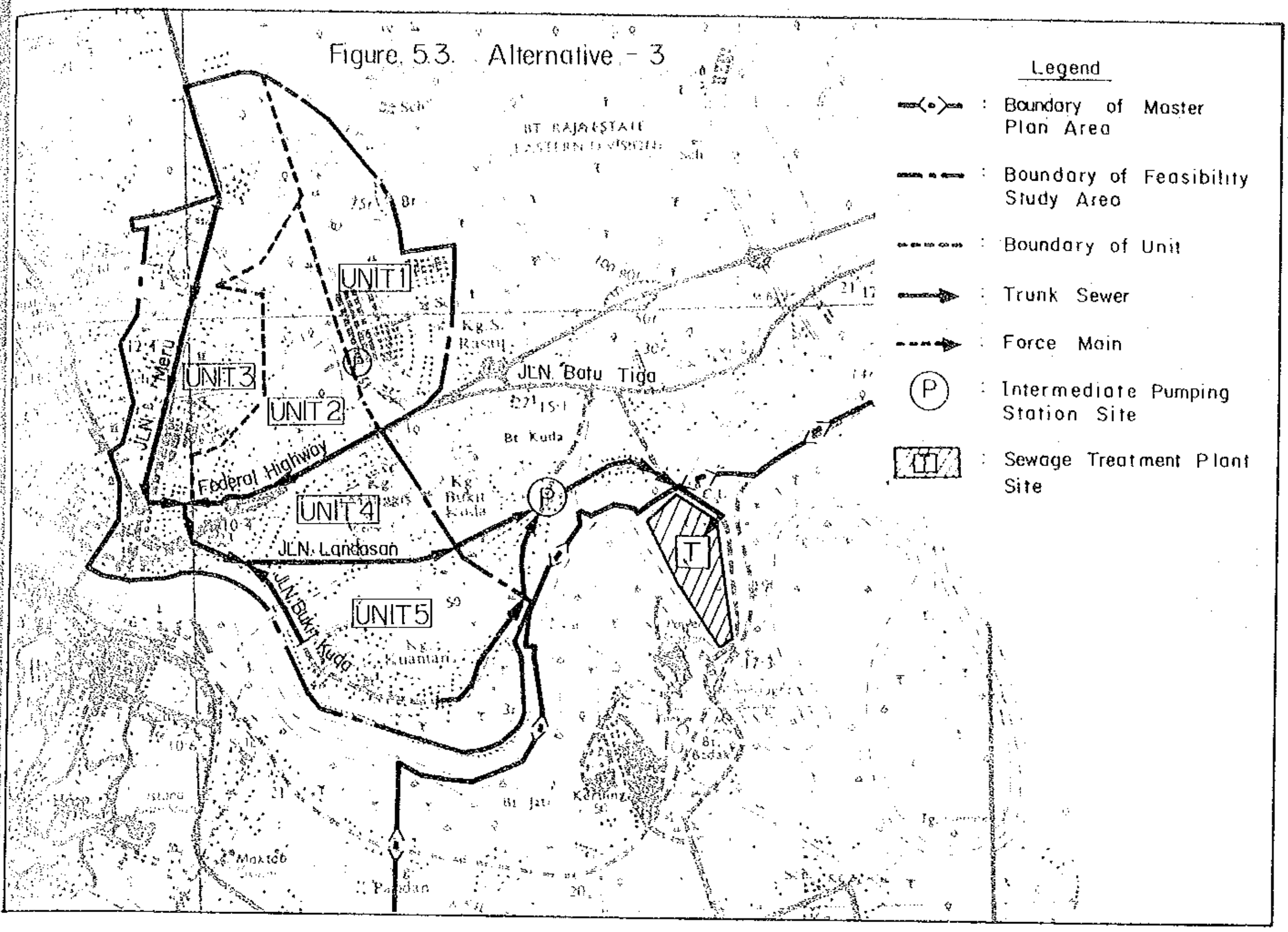


Figure. 5.3. Alternative - 3

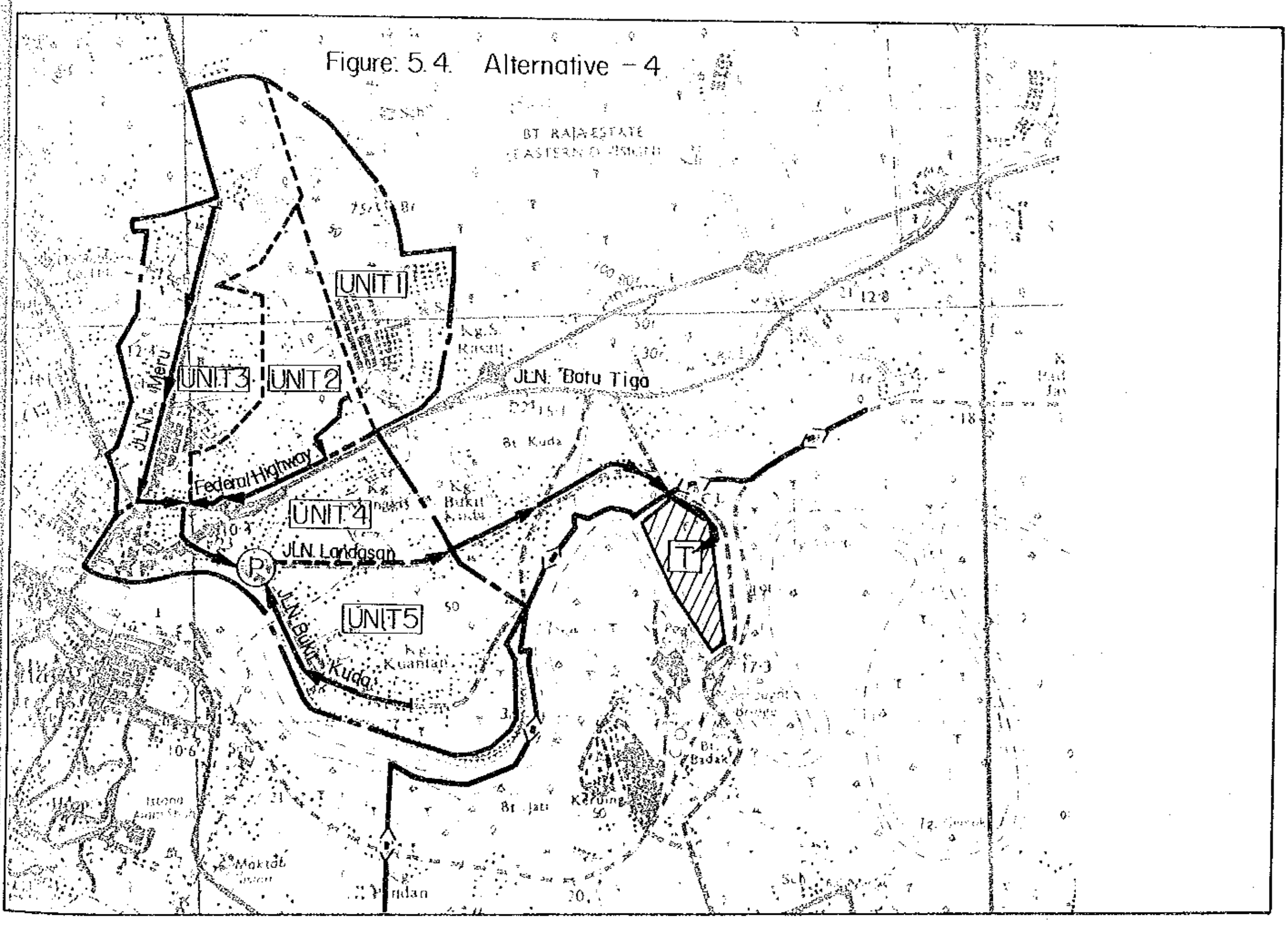


Figure. 5.4. Alternative - 4

5.1.2. Cost Comparison

Construction cost of each alternative is estimated, based on the design of facilities and the cost function developed in the Master Plan. Sewerage facilities involved are trunk sewers and intermediate pumping stations. Construction costs of branch and lateral sewers and treatment plant are excluded because these costs are considered to be almost the same regardless of which alternative is considered.

Results of the cost estimation are shown in the following table.

Table 5.1. Construction Cost of Alternatives

(Unit: M$1,000)

Facility	Alter-native-1	Alter-native-2	Alter-native-3	Alter-native-4
Trunk Sewer	6,646	6,771	10,407	6,990
Kg. Kuantan Pumping Station	1,319	1,319	2,025	1,319
Eng Ann Pumping Station	100	100	100	-
Total	8,065	8,190	12,534	8,309
Ratio	1.0	1.02	1.55	1.03

Trunk sewer and pumping station construction costs of Alternatives 1, 2 and 4 can be considered to be the same, taking cost function accuracy into account. On the other hand, total cost of Alternative-3 is evidently higher than that of any of the other three alternatives. The reasons for this cost increment are as follows:

1) Longer length of the deep trunk sewer upstream of the proposed pumping station outside the Study Area resulting in cost increase. On the other hand, the trunk sewer downstream of the

pumping station cannot be raised significantly because of the existence of deep drains. The former cost increase cannot be offset by a decrease in the latter.

2) Larger capacity of the pumping station, which also increases the construction cost.

5.1.3. Conclusion

Comparing the three alternatives; namely, Alternatives 1, 2 and 4, Alternative-4 has the following advantages.

1) Sewer crossing of the Federal Highway will be at one point, which will result in minimum disturbance to traffic.

2) Eng Ann pumping station will not be required, which will result in ease of maintenance and in saving operation and maintenance cost.

Taking into account the foregoing, Alternative-4 is recommended in the Study Area.

5.2. Facilities Considered with Preliminary Engineering Design

Major facilities proposed in the First Phase Program consist of the following items.

1) Trunk sewers with total length of 6,660 m, varying from diameter 375 mm to 1,200 mm, including force main.
2) Branch and lateral sewers with total length of 56,985 m, and diameter from 225 mm to 450 mm.
3) Kg. Kuantan Intermediate Pumping Station.
4) Connaught Wastewater Treatment Plant.

Preliminary engineering designs for the above are carried out on the basis of the recommended design basis described in Chapter 4.

5.2.1. Sewers

Alignment of the sewers, including trunks and branches and laterals, is planned based on the road network plan in the Study Area, inclusive of both existing and proposed roads. Development plans approved by TCP were collected through the City Planning Section of MPK in order to identify the location of proposed roads. Almost all the vacant areas in the Study Area are planned for development. However, formation level of the proposed roads are yet to be determined. Therefore, these levels are assumed by the Study Team based on natural topographic conditions and on the levels of the existing roads which were measured by the Study Team in the course of field survey for the Feasibility Study. The leveling results are presented in Fig. 5.5.

The sewer layout plan is shown in Fig. 5.6. Total length of sewers and other items according to each unit are summarized in Table 5.2. Calculation tables and longitudinal sections of trunk sewers are presented in Table 5.3 and Figs. 5.7 to 5.9.

Table 5.2. Number, Total Length and Average Length per Area of Sewers

	Trunk Sewers	Branch and Lateral Sewers					Total
		Unit-1	Unit-2	Unit-3	Unit-4	Unit-5	
Number of Sewers	26	85	128	145	112	171	667
Length of Sewers (m)	6,660	9,765	10,700	12,247	9,466	14,807	(56,985)* 63,645
Area (ha)	-	56	59	86	56	81	338
Average Length per Area (m/ha)	-	174	181	142	169	183	(169)* 188

Note: * ( ) Branch and lateral only.

