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SUPPLEMENTAL TEXT
Volume 1

Physical Planning and Project Implementation Planning

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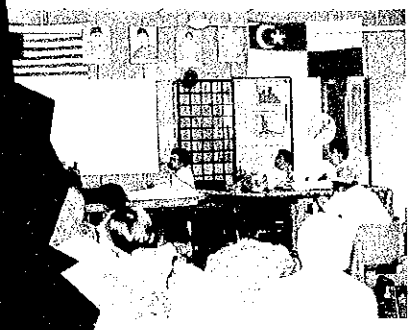
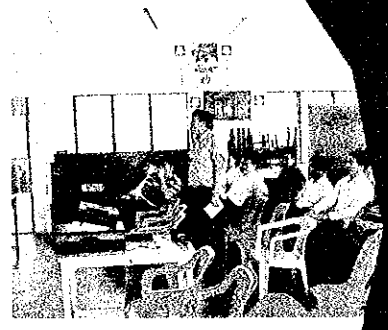
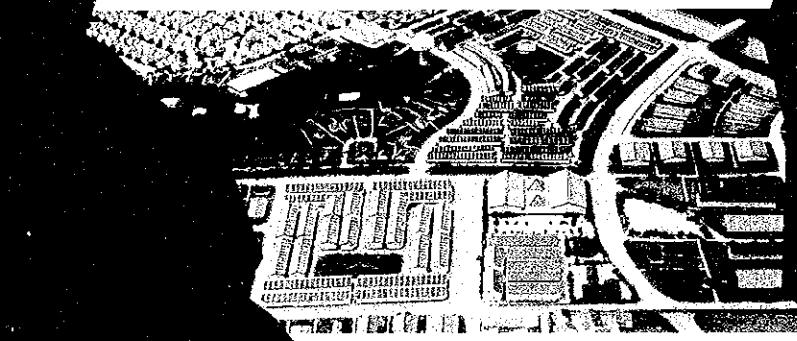






ALMEC CORPORATION
JAPAN ASSOCIATION OF LAND READJUSTMENT

JICA THE FEASIBILITY STUDY ON THE INTRODUCTION OF LAND READJUSTMENT IN MALAYSIA FINAL REPORT SUPPLEMENTAL TEXT Volume 1

PART I : LR PHYSICAL PLANNING

TABLE OF CONTENTS

Page

PART I : LR PHYSICAL PLANNING

1. INTRODUCTION 1-1

2. SUBANG PROJECT AREA

2.1 Summary of the Layout Plan 2-1
2.2 Land Development Plan 2-3
2.3 Road Network Plan 2-6
2.4 Flood Protection Plan 2-14
2.5 Water Supply and Disposal System Plan 2-24
2.6 Other Utilities 2-38
2.7 Estimation of Construction Cost in Subang Area 2-40

3. KUANTAN PROJECT AREA

3.1 Summary of the Layout Plan 3-1
3.2 Land Development Plan 3-3
3.3 Road Network Plan 3-3
3.4 Flood Protection System Plan 3-8
3.5 Water Supply and Disposal System Plan 3-12
3.6 Other Utilities 3-17
3-7 Estimation of Construction Cost 3-19

LIST OF TABLES

		Page
2.1	Land Use Plan for Subang Project Area	2-1
2.2	Road Types in Proposed Road Network	2-7
2.3	Average Vehicle Ownership vs. Total Houses in the Study Area	2-11
2.4	Trip Generation Rate by Land Use Type	2-12
2.5	Estimation of Average Runoff Coefficient	2-15
2.6	Estimation of Peak River Flow by Design Section Point	2-16
2.7	Estimated Capacity of Cross Sections	2-17
2.8	Required River Reserve	2-17
2.9	Allowable Discharge Quantity	2-20
2.10	Estimation of Required Retention Volume	2-21
2.11	Capacity of Block Drain	2-23
2.12	Expected Performance of Precast U-Drain by Type	2-23
2.13	Necessary Quantity of Drains by Type	2-24
2.14	Estimation of Daily Average Water Consumption	2-28
2.15	Designed Water Flow Capacity by Type	2-30
2.16	Necessary Quantity of Water Pipes	2-30
2.17	Designed Sewer Flow Capacity by Type	2-34
2.18	Necessary Quantity of Installation Work	2-35
2.19	Estimated Construction Cost for Subang Area	2-40
3.1	Land Use Plan	3-1
3.2	Road Types in Proposed Road Network	3-5
3.3	Average Runoff Coefficient in Kuantan Area	3-8
3.4	Estimated Retention Volume	3-9
3.5	Required Number of Drains and Waterways	3-10
3.6	Estimation of Daily Average Water Consumption	3-13
3.7	Designed Flow Capacity by Pipe	3-14
3.8	Necessary Quantity of Water Supply Pipes	3-14
3.9	Designed Sewer Flow Capacity by Pipe	3-17
3.10	Estimated Construction Cost for Kuantan Area	3-19

LIST OF FIGURES

		Page
1.1	Coverage of LR Engineering Designs	1-2
2.1	Subang Area Layout Plan	2-2
2.2	Guideline on Rolling Terrain Earth Works	2-4
2.3	Soil Haulage Plan in Subang	2-5
2.4	Subang Area Road Network	2-8
2.5	Typical Cross Section of Roads	2-9
2.6	Designs of Layer Thickness	2-10
2.7	Existing Traffic Demand	2-11
2.8	Residents' Selected Destinations	2-11
2.9	Steps in Traffic Demand Forecasting	2-12
2.10	Future Traffic Demand on the Major Network and Major Intersection	2-13
2.11	Subdivided Catchment Area by Point of Design Section	2-15
2.12	Cross Section Designs of the Rivers	2-18
2.13	Catchment Areas of Retention Ponds	2-19
2.14	Current Cross Sections at Downstream Sections	2-20
2.15	Proposed Depth and Side Shape	2-21
2.16	Outline of Outlet	2-22
2.17	Sectional Designs	2-23
2.18	Flood Protection System Plan in Subang Area	2-25
2.19	Existing Water Supply System	2-26
2.20	Concept of Future Water Supply System	2-27
2.21	Water Supply System in Subang Area	2-31
2.22	Outline of Oxidation Ditch System	2-33
2.23	Necessary Site Allocation for Sewerage Plants	2-36
2.24	Sewerage System Plan in Subang Area	2-37
2.25	Concept of Future Electricity Supply System	2-39
3.1	Land Use Plan for Kg. Kuantan Case Study Area	3-2
3.2	Earthworks Plan in Kg. Kuantan	3-4
3.3	Road Network Plan in Kg. Kuantan	3-6
3.4	Typical Cross Section of the Roads	3-7
3.5	Retention Pond Sectional Design	3-9
3.6	River and Drainage System Plan in Kg. Kuantan	3-11
3.7	Current Water Supply Around Kg. Kuantan	3-12
3.8	Water Supply System Plan in Kg. Kuantan	3-15
3.9	Sewerage System Plan in Kg. Kuantan	

CHAPTER 1 INTRODUCTION

LR requires the following series of physical planning works:

(a) Land Use Planning: This basically entails the conversion of the existing land use into a more effective urban use.

(b) Layout Planning: This involves the physical delineation of lands and the provision of necessary infrastructure.

(c) Engineering Design: This work closely relates to physical planning since it entails the designing of various infrastructure and facilities as well as the resolution of existing buildings.

Land use planning and Layout Planning are discussed in the main text.

Engineering designs have been worked out prior to the preparation of the case study areas. Under the procedure of LR implementation work, engineering designs are considered to be essential for the following reasons:

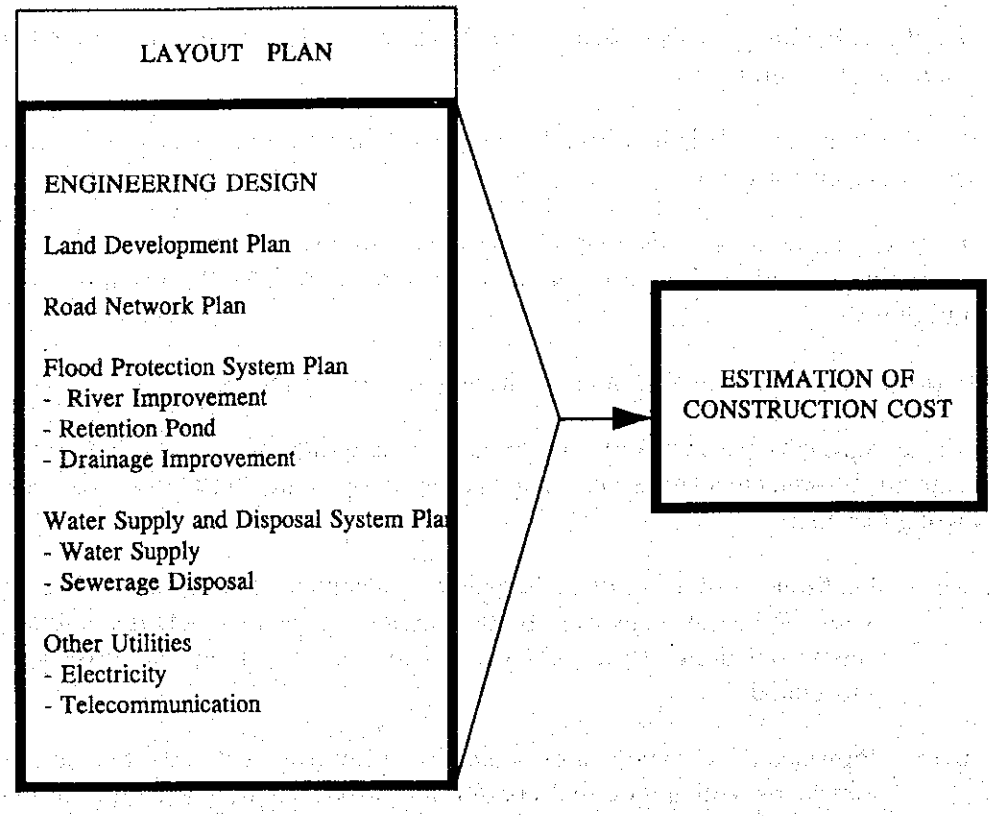
(a) Realization of Layout Plan: Engineering design is regarded as a subsequent work after the layout plans even though some feedback work is inevitable. As such engineering design takes the role of substructure planning and makes layout plans substantial.

(b) Provision of Safe and Comfortable Urban Environment: All engineering designs aim at providing safe and comfortable urban environment in accordance with relevant Malaysian regulations and guidelines. Without adequate earth works and sufficient infrastructure and utilities, adverse environmental effects under full urbanization would be hardly bearable for residents and expose them to danger.

(c) Estimates of Construction Cost: The precise construction cost should be quantified for the implementation plan can only be estimated based on the results of the engineering design. Needless to say, popular and economical construction methods are favored under an LR project.

It should be noted that all the LR engineering designs are prepared in order to formulate an implementation plan. After approval of the implementation plan and prior to actual construction, a designated implementation body prepares the detailed design.

Figure 1.1
Coverage of LR Engineering Design



CHAPTER 2 SUBANG PROJECT AREA

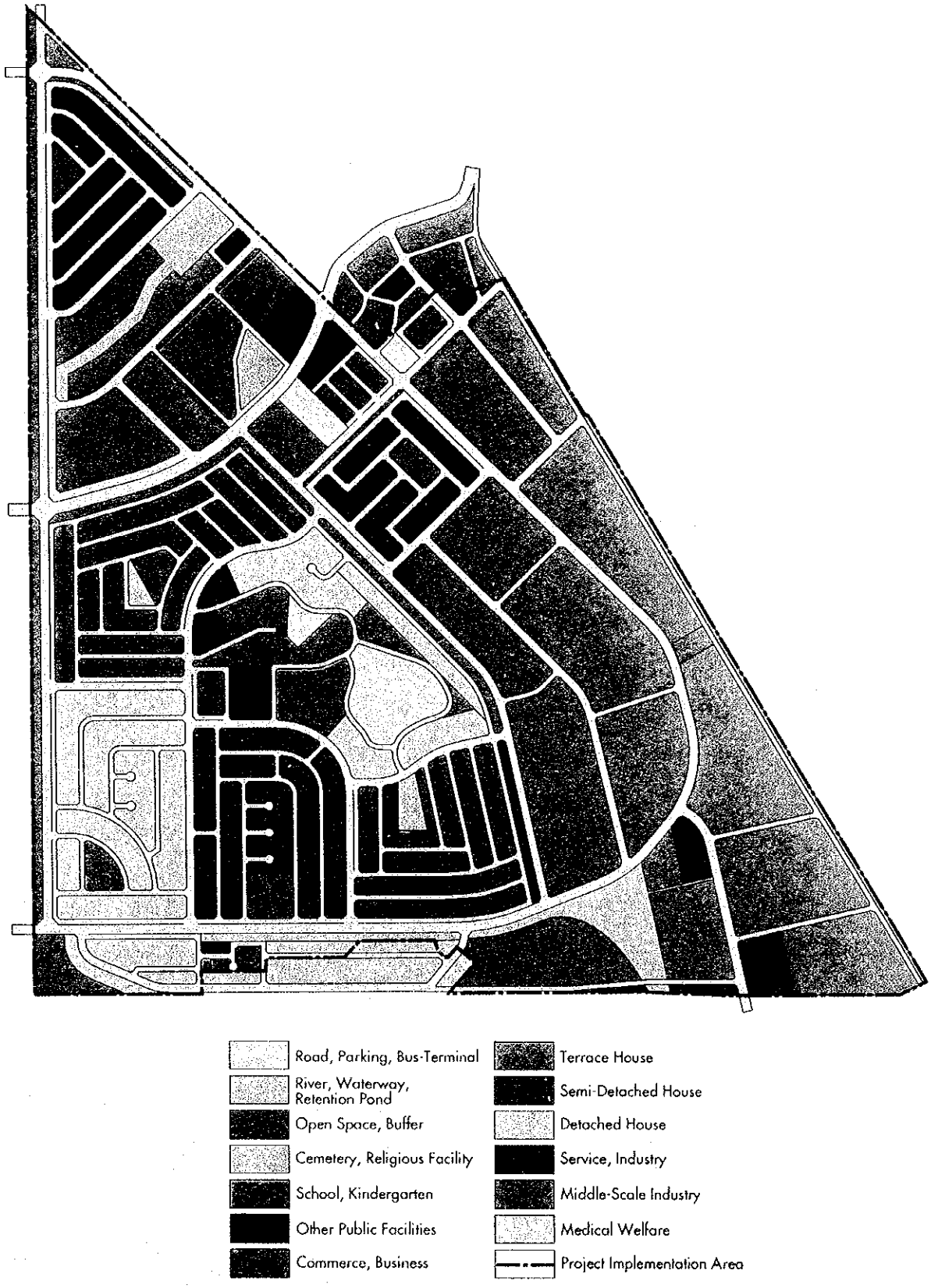
2.1 Summary of the Layout Plan

Table 2.1 and Figure 2.1 provides a summary of the layout plan for the Subang project area:

Table 2.1
Land Use Plan for Subang Project Area

Land Use				Total	%
PUBLIC LAND USE	Basic Infrastructure	Road			
		Major Road	W = 30m	29,640	
		Collector Road	24m	157,614	
		Major Local Road	20m	204,263	
		"	15m	61,823	
		Minor Local Road	12m	293,885	
		Approach	6m	222	
		Public Parking		11,920	
		Bus Terminal		3,950	
		Sub-Total		763,317	23.92
		Open Space			
		Buffer Zone		78,325	
		Park		93,530	
		Reserved Forest		145,080	
		Sub-Total		316,935	9.93
		River			
		River		34,570	
		Waterway		23,340	
		Retention Pond		60,000	
		Sub-Total		117,910	3.70
	Basic Infrastructure Total			198,162	37.55
	Others	School		81,850	
		Kindergarten		5,520	
		Sub-Total		87,370	2.74
		Cemetery		13,250	
		Religious Facility		13,430	
		Sub-Total		26,680	0.84
		Other Public Facilities			
		Fire Station		7,310	
		Police Station		11,000	
		Post Office		1,400	
		Multi-Purpose Hall		9,170	
		Community Hall		5,370	
		Clinic		6,120	
		Rader		400	
		Water Tank		7,450	
		Tel. Exchange Station		9,730	
		Electric Substation		28,760	
		Sewe. Treatment Plant.		15,700	
		Sub-Total		102,410	3.21
	OTHERS TOTAL			216,460	6.78
	PUBLIC LAND USE TOTAL			1,414,622	44.34
PRIVATE LAND USE	Residential Site	Terrace House		243,074	7.62
		Semi Detached		134,616	4.22
		Detached		274,447	8.60
		Sub-Total		652,137	20.44
		Industrial Site			
		Small-Scale		139,291	4.37
		Medium-Scale		879,317	27.56
		Sub-Total		1,018,608	31.93
		Site for Other Purposes			
		Medical Welfare		48,119	1.51
		Commerce/Business		57,101	1.79
		Sub-Total		105,220	3.30
	PRIVATE LAND USE TOTAL			1,775,965	55.66
SUBANG PROJECT AREA TOTAL				3,190,587	100.0

Figure 2.1
Subang Area Layout Plan



2.2 Land Development Plan

(1) Design Guidelines

The following design guidelines were considered for the proposed land use plan:

(a) Some hilly terrains will be preserved in its natural state from an environmental viewpoint;

(b) The area where suitable buildings are intensively situated in association with the proposed land use plan will be undisturbed unless relevant infrastructural work needs to be done; and

(c) Cutting and filling work will be balanced within the area. Consequently, imported soil will not be brought into the area from outside.

(2) Planned Ground Level

The ground level of the land to be developed was planned with the following design criteria:

(a) The ground level should be higher than the high water level in the proposed retention ponds;

(b) All the road surface levels should be designed within the acceptable range of road slopes and drain slopes;

(c) The two river catchments in the area, i.e., Sg. Pelumut and Sg. Air Kuning should remain as they are; and

(d) Proper earth work should be done with current land modulations retained in some areas and modeled for the expected improvements in other areas.

Based on the above, the manner and degree of improvements to be done on the land is presented in Figure 2.3.

(3) Slope Protection Measures

The protection measures proposed to stabilize the newly exposed slopes after the earth works are carried out by either cutting or filling the original ground slope and turfing the top soil or building a retention wall. These are illustrated in Figure 2.2.

(4) Earth Volume Treatment

The earth volume which is the work volume of cutting and filling was calculated to be approximately totals 5,000,000 m^3 (i.e., 2,500,000 m^3 for the cutting work and another 2,500,000 m^3 for the filling work). In the calculation, the soil changeable rate (c), by grading and compacting works, was assumed to be 1.0. In the actual implementation phase, however, a series of soil surveys and experimental banking should essentially be done to check this rate.

The soil land use plan which shows the origin site and destination site of soil was prepared in compliance with the calculated earth volume by spot. In planning the movements of individual earth volume, the distances were minimized with due

consideration to road alignment and other restricting factors. The results are illustrated in Figure 2.3.

(5) Disaster Prevention Measures

To avoid anticipated damages caused by earth works, the following should be taken prior to earth works:

(i) Subdrainage: The current small creeks which will be affected by the earth works should be replaced with the perforated hume pipes ranging from 150 mm. to 300 mm. in diameter. It will ensure protection against landslide to a great extent.

(ii) Storm Water Measures: To control the strong current in the rivers, fences and gabions should be properly installed. In addition, some temporary dams should be constructed to prevent soil outflow.

