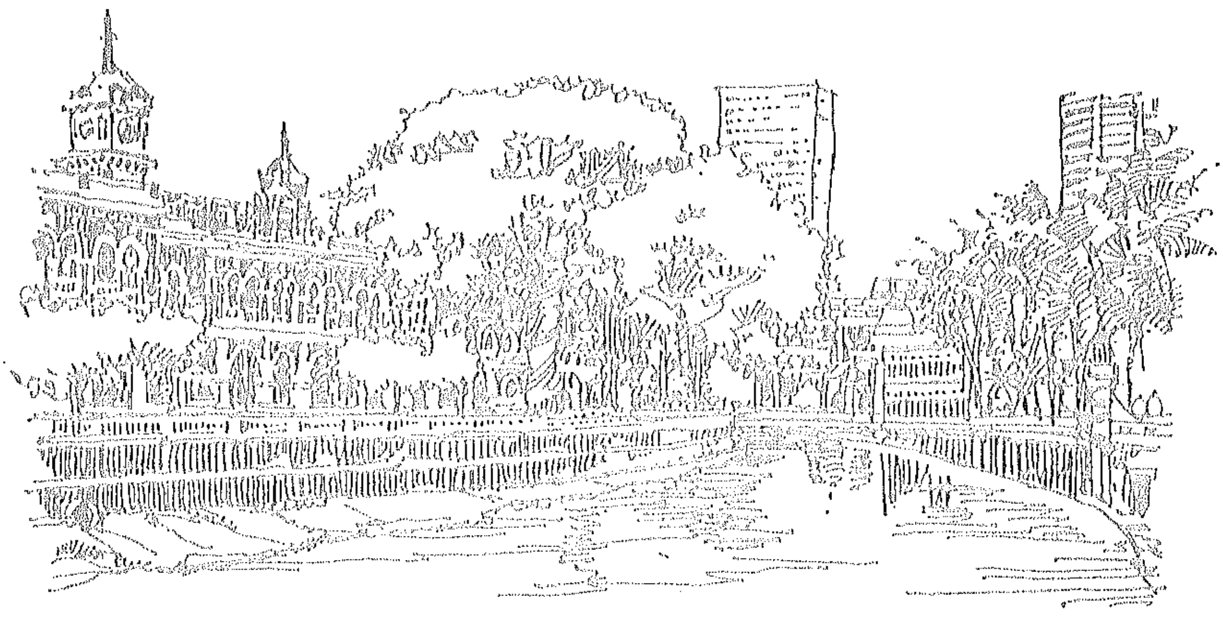
社会開発協力部報告書

No. 3

GOVERNMENT OF MALAYSIA

THE STUDY ON THE FLOOD MITIGATION OF THE KLANG RIVER BASIN

SUPPORTING REPORT
VOLUME II
(APPENDIX J～P)



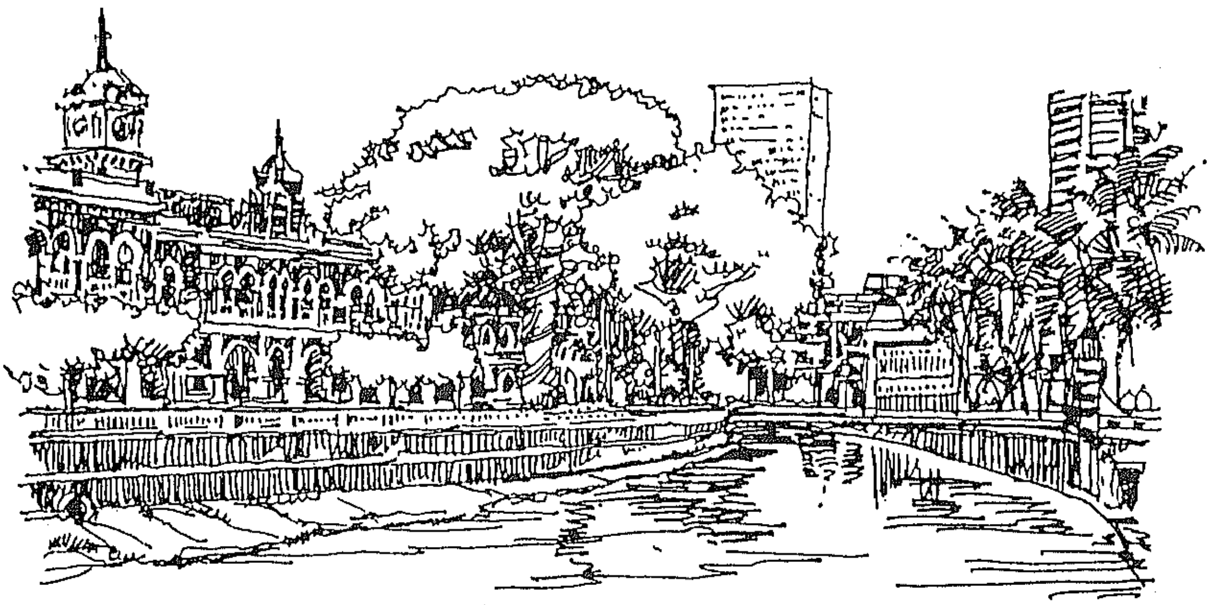
JANUARY 1989

JAPAN INTERNATIONAL COOPERATION AGENCY

GOVERNMENT OF MALAYSIA

THE STUDY ON THE FLOOD MITIGATION OF THE KLANG RIVER BASIN

SUPPORTING REPORT
VOLUME II
(APPENDIX J ~ P)



JANUARY 1989

JAPAN INTERNATIONAL COOPERATION AGENCY

SUPPORTING REPORT

VOLUME II
APPENDIX (J~P)