5.2.2. Pumping Station

As a result of alternative study on selection of pump type, submersible non-clog pump is proposed (Ref. to Appendix L, Vol. IV). The advantages of submersible pump include (1) lower construction cost of structure, resulting from elimination of dry-well, and (2) lower operating and maintenance cost.

One intermediate pumping station is required, according to the recommendation, in the sewerage system proposed for the First Phase Program. The Kg. Kuantan pumping station is designed on the basis of recommendation stated in Chapter 4. Structures and pump capacity are designed to meet requirements for the year 2000. All the facilities required in the year 2000 shall be provided by 1990, since the pumping station serves exclusively for the Study Area, hence the anticipated flow rate in 1990 is close to that in 2000.

The proposed shape of the pump well is rectangular as shown in Fig. 5.10. A coarse bar screen with 100 mm intervals is installed in front of the pump well. Screenings will be removed manually and transported by truck to the disposal site. No grit chamber is provided.

The design flow of the pumping station and outline specifications of the pumps to be provided are shown in Table 5.4.

Table 5.4. Design Flow of Kg. Kuantan Pumping Station

	Year 1990	Year 2000
Daily Average Flow (m^3/day)	11,600	16,000
Peak Flow (m^3/min.)	23.7	29.2
Total Design Head (m)	15	
Number of Pumps	3, including one stand-by	
Pump Type	Submersible, non-clog	

5.2.3. Wastewater Treatment Plant

As discussed in the Master Plan Report and also in Chapter 4 of the current Report, the aerated lagoon system should be adopted by the year 2000. However, the possibility of adopting the stabilization pond as a temporary facility before the demand exceeds its capacity is suggested to minimize the First Phase construction cost and also operation and maintenance work.

In the Master Plan, it is proposed that the wastewater treatment plant for the Study Area be used by the year 2000 to treat the wastewater generated outside of the Study Area; i.e., Kelang North, Zone-1, Sub-zone-2. Wastewater and waste load quantities projected up to the year 2000 on the basis of design in the Master Plan are shown in Table 5.5.

Table 5.5. Wastewater and Waste Load Projection

Item	1990	2000		
		Study Area	Other Areas	Total
Served Population Equivalence (person)	41,243	53,849	41,849	95,698
Domestic Wastewater (m^3/day)	9,898	14,000	10,881	24,881
Industrial Wastewater (m^3/day)	-	-	3,152	3,152
Infiltration (m^3/day)	1,694	2,023	3,609	5,632
Total Wastewater (m^3/day)	11,592	16,023	17,642	33,665
BOD Load (kg/day)	1,980	2,800	2,681	5,481
SS Load (kg/day)	1,980	2,800	2,807	5,607

Note: * Projection for 1990 is only for Study Area.

Based on the foregoing projection and design criteria, the required surface area for the stabilization pond only for Sub-zone-1 at each year is calculated as follows:

Table 5.6. Required Pond Area

(Unit: ha)

	1990	2000
Facultative Pond	6.19	8.75
Maturation Pond	2.32	3.20
Total	8.51	11.95

Taking into account the fact that it takes a few years or more for the treatment plant to reach design flow capacity, the actual influx for the time being after completion of construction work in 1990 will be less than that shown in Table 5.5. Therefore, it is expected that the 1990 design flow capacity for the stabilization pond will provide sufficient service for several years after 1990.

However, since the available area for the Connaught Wastewater Treatment Plant is approximately 12.68 ha, the stabilization pond system may not provide satisfactory treatment of the anticipated flow in the year 2000. Therefore, modification of the treatment plant into an aerated lagoon may be required by the year 2000. At that time, experience expected to be accumulated by that time will help determine the possibility of operating the stabilization pond at a higher BOD load than proposed.

The layout plan for construction of the stabilization ponds during the First Phase, including necessary facilities, is worked out, taking into account various factors, such as the shape of the site, the Kelang River water level, etc., simultaneous with the aerated lagoon layout plan at the ultimate stage. Special consideration is given to ease of modifying the stabilization ponds into aerated lagoons in designing these layout plans.

One of the three facultative ponds, No. 2 pond, is divided into two ponds for ease in modifying one of them into an aerated lagoon at a later stage. During modification work, only the first pond should be dried up, while the second facultative pond and the next maturation pond are kept in operation. Although the first pond is not expected to become anaerobic under the anticipated BOD load of approximately 600 kg/ha.day, it is recommended inlet pipes and valves be provided at suitable points to enable operation of the two facultative ponds as a unit to avoid producing inferior effluent quality. Layout plan for the slabilization ponds and aerated lagoons are shown in Fig. 5.11 and Fig. 5.12 respectively.

A plan including cross-sections of the pumping station for the Connaught Wastewater Treatment Plant is shown in Fig. 5.13. Based on an alternative study, the type of pump selected is the submersible pump (Ref to Appendix L, Vol. IV). Of the five pumps required at the ultimate stage, three pumps, including one stand-by, should be installed at the First Phase construction.

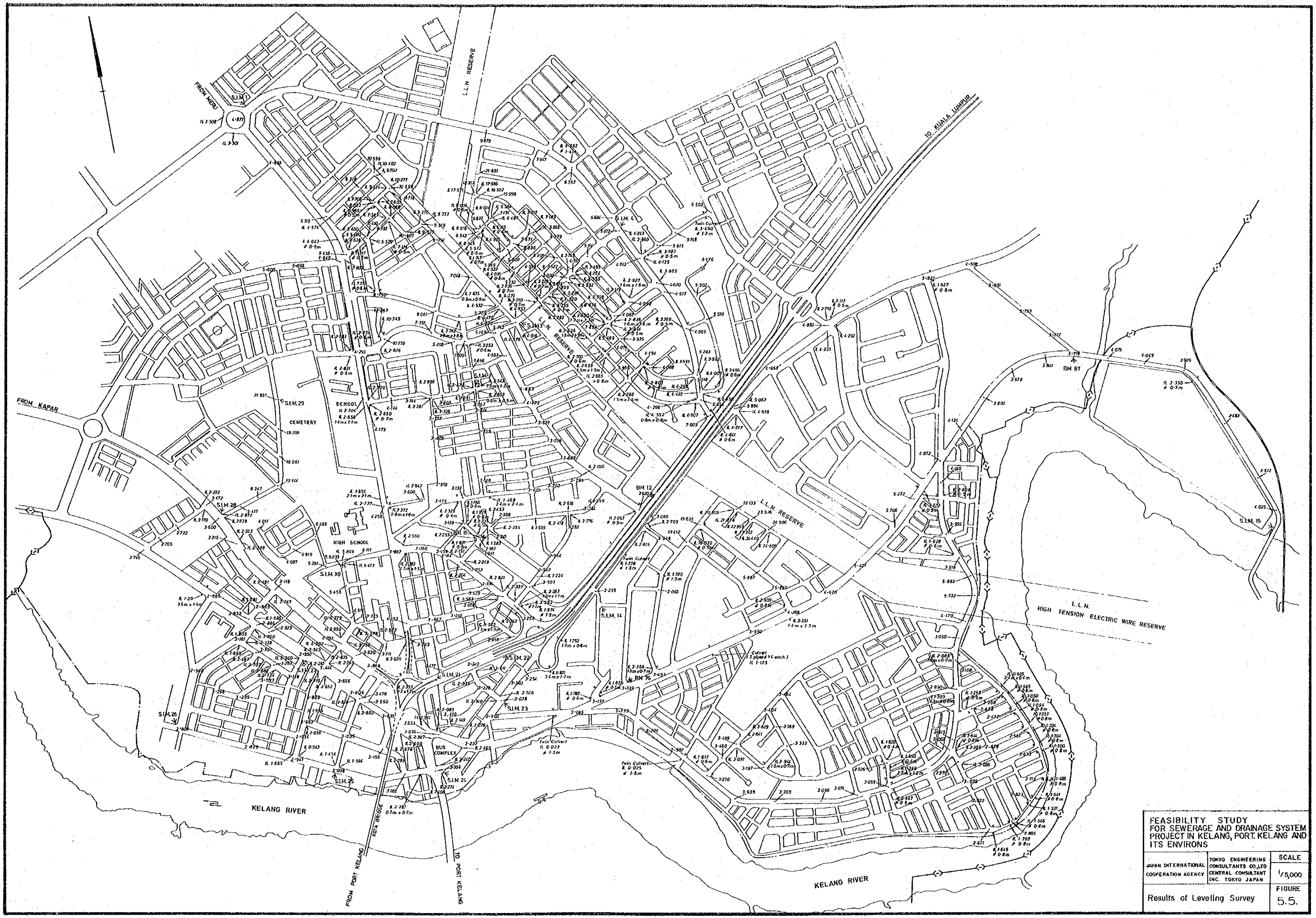
Since the plant site is adjacent to the Kelang River, some protective measures should be provided to prevent erosion which might be caused by the river stream. Taking into account the high water level of the Kelang River as well as the proposed ground elevation, construction of a reinforced concrete retaining wall approximately 3.5 m high is proposed along the Kelang River bank. Location of the retaining wall is shown in Fig. 5.11.

Table 5.3. Calculation Table for Trunk Sewers

No. of Sewers	No. of Joint Sewers	Area: Increment	Area: Total	Population	Peaking Factor	Length: Increment	Length: Total	Design Flow: Domestic Waste	Design Flow: Other	Infiltration: Area	Infiltration: Flow	Total	Designed Sewer: Diameter	Slope	Length	Full Velocity	Full Capacity	Invert Elevation: Begin Point	Invert Elevation: End Point	Elevation Ground Surface	Earth Covering	Remarks
		ha	ha	persons		m	m	m³/sec	m³/sec	ha	m³/sec	m³/sec	mm	‰	m	m/sec	m³/sec	m	m	m	m	
①			24.84	5323	3.94	300	300	0.063			0.002	0.065	375	2.10	300	0.81	0.080	1.349	0.719	4.65 / 4.29	2.87 / 3.14	
②			38.70	8294	3.70	112	412	0.092			0.003	0.095	450	1.90	112	0.86	0.124	0.644	0.431	4.29 / 4.18	3.14 / 3.24	
③			45.02	9648	3.62	476	888	0.105			0.004	0.109	450	1.90	476	0.88	0.124	0.431	-0.474	4.18 / 3.89	3.24 / 3.85	
④			71.17	15249	3.39	234	1122	0.155			0.006	0.161	525	1.80	234	0.95	0.182	-0.549	-0.970	3.89 / 4.15	3.84 / 4.53	
⑤			77.65	16638	3.35	174	1296	0.168			0.006	0.174	600	1.70	174	0.97	0.253	-1.045	-1.341	4.15 / 3.20	4.52 / 3.87	
⑥			83.66	17925	3.31	90	1386	0.178			0.007	0.185	600	1.70	90	0.98	0.253	-2.245	-2.398	3.20 / 3.48	4.77 / 5.20	
⑦			86.00	18426	3.30	94	1480	0.183			0.007	0.190	600	1.70	94	0.98	0.253	-2.398	-2.558	3.48 / 3.35	5.20 / 5.23	
		Flow to ⑪																				
⑧			56.00	6075	3.86	1113	1113	0.070			0.005	0.075	450	1.90	1113	0.82	0.124	0.991	-1.893	3.80 / 3.10	2.30 / 4.48	
⑨			112.11	15578	3.38	64	1177	0.158			0.009	0.167	600	1.50	64	0.91	0.238	-2.378	-2.474	3.10 / 3.10	4.80 / 4.90	
⑩			115.00	16068	3.36	166	1343	0.163			0.009	0.172	600	1.50	166	0.92	0.238	-2.474	-2.723	3.10 / 3.35	4.90 / 5.40	
⑪	⑦		201.00	34494	3.02	170	1650	0.313			0.016	0.329	750	1.40	170	1.05	0.417	-2.873	-3.111	3.35 / 3.08	5.38 / 5.35	
⑫			203.86	35026	3.01	60	1710	0.317			0.017	0.334	750	1.40	60	1.05	0.417	-3.111	-3.195	3.08 / 2.96	5.35 / 5.32	
⑬			214.09	36940	2.99	216	1926	0.332			0.017	0.349	750	1.40	216	1.06	0.417	-3.195	-3.498	2.96 / 3.00	5.32 / 5.66	
⑭			219.78	38004	2.97	121	2047	0.340			0.018	0.358	750	1.40	121	1.06	0.417	-3.498	-3.667	3.00 / 3.15	5.66 / 5.98	
⑮			257.00	44978	2.90	30	2077	0.393			0.021	0.414	900	1.20	30	1.05	0.627	-4.063	-4.099	3.15 / 3.40	6.22 / 6.50	Flow into pumping station
		Flow to ㉒																				
⑯			53.98	5921	3.88	360	360	0.069			0.004	0.073	450	1.90	360	0.82	0.124	-0.877	-1.561	3.07 / 3.58	3.44 / 4.63	
⑰			59.17	6490	3.83	144	504	0.075			0.005	0.080	450	1.90	144	0.83	0.124	-1.561	-1.834	3.58 / 3.27	4.63 / 4.59	
⑱			65.32	7165	3.77	90	594	0.082			0.005	0.087	450	1.90	90	0.85	0.124	-2.563	-2.734	3.27 / 3.00	5.32 / 5.22	
⑲			69.55	7627	3.74	180	774	0.086			0.006	0.092	450	1.90	180	0.86	0.124	-2.763	-3.105	3.00 / 3.22	5.25 / 5.81	
⑳			78.83	8634	3.67	86	860	0.096			0.006	0.102	450	1.90	86	0.87	0.124	-3.105	-3.268	3.22 / 3.24	5.81 / 6.00	