(iii) Falling Stones: Dangerous steep slopes should be surrounded by prevention fences to intercept falling stones.

Figure 2.2
Guideline on Rolling Terrain Earth Works

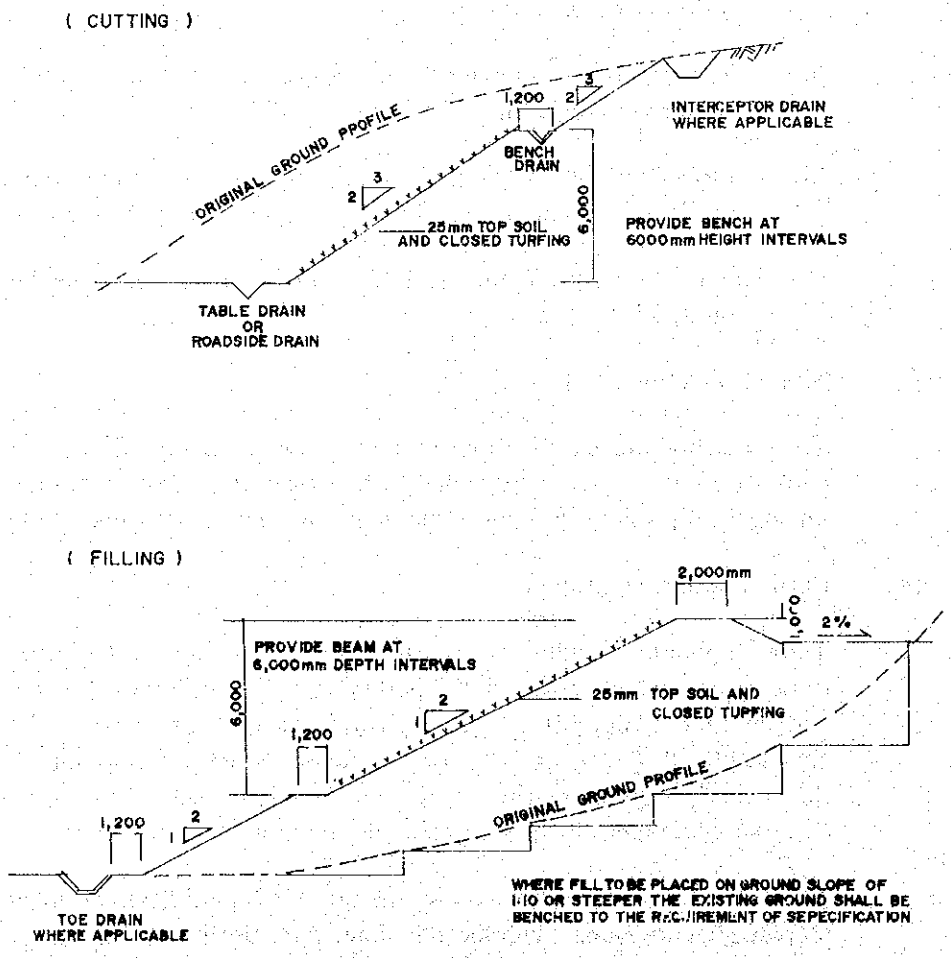


Figure 2.3
Soil Haulage Plan in Subang

2.3 Road Network Plan

(1) Road System Analysis

(a) Regional Road Network

The draft structure plan of Petaling District and part of Klang District proposes the new as well as the upgrading of highways comprising the Outer Ring Road network, the Inner Ring Road network, and the secondary distribution network. These networks will ensure smooth traffic flow and relieve anticipated congestions at the junctions of the existing Federal Highway and the North-South Expressway, and the proposed Shah Alan Highway.

One of the areas which will greatly benefit from the plan is the Batu Tiga - Kg. Seri Subang - Sungai Buloh corridor. Under the Outer Ring Road network, Batu Tiga - Sungai Buloh Road will be upgraded to six lanes. Furthermore, a new six-lane road will be developed between Kg. Seri Subang and Sungai Buloh, although the road alignment has not been precisely determined. At the distribution network level, the existing two-lane road between Subang International Airport and Kg. Seri Subang will be upgraded to become a four-lane road.

(b) Internal Road System

The roads in the area are substandard in terms of road width and pavement. Inspite of that, main roads have relatively large traffic volumes (e.g., Jln. Subang - 12,000 veh./day, Jln. Saraf - 6,000 veh./day, and Jln. 3D - 9,000 veh./day, inclusive of motorcycles).

As a road network, the road density itself is insufficient and the following problems can be pointed out:

- Presently, Jln. Subang, Jln. Saraf and Jln. 3D handle through-traffic. The two intersections nearby Pekan Subang with an interval of only 300 m. always hamper smooth circulation of traffic. Alignment of the roads should be modified to meet at only one intersection.
- Only Jln. 3D and the extension of Jln. Bukit Badak can join at Batu Tiga - Sungai Buloh Road directly from the area. Alternative access roads should be provided.

With the project implementation, traffic volume will increase due to the following reasons:

- increase in through-traffic due to road improvement and smooth circulation;
- increase in night time population which will be quadrupled;
- increase in the number of establishments and employees which will be tripled; and
- development of the new urban center (expansion of Pekan Subang).

Accordingly, the existing road system will be unable to meet future traffic demand and will have to be totally renewed.

(2) Proposed Road System

The hierarchy of the proposed road network will be comprised of the following types of roads:

Table 2.2
Road Types in the Proposed Road Network

	JKR Type	Width (m.)	No. of Lanes	Total Length (m.)
Major Road	U4	30	4	988
Collector Road	U3	24	4	6,507
Major Local Road	U2	20	2	10,074
Minor Local Road for the area of service Industry	U1	15	2	4,000
Minor Local Road	U1	12	2	24,130
Backlane, sidelane	-	6	-	10,267

As a major road in the area, Jln. 3D will be modified and smoothly connected with Jln. Subang. The area will also be upgraded to become a four-lane road.

As a collector road, an internal circular road of 6.5 km. consisting of the upgraded existing section (Jln. Bukit Badak and Jln. Saraf) and the newly constructed section will be developed.

As for external connection, there will be one access road to the airport, four to Batu Tiga - Sungai Buloh and one to the Malaysian Air Force Base (TUDM).

The proposed road system is depicted in Figure 2.4 and the typical cross sections and designs of layer thickness are illustrated in Figures 2.5 and 2.6., respectively.

Figure 2.4
Subang Area Road Network

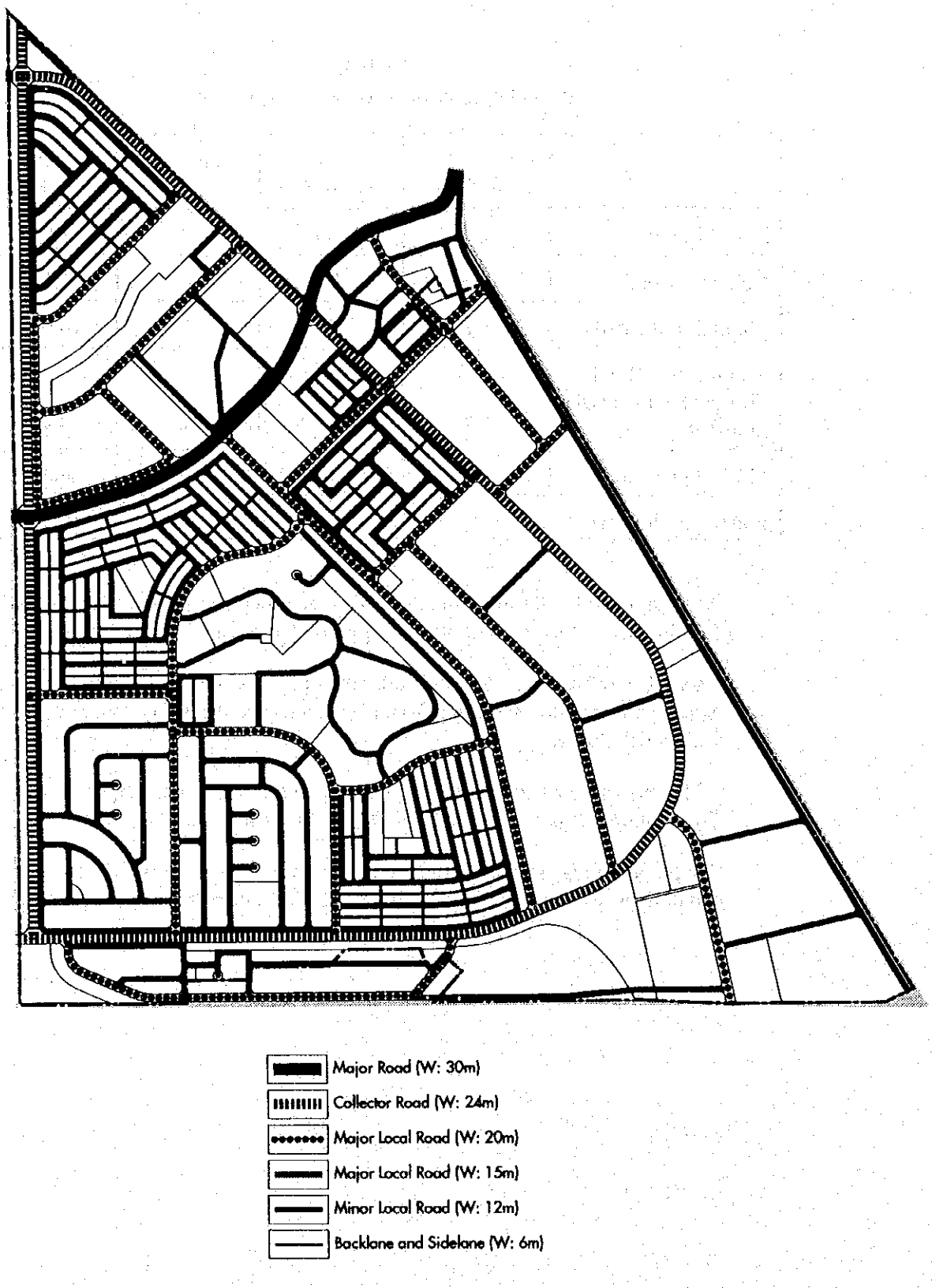
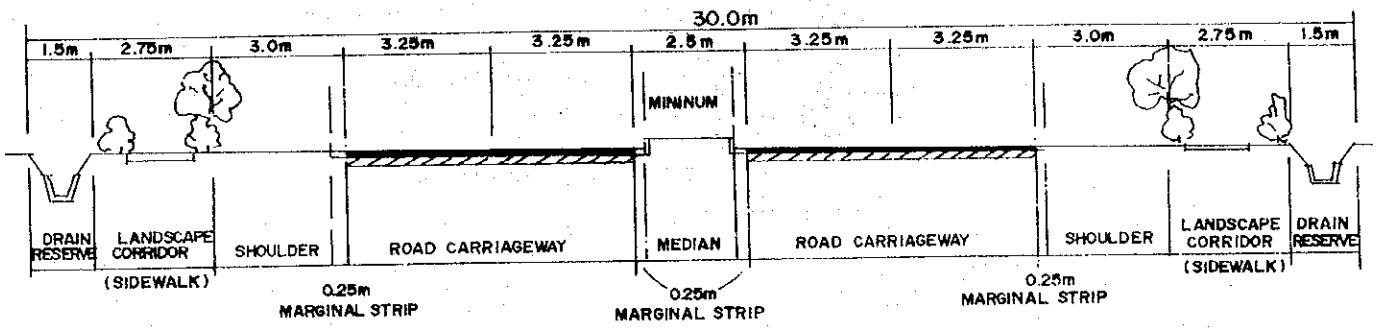
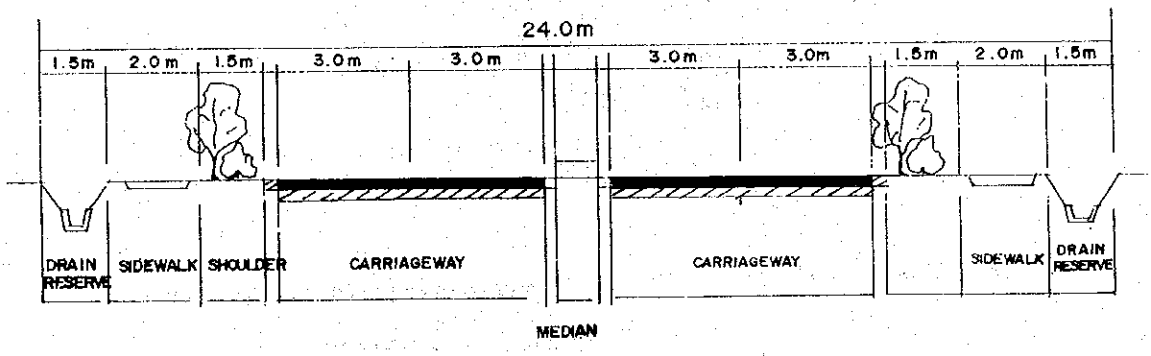


Figure 2.5
Typical Cross Section of Roads

Major Road (Road Standard (U4)



Collector Road (Road Standard U3)



Major Local Road (Road Standard U2)

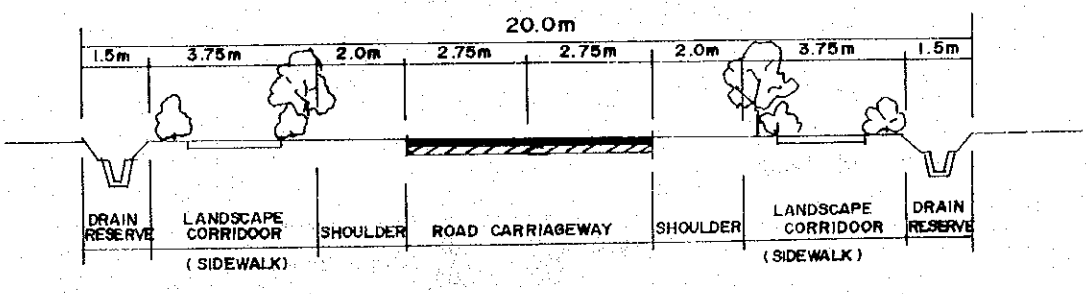
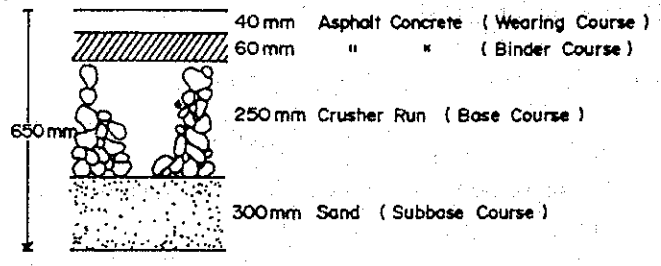


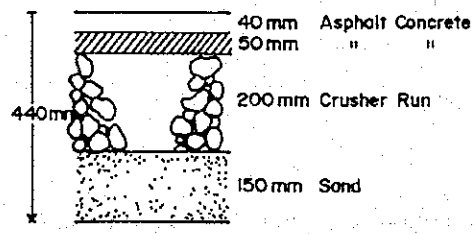
Figure 2.6
Designs of Layer Thickness

Major Road (U4) Collector Road (U3) TA = 1.0x(4+6)+a32x25+a23x15 = 21.45 20.0



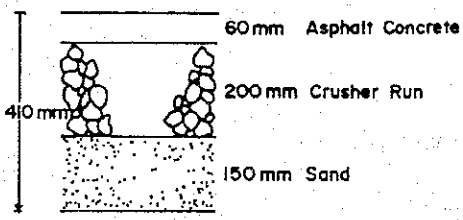
Major Local Road (U2)

TA = 1.0x(4+5)+0.32x20+0.23x15 = 18.85 18.0

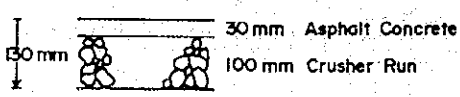


Minor Local Road (U1)

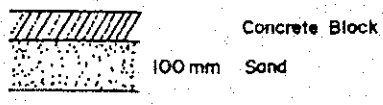
TA = 1.0x6+0.32+20+15 = 15.85 15.0



Back / Side Lane



Sidewalk

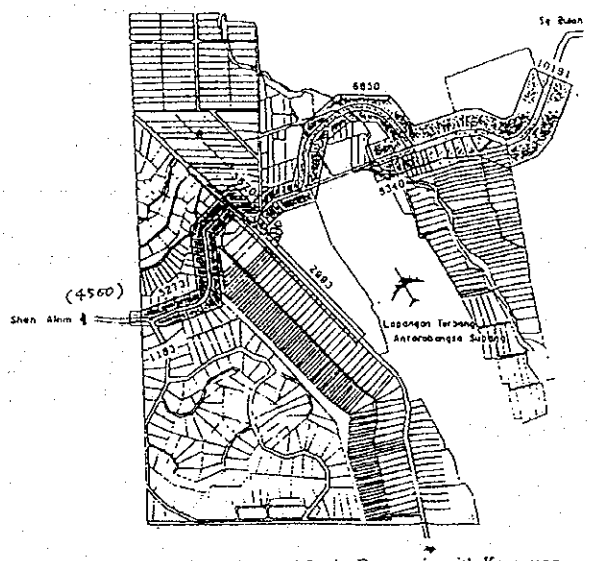


(3) Assessment of Future Traffic

After land readjustment, traffic demand and flow in the area will be increased and altered by the expanded economic activities and the changes in the the land use pattern.

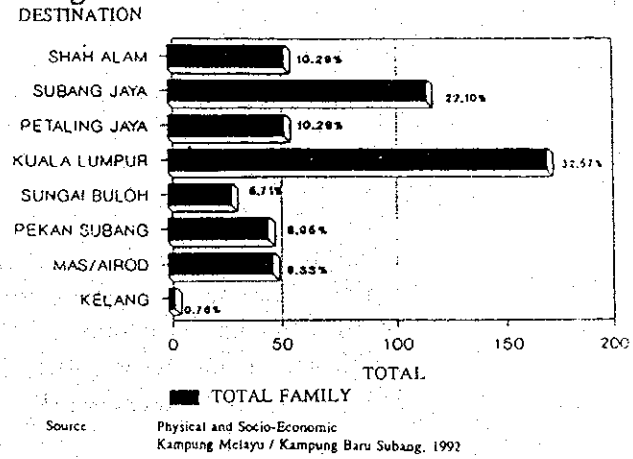
The existing traffic demand can be referred to the ITM Study Report (Physical and Socio-Economic Study for Kg. Melayu and Kg. Baru Subang, 1992) as shown in Figure 2.7. The traffic volume of 6 peak hours, 2 hours each in the morning, afternoon, and evening) was counted to be approximately 6,850 vehicles at the east side entry point and 4,500 vehicles at the west side. The study also observed a huge number of through-traffic running from east to west which is causing the traffic congestion on the main road.

Figure 2.7 Existing Traffic Demand



Source : Physical and Socio-Economic with Kampung Melayu/Kampung baru Subang 1992

Figure 2.8 Residents' Selected Destination



Source : Physical and Socio-Economic Kampung Melayu / Kampung Baru Subang, 1992

The destinations of trips made by the residents in the area are mainly Kuala Lumpur with 32.6% of the total trips followed by Subang Jaya 22,1%, while Shah Alam and Petaling Jaya posted 10.3% (refer to Figure 2.8). The average vehicle ownership in the study area is shown in Table 2.3. The motorcycle ownership is highest among all vehicle types and passenger car ownership is 0.5 per household. The traffic demand after the implementation of land readjustment in the study area is estimated with these available data and information.