LIST OF CONTENTS

VOLUME I

VOLUME II

APPENDIX J: URGENT FLOOD MITIGATION PLAN

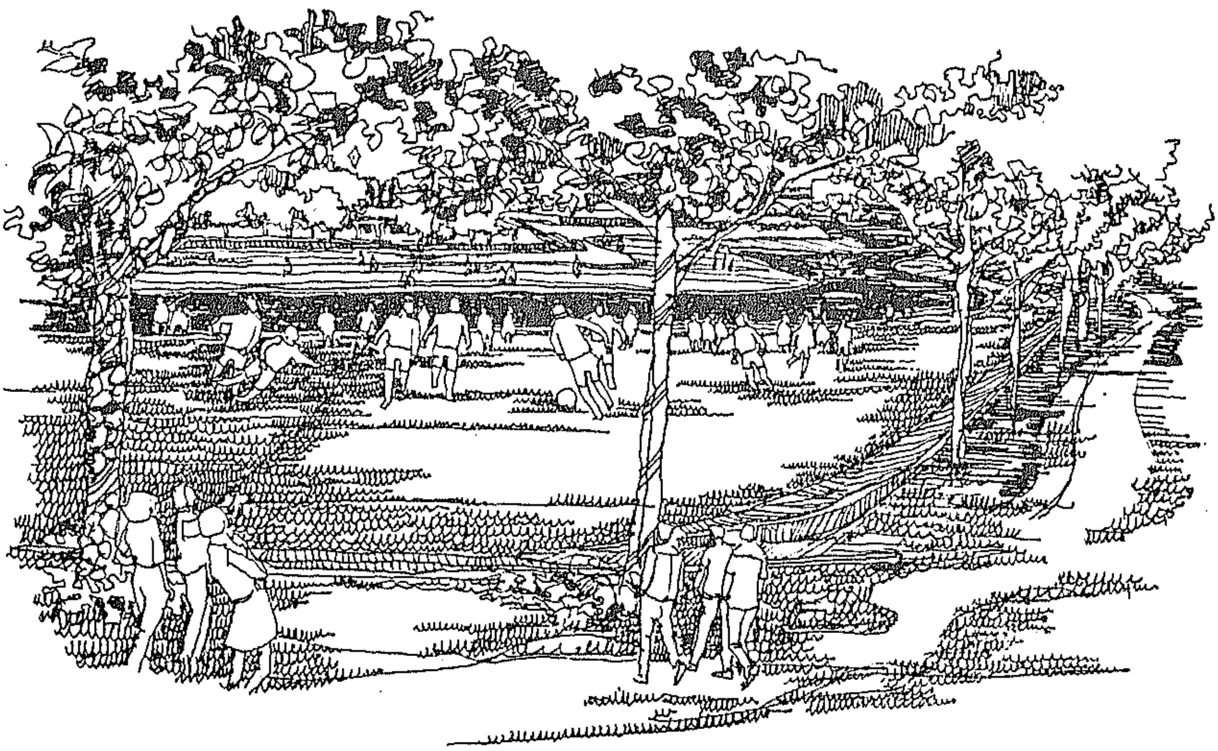


TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

APPENDIX J. URGENT FLOOD MITIGATION PLAN

1. GENERAL

The comprehensive flood mitigation plan aims to mitigate flood damage not only in the existing, but also future urban area. The economic viability of the plan under the present stage is not high for the downstream stretches, where much capital will be required due to its large project scale. However, as mentioned in the APPENDIX G, the existing urban area of Kuala Lumpur City often suffers from flood damage and requires immediate attention. For this reason, an "urgent flood mitigation plan" based on the master plan is studied to formulate a priority project for immediate implementation, aimed at mitigating of flood damage in the existing urban area.

2. SELECTION OF AREA FOR URGENT FLOOD MITIGATION PROJECT

The drainage basin and the corresponding river stretch for consideration to the flood mitigation facility of the urgent Flood Mitigation Project, that consists of structural measures of flood mitigation, is to be selected by taking into account the following factors;

- The extent of economic effectiveness
- Degree of urgency based on social requirement
- Scale of investment
- Frequency of inundation
- Current situation of on-going river improvement works
- Effects imparted downstream due to the project realization
- Extent of compensation for existing facilities
- Time requirement for removal of squatters
- Degree of complexity involved in project execution

Among those flood prone areas that are in need of structural measures, the upper reach of Sulaiman Bridge was selected for feasibility study of the Urgent Flood Mitigation Plan due to the following reasons;

(1) Among the proposed flood control projects area, this stretch at upper reach of Sulaiman bridge has the highest economic viability.

(2) A retention pond is very reliable, and hence, the reduction of peak discharge could be achieved with high degree of certainty to mitigate flood damage at downstream.

(3) In this upper reach area of Sulaiman bridge, there are many flood prone areas including the lowlying area of Kg. Baru which is frequently inundated by flash floods. Based on this fact and governmental requirements, this area must be included in the urgent project.

(4) The river improvement work in the Kuala Lumpur city center, which forms a portion of this selected project area, is partly executed by DID, with problems involving land acquisition being partly solved.

3. FLOOD PROTECTION LEVEL OF URGENT PROJECT

As described in APPENDIX E, the river stretches in the central part of the City are already partially improved. These stretches have been widened to their final widths with only the excavation works of river beds still remain to be executed. The river beds of these stretches can be excavated only after the completion of improvement works of downstream stretches. Hence, the existing flow capacity of these stretches will be the same as that prior to the implementation of urgent project works, but the flood protection level will be raised due to the effect of flood mitigation by retention pond.

At Sulaiman Bridge of the Klang River, the flood protection level will be increased from 1/25 to 1/35 after the completion of this urgent flood mitigation plan.

4. PROPOSED URGENT FLOOD MITIGATION PLAN

4.1 Flood Mitigation Facilities of Urgent Project

The flood mitigation facilities to be executed in Phase-I of urgent project are shown in Table J-1 and Fig. J-1.

The river improvement works will be executed for the stretches of 10.4 km in length of the Klang, Gombak and Batu Rivers.

The stretch K9 of the Klang River is the one that has the highest priority for improvement, and also the stretches G4, B2 and B3 have to be improved for the effective use of the Batu Retention Pond.

The Batu Retention Pond and the Gombak Diversion Channel will also be constructed in this stage.

Five bridges across the Batu River and one bridge across the Klang River are to be reconstructed.

4.2 River Improvement

4.2.1 General

The stretches to be improved for the urgent project are of 11.5 km long and it is possible to improve these stretches to their final sections. Hence, after the improvements the design discharge will be a 100-year floods. All stretches already improved by DID do not have enough flow capacity for their flood discharges, because their low water channel portions still remain unimproved. The river bed in these stretches could be excavated only after the completion of river improvement of the downstream stretches and removal of Puchong Drop structure. Furthermore, in some stretches, the steep slope berm or narrow low flow channel width, caused by the obstructions due to the existing river related structures, decrease the flow capacity of the channel. In this section, the re-improvement plan of these channel sections are studied.

4.2.2 Distribution of Proposed Design Discharge

The design discharges are formulated under the following conditions:

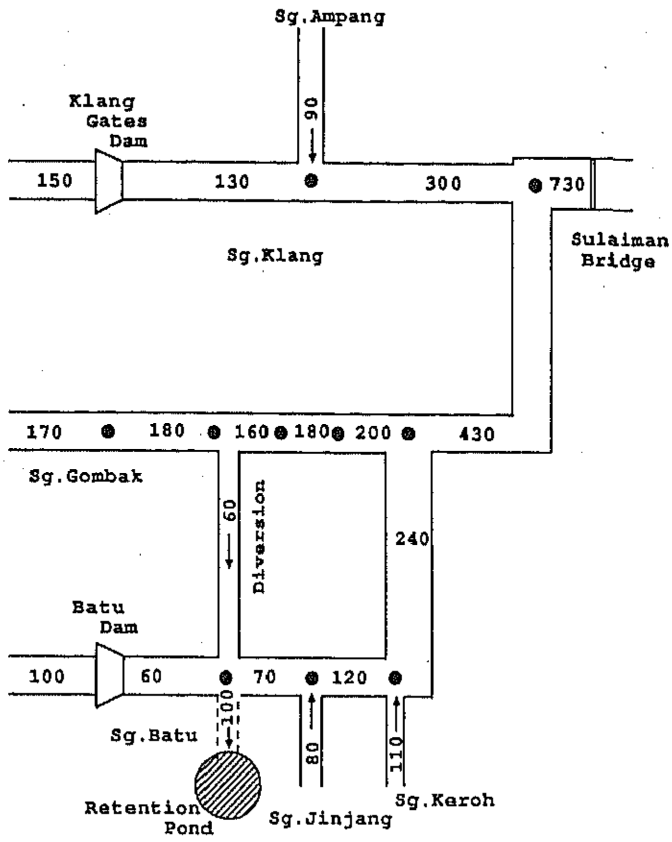
i) A design storm of 35-year return period was used for Urgent Project,

ii) Land use condition is for the year 2005,

iii) The Klang Gates Dam and the Batu Dam are used for flood mitigation and their maximum water release during a flood event are 15 m^3/s and 7 m^3/s respectively, and

iv) Maximum flow capacity at Sulaiman Bridge after improvement works will be 730 m^3/s.