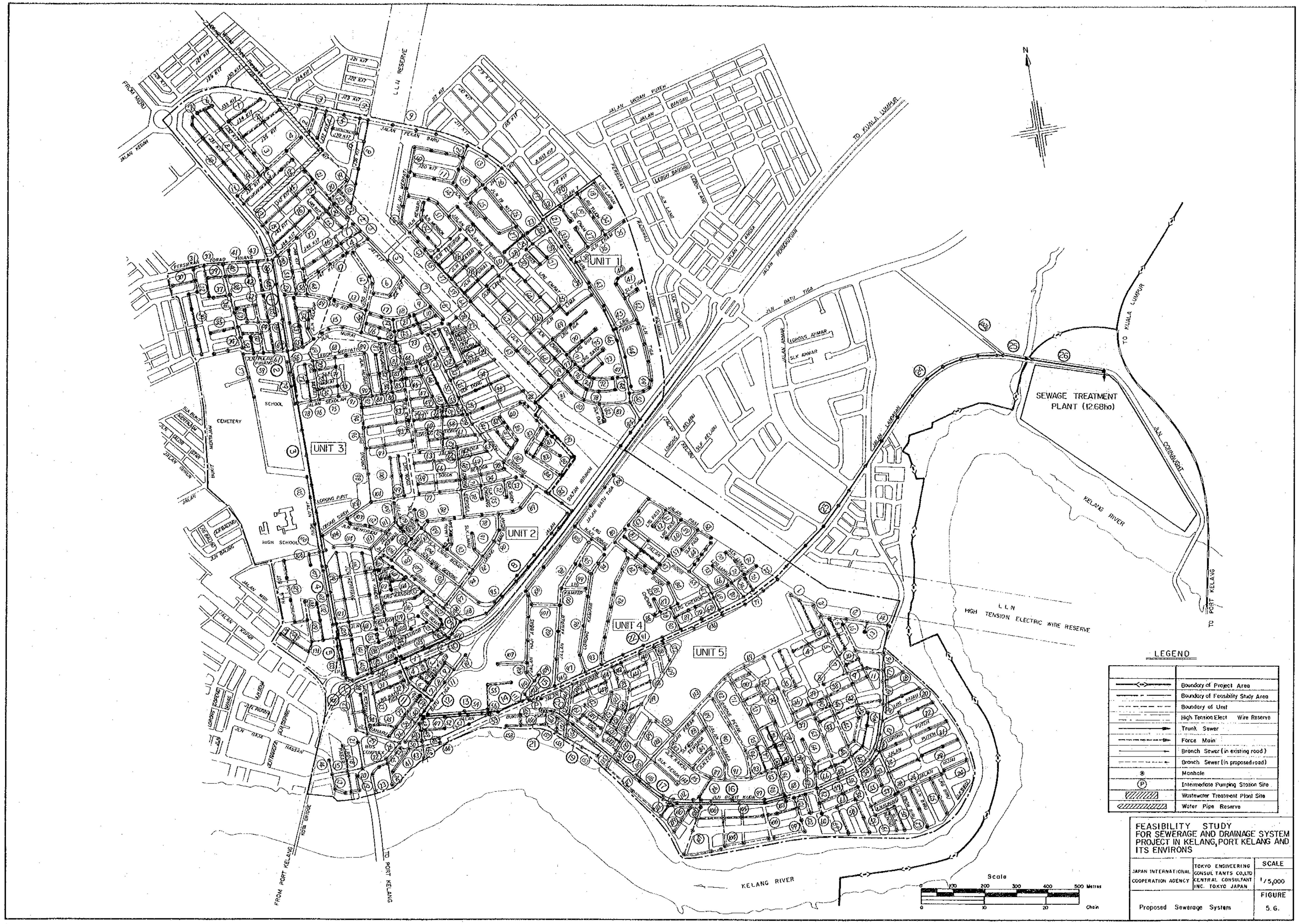
Table 5.3. (Cont.)

No. of Sewers	No. of Joint Sewers	Area Increment	Area Total	Population	Peaking Factor	Length Increment	Length Total	Design Flow Domestic Waste	Design Flow Other	Infiltration Area	Infiltration Flow	Design Flow Total	Diameter	Slope	Length	Full Velocity	Full Capacity	Invert Elevation Begin Point	Invert Elevation End Point	Elevation Ground Surface	Earth Covering	Remarks
		ha	ha	persons		m	m	m³/sec	m³/sec	ha	m³/sec	m³/sec	mm	‰	m	m/sec	m³/sec	m	m	m	m	
(21)			81.00	8871	3.66	42	902	0.097			0.007	0.104	450	1.90	42	0.88	0.124	-3.268	-3.348	3.24 3.40	6.00 6.24	Flow into pumping station
(22)	(15)		338.00	53849	2.83	950	3027	0.459			0.027	0.486	600		950	1.72	0.486	1.525	3.526	3.40 5.40	1.20 1.20	Force Main
(23)			371.10	56402	2.81	358	3385	0.477	0.002		0.030	0.509	900	1.30	358	1.14	0.653	1.901	1.436	5.40 4.97	2.50 2.54	
(24)			392.20	58029	2.80	630	4015	0.489	0.003		0.032	0.524	900	1.30	630	1.14	0.653	1.436	-3.627	4.97 3.72	2.54 6.35	
(25)			927.00	99278	2.59	190	4205	0.775	0.035		0.075	0.885	1200	1.00	190	1.19	1.233	-3.927	-4.117	3.72 4.06	6.32 6.85	
(26)			970.00	99304	2.59	210	4415	0.775	0.035		0.079	0.888	1200	1.00	210	1.19	1.233	-4.117	-4.327	4.06 4.20	6.85 7.20	Flow into treatment Plant



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

JAPAN INTERNATIONAL COOPERATION AGENCY	TOKYO ENGINEERING CONSULTANTS CO.,LTD CENTRAL CONSULTANT INC. TOKYO JAPAN	SCALE 1/5,000
Results of Leveling Survey		FIGURE 5.5.

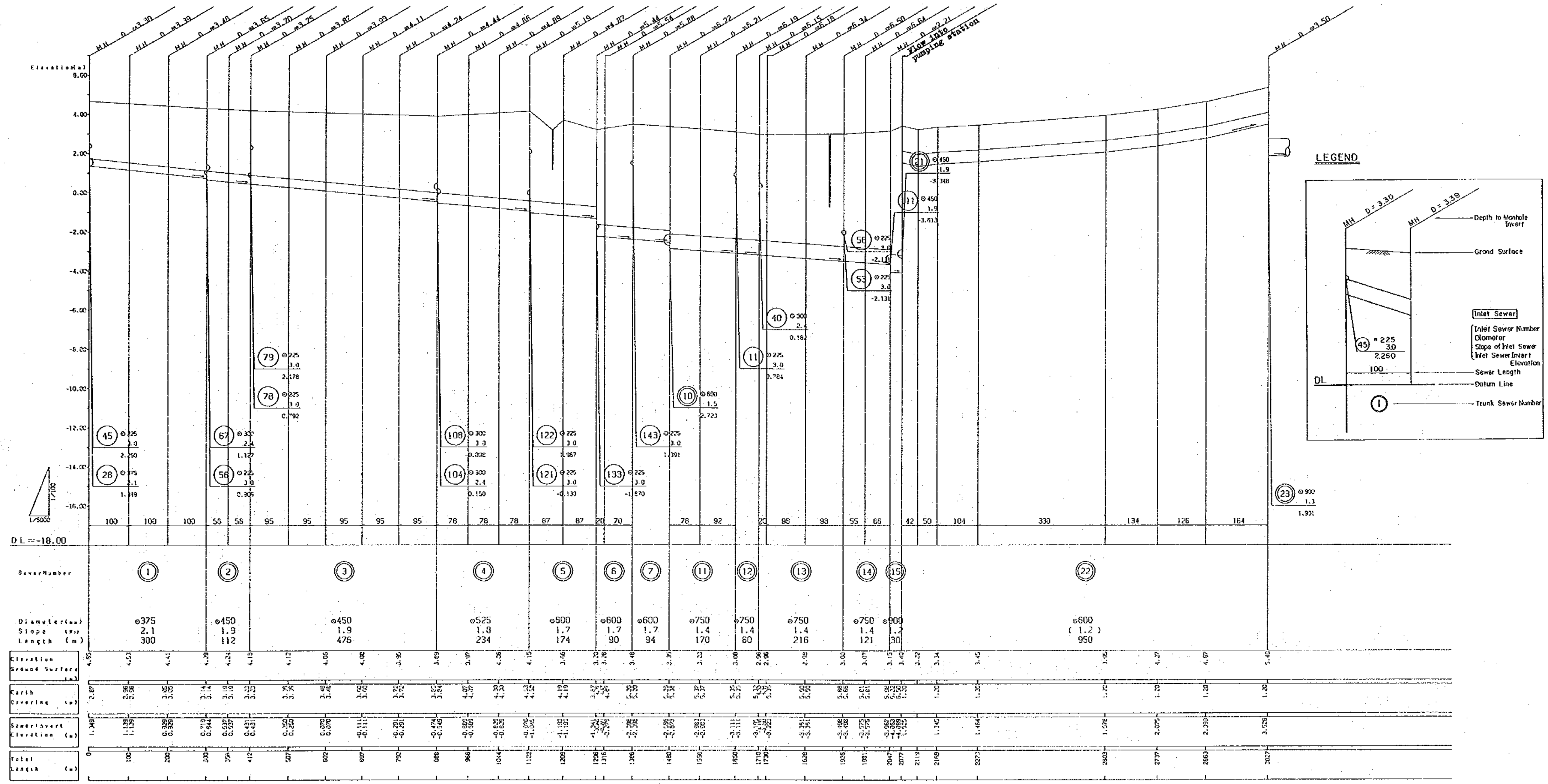


FEASIBILITY STUDY FOR SEWERAGE AND DRAINAGE SYSTEM PROJECT IN KELANG, PORT KELANG AND ITS ENVIRONS

JAPAN INTERNATIONAL COOPERATION AGENCY	TOKYO ENGINEERING CONSULTANTS CO., LTD CENTRAL CONSULTANT INC. TOKYO JAPAN	SCALE 1/5,000
Proposed Sewerage System		FIGURE 5.6.