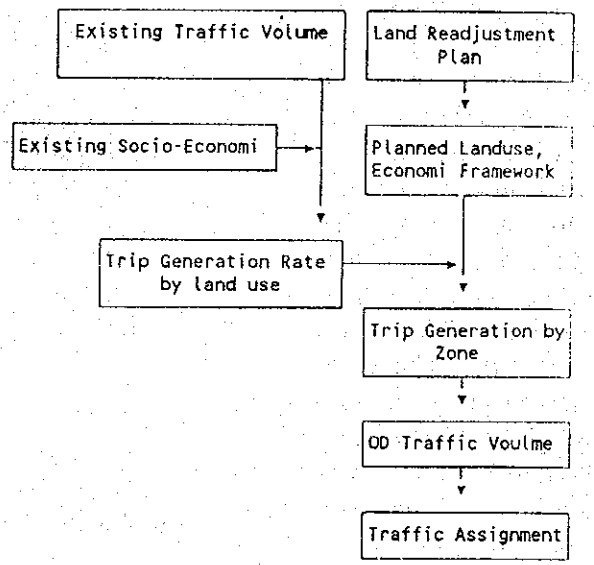
Table 2.3 Average Vehicle Ownership vs. Total Households in the Study Area

Type	Ave./HH
Bicycle	0.4
Motorcycle	0.9
Car	0.5
Van	0.05

Source: Physical and Socio-economic Study for Kg. Melayu Subang, 1992

The methodology of the traffic demand forecasting is depicted in Figure 2.9. Firstly, trip generation rates by land use type is analyzed based on the existing traffic demand and socio-economic data such as population and employment.

Figure 2.9
Steps in Traffic Demand Forecasting



Using the trip generation rate, traffic generation volume from each traffic zone, which is delineated in the study area to be ten (10) traffic zones based on the planned land use, is estimated. The traffic generation volume is converted to the Origin-Destination (OD) traffic volume. Then, the OD traffic volume is assigned into the planned road network.

Table 2.4
Trip Generation Rate by Land Use Type

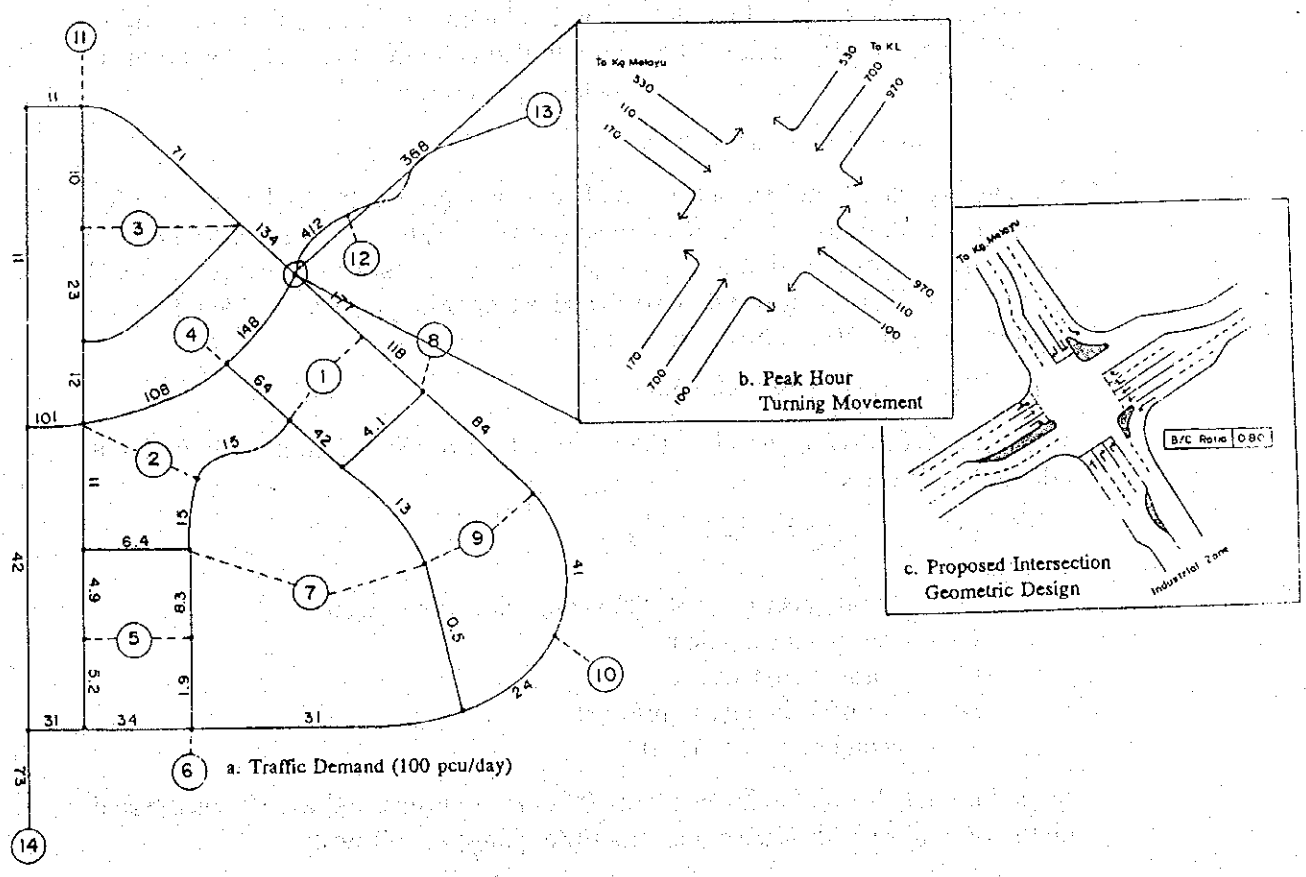
Land Use	P. Car	Lorry/Van	M/C
Middle Industry	45	40	45
Service Industry	230	200	203
Commercial	300	120	300
Detached House	40	-	30
Semi-Detached House	100	-	90
Terrace House	190	-	270

The result of the traffic assignment is shown in Figure 2.10 (a). Traffic demand on the east-west trunk road, which is proposed to be a four-lane road, is estimated to range from 10,000 to 40,000 passenger car units (pcu) per day, and internal circumferential major road is from 3,000 to 18,000 pcu per day.

Figure 2.10 (b) shows the turning movement at the intersection near Pekan Subang. The large volume of right/left turning movement between between east bound (to KL) and north (to Kg. Melayu) or south (to Kg. Seri Subang industrial zone) are observed. In order to accommodate those traffic demand, the geometric design of the intersection will be required to be as shown in Figure 2.10 (c).

In conclusion, grade crossing will still be operative at the most congested intersection while elevated crossing seems to be an excessive investment.

Figure 2.10
Future Traffic Demand on the Major Network and Major Intersection



2.4 Flood Protection System Plan

Urbanization decreases the capacity of natural water retention on land and exposes the land to floods. An urban development project has to take the responsibility of controlling storm water runoff in its project area to avoid additional influence on the downstream area.

The development of comprehensive flood protection, rivers, drains and retention ponds are to be considered in the same context.

A. River Improvement

(1) Catchment Area

For river improvement, sectional plans are to be prepared with consideration of the whole upstream area. A future catchment area may develop because of the uncertainty of future developments. The catchment area of Sg. Pelumut is 603.0 ha. while Sg. Air Kuning 256.1 ha.. Subdivided catchment areas by the points of design sections in the study area are depicted in Figure 2.11.

(2) Average Runoff Coefficient

The average runoff coefficient based on future land use is estimated at 0.35 for Sg. Pelumut and 0.56 for Sg. Air Kuning as shown in Table 2.5. In this connection, the future land use outside the area is assumed to be residential and recreational along Batu - Tiga - Sungai Buloh Road, and preservation of forest on the hilly land with more than 150 ft. above sea level.

(3) Peak River Flow Estimation

For peak river flow estimation, the modified form of the Rational Method was adopted as follows:

$$Q = 1 / 360 * Cs * C * i * A$$

where,

Q = peak river flow of 100 years' return period (m^3/s)
Cs = storage coefficient
C = runoff coefficient
i = rainfall intensity (mm/hr)
A = catchment area (ha.)

In the formula, the rainfall intensity for 100 years' return period was obtained based on the rainfall records at Kuala Lumpur (Ampang) as follows:

$$Rainfall\ intensity\ (mm/hr) = 6,223 / (tc^{0.9} + 16.38)$$

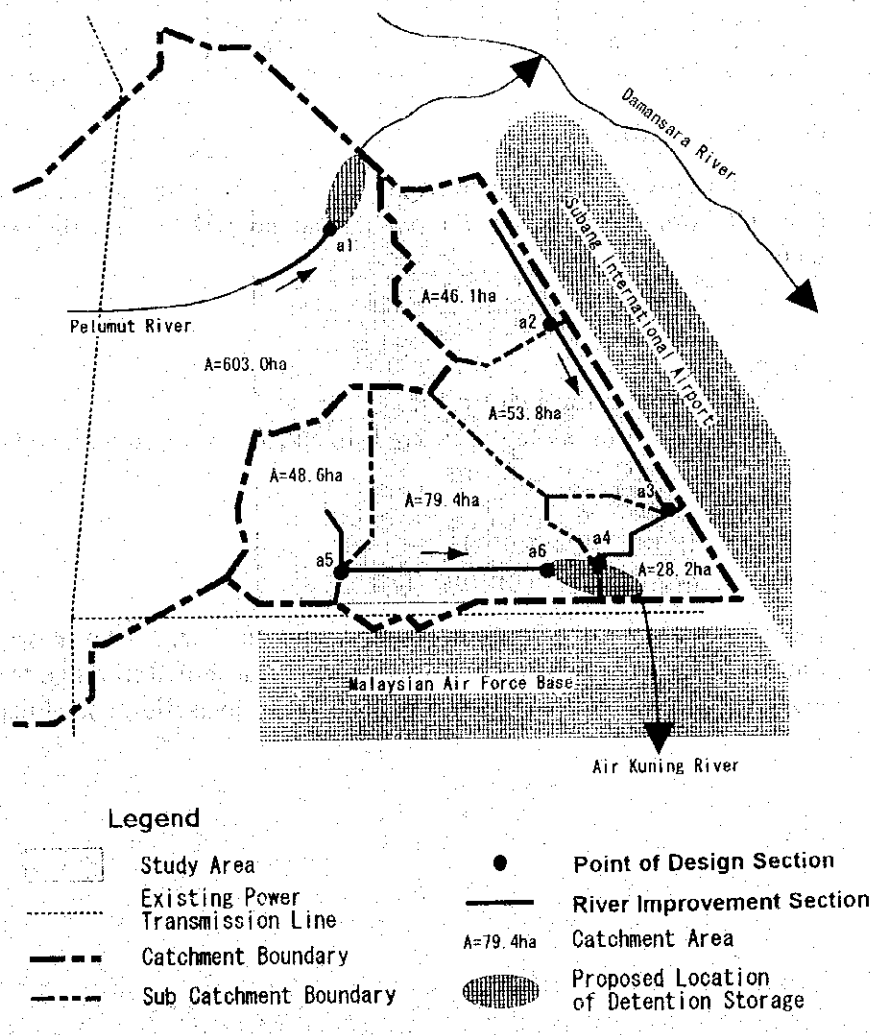
where,

tc = time of concentration (mm). This is the duration of the water flow from the remotest point to the design point for cross section in a catchment area. It consists of the time on ground surface and the time in the river.

Table 2.5
Estimation of Average Runoff Coefficient

Land Use	Runoff Coefficient C	Pelumut River				Air Kuning River			
		Study Area (ha)	Exterior Area (ha)	Total (ha) A	A*C	Study Area (ha)	Exterior Area (ha)	Total (ha) A	A*C
Business Area	0.85	6.10	-	6.10	5.185	16.10	-	16.10	13.685
Residential Area	0.40	21.80	139.60	161.40	64.560	58.40	-	58.40	23.360
Light Industrial Area	0.65	27.30	-	27.30	17.745	73.20	17.80	73.20	47.580
Unimproved Area	0.20	-	195.10	195.10	39.020	-	-	17.80	3.560
Streets	0.85	21.90	46.50	68.40	58.140	58.70	-	58.70	48.895
Lawn (part etc.)	0.20	11.90	132.80	144.70	28.940	31.90		31.90	6.380
Total	-	89.00	514.00	603.00	213.590	238.30	17.80	256.10	144.460
Average Runoff Coefficient		A * C / A = 0.35				A * C / A = 0.56			

Figure 2.11
Subdivided Catchment Area by Point of Design Section



As the catchment area gets larger, the effects of channel storage on the attenuation of the flood wave becomes more pronounced. To allow storage effect for the peak river flow, storage coefficient (Cs) was determined as follows

$$Cs = 2tc / (2tc * td)$$

where,

tc = time of concentration (min)
td = time in the river (min)

In conclusion, the volume of river flow at the peak of 100 years' probability was estimated in Table 2.6.

Table 2.6
Estimation of Peak River Flow by Design Section Point

Point of Design Section	Catchment Area (ha)		Time of Concentration	Runoff Coefficient	Storage Coefficient	Peak River Flow (m^3/s)
	Inlet	Cumulated				
Sg. Pelumut A1	603.0	603.0	54	0.35	0.80	55.201
Sg. Air Kuning A2	46.1	46.1	14	0.56	0.88	14.344
A3	53.8	99.9	22	0.56	0.79	23.301
A4	28.2	128.1	27	0.56	0.76	26.139
A5	48.6	48.6	11	0.56	0.96	17.861
A6	79.4	128.0	17	0.56	0.83	34.936

(4) Design Cross Section

The two rivers shall be improved to withstand the peak currents. The following Manning Formula has been commonly employed to determine the necessary cross sections:

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

where,

V = velocity in river (m/sec)
n = Manning's roughness coefficient (0.015 for concrete channel)
R = hydraulic radius (m)
S = slope
Q = flow in river (m^3/s)
A = sectional area of flow (m^2)

The rivers are designed for open channels and the freeboard of more than 30 cm. shall be attached. The velocity in river flow is designed to range from 1.0 m/sec and 3.0 m/sec with due consideration of the grit transaction and abrasive damage.

The necessary river flow capacity was estimated at every point of the design section in Table 2.7 and the proposed cross section was worked out as shown in Figure 2.12.

Table 2.7
Estimated Capacity of Cross Sections

Point of Section Design	Bottom Width (m)	Site Slope (1 : x)	Depth (m)	Slope	Velocity (m/s)	Capacity (m^3)
Sg. Pelumut A1	6.5	0.5	2.5	0.001	2.888	55.955
Sg. Air Kuning A2	3.0	0.5	1.8	0.001	2.107	14.791
A3	3.7	0.5	2.1	0.001	2.365	23.591
A4	3.8	0.5	2.2	0.001	2.428	26.174
A5	3.4	0.5	1.9	0.001	2.221	18.357
A6	4.1	0.5	2.5	0.001	2.613	34.949

(5) River Reserve

According to the DID planning standards, both rivers shall flow between the designed river reserves as shown in Table 2.8. The necessary river reserve in the area is ten (10) meters in width on each bank. The prime function of a river reserve is to allow personnel access to a river, plant or other apparatus for maintenance. In this sense, a road parallel with a river can serve as a river reserve.

Table 2.8
Required River Reserve

Width of River	Required Reserve Land on Each Bank (m)
more than 40m	50
20m - 40m	40
10m - 20m	20
5m - 10m	10
less than 5m	5

B. Retention Pond Development

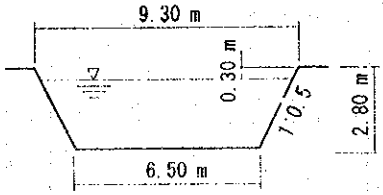
(1) Catchment Area

As a desirable approach, to prevent adverse effects of urban development on the downstream area, a retention pond is to be developed temporarily to adjust the quantity of outflow. In the area, two retention ponds shall be developed corresponding to the catchment areas of the existing rivers of Sg. Pelmut and Sg. Air Kuning.

Figure 2.12
Cross Section Designs of the Rivers

1. Pelumut River

Point of Design Section: a1
Peak Discharge: 55.201 m^3/s

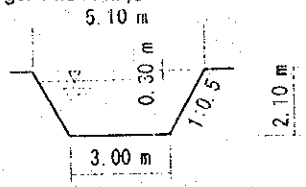


Roughness Coefficient: n = 0.015
Slope = 0.001
Velocity = 2.888 m/s
Capacity = 55.595 m^3/s

Minimum Reserve Width
= 9.30 + 10 * 2 = 29.30 m.

2. Air Kuning River

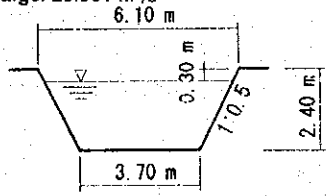
Point of Discharge: a2
Peak Discharge: 14.344 m^3/s



Roughness Coefficient: n = 0.015
Slope = 0.001
Velocity = 2.107 m/s
Capacity = 14.791 m^3/s

Minimum Reserve Width
= 5.10 + 10 * 2 = 25.10 m.

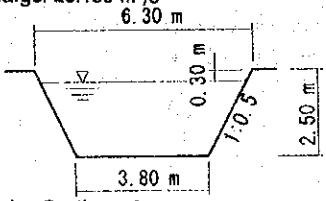
Point of Design Section: a3
Peak Discharge: 23.301 m^3/s



Roughness Coefficient: n = 0.015
Slope = 0.001
Velocity = 2.107 m/s
Capacity = 14.791 m^3/s

Minimum Reserve Width
= 5.10 + 10 * 2 = 25.10 m.

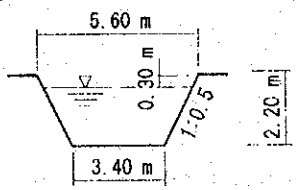
Point of Design Section: a3
Peak Discharge: 26.139 m^3/s



Roughness Coefficient: n = 0.015
Slope = 0.001
Velocity = 2.428 m/s
Capacity = 26.174 m^3/s

Minimum Reserve Width
= 6.30 + 10 * 2 = 26.30 m.

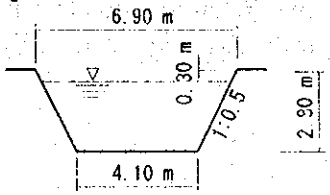
Point of Design Section: a3
Peak Discharge: 17.861 m^3/s



Roughness Coefficient: n = 0.015
Slope = 0.001
Velocity = 2.221 m/s
Capacity = 18.357 m^3/s

Minimum Reserve Width
= 5.60 + 10 * 2 = 25.60 m.