The design discharges for the upstream stretches of the Sulaiman Bridge are shown below:



4.2.3 Review of Existing River Improvement Plan

(1) General

The river improvement plan for the Klang River and its main tributaries, the Gombak River and Batu River, was first formulated in 1974. Since then, the plan has been revised several times until the last revision in 1984. By then more detailed information and data pertaining to the final river improvement plan, as well as the existing detailed design drawings, were completed.

A comparison between the actual flow capacity and the capacity proposed by JICA at each cross section was carried out. Three types of plans were obtained. They are: the latest plans completed in 1984, the detailed design plans, and the 1974 plans.

The following coefficient of roughness were adopted:

For earth section	Manning's	n = 0.025
For grass section		n = 0.030
For concrete section		n = 0.015
And for steel sheet piles		n = 0.025

It is likely that a typical section will comprise of a combination of the materials listed above resulting in a composite roughness. The water area is divided into N parts with wetted perimeter P1,P2,...,PN and the respective coefficients of roughness being known values n1,n2,...,nN. It is assumed that each part of these area has the same mean velocity, which is equal to the mean velocity of the whole section. Then the composite roughness may be obtained by the following equation:

$$n = \left[\frac{\sum_{1}^{N} (P_N n_N{}^{1.5})}{P} \right]^{2/3} = \frac{(P_1 n_1{}^{1.5} + P_2 n_2{}^{1.5} + \cdots + P_N n_N{}^{1.5})^{2/3}}{P^{2/3}}$$

Uniform flow theory is applied and the discharges are obtained by using Manning Formula.

(2) Comparison of the River Improvement Plans

Only the completed sections are considered in this investigation as it would give a fair comparison between the actual flow capacity and that proposed by JICA Study Team. The effect of piers is not considered in the flow capacity calculation.

i) Klang River

At the Leboh Pasar (Market Street) section, the existing flow capacity of 654 m^3/s is lower than the proposed design discharge of 730 m^3/s while the flow capacity at the Gombak River Confluence is only 612 m^3/s compared to the proposed discharge of 730 m^3/s.

From the Gombak River Confluence to the Tun Perak Bridge and at upstream until Sultan Ismail Road Bridge, the actual flow capacities are 640 and 560 m^3/s respectively, compared to the proposed uniform design capacity of only 310 m^3/s. This means that the actual channel section designs are conservative.

ii) Canalization of the Gombak River from the Klang River Confluence upstream until Tun Razak Road Bridge has been completed. The actual flow capacity of Gombak River at the completed sections are all found to be lower than the proposed design capacity. The table below shows the comparison of the discharges.

Location Gombak River at:	Actual Capacity (m^3/s)	Proposed Capacity (m^3/s)
Raja Road Bridge	365.7	430
RTBKL No. 22	381.6	430
RTBKL No. 14	402.2	430
Tun Razak Road Bridge	182.7	200

iii) Batu River

The canalized section of Batu River stretches from Gombak River confluence to Batang Tolak River confluence and is known as RTBKL No. 4. The flow capacity of this channel is 167 m^3/s compared to the proposed capacity of 240 m^3/s.

As some of the existing sections are unable to carry the proposed capacity, structural measures are to be taken to rectify the situation. This will be discussed under the structural plan of river improvement in the next chapter.

4.2.4 Structural Plan of River Improvement

(1) Standard Sections for River Improvement Works

The types of channel sections adopted were based on those of the existing river improvement plan. However, if the channel section selected has a capacity lower than the designed discharge capacity, a new section will be considered.

Such changes would most likely take place at the following areas:

a) River Bend Curvatures

To reduce losses at river bends, the river should have a radius of curvature of at least 120 m, or 4 times the top width of the river section at the bend.

b) River Reserve

The following river reserve widths should be adhered to as far as possible for a 100-year floods.

100-year Discharge, Q (m^3/s)	Reserve Width (m)
$Q < 28$	30
$28 < Q < 85$	40
$85 < Q < 198$	50
$198 < Q < 283$	60
$Q > 283$	Special Consideration

c) Computation of the Capacity of the River Section

It is generally accepted that the conditions uniform flow applies for an open channel. Hence, Manning's formula is used.

(2) The Proposed River Improvement Plan for Klang, Gombak and Batu Rivers

The river alignment and the planned longitudinal profile will follow those of the existing river improvement plan. The planned cross sections will be governed by several factors. These sections must be able to contain the capacity of the design discharges. The governing factors are i) the maximum design velocity of about 3 m/s, ii) the avoidance of permanent constrictions or obstructions, and iii) the reduced level of the river banks. The top bank elevations is determined by checking the critical levels of the river bed and the design high water level. Location of drop structures are determined by the nature of the slope of the river bed.

(3) River Improvement

In the Klang River, the K9 stretch of 1.3 km in length between Tun Perak Bridge and Jln. Sultan Ismail Bridge is to be widened and deepened. With completion of this improvement works, the whole stretches between 3rd Mile Railway Bridge and Circular Road Bridge of the Klang River will be completed, with only a partial deepening works of the river bed still remain to be executed. K9 channel section is double cross section and consists of retaining walls with sheet piles and concrete lining on the berms.

In the Gombak River, the G4 stretch of 2.5 km in length between Sg. Belongkong confluence and Gombak Diversion channel is to be widened and deepened to facilitate diverting the design discharge into diversion channel. The channel has double cross section with concrete retaining walls in the low flow channel. The berm will be protected with sod-facing.

In the Batu River, the stretch B3 along the proposed retention pond and the stretch B2 between Ipoh Road Bridge and Sg. Batang Tolak confluence are to be widened and deepened to obtain the necessary effective water depth of retention pond. The channel is of 6.6 km long and double cross section with concrete retaining walls in low flow channel. The construction of three drop structures are also to be executed.

Five bridges across to Batu River are to be reconstructed due to inadequate span length for the proposed river section. These typical sections of river related structures are illustrated in Fig. J-2.