UNIT 3

UNIT 4



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

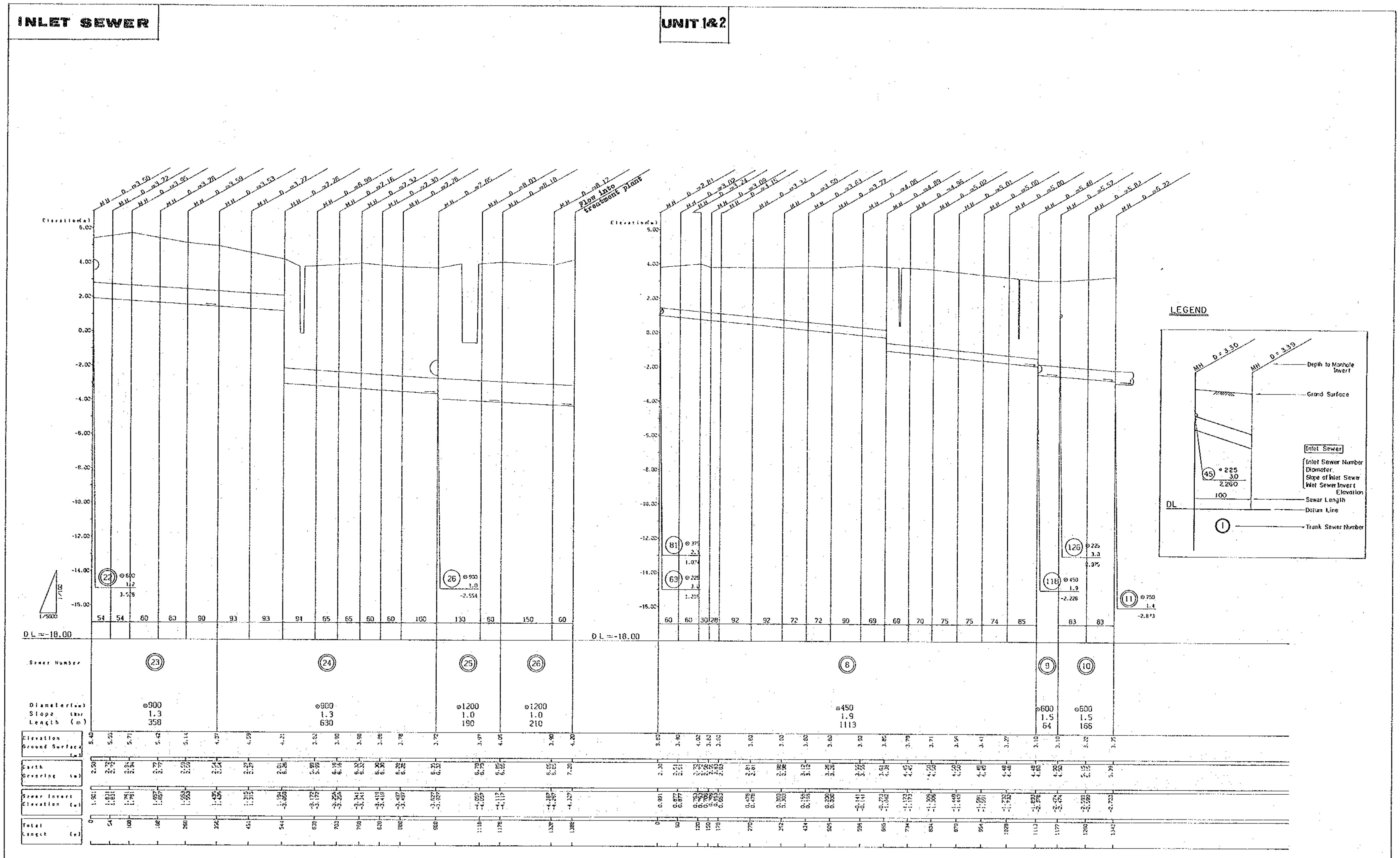
JAPAN INTERNATIONAL COOPERATION AGENCY

TOKYO ENGINEERING CONSULTANTS CO., LTD. CENTRAL CONSULTANT INC. TOKYO JAPAN

SCALE V=1/100 H=1/5000

Longitudinal Section of Trunk Sewers (1/3)

Fig. 5.7.



Sewer Number				
23	24	25	26	8
9	10			

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

JAPAN INTERNATIONAL COOPERATION AGENCY

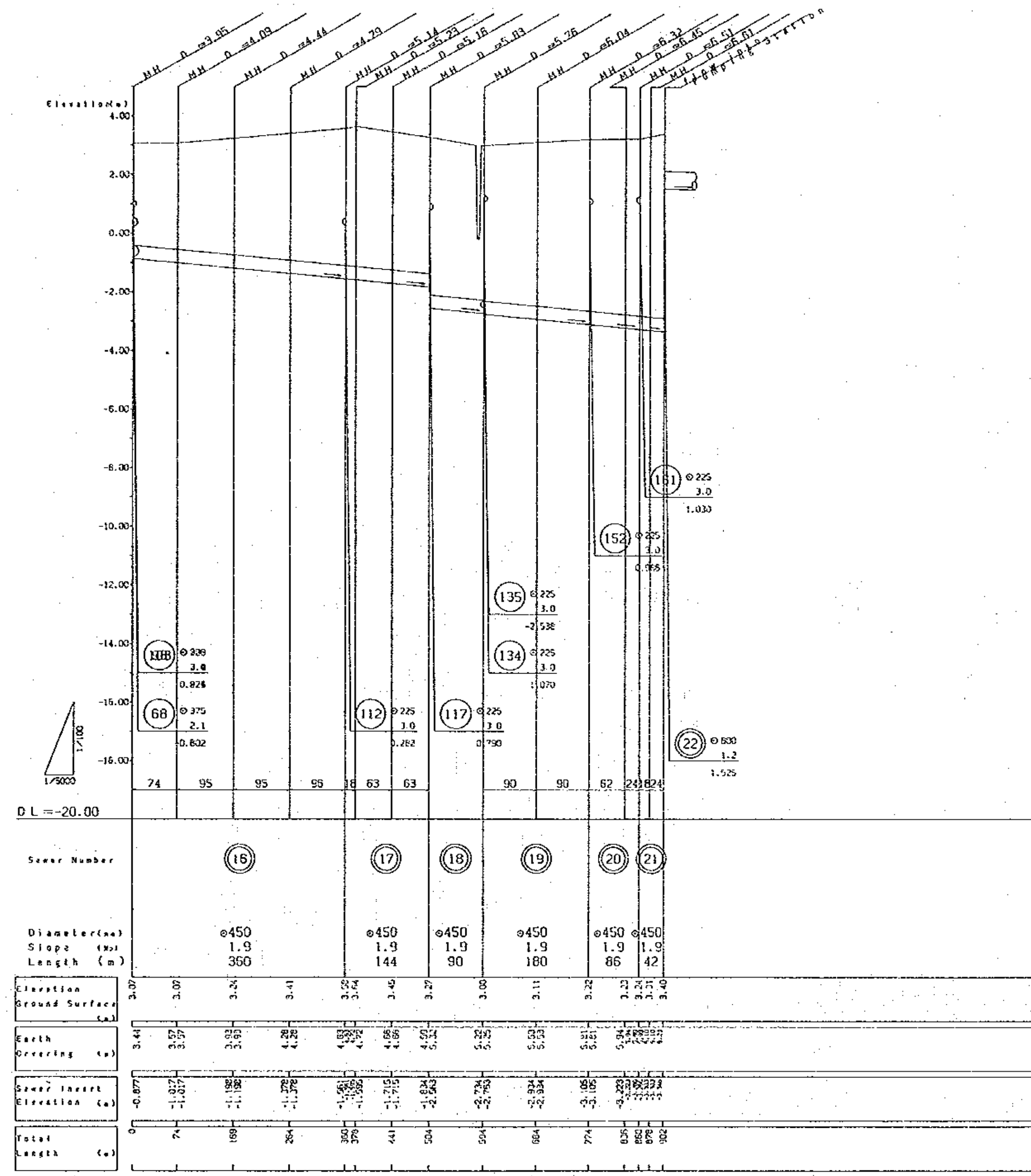
TOKYO ENGINEERING CONSULTANTS CO., LTD.
CENTRAL CONSULTANT INC. TOKYO JAPAN

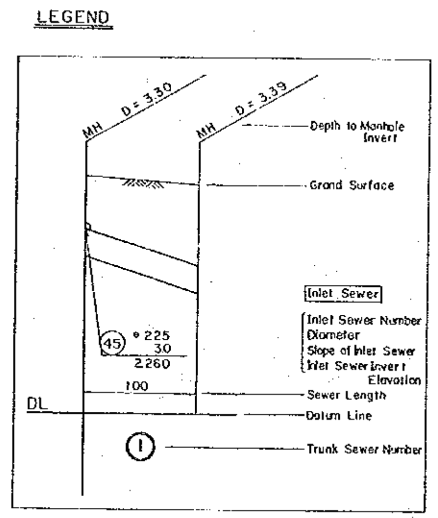
SCALE
V=1/100
H=1/5000

Longitudinal Section
of Trunk Sewers (2/3)

Fig. 5.8.