Point of Design Section: a3
Peak Discharge: 34.936 m^3/s

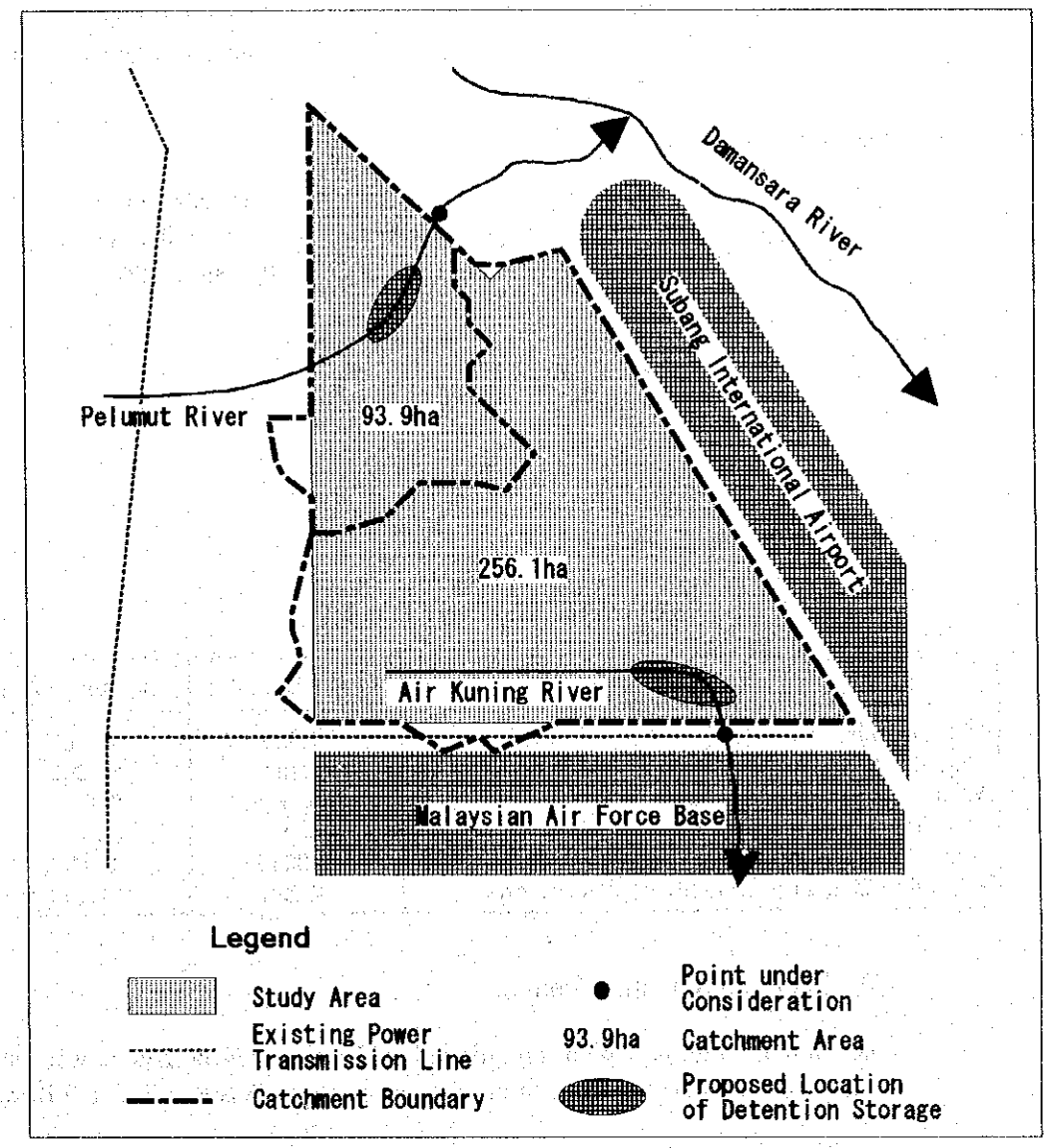


Roughness Coefficient: n = 0.015
Slope = 0.001
Velocity = 2.613 m/s
Capacity = 34.949 m^3/s

Minimum Reserve Width
= 6.90 + 10 * 2 = 26.90 m.

Since it is a provisional measure until the whole downstream area is improved, the retention ponds are designed to withstand the rainfall intensity for five (5) years. The service area of these retention ponds are, therefore, to be restricted within the case study area and unavoidable adjacent area as shown in Figure 2.13.

Figure 2.13
Catchment Areas of Retention Ponds



(2) Analysis of Present Downstream Section

The current shapes of downstream sections adjacent to the area are depicted in Figure 2.14. The current capacity and allowable discharge quantity was estimated based on the Manning Formula as shown in Table 2.9. In the formula, Manning's roughness coefficient for a natural river is 0.03

Figure 2.14
Current Cross Sections at Downstream Sections

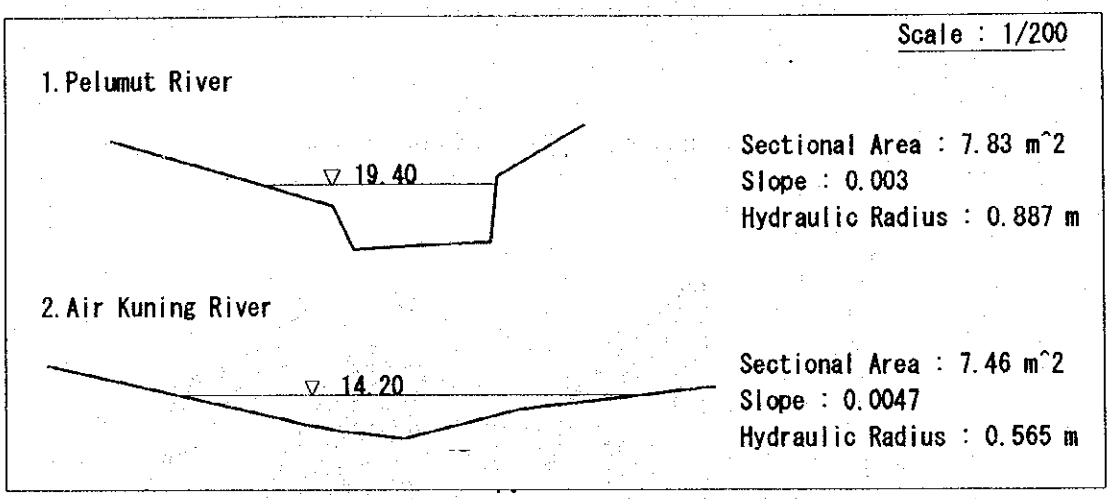


Table 2.9
Allowable Discharge Quantity

	Sg. Pelumut	Sg. Air Kuning
Velocity (m/s)	1.685	1.562
Capacity (m^3/s)	13.194	11.653
Whole Catchment Area (ha)	609.7	256.1
Catchment Area in Study Area (ha)	93.9	256.1
Normal Discharge	0.0216	0.0455
Allowable Discharge Quantity from Study Area	2.028	11.653

(3) Required Retention Volume

The retention volume which is required, besides those of the rivers, was estimated by the formula derived from Japan Sewerage Work Association as follows:

$$Vi = (ri - rc/2) * 60 * ti * C * A * 1/360$$

where,

Vi = required retention volume
ri = rainfall intensity of 5 years' return period (mm/hr)
rc = rainfall intensity in case of allowable discharge quantity (mm/hr)
C = runoff coefficient
A = catchment area (ha)

In the above formula, the maximized Vi during Ti is the required retention volume. Adopting this to the area, the required retention volume was estimated as shown in Table 2.10.

Table 2.10
Estimation of Required Retention Volume

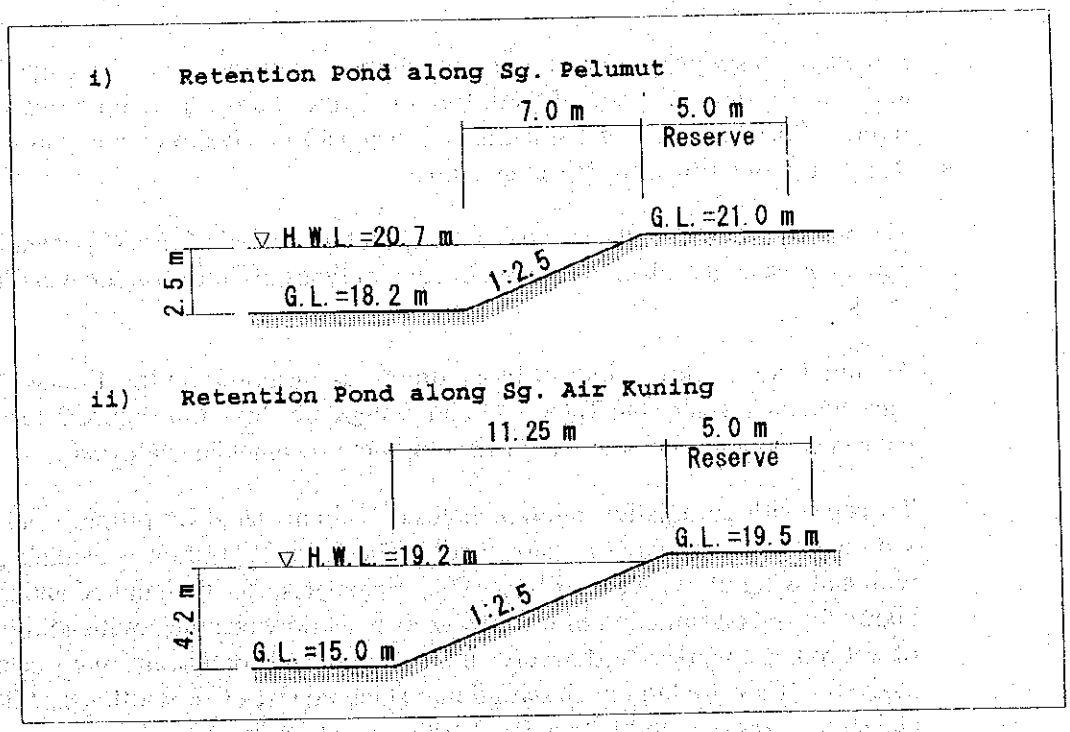
	Sg. Pelumut	Sg. Air Kuning
(Conditions)		
Catchment Area (ha)	93.90	256.10
Allowable Discharge (m^3/s)	2.028	11.653
Runoff Coefficient	0.57	0.57
Rainfall Intensity (mm/hr)	$3.867 / (t^{0.9} + 10.85)$	$3,867 / (t^{0.9} + 10.85)$
(Results)		
rc (mm/hr)	13.6	28.7
t (min)	162	87
Vmax (m^3)	41,800	92,700

In conclusion, the nccessary areas of retention ponds are 2.2 ha. for the catchment area of Sg. Pelumut and 3.8 ha. for Sg. Air Kuning based on the proposed depth and side slope.

(4) Design Aspects

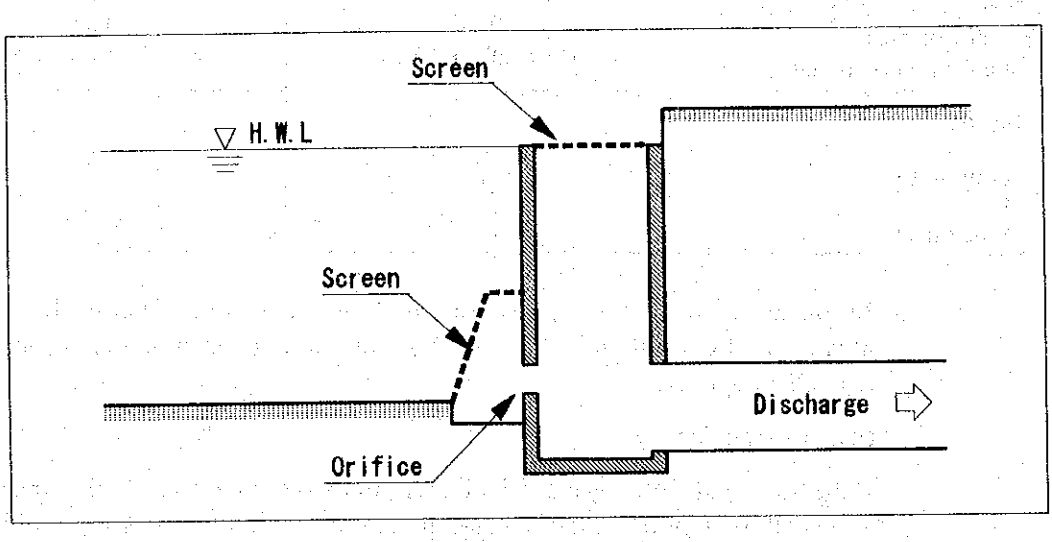
Retention ponds introduce a risk element in that at the onset of an extreme storm, an overflow may occur at the basic embankment resulting in the possible failure of the structure. To ensure that this risk element is kept at a minimum, the embankment is designed to withstand an inflow flood as shown in Figure 2.15.

Figure 2.15
Proposed Depth and Side Shape



An outlet which intends to control the downstream discharge under allowable levels will be installed at each retention pond. The outlet is outlined in Figure 2.16.

Figure 2.16
Outline of Outlet



C. Drainage Improvement

(1) Drain Types

Streets are a significant and important component of the urban drainage system and full use shall be made of them for conveying storm runoff up to reasonable limits. Utilization of a street as a drainage channel will have to be compatible with its primary function of traffic conveyance.

The drainage system in the area has a design return period of five (5) years in line with future land use plan. It consists of several types of drains on local and major roads.

As initial drains, three kinds of block drains are proposed on local roads. Their capacities are estimated in Table 2.11 and designs are shown in Figure 2.17. They have been adopted in a number of development schemes in Malaysia.

To cope with cumulative rainfall, precast U-drains shall be properly installed within the right-of-way of major roads. The pre-cast U-drain is available both with and without dry weather flow (DWF) channels. Easily handled and laid, it allows for fast construction of waterways or open flow channels with a minimum of wet concrete works. And to serve under diversified conditions, many sizes are available. They are largely classified into standard sizes (for width < 1,800 mm) and super sizes (for width between 2,100mm and 3,600mm)

In the case study area, several standard types are proposed. Their dimensions and expected performances are indicated in Table 2.12.

Table 2.12
Capacity of Block Drain

Type of Drain	Sectional Area (m^2)	Hydraulic Radius (m)	Slope (%)	Velocity (m/s)	Flow Capacity (m^3/s)	Designed Service Area (ha)
300mm Block Drain	0.037	0.061	2.00	1.461	0.054	0.3
600mm Block Drain	0.180	0.142	2.00	2.566	0.462	2.3
Block Drain with Brickwall	0.410	0.158	2.00	2.755	1.130	5.7

Table 2.12
Expected Performance of Precast U-Drain by Type

Dimensions of U-Drains				Effective Depth (m)	Sectional Area (m^2)	Hydraulic Radius (m)	Velocity	Capacity	Designed Service Area (ha)
Nominal Size (mm)	b (mm)	h (mm)	td (mm)						
750*600	750	600	80	0.54	0.399	0.230	3.539	1.412	7.1
750*750	750	750	80	0.68	0.504	0.250	3.742	1.886	9.5
900*750	900	750	80	0.68	0.606	0.280	4.035	2.445	12.3
900*900	900	900	80	0.81	0.723	0.298	4.206	3.041	15.3
1200*900	1200	900	50	0.81	0.970	0.351	4.691	4.550	22.9
1200*1200	1200	1200	50	1.08	1.294	0.392	5.050	6.535	32.8
1500*1200	1500	1200	100	1.08	1.610	0.454	5.569	8.966	45.1
1500*1500	1500	1500	100	1.35	2.015	0.494	5.892	11.872	59.7
1800*1500	1800	1500	115	1.35	2.417	0.554	6.360	15.372	77.2
1800*1800	1800	1800	115	1.62	2.903	0.592	6.647	19.296	96.7

Note:
Given Conditions (roughness coefficient = 0.015; slope = 0.02; effective depth = 90%)

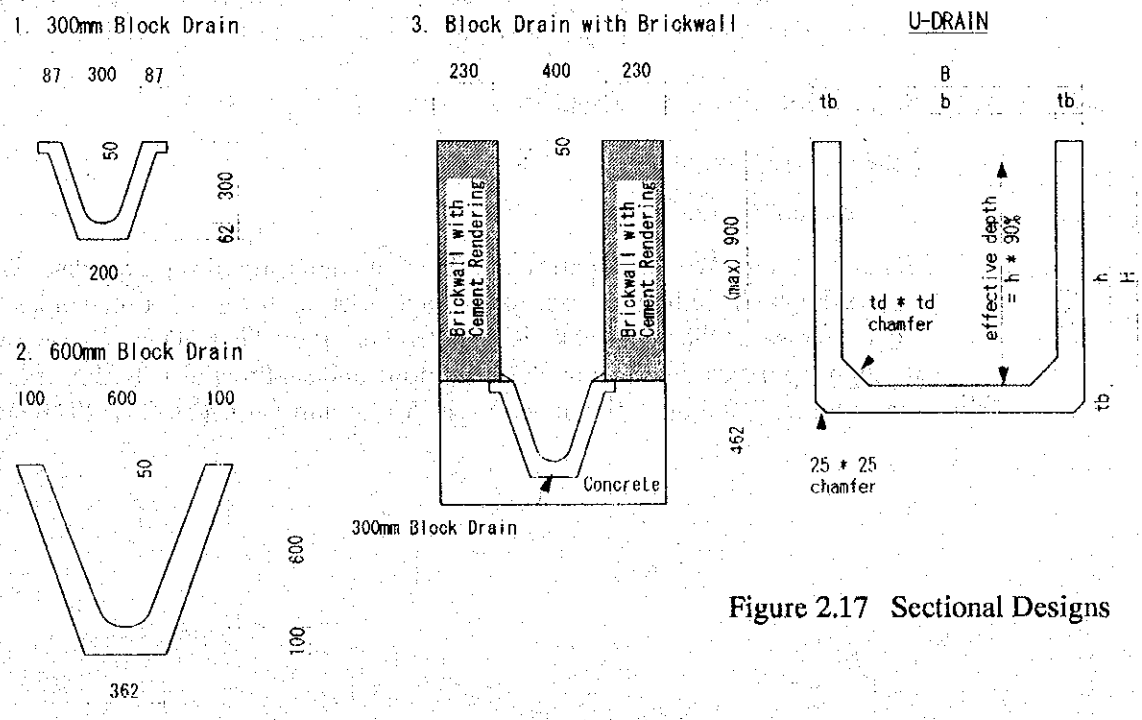


Figure 2.17 Sectional Designs

(2) Installation

Several types of block drains and U-drains will be installed at road sides while several box culverts will also be installed to cross under roads and some physical obstacles.

Their sizes were properly selected in terms of the storm water runoff on each block and its accumulation. Accordingly, the necessary lengths of drains were measured and summarized in Table 2.13 in association with the proposed layout plan.

Table 2.13
Necessary Quantity of Drains by Type

Type		m
Block Drain	300mm	3,600
	600mm	62,300
	400 x 1,200mm with brickwall	4,175
U-Drain	750 x 750	1,950
	900 x 900	1,450
	1,200 x 1,200	2,850
	1,500 x 1,500	1,780
	1,800 x 1,800	1,000
Sub Drainage (Box Culvert)	500 x 600	6,000
	400 x 1,200	360
	750 x 750	90
	900 x 900	170
	1,200 x 1,200	160
	1,500 x 1,500	160
	1,800 x 1,800	15

As a conclusion, based on the above three components, the overall flood protection system in the area is proposed as depicted in Figure 2.18.