In B3 stretch, there exists a primary regulation pond to serve during flooding. The design longitudinal profiles and cross sections of these stretches are shown in Figs. J-3 to J-6.

4.3 Batu Retention Pond

4.3.1 Present Conditions of Proposed Site for Retention Pond

The proposed site for the Batu Retention Pond is located in an ex-mining area bordering the western bank of the Batu River lying between 6.0 km point and 8.4 km point along the Batu River. In APPENDIX D, after due considerations of various alienations made by City Hall on this abandoned mining area, Lots R1, R3, R4 and T1 had been recommended to be allocated for siting the Batu retention pond cum park complex.

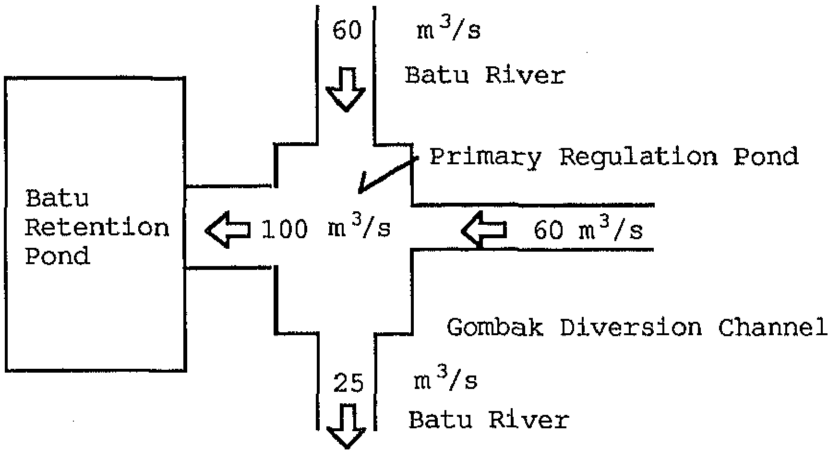
Topographically speaking, the land is undulating, with mounds and small hills as well as large existing abandoned mining pond having a water surface area of 55.7 ha, and a maximum depth of some 35 m. The western part of this pond has been alienated for housing development and filling in of this part of the pond is already in progress.

Ecologically speaking, the entire abandoned mining area is almost barren, with only several species of hedges and hardy shrubs as major plants.

4.3.2 Basic Conditions for Design Considerations

(1) Proposed Design Discharge Distribution

The design discharge into the retention pond is 100 m^3/s of which 60 m^3/s is the discharge from the diversion channel and 40 m^3/s from the Batu River. The design discharge distribution is as follows:



(2) Design Storage Capacity of the Retention Pond

The design storage capacity is 2.7 million m^3 which is derived from the Net Storage, storage from the retention pond area and the free storage.

The value of the net storage is obtained from a simulation model, while the storage of the retention pond is calculated as follows:

$V = A \times C \times R$ where, V = storage (m^3)

A = retention pond area (m^2)

C = run-off coefficient (0.9 is used)

R = 2 days (design) rainfall of 182 mm

About 50% of the net storage is set as free storage to cover the difference between the estimated volume and actual volume, etc.

(3) Design Discharge of Channel at Downstream of Regulation Pond

The design discharge of this channel depends on the following factors 1) discharge from Batu Dam after a flood event (100 year flood), 2) the amount of run-off into the river from the catchment between the dam and the retention pond, and 3) dewatering discharge from the retention pond.

The most critical case would be the release of water from the dam and from the retention pond after the 100-year flood event.

Discharges from the Batu Dam varies with the time of dewatering as shown below.

Flood Control Volume of Batu Dam	Dewatering	
	Hour (hr)	Discharge (m^3/s)
4,890,000 m^3	12	115
	24	60
	36	40
	48	30

The dewatering time was set at 36 hours considering the total time with 2 days design rainfall. 84 hours is the estimated interval until the next flood. In such a case, the dewatering discharge is about 40 m^3/s.

The dewatering time from the retention pond should be the same as that of the Batu Dam, i.e., 36 hours. The rate of dewatering discharges will be 20 m^3/s.

(4) Frequency of Overflow

The minimum discharges to overflow the diversion weir are as follows:

Gombak River $Q = 125\ m^3/s$

Batu River $Q = 25\ m^3/s$

Any flow greater than these values will overflow into the diversion channel or retention pond.

Run-off calculations are carried out to determine the frequency of overflow and probable rainfalls of 1.5 to 50-year return periods were used to determine the amount of run-off.

The frequency of overflow of the Batu retention pond is 2.5 years while that of Gombak is 38 years. These values were obtained by interpolating the values of return periods versus discharges, as shown below:

Batu River		Gombak River	
Return Period (year)	Discharge (m^3/s)	Return Period (year)	Discharge (m^3/s)
1/5	35	1/50	140
1/2	22	1/30	113
1/1.5	14	1/10	68

4.3.3 Structural Plan of Retention Pond

(1) Retention Pond

The Batu Retention Pond will be constructed using the ex-mining area bordering the western bank of the Batu River, lying between 6.0 km point and 8.4 km point of the Batu River.

During the design flood of 100-year return period, 60 m^3/s from the Gombak River and 40 m^3/s from the Batu River will flow into the retention pond.

The capacity of the Retention Pond is 2,700,000 cubic meters and the maximum effective depth for flood mitigation will be 7.3 meter. The dimensions of this pond are as follows:

Pond Capacity	2,700,000 m^3
Pond Area	61.4 ha
Permanent only	30.5 ha
Temporary only	30.9 ha

Entire Area of Retention Pond including Park area		113.4 ha
Water Level of Pond		
L.W.L.	:	EL. 38.20 m
H.W.L.	:	EL. 43.70 m
Max. H.W.L.	:	EL. 45.50 m
Top of Levee	:	EL. 47.00 m
Base level of permanent pond	:	15.00 m

The retention pond is categorized into sections according to their functions in terms of flood mitigation. The plan of the Retention Pond is shown in Fig. J-7.

The central section of the pond is permanently filled with water. The depth of this pond is about 23 m. The edges of this pond will be landscaped from upper reach down to the lower, adjoining the waterfront. This permanent pond will be capable of containing the flood water caused by a nominal flash floods only with a slight increase in pond water level. Typical sections of the retention pond are shown in Fig. J-8.

The section surrounding the permanent pond is planned as the temporary pond. This portion of the pond serves for flood mitigation during flooding. However, this section is normally used as a parkland to cater for needs of diversified facilities of sports and recreational activities.

The entire temporary retention pond area will be sub-divided into several portions to meet the retention capacity required for various probable floods. Figures J-9 and J-10 show the water level of the pond and water surface for various probable floods, respectively.

(2) Structures Related to Retention Pond

For the effective operation and maintenance of the Retention Pond, the following related structures will be necessary.

i) Regulation Pond

This pond will be constructed near the Retention Pond to the east as illustrated in Fig. J-7. This pond is located at the confluence of the Batu River and Gombak Diversion Channel and serves as a regulation pond for diverting the design discharge over the diversion weir during flooding. Under normal circumstances, this pond serves as a sedimentation pond for the Batu River.