UNIT 5





Sewer Number				
16	17	18	19	20
21				

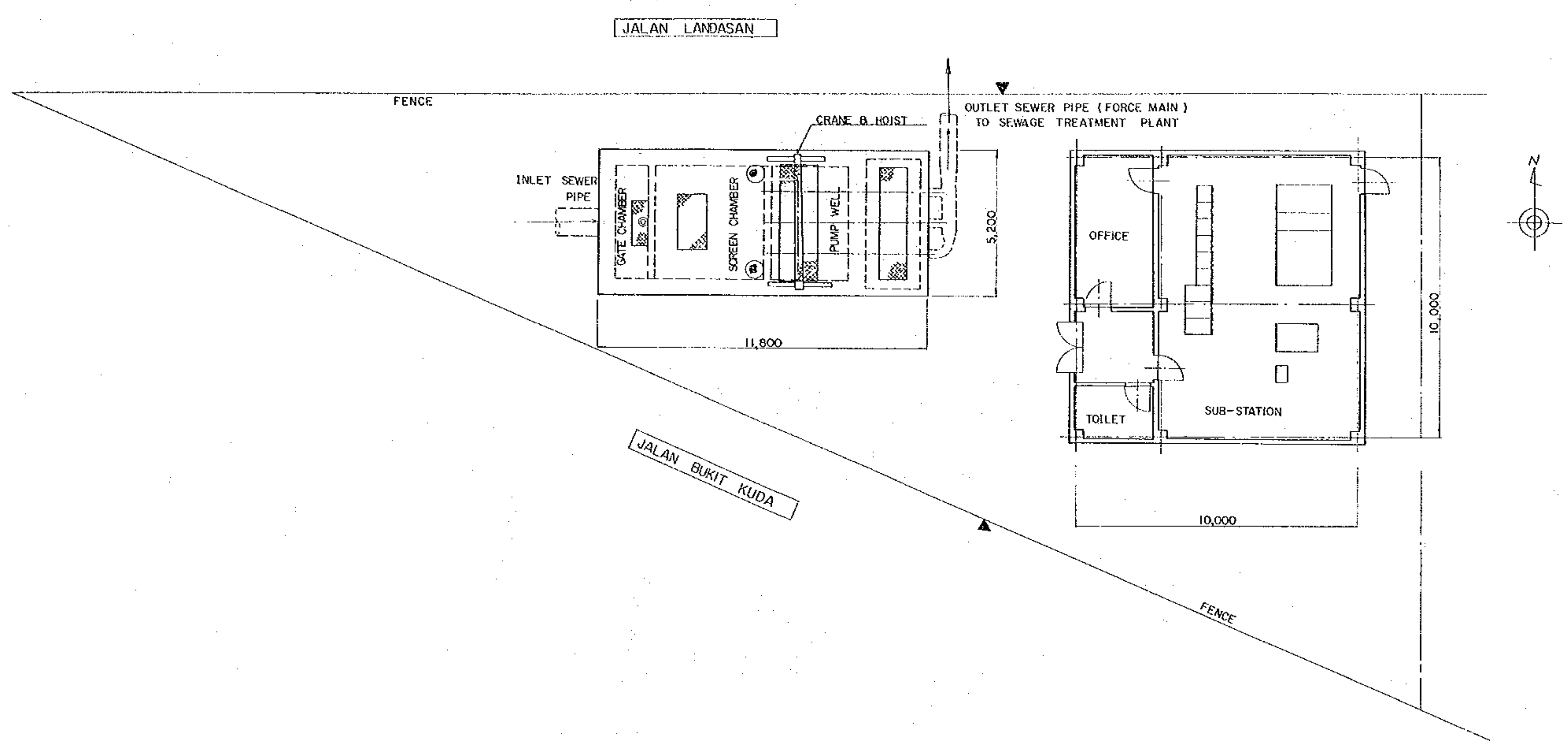
FEASIBILITY STUDY FOR SEWERAGE AND DRAINAGE SYSTEM PROJECT IN KELANG, PORT KELANG AND ITS ENVIRONS

JAPAN INTERNATIONAL COOPERATION AGENCY	TOKYO ENGINEERING CONSULTANTS CO., LTD. CENTRAL CONSULTANT INC. TOKYO JAPAN	SCALE V=1/100 H=1/5000

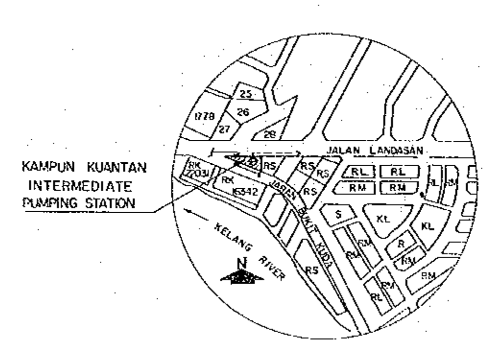
Longitudinal Section of Trunk Sewers (3/3)

Fig.5.9.