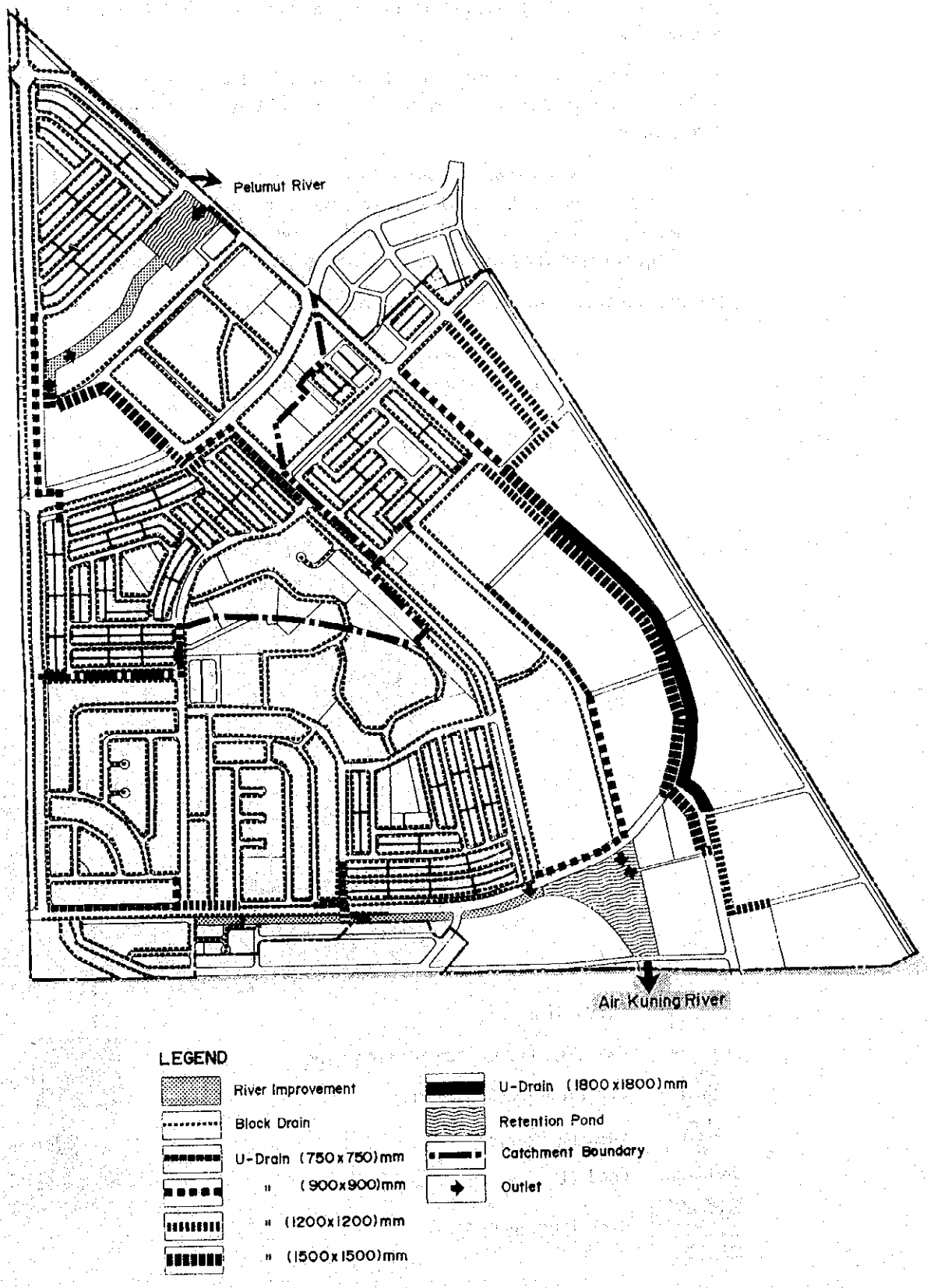
2.5 Water Supply and Disposal System Plan

A. Water Supply System

(1) Present Condition

Selangor Water Works Department (JBA Selangor) supplies piped water within its jurisdiction including the case study area. The main water source comes from Sg. Damansara where an intake is installed near Batu Tiga. The water is treated through a purification plant at Bukit Jelutong and sent to a distribution reservoir via a pumping station both located in the Malaysian Air Force Base (TUDM).

Figure 2.18
Flood Protection System Plan in Subang Area



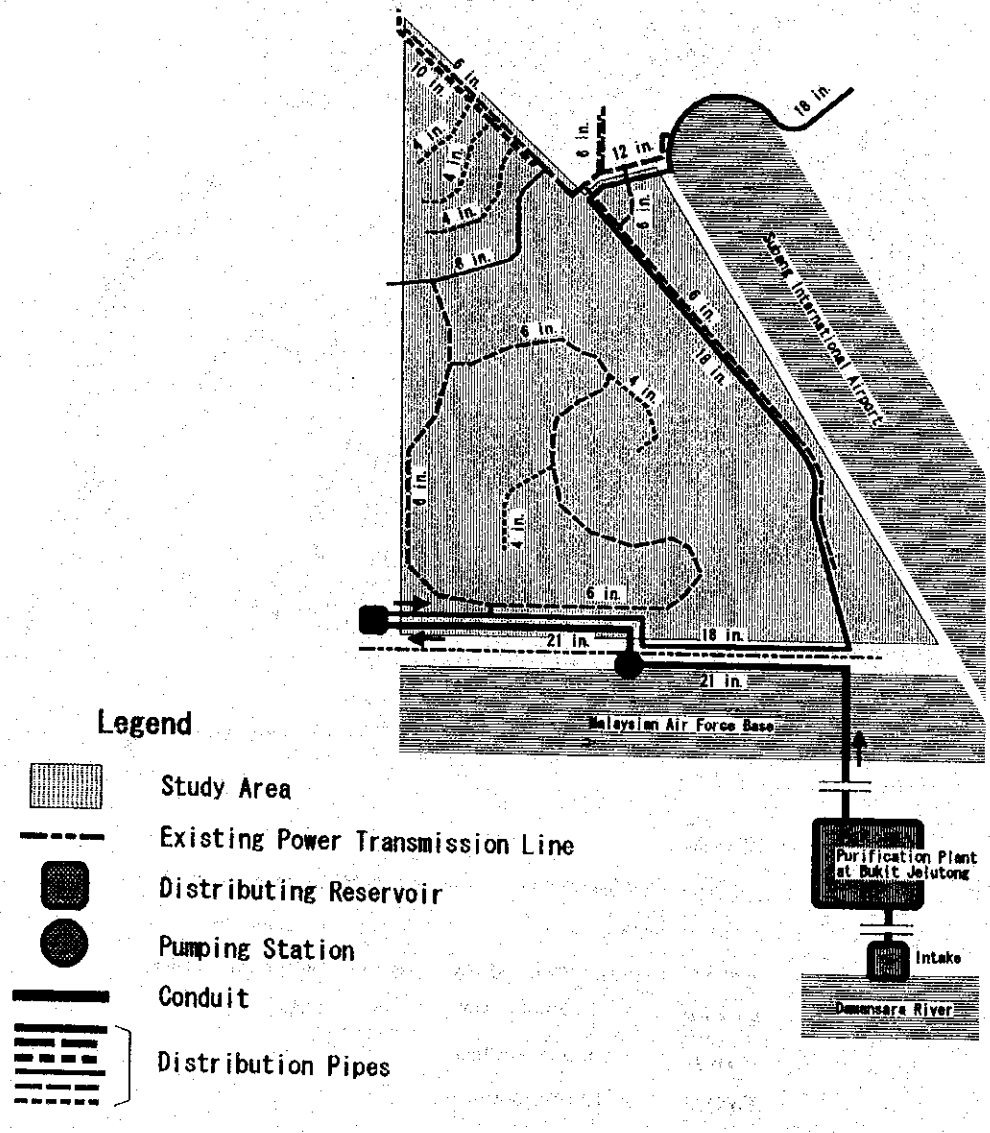
The distribution reservoir is installed on a hill next to the southeast edge of the area, 76 meters above sea level. The reservoir, with a capacity of 1,000,000 gallons (4,546m^3) distributes water among the consumers in Kg. Seri Subang, Kg. Melayu Subang and its environs.

As for water supply conditions, the Physical and Socio-Economic Survey in Kg. Melayu Subang and Kg. Seri Subang by ITM in 1992 gave the following description:

> *"It is estimated that the water loss rate is to be 30% of the JBA's supply. The high rate of loss is caused by use of old pipes, road damage from heavy vehicles and so on. Therefore, consumers frequently suffer from suspension and shortage of water supply."*

The present water supply system is depicted in Figure 2.19.

Figure 2.19
Existing Water Supply System



(2) Policy Setting

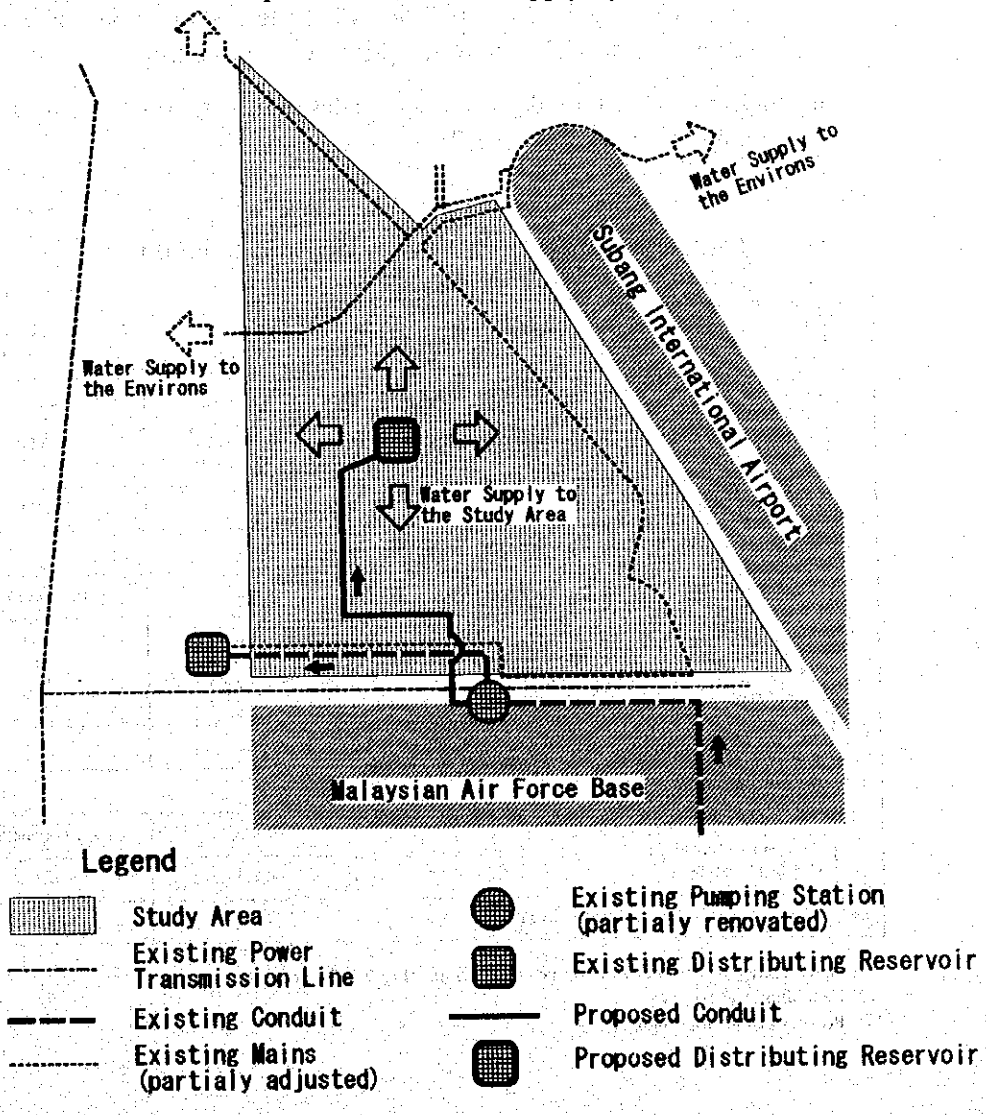
The existing water supply system in the area should be entirely renovated so as to meet the increasing demand in line with residential and industrial development. For that purpose, a new distribution reservoir shall be installed on the hill side at Bukit Subang instead of the existing one. In this connection, the existing pipes shall also be renovated.

It is noted that the present distribution reservoir is intended to service the adjacent area. Therefore, the existing arterial and secondary lines leading to the adjacent area should be preserved. Otherwise, alternative lines shall have to be laid within the Study Area.

The existing pumping station at the TUDM is expected to provide water to the proposed reservoir in the future. Accordingly, if necessary, the existing pumping station shall be strengthened.

The proposed water supply system is conceptualized in Figure 2.20.

Figure 2.20
Concept of Future Water Supply System



(3) Water Demand Forecast

Water Demand can be generally classified into the following five types in terms of usage. Total demand is considered as the sum of the individual types.

a) Domestic: Domestic use varies with the economic level of consumers. The JBA's standard classifies it into several house types. On the other hand, a variety of houses will be located in the area for the purpose of the kampung improvement. Taking such capita is assumed at 273 liters which is equivalent to the water demand of a medium cost house in the JBA's standard. The volume includes watering of lawns and gardens.

b) Commercial: The demand for commercial use is assumed based on the calculation of the equivalent population which is defined in the Malaysian Standard.

c) Industrial: JBA does not prepare any guidelines under this category while the Malaysian Standard estimates the demand for light industry in manufacturing process at $20m^3$/ha per day. The latter is employed in this study.

d) Miscellaneous: Some miscellaneous uses such as school, factory excluding manufacturing process, etc. are duly estimated in accordance with the JBA's standard or the Malaysian Standard.

e) Loss: Current water loss ratio is reported to be 30%. The future rate is expected to be 10% due to the proposed renovation.

In conclusion, the future daily average water consumption in the area is estimated at $6,836m^3$ as shown in Table 2.14

Table 2.14
Estimation of Daily Average Water Consumption

Estimation by Equivalent Population : A *1

Type of Premise	Equivalent Population	Quantity	Water Demand (m^3)
Residential	5 per unit	2,130 (unit)	2,907
Commercial	3 per $100m^2$ gross area	58,500 (m^2)	479
Bus Terminal	4 per bus bay	10 (bay)	11
Industrial (1) *2	0.3 per staff	7,510 (staff)	615
Total	-	-	4,012

Estimation by Unit Volume : B

Type of Premise	Unit Volume	Quantity	Water Demand (m^3)
Industrial (2) *3	20 m^3 per hectare	99.16 (ha)	1,983
School	23 litres per student	3,600 (student)	83
Community Hall	22.8m^3 per unit	4 (unit)	91
Petrol Station	45.5m^3 per unit	1 (unit)	46
Total	-	-	2,203

Estimation of Water Loss : C

Equation for Water Loss : C = (A+B) x 10%	Quantity	Water Demand (m3)
	6,215	621

Daily Average Water Consumption (m^3/day) : (A+B+C)	6,836

*1 : Daily average water consumption per capita is equal to 273 litres/capita
*2 : Excluding process use
*3 : Process use for light industry

(4) Installation of New Distribution Reservoir

The proposed reservoir shall be properly allocated with the following conditions:

- the site should be higher than residential lots by 15m or more; and
- the site should be high enough to supply water among consumers with a pressure of 150 kpa or more.

To determine its capacity, daily water consumption has to be calculated as shown below:

Daily Maximum Water Consumption = *Daily Average Water Consumption x Daily Maximum Coefficient*
= *6,838 * 1.3*
= *8,889 (m^3)*

The proposed reservoir is designed to store 30% of the daily maximum water consumption (2,667m^3) and to have a depth of 3m and a setback of 10m. Accordingly, the required minimum lot for the proposed reservoir is 0.27 ha.

The proposed reservoir fills at night when water demand is low and pressure is high. To keep the necessary pressure level during daytime, automatic valves shall be equipped.

(5) Development of New Distribution System

a) Areal Water Consumption: The capacity of distribution system can be determined based on the hourly maximum water consumption which is estimated as follows:

Hourly Maximum Water Consumption = *Daily Maximum Water Consumption / 24 * c*
= *8,889 / 24 * 2.0*
= *741 (m^3)*

Note: c : coefficient related with size of city, for example, 1.3 for large size, 1.5 for medium size, and 2.0 for small size.

Furthermore, maximum areal water consumption can also be estimated in terms of hectares and time (in seconds) as follows:

Maximum Areal Water Consumption = *Hourly Maximum Water Demand / 60 * 60/A * S*
= *741 / 3,600 / 319.1 * 1.5*
= *0.00091 (m^3/sec/ha)*

In the formula, A is the catchment area which is equivalent to the Project Area of 319.1 hectares, and S represents the coefficient of surcharge.

b) Designed Flow Capacity by Pipe Size: The following Williams formula has been commonly employed to determine the necessary size of individual pressure pipes:

$$Q = 0.27853 * C * D^{2.63} * I^{0.54}$$

where,

Q = flow capacity in pipe (m^3/sec)
C = velocity coefficient (100 for concrete pipes)
D = diameter (m)
I = slope (height/length)

The velocity shall always be controlled at a constant level of automatic

valves. The size of a water pipe can be determined by its service area as shown in Table 2.15.

Table 2.15
Designed Water Flow Capacity by Pipe

Pipe Size (diameter in mm)	Slope (%)	Velocity Coefficient	Designed Flow Capacity (m^3/sec)	Designed Service Area (ha)
100	2	100	0.008686	8.9
150	2	100	0.025231	25.8
200	2	100	0.053768	55.0
250	2	100	0.096694	99.0
300	2	100	0.156189	159.9

c) Installation: For the distribution of water to the consumers within the area, the water supply pipes ranging from 100mm to 300mm in diameter will be installed at the right-of-way.

To supply water to the adjacent areas from the existing distribution reservoir, pipes ranging from 250mm to 450mm in diameter will be installed to replace the existing ones.

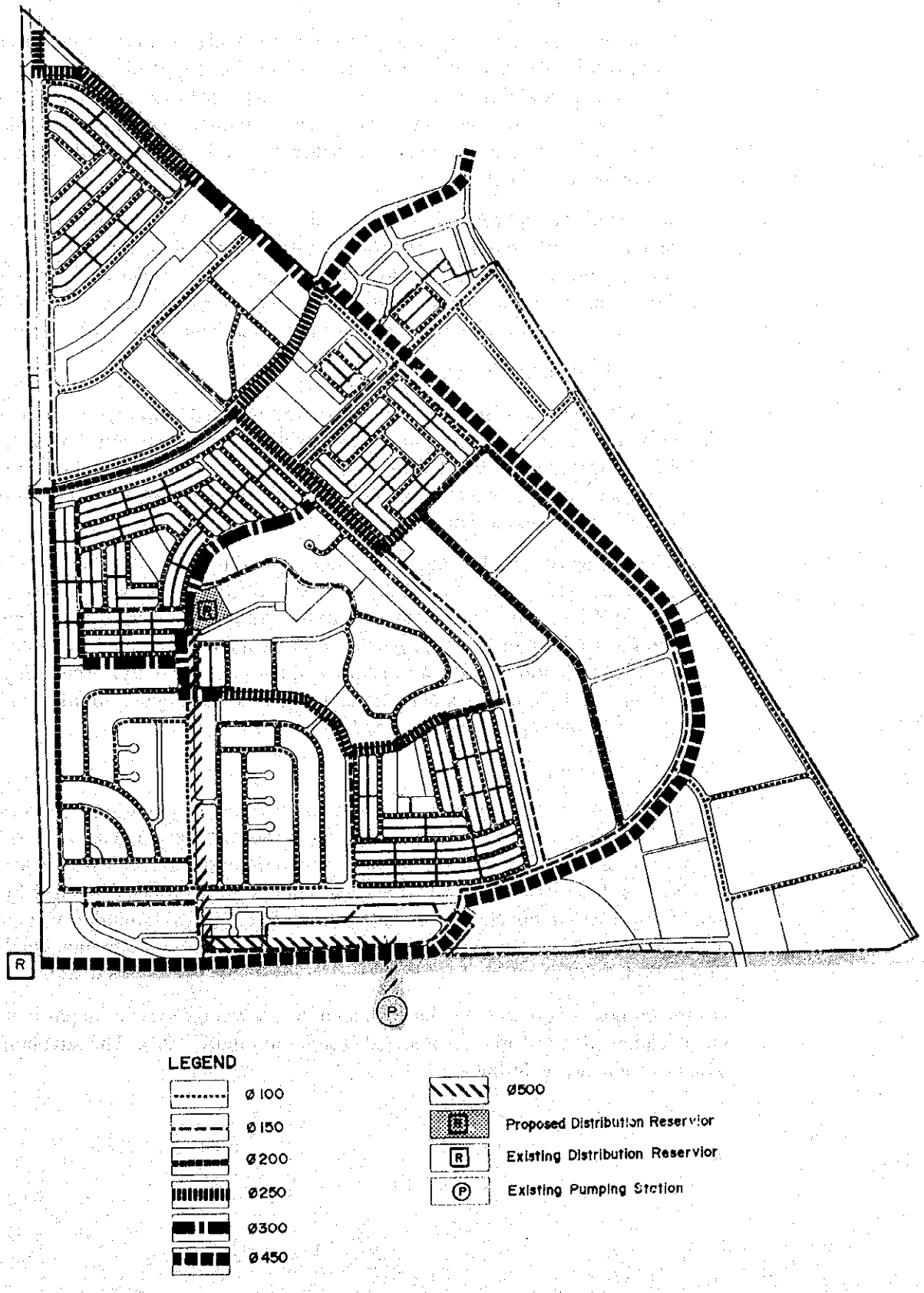
A conduit of 500mm in diameter will be installed to connect the proposed distribution reservoir at Bukit Subang to the existing pumping station in the TUDM.