The floating debris can be screened ahead of the water gate and diversion weir through the screening facilities. This pond has an area of 55,600 square meters and a maximum depth of 4.5 m.

ii) Diversion Weir

The diversion weir is to be constructed between retention pond and regulation pond to divert the discharge of 100 m^3/s into the retention pond.

The weir is of 4.5 m high and 50 m long. The final dimensions of this weir as well as Gombak Diversion Weir should be decided by carrying out hydraulic model test. Figure J-11 shows longitudinal section of the weir.

iii) Inlet Sluice Gate

At the uppermost part of the Retention Pond the sluice gate (B = 1.0 m, H = 1.5 m) is to be installed to introduce the maintenance water from the Batu River to the Retention Pond. The plan and longitudinal profile are shown in Fig. J-12.

iv) Outlet Sluice Gate

At the lowermost portion of the Retention Pond, the outlet gates (B = 2.5 m, H = 2.5 m, 4 sets) will be installed to release the pond water into the Batu River after flooding. The plan and longitudinal section are shown in Fig. J-13.

v) Water Gate in the Batu River

In the south side of the regulation pond, the water gates with two double leaves will be constructed to release the maximum discharge of 25 m^3/s to the downstream during flooding. This gate will be fully opened after flooding or in the case of excess floods. The longitudinal and cross section of the Water Gate are shown in Fig. J-14.

4.4 Gombak Diversion Channel

4.4.1 Present Conditions of Proposed Channel Route

The diversion channel is to be located along the route connecting the 9.9 km point of the Gombak River to the 7.4 km point of the Batu River. There is a 4.5 m difference between the elevation of these two points for the normal water level of the rivers.

The channel route passes through the original ex-mining area which has since been filled up and developed into housing and agricultural land. Only a few houses along the route will have to be relocated.

The significant obstacles exist along this route are the K.L.-Karak Highway, and the Sg. Kamusing, a tributary of Gombak River.

No construction problems are expected to be encountered across the K.L.-Karak Highway as the road surface has enough difference of elevation for the design water level of the channel.

The Sg. Kamusing has only some 1.5 km^2 of catchment and would not cause any major problem for the construction the diversion channel.

4.4.2 Design of Diversion Channel

(1) General

The diversion channel linking the Gombak River with the Batu River has designed based on the discharge distribution and the results of the topographical survey.

The length of the diversion channel is 3,250 m and the and designed with a flow capacity of 60 m^3/s. Three typical alternative cross sections were studied. For the stretch of 600 m length passing through Malay reservation area, the closed channel type alternative was also studied.

Major related structures are two box culverts which cross K.L.-Karak Highway and urban planning road near the Batu Retention Pond, and five bridges. The overflow weir of 55 m long and 2.60 m high will be constructed in the entrance of the diversion channel. The diversion channel leads flow into the regulation pond.

(2) Design of Diversion Channel

The section of the channel was decided by the uniform flow analysis. The non-uniform flow analysis was used together with the weir overflow formula developed by Honma in designing the diversion weir. A weir height of 2.59 m and width of 55 m was selected as the dimensions of the overflow weir of the diversion channel.

An ideal location for the overflow weir would be at the point 9.9 km upstream of the Klang River confluence along the Gombak River. The plan and longitudinal profile of the channel are illustrated in Fig. J-15.

Suitable alternative methods of channel lining were considered. Sheet piles will be used if ground conditions are favorable for piling. In areas where bed rock is found at a shallow depth, pre-cast reinforced concrete units will be used instead. In either case, a vertical-walled center channel will be constructed. If concrete blocks were used to line the channel, then a slope of 1:0.5 is required for stability.

Sheet piles would be the most expensive alternative but it is faster and easier to implement. Precast units cost less than sheet piles but will encounter problems in alignment during construction. With concrete blocks, however, the top width of the channel will be wider than the bottom width and this could mean that more land had to be acquired. Hence, the center channel type is selected based on the comparison of the total cost.

Typical cross sections of open and closed channel are shown in Fig. J-16.

The construction costs for these three types of the protection channel are as follows:

Unit:M$/m

Type A	Trapezoidal concrete facing	1,960
Type B	Compound sheet pile	2,310
Type C	Compound pre-cast concrete	4,120

As a result, the Type A was selected. For the box culvert in the Malay reservation stretch, the construction cost is as follows:

Unit: M$

	Open Channel	Box Culvert
Direct cost	1,004,700	3,782,000
Land acquisition	563,100	281,600

The berm portion of the channel will be protected by sod turfing. The minimum space of 3 meters should be allowed for channel maintenance along the berm. The total river reserve would be kept basically to 60 m width.

In order to ensure the protection of areas along the proposed Gombak diversion channel against flooding due to levee breach, that may be caused by floods with a return period greater than the design return period of 100 years, the following countermeasures are to be necessarily incorporated in the diversion channel design.

1) The elevation of the portion of diversion channel levee between the Gombak River and Karak Highway shall be at least 0.50 m higher than that of the levee of the Gombak River, so that any flooding would occur only by the levee breaching of the Gombak River.

2) In order to ensure that the discharge in the diversion channel would not exceed the design discharge of about 60 m^3/s in the Batu drainage basin, the inlet of the box culvert under the Karak Highway should be designed for a maximum discharge of about 60 m^3/s.

4.5 Drainage Plan in Kampung Baru Area

4.5.1 General

The Kampung Baru area with a catchment of 0.73 km^2 is one of the infamous flood prone low lying areas in the Federal Territory. It is located on the right bank of the Klang River approximately 2 km upstream from its confluence with the Gombak River as shown in Fig. J-17. Approximately 52 ha of residential area was inundated and severely damaged by the January 1971 floods. In addition to this floods, Kampung Baru is often inundated by flash floods.

Approximately 35 ha of this area will be lower than the design flood level after completing all river improvement works for the Klang River. Therefore, the low lying areas in Kampung Baru will be inundated by inner water forever. To solve or mitigate this problem, an inner water drainage plan is required.

4.5.2 Present Situation of Drainage Basin

This drainage basin is located in the central area of Kuala Lumpur and is bounded by Jln. Tun Razak on the east, Jln. Raja Muda on the north, Jln. Raja Abdullah on the west and the Klang River on the south. Kampung Baru has a long history. It was proclaimed as the Malay Agricultural Settlement in 1900. Land use of this area is mainly occupied by residences and its population density was about 330 persons/ha in 1980. Almost all residences have open access to a paved road, such as Jln. Raja Uda, Jln. Raja Mahmud, Jln. Raja Muda Musa, Jln. Raja Mahadi and Jln. Sungai Baru.

In the January 4 and 5, 1971 Floods, Kampung Baru was severely damaged by water overflowing from the Klang River. The distribution between inundated depth and area by this floods is shown in Fig. J-17 and also tabulated below;

INUNDATED DEPTH AND AREA IN JANUARY 4 AND 5, 1971 FLOOD

Inundated Depth (m)	Inundated Area (ha)
0 - 1	12
1 - 2	19
2 - 3	21
Total	52

Approximately 600 houses and buildings were considered to have been affected by this floods.