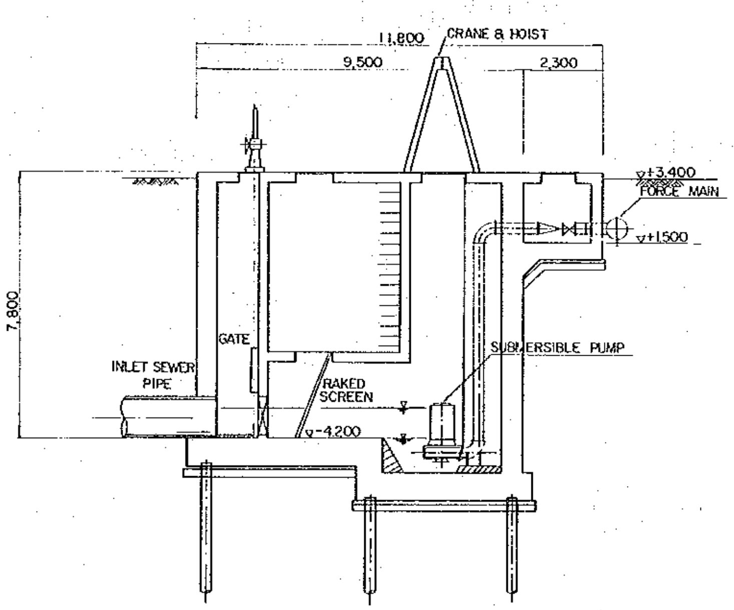
GENERAL PLAN



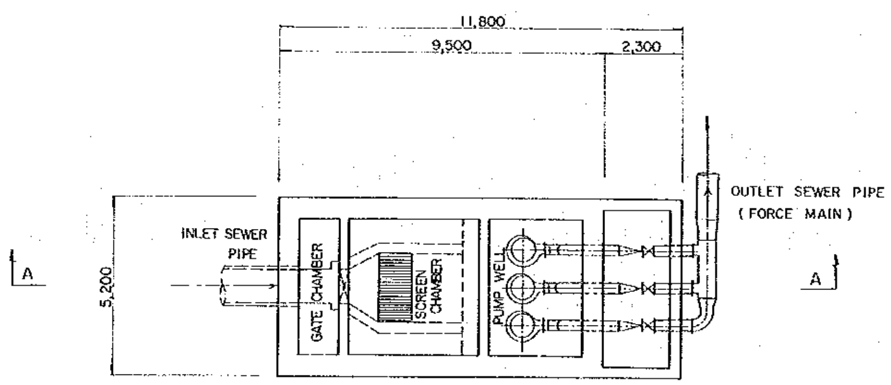
LOCATION SCALE 1:5,000



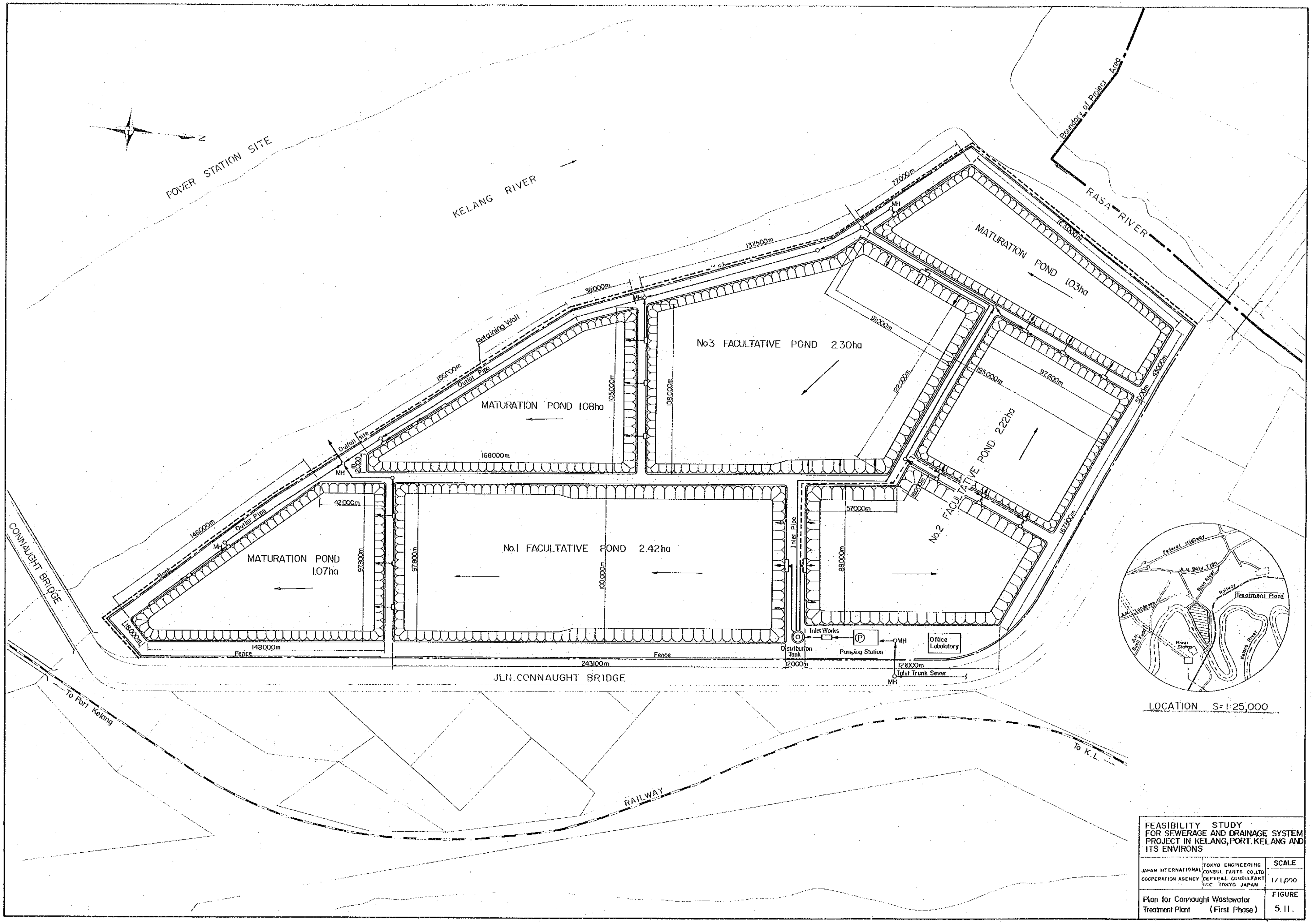
SECTION A-A

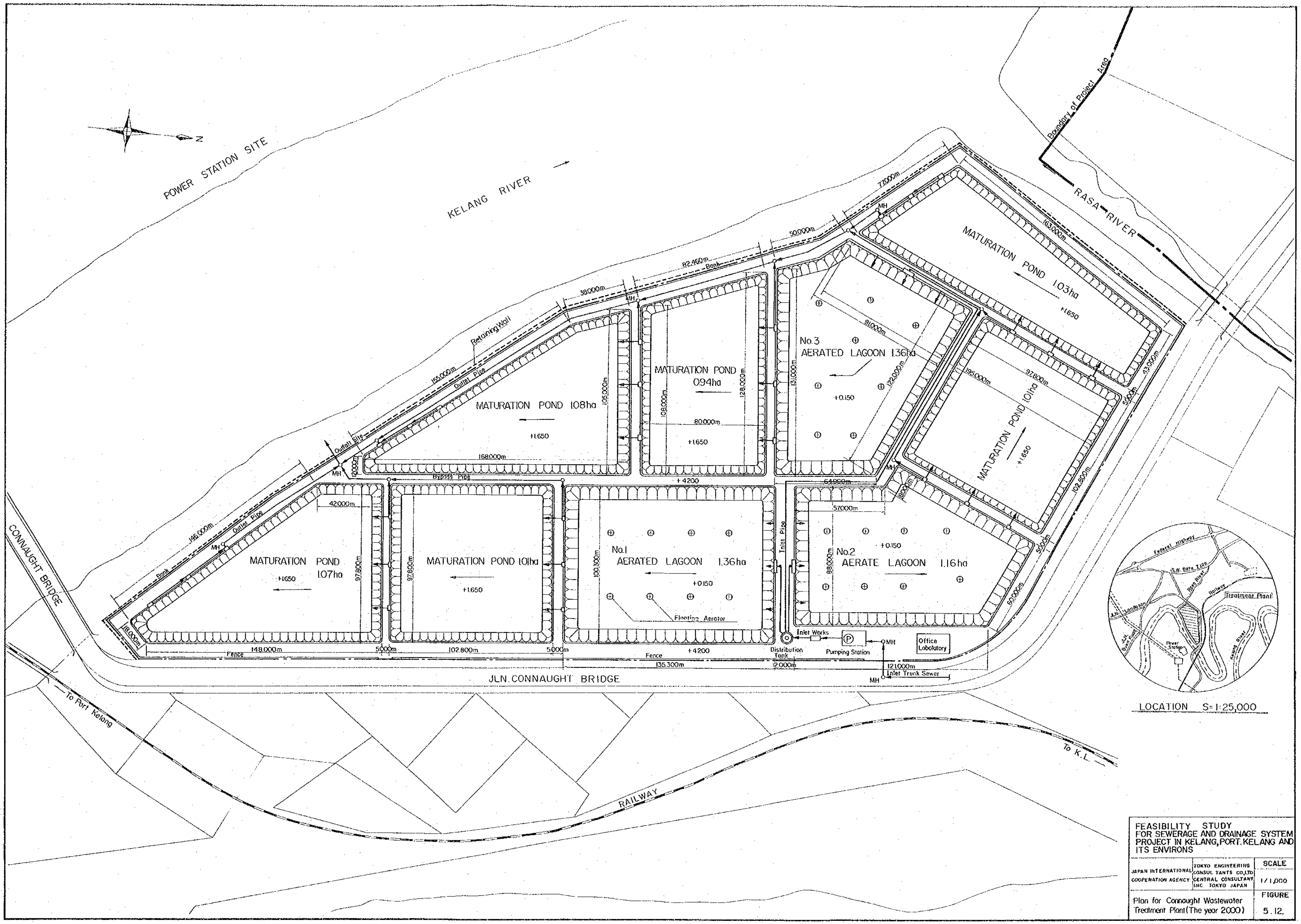


BASEMENT PLAN



FEASIBILITY STUDY FOR SEWERAGE AND DRAINAGE SYSTEM PROJECT IN KELANG, PORT. KELANG AND ITS ENVIRONS		
JAPAN INTERNATIONAL COOPERATION AGENCY	TOKYO ENGINEERING CONSULTANTS CO., LTD CENTRAL CONSULTANT INC. TOKYO JAPAN	SCALE 1/100
Design for Kg. Kuantan Intermediate Pumping Station		FIGURE 5.10.


POWER STATION SITE
KELANG RIVER
RASA RIVER
Boundary of Project Area
MATURATION POND 1.03ha
No.3 FACULTATIVE POND 2.30ha
No.2 FACULTATIVE POND 2.22ha
MATURATION POND 1.08ha
No.1 FACULTATIVE POND 2.42ha
MATURATION POND 1.07ha
Retaining Wall
Outlet Pipe
Outfall Site
Inlet Pipe
Inlet Works
Distribution Tank
Pumping Station
Office Lobolatory
Inlet Trunk Sewer
Fence
Bank
MH
CONNAUGHT BRIDGE
JLN. CONNAUGHT BRIDGE
To Port Kelang
To K.L.
RAILWAY
LOCATION S=1:25,000
Federal Highway
Treatment Plant
Kelang River
FEASIBILITY STUDY FOR SEWERAGE AND DRAINAGE SYSTEM PROJECT IN KELANG, PORT. KELANG AND ITS ENVIRONS
JAPAN INTERNATIONAL COOPERATION AGENCY
TOKYO ENGINEERING CONSULTANTS CO.,LTD. CENTRAL CONSULTANT INC. TOKYO JAPAN
SCALE 1/1,000
Plan for Connaught Wastewater Treatment Plant (First Phase)
FIGURE 5.11.



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

JAPAN INTERNATIONAL COOPERATION AGENCY

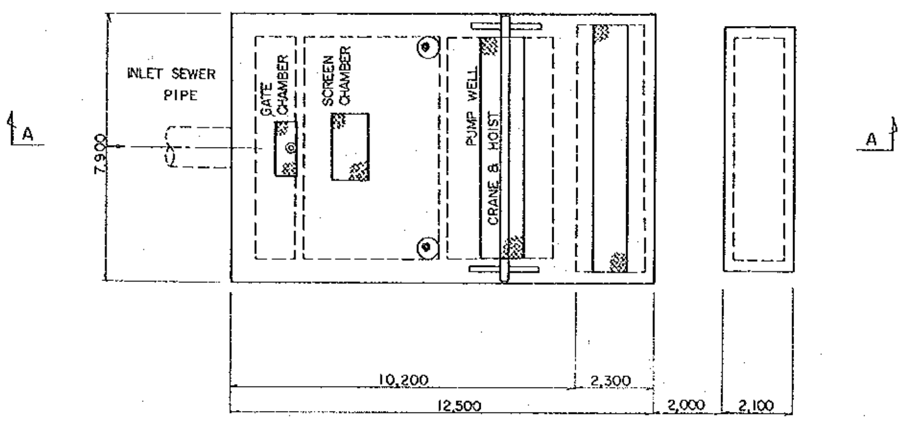
TOKYO ENGINEERING CONSULTANTS CO.,LTD. CENTRAL CONSULTANT, INC. TOKYO JAPAN

SCALE 1/1,000

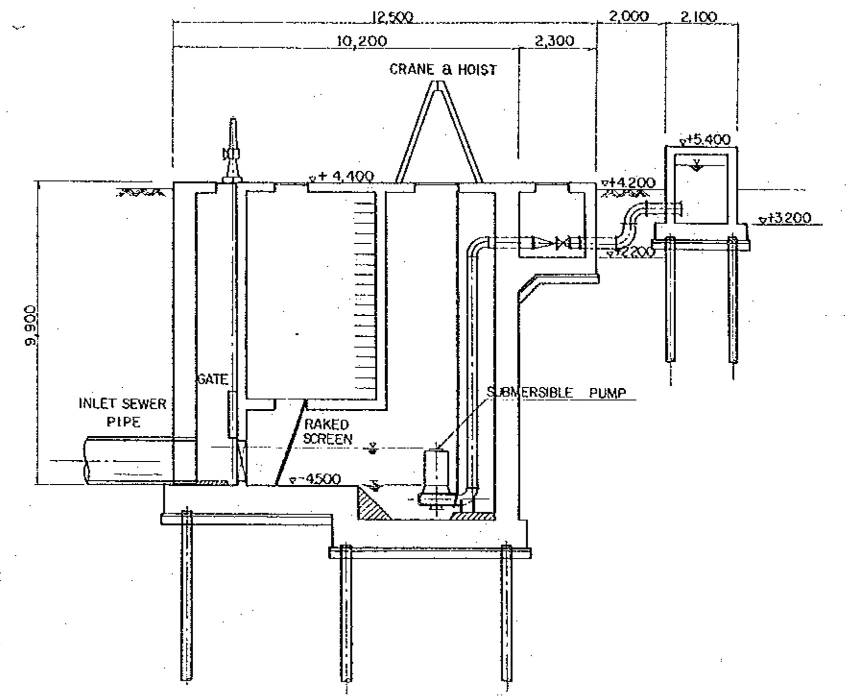
Plan for Connaught Wastewater Treatment Plant (The year 2000)

FIGURE 5.12.

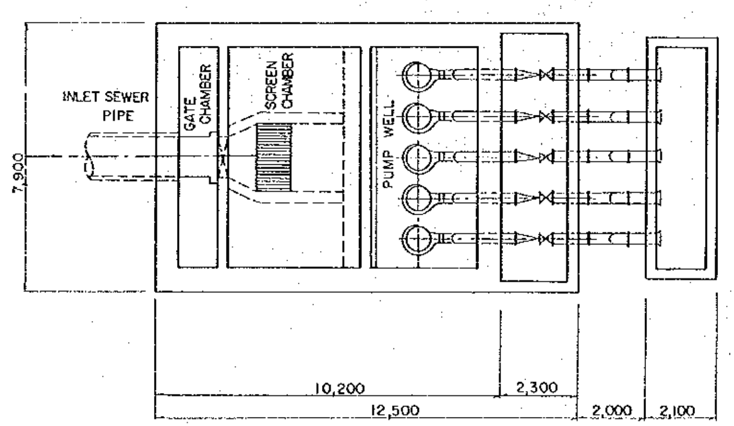
PLAN



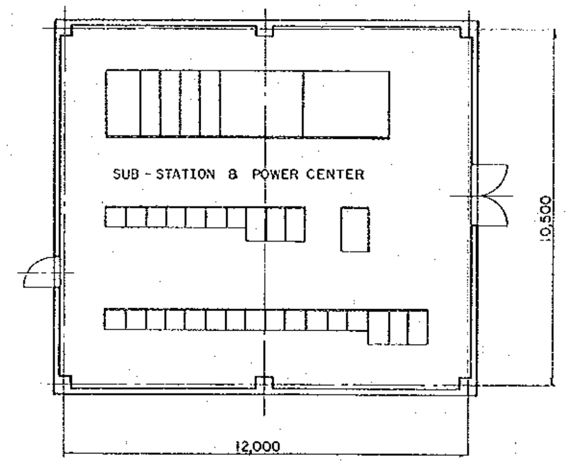
SECTION A - A



BASEMENT PLAN



PLAN OF SUB-STATION & POWER CENTER



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

JAPAN INTERNATIONAL COOPERATION AGENCY	TOKYO ENGINEERING CONSULTANTS CO.,LTD CENTRAL CONSULTANT INC TOKYO JAPAN	SCALE 1/100
Design for Pumping Station in Connought Wastewater Treatment Plant		FIGURE 5. 13.

CHAPTER 6

COST ESTIMATION AND IMPLEMENTATION SCHEDULE

CHAPTER 6 COST ESTIMATION AND IMPLEMENTATION SCHEDULE

6.1. Cost Estimation

6.1.1. Procedure for Estimating Construction Cost

Construction cost of all required facilities; namely, trunk sewers, branch and lateral sewers, intermediate pumping station and wastewater treatment plant, are estimated and presented in this section. Cost of house connections is not dealt with since it is to be borne by the property owners.

Cost estimation is based on the preliminary engineering design for required facilities and basic unit cost of each item or material. Supplementary information on unit cost was collected during the Feasibility Study field survey period from September to December, 1981 and necessary modification undertaken accordingly on the unit cost shown in the Master Plan. All the prices presented are at 1981 price level.

All cost are divided into two categories; i.e, local and foreign currency, based on information obtained in Malaysia. Basic concept of the division is that cost of all imported goods such as machinery to be used for sewerage facilities and/or for construction work or for factories in producing necessary products are deemed to belong to the foreign currency portion and the rest as local carrency requirement. Cost for machinery is estimated based on CIF price. Table 6.1 shows labor cost. Tables 6.2 and 6.3 show portions of local currency and foreign price of basic materials and unit cost respectively.