The necessaray installation works was measured in terms of length and width-openings of pipes as summarized in Table 2.16.

Table 2.16
Necessary Quantity of Water Pipes

Size (diameter in mm)	Length (m)
100	26,890
150	6,270
200	3,710
250	2,390
300	1,270
450	2,070
500	1,400

Figure 2.21
Water Supply System in Subang Area



B. Sewerage Disposal System

(1) Present Condition and Background

a) Study Area

In the case study area, the effluent from septic tanks are discharged into the surface drainages or waterways and finally flow into Sg. Pelumut and Sg. Air Kuning. In addition to domestic waste, many factories and animal firms discharge their effluents in the same manner without proper pre-treatment. As a result, the Study Team observed that the area emits a foul smell and impureness is evident.

In general, the septic tank is a primary sedimentation basin in the rural areas and outskirts of the urban areas where sewer and central treatment system are not provided. The area and its environs have recently faced rapid urbanization and active industrialization. Accordingly, a comprehensive sewerage system is deemed necessary in comparison to the existing one.

b) National Sewerage System

An agreement on the privatization of the national sewerage system was signed by the Federal Government and Indah Water Konsortium (IWK) Sdn. Bhd. in December 1993. IWK was awarded a 28-year concession agreement to manage, operate and maintain the national sewerage system currently done by the respective local authorities.

The Ministry of Housing and Local Government (MHLG) formerly recommended the installation of stabilization ponds for housing developments with more than 100 units. An oxidation pond is a popular form of stabilization pond. However, IWK is intending to do away with the existing oxidation ponds in most areas due to land scarcity. Accordingly, mechanical treatment system is expected to be made popular in urban areas instead of the septic tanks and oxidation ponds.

(2) Policy Setting

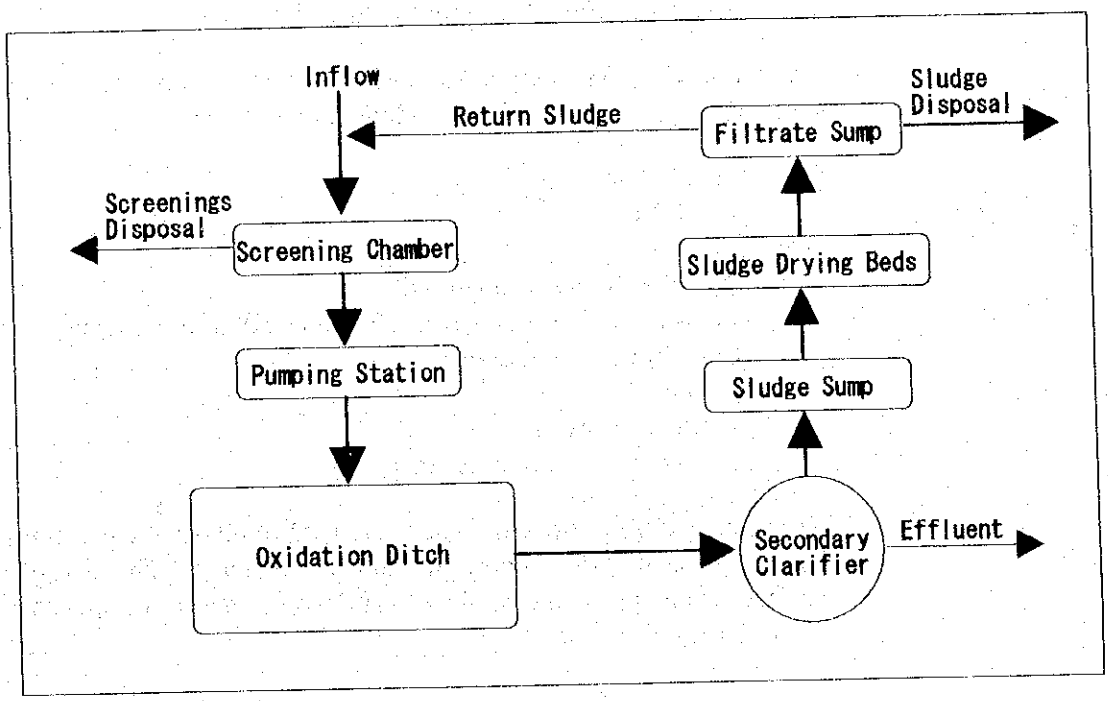
A sanitary sewer is required to be developed as a separate system from the storm water disposal in urbanized areas. Sewers are to be designed and developed for the purpose of collection and conveyance of both domestic and industrial wastes. It is needless to say that industrial effluents are not permitted to be discharged into the sewerage system directly. Such wastes should be purified through sewers and sewerage plants below the permissible levels given by the Environmental Quality Regulation, 1979.

For the purpose of efficient land use, mechanical sewerage system, in particular, the oxidation ditch system is recommended (refer to Figure 2.22). The advantages of said system are as follows:

- proven by its wide experience in Malaysia;
- low construction cost;
- minimum mechanical equipment; and
- minimal operator attention.

Sewerage treatment works shall be located as far from the public right-of-way and habitable buildings as economically practicable. In practice, the sewerage treatment works and pumping station shall be at least 20 meters away from any habitable building.

Figure 2.22
Outline of Oxidation Ditch System



(3) Sewer Installation Plan

a) Sewerage Demand

The amount of sewerage demand is closely related to the amount of water consumption. In practice, the former is estimated to be 80% of the latter with consideration of water leakage and infiltration. According to the water supply improvement plan, the area will consume a piped water of 8,889 cubic meters. Therefore, the sewerage demand is estimated at 7,111 cubic meters as follows:

Daily Maximum Sewerage Demand = *Daily Maximum Water Consumption x 80%*
= *8,889 * 0.8*
= *7,111*

b) Areal Maximum Sewerage Demand

Sewerage demand can also be estimated per hectare per second as follows:

Area Maximum Sewerage Demand = *Hourly Maximum Sewerage Demand / 60 * 60 / A*S*
= *(Daily Maximum Sewerage Demand / 24 * 1.5) / 60 * 60 / A * S*
= *7,111 / 24 * 1.5 / 3,600 / 319.1 * 2.0*
= *0.00077 (m^3/sec/ha)*

In the formula, A is the catchment area which is equivalent to the Study Area of 319.1 hectares, and S represents the coefficient of surcharge.

c) Designated Flow Capacity by Pipe Size

The following Manning's formula has been commonly employed to determine the necessary size of individual conduits:

$$V = 1/n * R^{2/3} * S^{1/2}$$
$$Q = A * V$$

where,

V = velocity in sewer (m/sec)
N = Manning's roughness coefficient (0.013 for concrete pipes)
R = hydraulic radius (m)
S = slope
Q = flow to sewer
A = internal area of pipe (m^2)

The velocity in full flow is designed to range from 0.6m/sec to 3.0m/sec with consideration of grit traction and abrasive damage. The size of a sewer conveying raw sewerage can be determined by its service area as shown in Table 2.17.

Table 2.17
Designed Sewer Flow Capacity by Pipe

Pipe Size (diameter in mm)	Slope (%)	Velocity (m^3/sec)	Designed Flow Capacity (m^3/sec)	Designed Service Area (ha)
200	0.5	0.738	0.023	29.8
250	0.5	0.861	0.042	54.5
300	0.5	0.967	0.068	88.3
350	0.5	1.076	0.103	133.8
400	0.5	1.172	0.147	190.9
450	0.5	1.271	0.202	262.3
500	0.5	1.360	0.267	346.9

Note: * Designed Service Area (ha) = Designed Flow Capacity (m^3/sec)/Areal Maximum Sewerage Demand (m^3/ha/sec)

d) Sewer Installation

Two sewerage treatment plants are proposed in the area since the area can be divided into two in terms of catchment areas of the current two rivers. As for coverage area, one along Sg. Pelumut is 93.9 ha while the other along Sg. Air Kuning is 256.1 ha. Accordingly, the sewer pipes ranging from 200mm to 450mm in diameter shall be installed in line with the proposed layout plan.

In installing sewer pipes, the following points shall be considered:

- Sewers shall be located beneath streets and alleys within the right of way;
- Minimum depth of invert to be adopted shall be 1.2m; and
- Manholes and inspection chambers shall be provided at the upstream end of all sewers and every change in alignment, gradient and size of sewer.

There will be a need to equip one pumping station where ground level is very low along Sg. Pelumut. The pumping station is compact enough to be located in the buffer zone. In this connection, a pressure conduit will be necessary to connect the pumping station to the sewerage treatment plant along Sg. Pelumut.

The necessary sewer installation works was measured in terms of length and type of pipes as summarized in Table 2.18.

Table 2.18
Necessary Quantity of Installation Works

Type (diameter in mm)	Length	Material
Sewer 200	30,880	Concrete
Sewer 250	540	Concrete
Sewer 300	1,350	Concrete
Sewer 350	240	Concrete
Sewer 400	200	Concrete
Sewer 450	120	Concrete
Pressure conduit 450	650	Steel

4) Sewerage Plant Development Plan

The two sewerage plants, which employed the oxidation ditch system, were designed to serve the same estimated population for the water supply. The plants shall be surrounded by a buffer zone of at least 20 meters in width with the required landscaping. As for the necessary site, one sewerage plant in Sg. Pelumut requires 4,500m^3 while the other along Sg.Air Kuning 9,100 m^3 as shown in Figure 2.24.

If the oxidation pond were designed to be the same as before, it would need a relatively large area of 36,700m^3. It is evident that the proposed plants contribute to the efficient use of land.

Figure 2.23
Necessary Site Allocation for Sewerage Plants

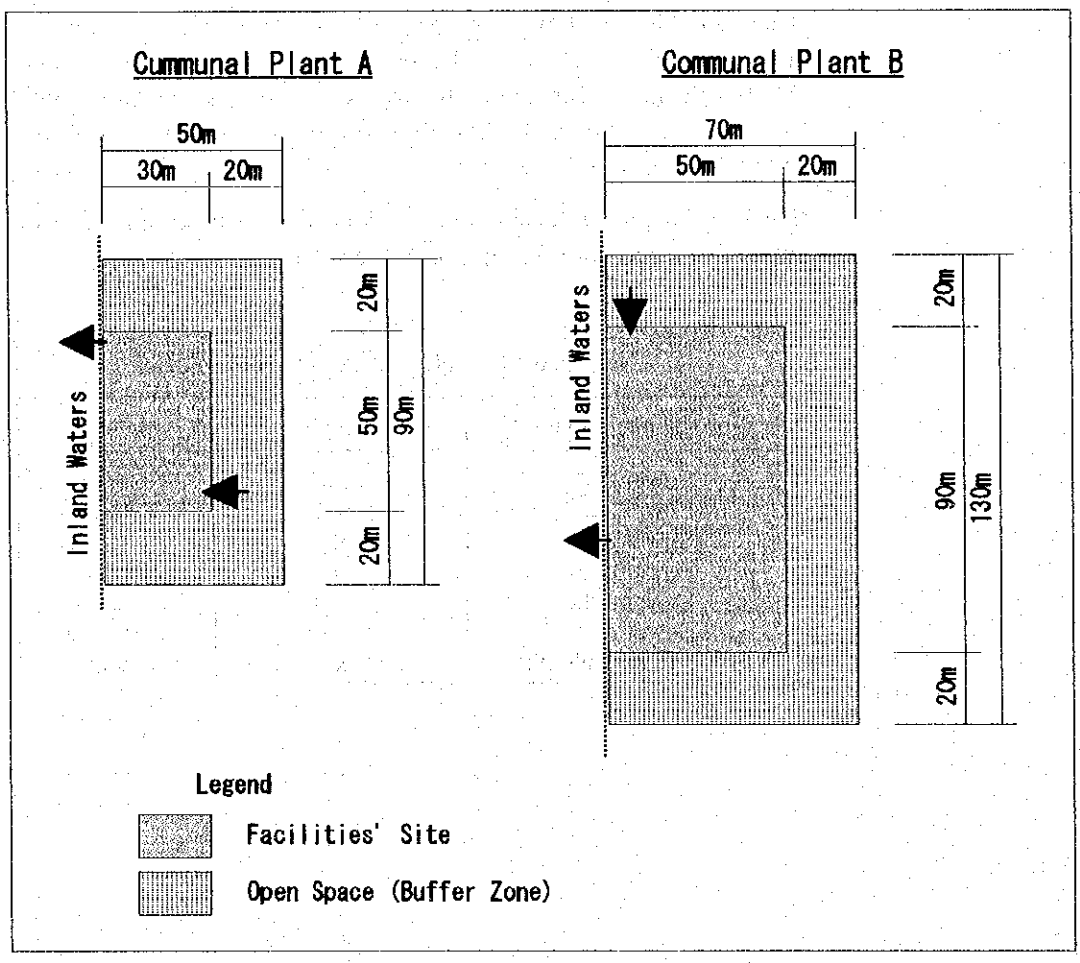
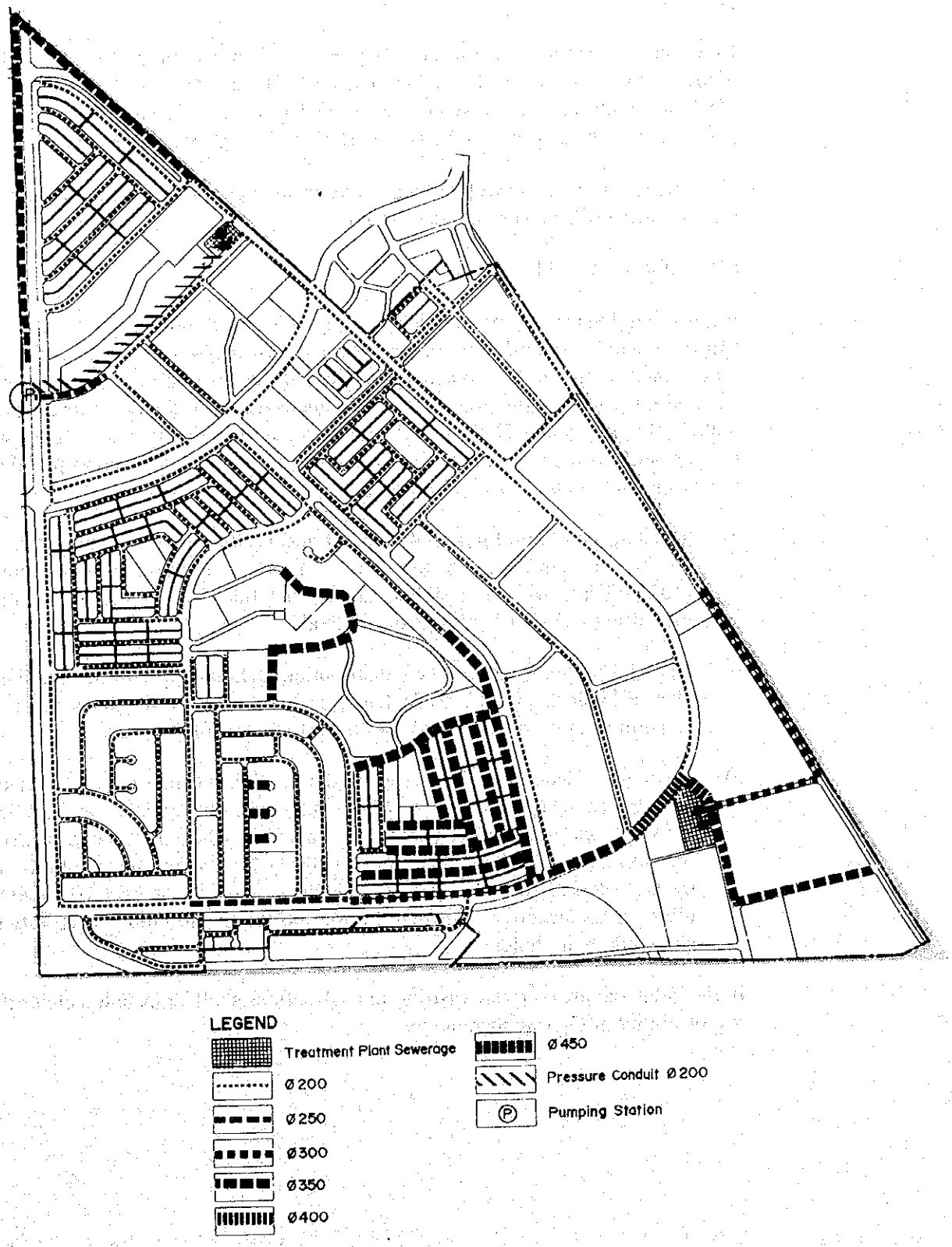


Table 3.24
Sewerage System Plan in Subang Area



2.6 Other Utilities

A. Electricity

(1) Existing Conditions

Electricity is supplied to the area by Tenaga Nasional Berhad (TNB). The distribution main intake (33kv/11kv) located at the Military Air Force Base (TUDM) supplies the consumers in the area with electricity through 24 substations (11kv/433kv) and 29 privately-owned substations (11kv/433kv) for industrial use.

Nowadays, frequent power shortage has been reported to occur due to the mushrooming of factories in recent years.

(2) Improvement Plan

It is obvious that the current electricity supply system will not be able to meet the future demand. Accordingly, the improvement plan covering the transmission main intake, the distribution main intake and the distribution substation was worked out based on the proposed development framework and the discussions with TNB Selangor and TNB Shah Alam. In addition, existing electric lines will be replaced with new ones that run underground. The conceptualized improvement plan is shown in Figure 2.25.