In addition to the January 4 and 5, 1971 Floods, this area is frequently hit by flash floods, at a rather high frequency of more than 10 times per year in the low lying area especially along Jln. Raja Mahadi, with an estimated average inundation duration and depth of 5 hours and 0.9 m respectively. The main cause of this floods is inner water from rainfall run-off. Ground level of the low lying area, along Jln. Raja Mahadi, is about EL. 28.2 m and this level is only 1.0 m higher than the riverbed elevation of EL. 27.2 m surveyed in November, 1987. Under these circumstances, rainfall run-off from this basin cannot be discharged by gravity when the flood water level of the Klang River is higher than the ground level. Another cause of flooding is the intrusion of water through the gates erected on the right bank of the Klang River.

There is no proper trunk drainage in this basin. However, small drains run almost along every road sides to collect rainfall and for discharge into the Klang River. Its dimensions are approximately 0.5 m to 1.0 m in width and 0.5 m to 1.5 m in depth with a rectangular cross-section.

There are seven (7) outlet structures at the end of the small drains along the right bank of the Klang River as shown in Fig. J-17. Each structure is connected via a concrete pipeline (diameter 0.9 m) under dike to a screw type control gate (1 m x 1 m). All gates are operated manually by inhabitants staying nearly. These gates have apparently not been maintained or operated properly, as water intrusion through gates were observed at some gates when water level in the Klang River was high.

The reason for this water intrusion is suspected to be due to the improper sealing caused by sediment or rubbish collecting around the edge of the gate opening.

4.5.3 Plan of Inner Drainage

To solve or mitigate the inner water problem, the pumped drainage system with underground pondage is being proposed as the countermeasure. Basic concept of this plan is as follows;-

i) In case the water level of the Klang River is lower than ground level

- Rainfall run-off from the basin is collected and discharged by the new drains into the Klang River by gravity.

ii) In case the water level of the Klang River is higher than ground level

- Rainfall run-off from the basin is collected and discharged by the new drains to an underground pondage.
- Run-off water is stored in the underground pondage which is proposed to be constructed under existing roads.
- Stored water is drained by pumps into the Klang River.

For the sake of drawing up the drainage plan, some basic studies were carried out as follows;-

(1) Run-off Coefficient

Run-off coefficient in the catchment area was estimated by applying DID's "Urban Drainage Design Standard and Procedures for Peninsular Malaysia". An average run-off coefficient of 0.65 has been assumed.

(2) Total Run-off Amount

The total run-off amount for each return period were estimated by applying the Rational Method. In this study, three (3) hours rainfall was assumed and Rainfall Intensity-Duration-Frequency Relation at DID Ampang was applied for estimating the run-off amount. Estimated total run-off amounts for each return period are shown in Table J-2.

(3) Time of Flood Concentration

Time of flood concentration was assumed to be 20 minutes by applying the Design Standard and Procedures as mentioned above and the empirical formula prepared by the Public Works Research Institute of Ministry of Construction, Japan.

(4) Inundated Depth and Area

For the purpose to estimate the flood damage by the inner water, the inundated depth and area were estimated by applying the total run-off amount and the topographical map which was prepared in this study. Estimated inundated depth and area are shown in Table J-2 and summarized as below;

INUNDATED DEPTH AND AREA

Return Period (year)	Maximum Inundated Depth (m)	Inundated Area (ha)
2	0.96	10.9
5	1.02	12.2
10	1.06	13.1
20	1.09	14.0
50	1.14	15.0
100	1.17	15.7

(5) Pump Capacity, Underground Pondage Capacity and Frequency Relationship

From the hydrological condition as mentioned above, the relationships between pump capacity and required underground pondage capacity were estimated for each return period. These relationships are shown in Table J-2 and illustrated in Fig. J-18.

For the purpose to obtain the optimum scale of the drainage plan in Kampung Baru area, following thirty six (36) alternative cases were selected.

NUMBER OF ALTERNATIVE CASES

Design Recurrence Intervals (year)	Pump Capacity (m^3/s)					
	1	2	4	6	8	10
2	1-2	2-2	4-2	6-2	8-2	10-2
5	1-5	2-5	4-5	6-5	8-5	10-5
10	1-10	2-10	4-10	6-10	8-10	10-10
20	1-20	2-20	4-20	6-20	8-20	10-20
50	1-50	2-50	4-50	6-50	8-50	10-50
100	1-100	2-100	4-100	6-100	8-100	10-100

By applying the basic studies as mentioned above, comparative study was executed for each alternative case as follows;

(i) Design

Underground pondage is planned to be constructed under the existing roads such as Jln. Sungai Baru. Box culvert type is considered for this pondage because the surface of it will be used for road and up-lift by ground water will be expected to act at bottom of it.

Pump station will consist of inlet structure, pump house, outlet tank, outlet culvert and gate structure. Pump house would be provided with two (2) units duty pump and one (1) unit stand-by pump, all with the same capacity. After the completion of the drainage systems, this pumping facilities will be operated throughout the year to mitigate the flash floods. The stand-by pump is provided in consideration to effective operation and maintenance and to cope with mechanical failure.

New internal drainage system is necessary to collect the rainfall run-off from the area and to discharge to the Klang River or underground pondage. Three routes of new drains with a total length of 2,050 m is considered in this study. In parallel to the underground pondage, an overflow section with the crest elevation of 28.7 m is designed. In case the water level of the Klang River is higher than this crest elevation, flood run-off from the basin would be overflowed from this drain to underground pondage.

(ii) Construction Volume and Cost

The cost of the drainage plan is estimated for each alternative case. High cost items are computed based on the quantity measured from maps, whereas the low cost items are estimated in lump-sums quantity or by applying cost formulas.

The estimated direct construction cost for each alternative case is shown in Table J-3 and the cost curve for each design recurrence interval is illustrated in Fig. J-19.

(iii) Benefit

The benefit of a drainage plan is estimated for each alternative case. These benefit are computed by applying the decreased inundated depth and area of each drainage plan and the unit flood damage amounts. Unit flood damage amounts are estimated based on the number of buildings, unit cost of building, indoor property, stock and damage rate in the area concerned. These values are shown in APPENDIX G. By using these values, unit flood damage amounts are computed as given below;

UNIT FLOOD DAMAGE AMOUNT IN KAMPUNG BARU

Inundated Depth (m)	Unit Flood Damage (M$/m^2)		
	1988	1996	2005
0 ~ 0.5	11.47	12.68	13.88
0.5 ~ 1.0	26.50	29.29	32.07
1.0 ~ 2.0	33.54	37.06	40.58

From unit flood damage amounts and decreased inundated area, annual mean flood damage reduction is computed for each alternative case. In this computation, unit flood damage values in 1996 are adopted because Kampung Baru drainage system is planned to be operated from 1996. Estimated results are shown in Table J-3 and illustrated in Fig. J-20 for each design recurrence interval.