Table 6.1. Labor Costs

Type of Labor	Labor Cost per Day (8 hours) (M$/day)
Common Laborer	17.0
Skilled Laborer	24.0
Welder	27.0
Mason	27.0
Carpenter	27.0
Mechanic	27.0
Brick Layer	28.0
Concrete Worker	28.0
Steel Bender and Fixer	28.0
Painter	28.0
Lorry Driver	30.0
Equipment Operator	35.0
Foreman	45.0

Table 6.2. Price of Basic Materials

Item	Description	Unit	Price (M$)		
			L.C.	F.C.	Total
Cement		t	188.21	7.97	196.18
Sand		m^3	6.22	4.78	11.00
Laterite		"	3.00	0	3.00
Aggregate	9-13 mm	"	30.22	4.78	35.00
"	25-38 mm	"	26.22	4.78	31.00
Crusher-run		"	20.22	4.78	25.00
Diesel Oil		litre	0.46	0	0.46
Light Oil		"	0.50	0	0.50
Timber	Grade A	m^3	206.61	3.39	210.00
"	" B	"	256.61	3.39	260.00
H-shape Beam		t	104.00	996.00	1,100.00
Sheet Pile		"	99.63	934.80	1,034.43
V.C. Pipe	ϕ 225 mm	m	42.52	0.88	43.40
" "	ϕ 300 "	"	108.37	1.05	109.42
Concrete Pipe	ϕ 375 "	"	89.85	0.96	90.81
" "	ϕ 450 "	"	114.00	1.38	115.38
" "	ϕ 525 "	"	129.09	2.31	131.40
" "	ϕ 600 "	"	146.43	2.88	149.31
" "	ϕ 675 "	"	217.49	3.46	220.95
" "	ϕ 750 "	"	239.76	4.94	244.70
" "	ϕ 900 "	"	306.78	6.92	313.70
" "	ϕ1,050 "	"	393.28	8.65	401.93
" "	ϕ1,200 "	"	448.46	11.54	460.00

(Note) L.C.: Local Currency,
F.C.: Foreign Currency

Table 6.3. Unit Cost

Item	Description	Unit	Rate (M$)		
			L.C.	F.C.	Total
Excavation	Backhoe	m^3	0.61	1.00	1.61
"	Clamshell	"	1.75	5.33	7.08
"	Manual	"	9.89	0	9.89
Soil Transportation	Dump Truck 11 t	"	1.47	2.44	3.91
Backfilling	Sand	"	22.62	13.98	36.60
"	Excavated Soil	"	5.04	0	5.04
Spreading & Compaction of Soil	Bulldozer	"	0.46	0.90	1.36
Timber Sheeting	ℓ = 2.0 m	m	5.62	0.05	5.67
" "	ℓ = 2.5 m	"	7.55	0.07	7.62
" "	ℓ = 3.0 m	"	9.49	0.08	9.57
" "	ℓ = 3.5 m	"	11.41	0.08	11.49
Steel Sheet Piping Work	LSP II ℓ = 3.5 m	"	49.07	69.85	118.92
" " " "	" " ℓ = 4.0 m	"	53.29	75.83	129.12
" " " "	" " ℓ = 4.5 m	"	56.79	80.82	137.61
" " " "	SP II ℓ = 5.0 m	"	59.61	113.00	172.61
" " " "	" " ℓ = 6.0 m	"	69.15	131.07	200.22
" " " "	" " ℓ = 7.0 m	"	77.87	147.64	225.51

Table 6.3. (cont.)

Item	Description	Unit	Rate (M$)		
			L.C.	F.C.	Total
Steel Sheet Piling Work	SP II ℓ = 8.0 m	m	86.62	164.22	250.84
" " " "	" " ℓ = 9.0 m	"	96.95	183.81	280.76
" " " "	SP III ℓ = 15.0 m	"	175.00	300.00	475.00
Attaching & Detaching of Steel Work		t	141.63	114.92	256.55
Redemption of Steel Materials	H-shape	t/day	1.07	10.41	11.48
" " " "	LSP	"	0.20	1.85	2.05
" " " "	SP	"	0.09	0.86	0.95
Maintenance Cost for Steel	H-shape	t	8.28	80.67	88.95
" " " "	LSP-II	"	5.08	49.54	54.62
" " " "	SP-II	"	7.88	76.73	84.61
" " " "	SP-III	"	7.49	72.88	80.37
Steel Bars	ϕ 13 mm and below	"	1,716.44	19.37	1,735.81
" "	ϕ 16 mm and above	"	1,633.79	19.37	1,653.16
Concrete	1 : 1½ : 3	m^3	227.97	15.54	243.51
"	1 : 2 : 4	"	217.57	15.54	233.11
"	1 : 3 : 6	"	203.27	15.54	218.81
Timber Forming		m^2	14.23	0.05	14.28

Table 6.3. (cont.)

Item	Description	Unit	Rate (M$)
Bedding	Sand	m^3	36.60
"	Crusher-run	"	81.54
Restoring	Asphalt Paving	m^2	48.12
Masonry	Granite 30 cm	"	38.08
Pile Driving	18"x18", 30 m	No	224.58
Dewatering	5.5 kW,ϕ100 mm	day	58.54

(Note) L.C.: Local Currency
F.C.: Foreign Currency

1) Sewer Construction Cost

The following types of sheeting are assumed, depending on the excavation depth, in order to estimate construction cost.

Excavation Depth	Type of Sheeting
Down to 3 m	Timber Sheeting
3 m - 5 m	Light-weight Steel Pile
5 m and below	Steel Pile

The average gravity sewer construction cost per meter is estimated, depending on pipe size and depth to invert as shown in Table 6.4, including the cost for pipes, excavation, sheeting, dewatering, bedding, restoration of paving, along with contractor's profits and overhead. These costs also include cost for manholes, on the assumption that the cost of manholes is 15 percent of that of sewers.

Table 6.4. Unit Sewer Construction Cost

(Unit: M$/m at 1981 price level)

Diameter (mm)	Depth to Invert (m)						
	2.0	3.0	4.0	5.0	6.0	7.0	8.0
225	150	166	797	1,111	1,413	1,701	1,976
300	268	286	902	1,250	1,577	1,885	2,176
375	236	242	828	1,149	1,466	1,779	2,088
450	273	281	876	1,214	1,546	1,874	2,197
525	316	326	926	1,282	1,631	1,975	2,312
600	365	378	979	1,354	1,721	2,081	2,433
675	422	438	1,036	1,430	1,815	2,192	2,560
750	488	508	1,095	1,510	1,915	2,310	2,694
900	653	683	1,225	1,685	2,131	2,564	2,984
1,050	874	918	1,370	1,880	2,372	2,847	3,304
1,200	1,169	1,235	1,532	2,097	2,640	3,160	3,659

Construction cost of branch and lateral sewers to be located under the proposed roads are excluded from government financing, and are expected to be met through private contributions. Construction costs of trunk sewers and branch and lateral sewers for each unit of the area are presented in Table 6.5.

Table 6.5. Sewer Construction Cost

(Unit: M$1,000 at 1981 price level)

Unit	Government Contribution			Private contribution	Total
	Local Currency	Foreign Currency	Sub-total		
Trunk	3,495	3,495	6,990	-	6,990
Branch and Lateral Sewers					
Unit-1	1,165	291	1,456	104	1,560
Unit-2	1,366	341	1,707	615	2,322
Unit-3	1,343	336	1,679	520	2,199
Unit-4	2,543	636	3,179	461	3,640
Unit-5	706	176	882	1,374	2,256
Total	10,618	5,275	15,893	3,074	18,967

2) Pumping Station Construction Cost

Construction costs of the pumping station are estimated on the assumption that civil and architectural work will be done by local contractors while the pumps and other major mechanical and electrical equipment parts will be imported. The estimated costs of the imported equipment are based on reasonable assumptions and quotations obtained from reliable importing manufacturers.

Construction cost of the Kg. Kuantan Pumping Station are tabulated in Table 6.6.

Table 6.6. Kg. Kuantan Pumping Station Construction Cost

(Unit: M$1,000 at 1981 price level)

	Local Currency	Foreign Currency	Total
Civil Work	214	85	299
Architectural Work	216	24	240
Mechanical Work (inclusive of equipment)	51	352	403
Electrical Work (inclusive of equipment)	47	330	377
Total	528	791	1,319

3) Wastewater Treatment Plant Construction Cost

Facilities to be constructed at Connaught Wastewater Treatment Plant during the First Phase include a pumping station, inlet work, three series of stabilization systems, an office and distributing, collecting and disposal works. Estimated cost of these facilities, as well as the retaining wall required to prevent overflow from the Kelang River, are based on the same assumptions as those for the pumping station.

To fulfill the requirements by the year 2000, completion of civil works for such purposes as inlet work, pumping station, disposal facilities only will be necessary during the First Phase construction work, while the pumps will be provided only to the extent required for the First Phase Program.

Construction costs of Connaught Wastewater Treatment Plant are presented in Table 6.7.

Table 6.7. Connaught Wastewater Treatment Plant Construction Cost

(Unit: M$1,000 at 1981 price level)

	Local Currency	Foreign Currency	Total
Pumping Station	1,048	1,617	2,665
Civil Work	621	251	872
Architectural Work	240	0	240
Mechanical Work (inclusive of equipment)	65	447	512
Electrical Work (inclusive of equipment)	122	919	1,041
Inlet Work	163	443	603
Civil Work	163	443	603
Facultative Pond and Maturation Pond	2,894	1,322	4,219
Civil Work	2,894	1,322	4,219
Distribution Tank	200	47	247
Civil Work	200	47	247
Office	312	0	312
Architectural Work	312	0	312
Miscellaneous	602	138	740
Civil Work	602	138	740
Retaining Wall	2,363	921	3,284
Civil Work	2,363	921	3,284
Total	7,582	4,488	12,070

6.1.2. Procedure for Estimating Operation and Maintenance Cost

1) Sewers

Estimation of annual operation and maintenance cost for trunk and branch and lateral sewers, excluding that of house connections, are based on the following assumptions:

Assumptions

(a)	Frequency of Cleaning	:	once every four years
(b)	Cleaning Capacity	:	200 m/day/crew
(c)	Crew Number	:	6 persons/crew
(d)	Work Days	:	250 days/year
(e)	Work Hours	:	6 hours/day
(f)	Cleaning Machine	:	High pressure cleaning machine
(g)	Cost for Spare Parts, etc.	:	5% of equipment cost/year
(h)	Salary of Crew	:	M$330/month

2) Pumping Station

Inspection and cleaning of the pumps and removal of screenings will be made three times a week in general, to be carried out by laborers in the Connaught Wastewater Treatment Plant located at a distance of 2 km from the Kg. Kuantan pumping station. Therefore, labor cost is not calculated for the pumping station.

Annual cost for repair of civil works and buildings is assumed to be 0.25 percent of the construction cost and that of mechanical and electrical equipment is assumed to be 2 percent. Power cost is estimated at the prevailing unit cost of M$0.17/kWh.

3) Wastewater Treatment Plant

The main routine works at wastewater treatment plant are inspection of ponds, cleaning and lubrication of mechanical equipment such as pumps and aerators, removing screenings and water sampling at various points. Manpower required for these works are estimated to be six persons, depending on the type of process adopted and capacity of the plant.

The same assumption is adopted for repair cost as for the pumping station, which is 0.25 percent of construction cost for civil work and 2 percent for mechanical and electrical equipment. Power cost is also estimated at the same rate of M$0.17/kWh.

4) Annual Operation and Maintenance Cost Estimates

Annual operation and maintenance cost for the above-mentioned sewerage facilities are tabulated up to the year 1995 in Table 6.8. Power consumption rates depend on the quantity of wastewater treated; therefore, cost gradually increases as wastewater increases.