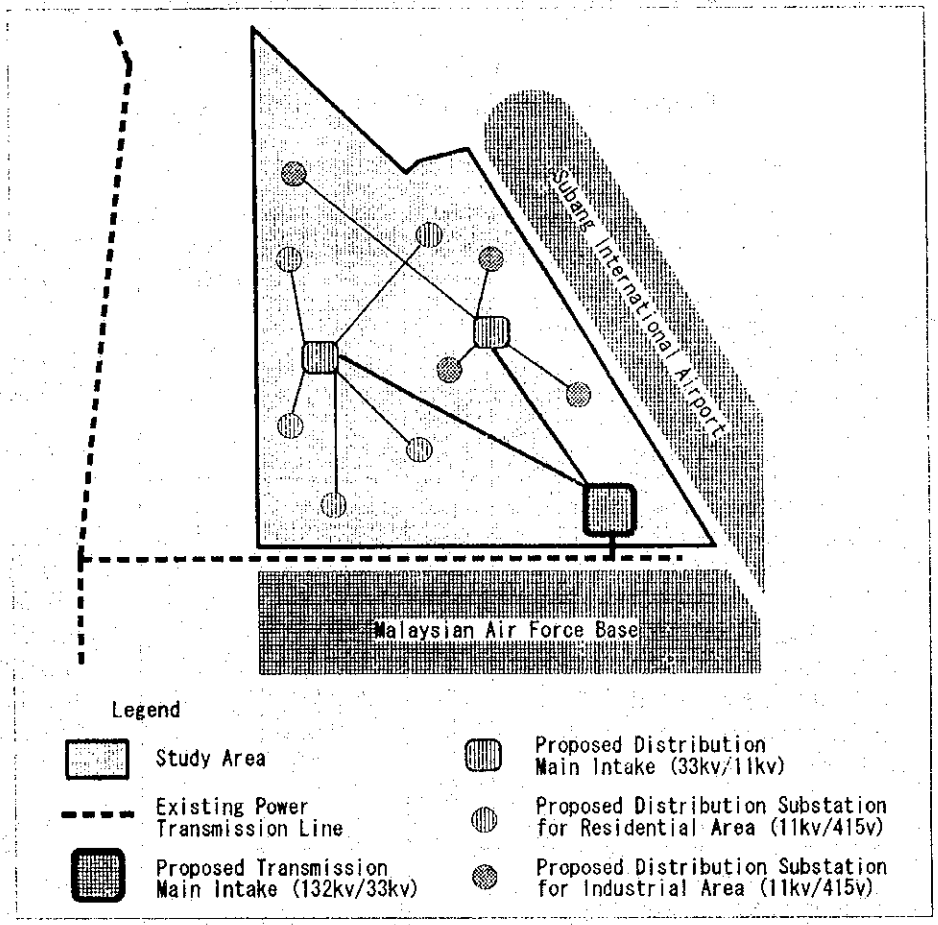
a) Transmission Main Intake: A power transmission line currently lies in the TUDM in parallel with the area. A new transmission main intake (132kv/33kv) will be installed nearby the line. It requires a lot area measuring 125 by 125 meters of flat land.

b) Distribution Main Intake: Two distribution main intakes will be separately allocated with one for the residential area and the other for the industrial area. It requires a minimum lot area of 46 by 46 meters of flat land.

c) Distribution Substation: Two types of distribution substations (11kv/415kv) are required to be installed at several points in the residential area. The first type has one transformer (1MVA in capacity) while the second has two transformers (2MVA in capacity). As for the area requirement, a lot of 4.6 by 7.7 meters ($35m^2$) is designed for the former and a lot of 4.6 x 10.7 meters ($49m^2$) is for the latter. One distribution substation can supply electricity to about 400 households.

In the industrial area, private distribution substations shall be installed under the responsibility of the establishments.

Figure 2.25
Concept of Future Electricity Supply System



B. Telecommunication

(1) Existing Condition

The telecommunication service is provided in the area by Telekom Malaysia through the telephone exchange station at the airport. Although the current exchange station has a capacity of more than ten thousand lines, the service area has rapidly urbanized and will continue to progress in the near future. Accordingly, Telekom Malaysia plans to develop a new exchange station somewhere around the area. The plan will be authorized and implemented in a few years.

Today, overhead telephone lines are in disarray in the area due to the pace of urbanization. It makes systematical management difficult.

(2) The following two points are proposed

- Allocation of a site for the new exchange station (two acres) in the area; and
- Replacement of telephone lines to run underground.

2.7 Estimation of Construction Cost in Subang Area

The table below shows the estimated construction cost for Subang Area.

Table 2.19
Estimated Construction Cost for Subang Area

(CIVIL INFRASTRUCTURE)

WORK ITEM	UNIT	QUANTITY	UN. PRICE	AMOUNT (RM)	REMARKS
1.1 Site Clearance					
1) General Site Clearance	ha	171	7,122	1,219,999	
2) Cutting of Trees (Grith)	pcs	1,000	165	165,000	
Sub-total				1,384,999	
1.2 Earthwork					
1) Cut to Fill (200m)	m^3	2,000,000	3.75	7,500,000	
2) Cut to Fill (1000m)	"	500,000	4.28	2,140,000	
3) Imported Fill	"	100,000	28.50	2,850,000	
4) Spread, Level & Compact Fill	m^2	2,400,000	1.15	2,760,000	
5) Slope Stability Work	"	300,000	0.24	72,000	
6) Turfing Work on Slope	"	300,000	2.82	846,000	
7) Stone Laying Work (30cm)	"	10,000	46	460,000	
8) Stone Pitching	"	3,150	154	485,100	
Sub-total				17,113,100	
1.3 Stormwater Drainage					
1) River Improvement Works					
: Sg. PELUMUT					
- Riverwall Revetment Work (20cmcan.Block)	m^2	4,850	128	620,800	
- Riverbed (20cm)	m^2	2,530	78	197,340	
: Sg. AIR KUNING					
- Riverwall Revetment Work (20cmcan.Block)	m^2	5,170	128	661,760	
- Riverbed (20cm)	m^2	3,290	78	256,620	
				(1,736,520)	
2) Retention Pond					
: Retention Pond A					
- Imported Fill	m^3	4,000	28.5	114,000	
- Spread, Level & Compact Fill	m^2	33,600	1.15	38,640	
- Gabion Mattresses	m^3	600	154	92,400	120x5x1=600
- Stone Pitching	m^2	2,100	154	323,400	300x7=2100
- Outlet	m^3	37	350	12,950	
- Box Culvert (1800x1800x3)	m	30	3,952	118,560	
- Apron	m^3	46	350	16,100	
- Downstream Improvement	m^2	350	128	44,800	5.5x5x1=28
* Riverwall Revetment Work (20cm.con.Block)	m^2	165	78	12,870	
* Riverbed (20cm)	m^3	28	154	4,310	
* Gabion Mattresses					

Cont. Table 2.19

WORK ITEM	UNIT	QUANTITY	UN. PRICE	AMOUNT (RM)	REMARKS
: Retention Pond B					
- Imported Fill	m^3	6,000	28.5	171,000	
- Spread, Level & Compact Fill	m^2	20,880	1.15	24,010	
- Gabion Mattresses	m^3	600	154	92,400	60x5x1x2=600
- Stone Pitching	m^2	3,400	154	523,600	
- Outlet	m^3	17	350	5,950	
- Box Culvert (1800x1800x3)	m	28	1,317	36,880	
- Apron	m^3	19	350	6,650	
- Downstream Improvement	m^2	260	128	33,280	
* Riverwall Revetment Work (20cm.con.Block)	m^2	110	78	8,580	3.7x5x1=19
* Riverbed (20cm)	m^3	19	154	2,930	
* Gabion Mattresses				(1,683,310)	
3) Drains					
: Block & U-Drain					
- Block Drain 300mm	m	3,600	60	216,000	
" 600mm	m	62,300	123	7,663,510	
" 400x1200mm	m	4,175	351	1,465,430	
- U-Drain 750 x 750mm	m	1,950	142	276,900	
" 900 x 900mm	m	1,450	185	268,250	
" 1200 x 1200mm	m	2,850	288	820,800	
" 1500 x 1500mm	m	1,780	360	640,800	
" 1800 x 1800mm	m	1,000	485	485,000	
				(11,836,690)	
: Box Culvert					
- Box Culvert 600 x 600mm	m	6,000	322	1,932,516	
" 400 x 1200mm	m	360	403	145,080	
" 750 x 750mm	m	90	422	37,980	
" 900 x 900mm	m	170	509	86,530	
" 1200 x 1200mm	m	160	770	123,200	
" 1500 x 1500mm	m	160	1,006	160,960	
" 1800 x 1800mm	m	15	1,317	19,760	
				(2,506,026)	
: Sump					
- Sump for Block Drain 300mm	pcs	30	206	6,180	
" 600mm	pcs	520	560	291,200	
" 400 x 1200mm	pcs	27	631	17,041	
- Sump for U-Drain 750 x 750mm	pcs	8	501	4,010	
" 900 x 900mm	pcs	12	667	8,000	
" 1200 x 1200mm	pcs	9	1,111	10,000	
" 1500 x 1500mm	pcs	9	1,638	14,740	
" 1800 x 1800mm	pcs	3	2,275	6,830	
				(358,001)	
: Con.Pipe Dia. 300mm	pcs	8,640	136	1,175,040	@40m 4m x 2160
: Slope Drain					
- Oblique Gutter Drain	pcs	180	81	14,580	
- Beam Drain	pcs	1,800	60	108,418	
				(122,998)	
Sub-total				19,418,585	

Cont Table 2.19

WORK ITEM	UNIT	QUANTITY	UN. PRICE	AMOUNT (RM)	REMARKS
1.4 Roads and Bridges					
1) Roads					
- Major Road (W=30m)	m	988	1,119	1,105,572	
- Collector Road (W=24m)	m	6,507	1,019	6,630,633	
- Major Local Road (W=20m)	m	10,074	606	6,104,844	
- Minor " (W=15m)	m	4,000	670	2,680,000	
- " " (W=12m)	m	24,130	510	12,306,300	
- Parking, Bus Terminal	m^2	15,870	22	349,140	
				(29,176,489)	
2) Bridges					
- Span 10m W=40m	m^2	400	804	321,600	
- " 10m W=16m	m^2	160	804	128,640	
				(450,240)	
Sub-total				29,626,729	
1.5 Water Reticulation					
1) Water Distribution Reservoir	m^2	2,667	550	1,466,850	Capacity = 2667m^2
2) Piping					
- Steel Water Pipe 100mm	m	26,890	125	3,361,080	
" 150mm	m	6,270	160	1,003,200	
" 200mm	m	3,710	200	742,000	
" 250mm	m	2,390	250	597,500	
" 300mm	m	1,270	330	419,100	
" 450mm	m	2,070	500	1,035,000	
" 500mm	m	1,400	600	840,000	
				(7,997,880)	
Sub-total				9,464,730	
1.6 Sewerage System					
1) Sewer (Con.Sewer Pipe)					
- Sewer Pipe Dia. 200mm	m	30,880	99	3,056,840	
" 250mm	m	540	115	62,100	
" 300mm	m	1,350	136	183,600	
" 350mm	m	240	153	36,720	
" 400mm	m	200	176	35,200	
" 450mm	m	120	210	25,200	
				(3,399,660)	
2) Manhole (Precast Con.)	pcs	4,710	861	4,054,560	
3) Brick Manhole	pcs	3,190	680	2,169,200	
4) Sewage Treatment Plant					
- Sg. Pelumut (Population 5,700)	Ls	1		1,140,000	
- Sg. Air Kuning (Population 14,000)	Ls	1		2,800,000	
5) Pumping Station	m^2	100	350	35,000	
- Pump Pit	Ls	1		30,000	
- Pump & Electrical Work					
6) Steel Water Pipe 200mm	m	650	200	130,000	
Sub-total				11,589,220	

Cont. Table 2.19

WORK ITEM	UNIT	QUANTITY	UN. PRICE	AMOUNT (RM)	REMARKS
1.7 Landscaping					
1) Turfing	m^2	94,500	2.82	266,490	
2) Recreational	m^2	23,620	4	94,480	
3) Planting Trees	no	2,000	50	100,000	
4) Planting Shrubs	no	30,000	5	150,000	
Sub-total				610,370	
TOTAL CIVIL INFRASTRUCTURE IMPROVEMENT COST				**89,207,733**	**27.89/m^2**

(MECHANICAL AND ELECTRICAL INFRASTRUCTURE)

WORK ITEM	UNIT	QUANTITY	UN. PRICE	AMOUNT (RM)	REMARKS
2.1 Electricity Supply					
1) Transmission Main Intake					
2) Distribution Main Intake					
- 3KV Switchgear	pcs	8	170,000	1,360,000	
- 3/11KV, 15MVA Transformer	pcs	4	550,000	2,200,000	
- Neutral/Earthing Resister	pcs	2	70,000	140,000	
- 11KV Switchgear	pcs	18	48,000	864,000	
- Ni-cad Batteries & Chargers	Ls	4	4,000	16,000	
- MV Distribution Panel	pcs	2	8,000	16,000	
- Earthing, etc.	Ls	2	10,000	20,000	
				(4,616,000)	
3) Distribution Substation					
- 11KV Switchgear	pcs	24	48,000	1,152,000	
- 11/415KV, 1MVA Transformer	pcs	12	43,500	522,000	
- MV Distribution Panel	pcs	12	8,000	96,000	
- Ni-cad Batteries & Chargers	set	6	4,000	24,000	
- Earthing, etc.	Ls	6	10,000	60,000	
				(1,854,000)	
4) Electrical Cable					
- 185mm2/3C 11KV Aluminium, PILCDSTA&S	m	101	46,600	4,707,013	
- 95mm2/4C 415V PVCSWAPVC	m	97	16,300	1,581,100	
- Trenching and making good	pcs	12	62,900	754,800	
				(7,042,500)	
Sub-total				13,512,913	

Cont. Table 2.19

WORK ITEM	UNIT	QUANTITY	UN. PRICE	AMOUNT (RM)	REMARKS
2.2 Telephone Service					
1) JC9A/R2A Manhole	pcs	350	10,000	3,500,000	
2) 8x100mm Dia PVC Ducting	m	40,000	100	4,000,308	
3) 2x100mm Dia PVC Ducting	m	22,900	30	687,000	
4) 200 pr Cable	m	30,000	40	1,199,993	
5) 100 pr Cable	m	10,000	20	200,000	
6) 10 pr Cable	m	22,900	8	183,200	
7) Trenching and making good	m	62,900	15	943,500	
Sub-total				10,714,001	
2.3 Street Light Installation					
1) 150W SON Lantan	pcs	250	640	160,000	
2) 250W SON Lantan	pcs	1,000	900	900,000	
3) 12m height Colum with Single Arm	pcs	250	900	225,000	
	pcs	1,000	1,000	1,000,000	
4) 12m height colum with Double Arm	m	18,000	26	468,000	
	m	18,000	10	180,000	
5) 16mm2/4 PVCSWAPVC Cabling	pcs	20	20,000	400,000	
6) Trenching and making good				3,333,000	
7) Feeder Pillar					
Sub-total					
MECHANICAL AND ELECTRICAL INFRASTRUCTURE IMPROVEMENT COST				**27,559,914**	**8.64/m²**

Civil, Mechanical and Electrical Infrastructure Improvement Cost	116,767,647	*1*
Detail Design Works	11,676,765	*2* = *1* X 0.10
Management and Supervision	2,3305,353	*3* = *1* X 0.02
Contigency	6,538,988	*4* = (*1* + *2* + *3*) X 0.05
Total Construction Cost	137,318,753	42.96/m²

CHAPTER 3 KUANTAN PROJECT AREA

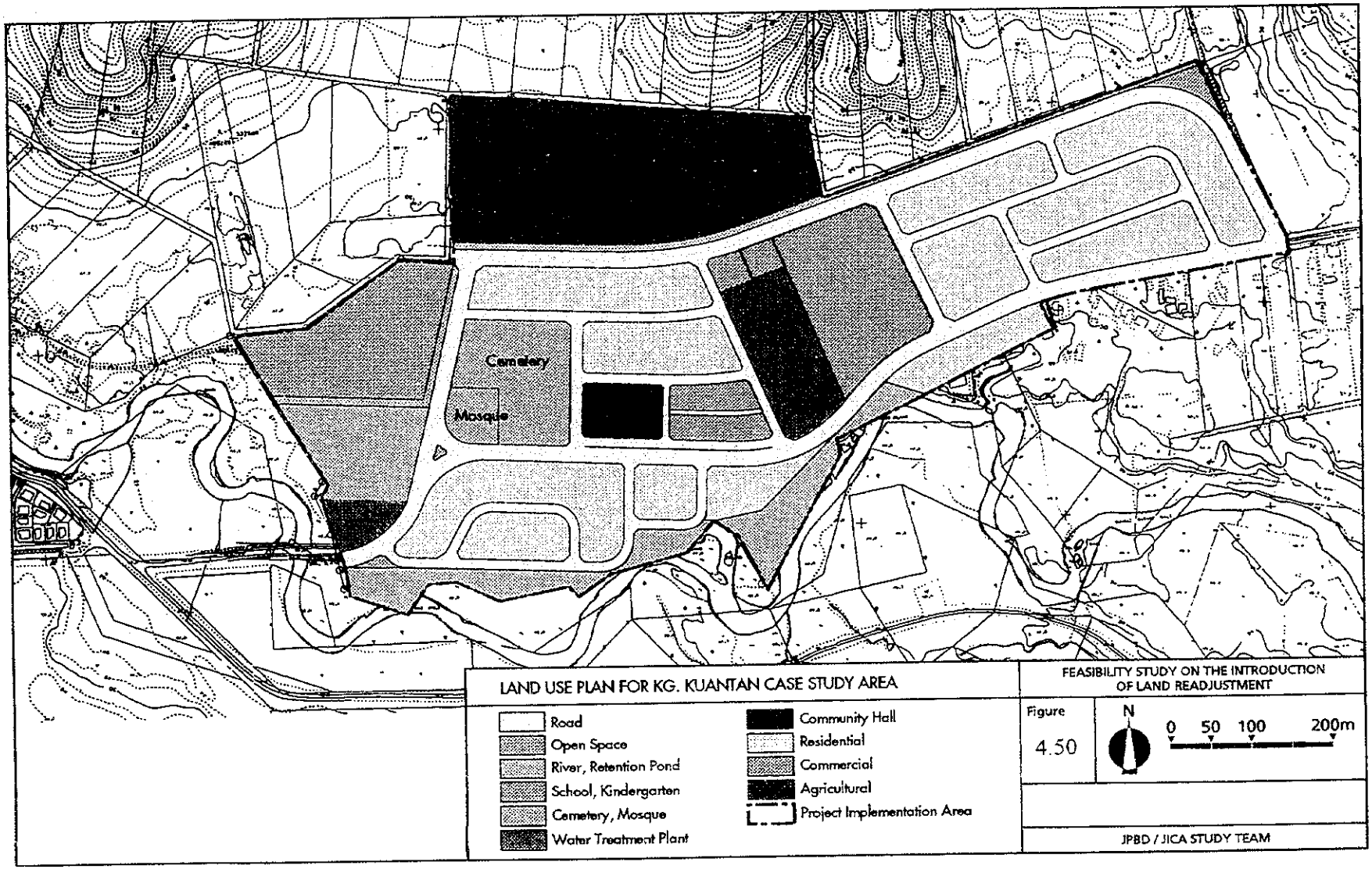
3.1 Summary of the Layout Plan

Table 4.1 summarizes the land use plan of Kuantan project area.