(iv) Optimization

The optimum scale of the drainage plan in Kampung Baru area is selected by comparing the annual mean flood damage reduction

(Benefit) and the direct construction cost (Cost). Results of these comparison are shown in Table J-3 and illustrated in Fig. J-20. Judged from these comparison results, the most economical case is:

- Case 2-5
- Design Recurrence Intervals : 5-years
- Pump Capacity : 2 m^3/s or 120 m^3/min.

(v) Alternative Sites for Underground Pondage

For the sake of selecting the optimum scale of the drainage plan in Kampung Baru area, underground pondage was planned for construction under the existing roads. In addition to this site, two other alternative underground pondage sites are also studied, and are refered to as Alternative A and Alternative B.

Alternative A site is located in Pasar Minggu and alternative B site is located in just northern part of the pump station as shown in Fig. J-17. Under the same design recurrence intervals and pump capacity with case 2-5, each of the three alternative construction cost is compared, including the case 2-5 alternative, as follows;

COST COMPARISON FOR ALTERNATIVE PONDAGE SITES

(Unit: 1,000 M$)

Item	Case 2-5	Alternative A	Alternative B
I. Direct Construction Cost			
1. Preparatory Works	680	636	562
2. Underground Pondage	3,213	2,338	2,427
3. Connection Channel from Pondage to Pump Station	0	581	0
4. Pump Station	758	758	758
5. Internal Drainage System	560	560	560
6. Pumping Equipments	3,036	3,036	3,036
Total	8,247	7,909	7,343
II. Land Acquisition for Underground Pondage	0	1,150	1,150
Total of I & II	8,247	9,059	8,493

In this cost estimate, market price of 16 M$/feet^2 is applied to land acquisition for underground pondage. From this cost comparison, it is evident that Case 2-5 is the most economical one. In addition to this economical assesment, the construction of underground pondage at alternative A and B sites cannot be recommended from a social point of view as well. There exist shops and residences in both these areas, which would cause much problems in acquiring land for these underground pondage. Hence from both economical and social points of views, Case 2-5 is recommended for the drainage plan in Kampung Baru area.

The optimum scheme of the drainage plan in Kampung Baru area was selected by the above mentioned comparative study. Details on the plan and section of the proposed drainage structures are shown in Fig. J-21.

The principal features of this optimum drainage plan are as follows;

Design Recurrence Intervals	:	5-year
Adopted Rainfall for Design	:	3 hours rainfall. Total 100 mm
Design Run-off Coefficient	:	0.65
Internal Drainage System		
Type	:	Box culvert
Total length	:	2,050 m
Inside dimension	:	0.9m ~ 2.7m wide x 0.9m ~ 3.0m high
Underground Pondage		
Type	:	Box culvert
Pond capacity	:	32,700 m^3
Total length	:	385 m
Inside dimension	:	17.0m wide x 5.5m high
Inlet		
Dimension	:	8.3m wide x 8.0m long x 7.5m high
Trashrack	:	2.1m wide x 8.1m high x 3 nos.
Base elevation	:	EL. 22.7 m
Pump House		
Type	:	Two floor open-air type
Dimension	:	12.0m wide x 17.8m long x 21.0m high
Outlet Tank		
Dimension	:	2.7m wide x 7.6m long x 4.3m high
Base elevation	:	EL. 28.2 m
Pumping Equipment		
Design head	:	7.6 m
Pump	:	Vertical shaft mixed flow 700ø, 60 m^3/min. x 3 units
Diessel engine	:	130 ps/1,200 rpm x 3 units
Valve	:	Electric driven butterfly valve 700ø x 3 units

4.5.4 Economic Evaluation

The drainage plan in Kampung Baru area is planned as a part of the flood mitigation of the Klang River Basin. However, it can be dealt with independently because of its peculiarity. In order to assess the appropriateness of the drainage plan in Kampung Baru area, an economic evaluation was executed.

In this economic evaluation, following basic conditions and assumptions are applied.

(i) Economic costs are derived from financial costs by applying the conversion factors. Financial costs and applied conversion factors are described in APPENDIX K and L respectively. The costs consist of construction costs, replacement costs, and operation and maintenance costs.

(ii) Economic benefit is derived from financial benefit by applying the conversion factors. Only flood reduction benefit by inner drainage is taken into account, and any intangible benefits are not taken into account.

(iii) Construction of the drainage systems are assumed to be implemented in 1994 and 1995.

(iv) The project life is set at 50 years from the initial year of implementation.

Based on these basic conditions and assumptions, economic evaluation was carried out for the drainage plan in Kampung Baru area. The flow of economic cost and benefit are shown in Table J-4. From this flow, the Economic Internal Rate of Return (EIRR) is estimated as 15.1%, which indicates that the drainage plan is economically feasible.

Economic sensitivity analysis of the drainage plan was conducted under the following conditions, and the resultant EIRR is also given;

SENSITIVITY ANALYSIS

	Case	EIRR (%)
1.	Benefit decrease by 20%	12.0
2.	Cost increase by 20%	12.5
3.	Simultaneous occurance of both the above cases	9.7

From the above results, the drainage plan in Kampung Baru area could be considered to be economically viable even in the event of the above mentioned economic changes.

4.6 Improvement Plan of River Related Structures

The soundness of the existing bridges crossing over Klang, Gombak and Batu rivers are evaluated in APPENDIX I. The evaluation was carried out based on standards such as span length or clearance. Accordingly four existing bridges are found to be under adverse conditions due to various deficiencies. Among them, Jalan Damai Bridge is to be reconstructed or repaired as soon as possible because of its structural damage. However the others have problems of obstructing the free river flow under flooding conditions.

In addition, it is also necessary to investigate whether the existing bridges could be used even after the river improvement works based on the proposed river improvement plan. The bridge evaluation was carried out by comparing the bridge lengths, clearance, stability and obstructions of foundations, and others with the requirements of the river improvement plans.

Accordingly, ten (10) bridges were identified to be in need of reconstructions due to one or more of the above mentioned factors. Pertinent informations concerning these bridges that must be reconstructed, including their required new lengths, are given below:

	Bridge Name	River Name	Required Length
(1)	Jalan Damai Bridge	Klang	34 m
(2)	*Jalan Tun Perak	"	28
(3)	Near Sentul Flats off Jalan Pahang Bridge	Gombak	35
(4)	Jalan Kampong Puah Sabarang Bridge	"	35
(5)	Jalan Chubadak Dalam Bridge	"	29
(6)	*2.5 Mile Jalan Ipoh Railway	Batu	37
(7)	*Jalan Selvadurai	"	37
(8)	*Jalan Segambut	"	37
(9)	*Jalan Cenderuh	"	32
(10)	*4.25 Mile off Jalan Ipoh	"	32

* : Bridge to be improved during Urgent Plan.

As described before, most of the bridges crossing Klang, Gombak and Batu rivers have not enough capacity to convey the floods downstream effectively. One main reason for this problem is that there exist no design standards on river bridges with consideration to the effect of maximum (flood) discharge in Malaysia. Therefore it is recommended to formulate the design standards for the construction of bridges with due consideration to flood discharge. For reference, related items of simplified Japanese design standard on bridges are given below.