Table 6.8. Annual Operation and Maintenance Cost

(Unit: M$1,000/year)

	1989	1990	1991	1992	1993	1994	1995
Sewer	24	24	24	24	24	24	24
Pumping Station	64	67	67	85	85	91	91
Wastewater Treatment Plant	128	132	143	143	147	147	152
Total	216	223	234	252	256	262	267

6.2. Implementation Schedule

6.2.1. General

Sewerage facilities to be provided by MPK up to 1990 include the trunk sewers, Kg. Kuantan intermediate pumping station, Connaught Wastewater Treatment Plant and branch and lateral sewers.

Installation of branch and lateral sewers will be implemented according to the priority assigned each unit. On the other hand, construction of trunk sewers, pumping station and wastewater treatment plant is scheduled based on the volume of work and period required for construction.

The following preparatory procedures are necessary before commencement of the general construction work.

1) Land acquisition for treatment plant and pumping station.
2) Detailed design of major facilities such as trunk and branch and lateral sewers, pumping station and wastewater treatment plant, including necessary field surveys.
3) Preparation of tender documents.
4) Tender invitation, evaluation of tenders and contract award.

Considering the timing and amount of time required for the abovementioned procedures, the earliest possible time for commencement of construction may be sometime late in 1984 or the beginning of 1985.

6.2.2. Priority of Units

In order to determine the order of priority of each unit, various parameters, such as population density, development condition, waste load generation and excreta disposal system, were considered. The results are shown in Table 6.9.

Table 6.9. Order of Implementation Priority by Units

Parameter	Unit-1	Unit-2	Unit-3	Unit-4	Unit-5
(1) Population Density	3	4	5	1	2
(2) Development Condition	1	3	4	2	5
(3) Waste Load Generation	5	3	2	1	4
(4) Excreta Disposal System	4	4	2	1	3
Total Points	13	14	13	5	14

As shown in Table 6.9, Unit-4 has the highest priority among the five units. The second priority is given to two units, Unit-1 and Unit-3, which have the same evaluation points of 13. The remaining two units, Unit-2 and Unit-5, follow with evaluation points of 14 which is very close to that of the units given second priority.

Installation of branch and lateral sewers in these five units is scheduled for six years, from 1985 to 1990, according to their evaluated priority.

6.2.3. Implementation Schedule

Based on the proposed implementation order of the five units, the First Phase implementation schedule up to 1990 has provisonally been worked out. With administrative efficiency in retaining engineering consultants for design work and awarding contracts to the suppliers and contractors, together with efficient performance of the civil contractors, it is possible to expedite the schedule of work and complete the work before 1990. As shown in Table 6.10 , treatment of wastewater might be started in 1989, one year prior to completion of the construction work.

Table 6.10. First Phase Implementation Schedule

Item	First Phase Program							
	1983	1984	1985	1986	1987	1988	1989	1990
I Preparatory Works								
Land Acquisition		////						
Detailed Design	////							
Tender Documents		////						
Tender Invitation, Evaluation and Contract Award		////						
II Sewer Collection System								
1) Trunk Sewers			////	////				
2) Branch and Lateral Sewers								
Unit-1 (56 ha)					////	////		
Unit-2 (59 ha)						////	////	
Unit-3 (86 ha)				////	////			
Unit-4 (56 ha)			////					
Unit-5 (81 ha)							////	////
3) Kg. Kuantan Pumping Station								
Civil Works					////	////		
Mech. & Electrical Works						////		
III Connaught WTP								
Civil Works				////	////			
Architectural Works						////		
Mech. & Electrical Works						////		

6.3. Disbursement Schedule

The cost of the sewerage facilities for the government contribution is estimated to be approximately M$41 million at 1981 price level. A period of eight years is envisaged for completion of the First Phase, based on technical and financial considerations, including the potential customers' ability to pay, assuming preparatory works will start from the year 1983.

Allocation of cost over an eight-year span has been made in Table 6.11, according to the implementation schedule presented in Table 6.10. The first two years, 1983 to 1984, are for preparatory works, such as land acquisition, detailed design, preparation of tender documents, tender invitation, evaluation of bids and contract awards. Construction work will be commenced from 1985, for completion by 1990.

Engineering cost for implementation of the First Phase work includes both detailed engineering design and construction supervision services. It is assumed that 15 percent of the construction cost may be needed for the engineering services, approximately 10 percent for the detailed design and the remaining 5 percent for the construction supervision services. Furthermore, it is estimated that half of the detailed engineering design cost for trunk sewers, pumping station and wastewater treatment plant will be chargeable to the foreign currency portion, while the remaining half and detailed design costs for branch and lateral sewers and supervisory services will belong in the local currency portion.

Contingency allowance of 10 percent is estimated for proper completion of the Project. Costs are estimated at both 1981 price level and each year's price level, at an annual escalation rate of 6.5 percent.

Table 6.11. Disbursement Schedule

(Unit: M$1,000)

Item	Total			1983		1984		1985		1986		1987		1988		1989		1990	
	L.C.	F.C.	Total	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.
I Constraction Works																			
1) Trunk Sewers	3,495	3,495	6,990	-	-	-	-	1,750	1,750	1,745	1,745	-	-	-	-	-	-	-	-
2) Branch and Lateral Sewers	7,123	1,780	8,903	-	-	-	-	2,543	636	1,343	336	1,165	291	1,366	341	356	90	350	86
3) Kg. Kuantan Pumping Station	528	791	1,319	-	-	-	-	-	-	-	-	322	97	206	694	-	-	-	-
4) Connaught Wastewater Treatment Plant	7,582	4,488	12,070	-	-	-	-	-	-	3,440	1,562	3,503	1,561	739	1,365	-	-	-	-
Construction Work Sub-total	18,728	10,554	29,282	-	-	-	-	4,293	2,386	6,428	3,643	4,990	1,949	2,311	2,400	356	90	350	86
II Consulting Services																			
5) Detailed Design	2,051	897	2,948	2,051	897	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6) Supervision	1,465	-	1,465	-	-	-	-	334	-	504	-	347	-	236	-	22	-	22	-
III Cleaning Machine	-	200	200	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	200
IV Contingencies 10% of (I + II + III)	2,225	1,166	3,391	205	90	-	-	463	239	693	364	534	195	255	240	38	9	37	29
V Land Acquisition	3,432	—	3,432	-	-	3,432	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Project Cost (1981 Price Level)	27,901	12,817	40,718	2,256	987	3,432	-	5,090	2,625	7,625	4,007	5,871	2,144	2,802	2,640	416	99	409	315
Escalation Factor 6.5% Annual				1.134		1.208		1.286		1.370		1.459		1.554		1.655		1.763	
Total Project Cost (Escalation Price)	38,025	17,935	55,960	2,558	1,119	4,146	-	6,546	3,376	10,446	5,490	8,566	3,128	4,354	4,103	688	164	721	555

Remarks : (1) L.C. = Local Currency
F.C. = Foreign Currency
(2) Escalation Factor, 6.5 percent Annual is based on Fourth Malaysiam Plan estimates.
(3) Procurement of equipment and materials included together with civil construction works.

CHAPTER 7

FINANCE

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7.1. Financial Projection

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 loan, to be provided most likely by the Federal Government and/or international lending agencies.
2) The required revenue for the operation and maintenance of the sewerage system should be raised through appropriate charge (sewerage surcharge rate on water bill and sewerage surcharge tax rate) against those who will receive benefits from its service.

Various financial projections were made under the above basis, in order to determine the most viable financing schedule, taking into consideration loan conditions, sewerage charge rate, sewerage surcharge tax rate, price escalation rate and extent of financial burden on MPK.

The financial statements prepared for these financial projections comprise: (1) profit and loss statement (income statement), (2) source and application statement (cash flow) and (3) balance sheet. The projections cover the fiscal period 1983 through 1995.

7.1.1. Fund Requirements

1) Capital and Operating Costs

The financial projection should be based on the estimates of both capital and operating costs. The construction cost is estimated about M$56 million, of which the land acquisition cost is about M$4 million. The estimated scale of the capital cost and the operation and maintenance cost each year for the First Phase program are shown in Table 7.1 through 7.3. All of the above costs are calculated at 6.5 percent escalation rate per year at 1981 prices, which is authorized by the Fourth Malaysia Plan.

Table 7.1. Project Cost Estimation

(Unit: M$1,000)

Item	1983		1984		1985		1986		1987		1988		1989		1990		Total	
	L	F	L	F	L	F	L	F	L	F	L	F	L	F	L	F	L	F
Construction Cost	-	-	-	-	4,293	2,386	6,428	3,643	4,990	1,949	2,311	2,400	356	90	350	86	18,728	10,554
Engineering Fee Design	2,948	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Engineering Fee Supervision	-	-	-	-	334	-	504	-	347	-	236	-	22	-	22	-	1,465	-
Cleaning Machine	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	200	-	200
Contingency	295	-	-	-	463	239	693	364	534	195	255	240	38	9	37	29	2,315	1,076
Land Acquisition	-	-	3,432*	-	-	-	-	-	-	-	-	-	-	-	-	-	3,432	-
Sub-total	3,243	-	3,432	-	5,090	2,625	7,625	4,007	5,871	2,144	2,802	2,640	416	99	409	315	28,888	11,830
Total	3,243		3,432		7,715		11,632		8,015		5,442		515		724		40,718	
Escalation Factor (a)	1.134		1.208		1.286		1.370		1.459		1.554		1.655		1.763		-	
Escalated Sub-total	3,677	-	4,146**	-	6,546	3,376	10,446	5,490	8,566	3,128	4,354	4,103	688	164	721	555	39,144	16,816
Escalated Total	3,677		4,146		9,922		15,936		11,694		8,457		852		1,276		55,960	
Accumulated Cost	3,677	-	7,813	-	14,369	3,376	24,815	8,866	33,381	11,994	37,735	16,097	38,423	16,261	39,144	16,816	-	-
Accumulated Cost exclud. Land	3,677	-	3,677	-	10,233	3,376	20,669	8,866	29,235	11,994	33,589	16,097	34,277	16,261	34,998	16,816	-	-

Note: F: Foreign Currency
L: Local Currency
(a): Escalated at 6.5% per annum from original price of the year 1981.

* This figure increases to 20,447 if total land required up to 2000 is purchased in the First Phase.
** This figure increases to 24,699 if total land required up to 2000 is purchased in the First Phase.

Table 7.2. Operation and Maintenance Cost*

(Unit: M$1,000)

Year	Payroll**	Maintenance	Administration***	Total
1983	155		16	171
1984	166		17	183
1985	212		21	233
1986	226		23	249
1987	262		26	288
1988	415		42	457
1989	575	278	58	930
1990	613	309	61	1,028
1991	653	350	65	1,131
1992	695	408	70	1,239
1993	740	443	74	1,326
1994	788	487	79	1,426
1995	840	529	84	1,528

Note: * Escalated at 6.5% per annum from original price in the year 1981.

** Wages and Salaries of personnel employed for the sewerage works.

*** Administration expense, including office supplies and other miscellaneous expenses.

Table 7.3. Total Cost of Construction and Operation/Maintenance*

(Unit: M$1,000)

Year	Construction	Operation/Maintenance	Total
1983	3,677	171	3,848
1984	4,146	183	4,329
1985	9,922	233	10,155
1986	15,936	249	16,185
1987	11,694	288	11,982
1988	8,457	457	8,914
1989	852	930	1,782
1990	1,276	1,028	2,304
1991	--	1,131	1,131
1992	--	1,239	1,239
1993	--	1,326	1,326
1994	--	1,426	1,426
1995	--	1,528	1,528
1996	--		1,754

Note: * Escalated at 6.5% per annum from original price in the year 1981.