Table 3.1
Land Use Plan

Land Use	Amount (m^2)	%
PUBLIC LAND USE	245,130	54.27
Road Inner Collector Outer Collector Collector Local (Back Lane)	 29,085 26,502 6,534 31,873 (702)	
Sub Total	93,994	20.81
River River River Reserve Retention Pond	 10,663 23,330 15,450	
Sub Total	49,440	10.95
Open Space Playground Playlot	 25,450 3,640	
Sub Total	29,090	6.44
Educational Facilities Primary School Kindergarten	 25,000 1,500	
Sub Total	26,500	5,87
Water Treatment Plant Oxidation Pond Cemetery Mosque	16,250 4,000 16,000 5,000	3.60 0.88 3.54 1.11
Institution Community Hall Clinic	 3,360 1,500	
Sub Total	4,860	1.07
PRIVATE LAND USE	206,570	45.73
Residential	133,370	29.53
Commercial	5,800	1.28
Agriculture	67,400	14.92
TOTAL	451,700	100.00

Figure 3.1
Land Use Plan for Kg. Kuantan Case Study Area



3.2 Land Development Plan

The case study area gently slopes on the northern and western sides. The area is 1.2 km broad from east to west with a height difference of only 1.4m which is equivalent to an inclination of 1.2%. Adversely, from a north-south section, it is surveyed that a small natural creek passes through the area and, consequently, has made a series of small hollows.

Based on the current situation, a land development plan has been prepared with the following planning considerations:

a) The small creek will be transferred to the northern edge of the area and the comparatively low land will be filled;

b) The land of existing houses and public facilities will be undisturbed;

c) Planned ground level will be determined by the following criteria:

- All ground levels will be higher than the designed high water level of a retention pond, and
- Filling and cutting works will be balanced within the area;

d) Prior to earth works, the following countermeasures will be taken against anticipated adverse effects:

- The perforated hume pipes (150mm - 300mm in diameter) will be installed to replace the existing tiny creeks to prevent landslides, and
- Fences and gabions will be equipped to reduce a river current and temporary dams will be developed to prevent soil outflow.

The amount of cutting and filling works was calculated at 152,000m^3. The soil haulage plan was prepared to minimize total haulage distance as depicted in Figure 3.2.

3.3 Road Network Plan

In accordance with the proposed Master Plan, the road network in the area will be comprised of roads shown in Table 3.2. The Inner Collector Road is for the daily short trips to and from around Kg. Kuantan. The following detail designs shall be adopted:

a) Large-sized drain reserve (3m in width) at the north side to collect the storm water runoff within the improved area; and

b) Cycle track (2m in width) at the south side for the convenience and safety of primary and secondary students.

Figure 3.2
Earthworks Plan in Kg. Kuantan

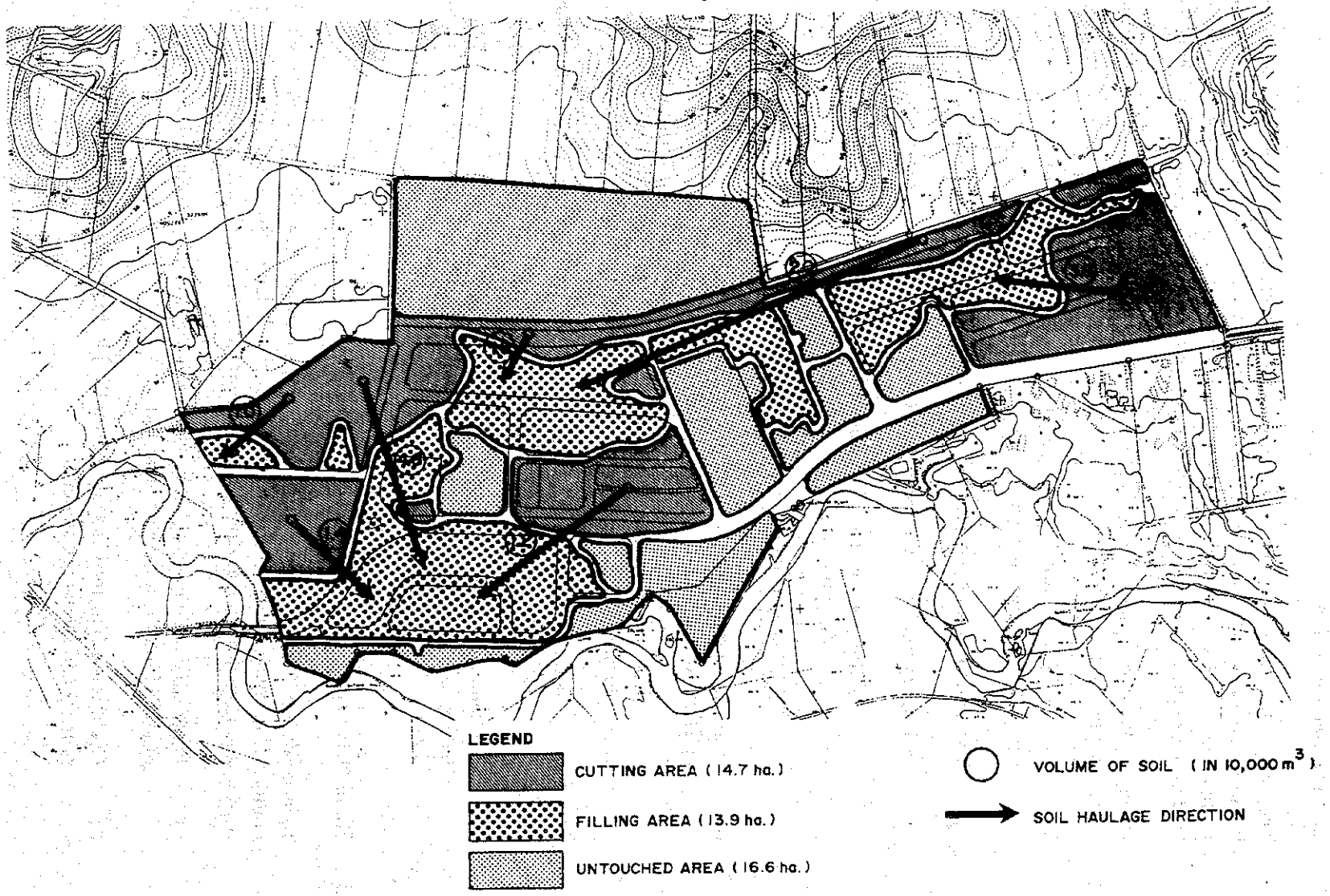


Table 3.2
Road Types in the Proposed Road Network

	JKR Type	Width (m.)	No. of Lanes	Total Length (m.)
Inner Collector Road	U2	24	2	1,290
Outer Collector Road	U2	20	2	1,403
Major Local Road	U1	15	2	414
Minor Local Road	U1	12	2	2,575
Backlane	-	6	-	106

On the other hand, the Outer Collector Road, which will eventually be connected with Batang Kali, intends to cope with through-traffic. A proposed waterway will flow in parallel with the road and, therefore, drain reserve will not be necessary at the waterway side.

The proposed road network is depicted in Figure 3.3 and the typical cross sections are illustrated in Figure 3.4. Since the Inner Collector Road and the Outer Collector Road are not antithetic, design directions are also indicated in Figure 3.3.

Figure 3.3
Road Network Plan in Kg. Kuantan

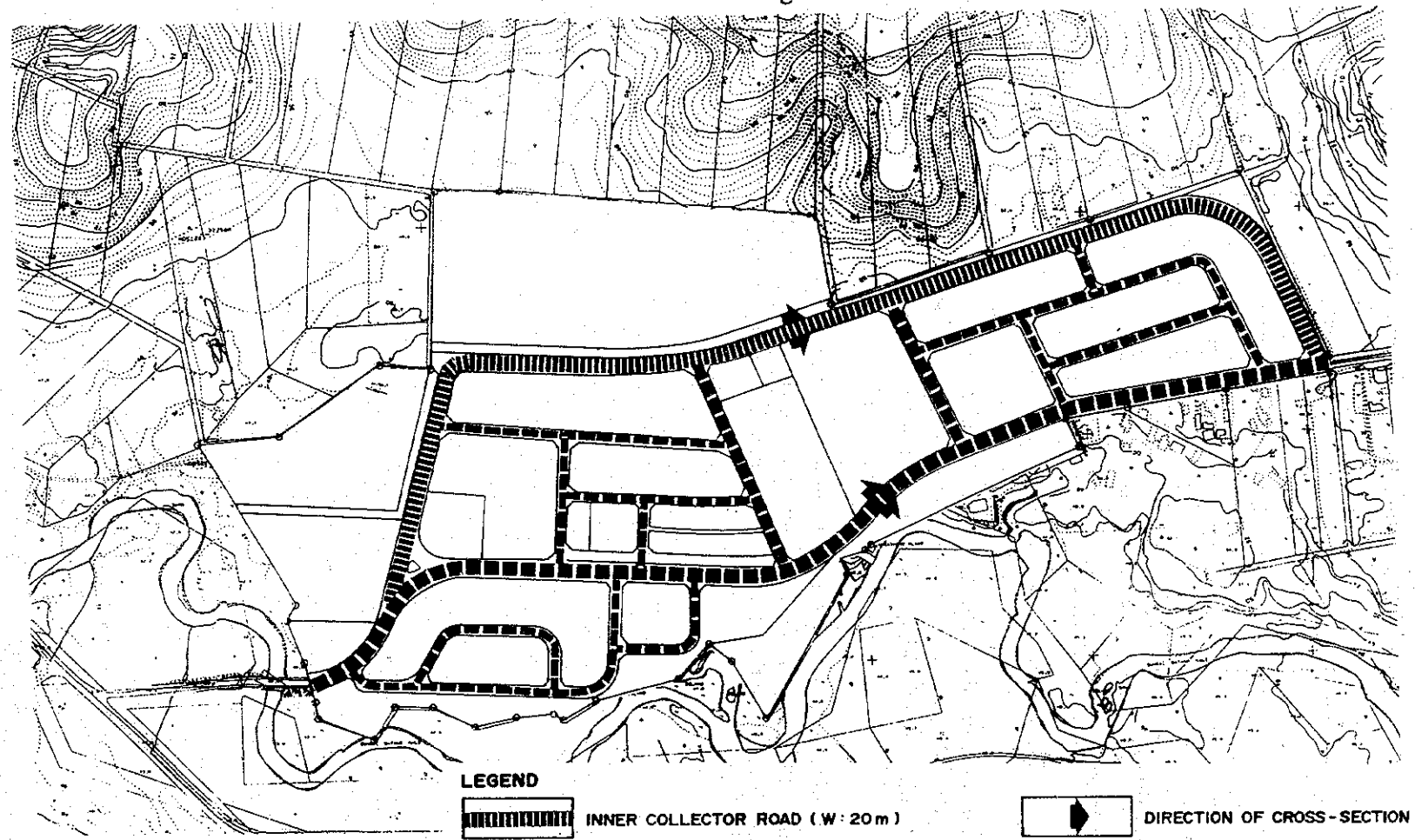
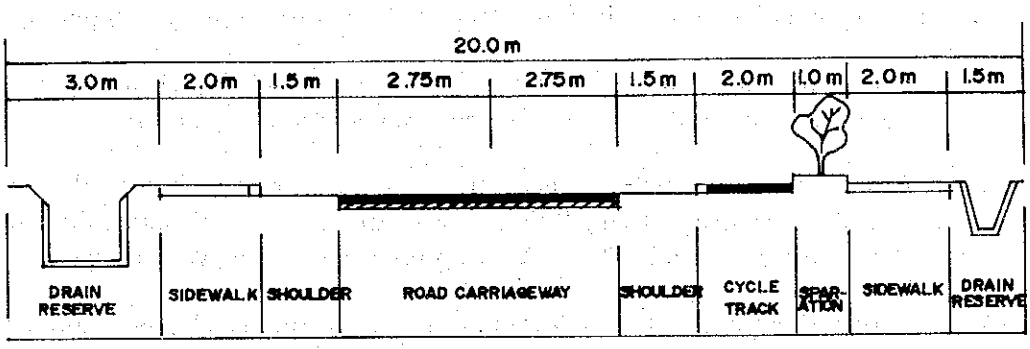
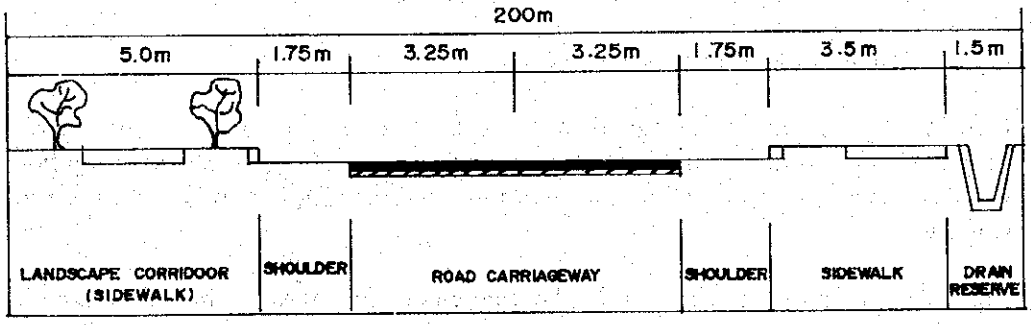


Figure 3.4
Typical Cross-Section of the Roads

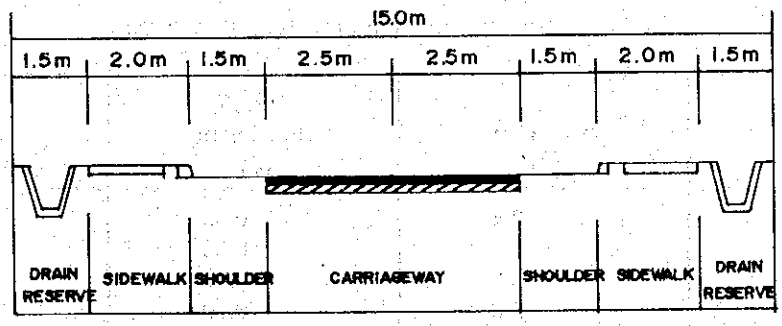
INNER COLLECTOR ROAD



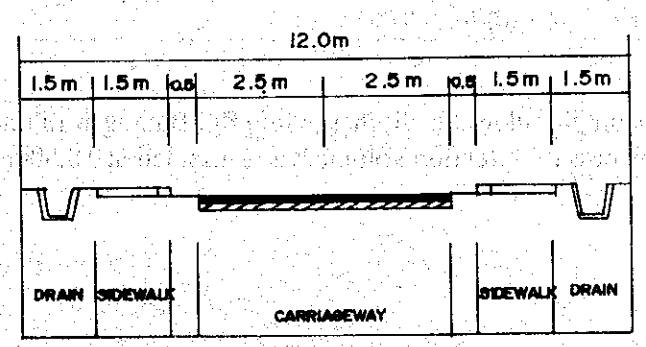
OUTER COLLECTOR ROAD



MAJOR LOCAL ROAD



MINOR LOCAL ROAD



3.4 Flood Protection System Plan

(1) Policy Setting

The following policies were set in drawing up the flood protection system plan:

a) The project implementation area will not encompass Sg. Batang Kali. Only adequate replot of the river reserve will be undertaken by the project.

b) A natural creek, which originates from the north, passes through the area and finally flows into Sg. Batang Kali, will be modified artificially along the proposed Outer Collector Road. The water will join in Sg. Batang Kali directly.

c) A retention pond will be allocated to minimize the development influence on downstream area.

d) Several types of drains will be installed at both roadsides except the proposed Outer Collector Road. Storm water runoff in the area will be initially poured into the drains and conveyed to a retention pond.

(2) Retention Pond Development Plan

One retention pond was designed for the catchment area of 30.6 ha which covers the proposed urbanized area and excludes agriculture land, playground, oxidation pond and river reserve in the project area to avoid the overlapping coverage with the proposed waterway.

The average runoff coefficient in the catchment area was estimated at 60% on the proposed land use plan as shown in Table 3.3.

Table 3.3
Average Runoff Coefficient in Kuantan Area

Land Use	Area (ha) (A)	Runoff Coefficient (B)	(A) x (B)
Residential	13.4	0.55	7.37
Commercial	0.5	0.80	0.40
Public Facilities	5.3	0.45	2.39
Playlot, Cemetery	2.0	0.20	0.20
Road	9.4	0.85	7.99
Total	30.8	-	18.35
Average Runoff Coefficient: (A) x (B)/(A) = 0.60			

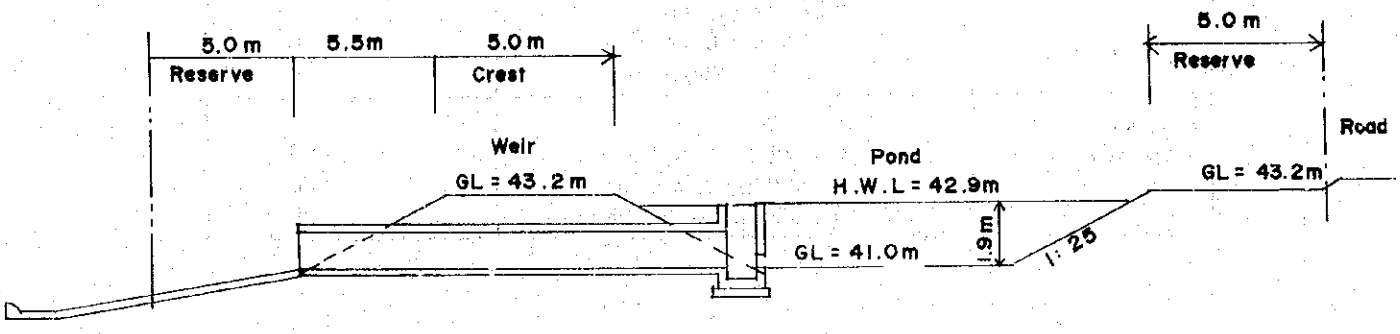
Taking into account the allowable discharge into Sg. Batang Kali under the five (5) years return period, necessary retention volume was estimated at 18.500m^3 as shown below:

Table 3.4
Estimated Retention volume

(Conditions)	
Catchment Area (ha)	30.8
Runoff Coefficient	0.60
Allowable Discharge (m^3)	0.302
Rainfall Intensity (mm/h)	3,867 ($t^{0.9}$ + 10.85)
(Retention Volume)	
rc (mm/h)	5.5
t (min.)	352
Vmax (m^3)	18,500

The necessary area for the retention pond, which includes reserve land, weir and pond, will be 1.6 ha based on the proposed sectional design illustrated in Figure 3.5.

Figure 3.5
Retention Pond Sectional Design



(3) Overall Drainage System Plan

The proposed overall drainage system consisting of an artificial waterway, drains and a retention pond is depicted in Figure 3.6. Several types of block drains and U-drains were employed in the plan. The necessary number of drains and waterways required is shown in Table 3.5.

Table 3.5
Required Number of Drains and Waterways

Type		Length (m)
Block Drain	300 mm	1,125
	600 mm	4,975
	400 x 1,200 mm with brickwall	1,660
U-Drain	750 x 750 mm	510
	900 x 900 mm	320
	1,200 x 1,200 mm	170
Sub-Drainage	600 x 600 mm	120
	400 x 1,200 mm	78
	750 x 750 mm	27
	900 x 900 mm	59
	1,200 x 1,200 mm	20
Artificial Waterway	(w) (h)	
	300-1,000 x 2,000 mm	493
	6,000-4,000 x 2,000 mm	820
	3,000 x 2,000 mm (Box Culvert)	20

Figure 3.6
River and Drainage System Plan in Kg. Kuantan