(i) Span length

$Q \geqq 2000$	$L \geqq 20 + 0.005Q$
$2000 > Q \geqq 500$	$L \geqq 20$
$Q < 500$	$L \geqq 15$
- do - $(25 \leqq W < 30)$	$L \geqq 12.5$ (2 spans)

where; L : Span Length (m)
Q : Design Flood Discharge (m^3/s)
W : River Width (m)

(ii) Clearance

$Q \geqq 10{,}000$	$L \geqq 2.0$
$10{,}000 > Q \geqq 5{,}000$	$L \geqq 1.5$
$5{,}000 > Q \geqq 2{,}000$	$L \geqq 1.2$
$2{,}000 > Q \geqq 500$	$L \geqq 1.0$
$500 > Q \geqq 200$	$L \geqq 0.8$
$Q < 200$	$L \geqq 0.6$

where; L : Clearance (m)

Q : Design Flood discharge (m^3/s)

(iii) Reduction Rate of river width due to piers

Reduction Rate $\leqq$ 5% (Basically)

Reduction Rate $\leqq$ 6% (At least)

where; Reduction Rate = (Gross Width of all Piers)/ (River Width)

(iv) Others

a) Location and Direction of Abutment
b) Figure, Footing Depth, Location and Direction of Pier
c) Others

4.7 Proposed Urgent Flood Mitigation Works

Based on the proposed river channel and retention pond mentioned before, the following major works are proposed for the urgent flood mitigation project in this study.

(1) Main stream of the Klang River

a. Excavation/dredging of channel
b. Bank protection by means of concrete wall and steel sheet pile
c. Reconstruction of bridge
d. Construction of drop structure

(2) The Gombak River

a. Excavation of channel
b. Bank protection by means of concrete wall and steel sheet pile
c. Reconstruction of bridge
d. Construction of drop structure

(3) The Batu River

a. Excavation of channel
b. Bank protection by means of concrete wall and steel sheet pile
c. Reconstruction of bridge
d. Construction of drop structure

(4) The Gombak Diversion Channel

a. Construction of overflow weir for diversion
b. Excavation of channel
c. Construction of concrete box culvert
d. Construction of bridge
e. Bank protection of concrete block/concrete retaining wall

(5) The Batu Retention Pond

a. Excavation of pond
b. Embankment of dyke
c. Bank protection by means of concrete block/sod facing
d. Construction of overflow-type diversion weir
e. Construction of inlet sluice gate/outlet sluice gate
f. Earthwork for park area
g. Construction of bridge
h. Landscaping

(6) Inner Water Drainage in Kampung Baru Area

a. Construction of pumping station
b. Construction of underground pondage
c. Construction of trunk drainage

The quantities of the proposed work are summarized below.

<u>River channel improvement</u>

Excavation/dredging	838.5×10^3 m^3
Embankment	26.6×10^3 m^3
Bank protection	
Concrete wall	-
Steel sheet pile	111.0×10^3 m^2
Sod facing	231.1×10^3 m^2
Concrete facing	8.8×10^3 m^3
Concrete block	38.9×10^3 m^2
Construction of drop structure	3 nos
Reconstruction of bridges	6 nos
Construction of overflow weir	2 nos
Construction of concrete box culverts	2 nos

Retention pond

Excavation	$2,324.6 \times 10^3$ m^3
Embankment	$2,030.0 \times 10^3$ m^3
Bank protection	
Sod facing	501.7×10^3 m^2
Concrete block	2.1×10^3 m^2
Construction of sluice gate	1 no
Construction of bridge	1 no

Inner water drainage

Construction of pumping station	4 nos
Construction of underground pondage	1 no
Construction of trunk drainage	2,050 m

4.8 Land Acquisition and Compensation

Land acquisition and compensation are required prior to the execution of the construction works. These quantities are summarized below:

Work Item	Land Acquisition
River channel improvement	13.4 ha
Diversion channel	19.5 ha
Inner water drainage	0.3 ha

These quantities were estimated by using the land acquisition maps prepared by DID under the condition of 60 m width of river reserve.

Table J-1 *FLOOD MITIGATION FACILITIES OF URGENT PROJECT*

- River Improvement Works

Stretch	River Length (km)	River Width (m)	Slope	Design Discharge (m3/s)	Remarks
Sg. Klang K9	20.2k 24.3k 4.1	20, 26, 37	1/865 1/120 1/1000 1/769	730 300	* L=1.7km R11(1.7km)
Sg. Gombak G4	7.4k 9.9k 2.5	16	1/300	120	
Sg. Batu B2	1.4k 4.8k 3.4	26, 34	1/905 1/600	120, 240	
B3	4.8k 8.0k 3.2	12, 16	1/400 1/500	40, 60, 70	

- Retention Pond

River	Location	Reservoir Surface	Capacity	Water Level	Effective Depth	Remarks
Sg. Batu	7.4km	233,000 m2	2,700,000 m3	45.0 m	6.0 m	

- Diversion Channel

Location	Length (km)	Width (m)	Slope	Design Discharge (m3/s)	Remarks
Sg. Gombak to Sg. Batu	3.25	12.0	1/1200	60	

- Drainage Facilities in Low Lying Area

Location	Facility	Capacity	Remarks
Kampung Baru	Pump Station Requlating Pond	Q= 2.0 m3/s V= 40,000 m3	
Kg. Haji Abdulah Hukom to Kg.Sentosa	Pump stations	Q= 0.5 m3/s x 3	

Table J-2 RUN-OFF AMOUNT, INUNDATED AREA WITHOUT PROJECT AND REQUIRED PUMP AND PONDAGE CAPACITY

Item	Return Period (year)					
	2	5	10	20	50	100
Total Rainfall (mm)	84	100	111	121	134	145
Total Run-off Amount (m3)	39,900	47,500	52,700	57,400	63,600	68,800
Maximum Inundated Depth (m)	0.96	1.02	1.06	1.09	1.14	1.17
Inundated Area without Project (m2)						
Inundated Depth : 0 - 0.5m	82,000	88,000	92,000	97,000	100,000	102,000
Inundated Depth : 0.5 - 1.0m	27,000	33,000	37,000	40,000	46,000	50,000
Inundated Depth : over 1.0m	0	1,000	2,000	3,000	4,000	5,000
Total	109,000	122,000	131,000	140,000	150,000	157,000
Required Pondage Capacity (m3)						
Pump Capacity : 1m3/sec	31,400	39,200	44,900	49,900	55,900	61,000
Pump Capacity : 2m3/sec	25,900	32,700	38,500	43,500	49,700	54,500
Pump Capacity : 4m3/sec	18,400	24,100	28,400	32,800	38,700	43,200
Pump Capacity : 6m3/sec	13,600	17,900	21,200	25,000	30,200	34,400
Pump Capacity : 8m3/sec	9,400	13,100	16,300	18,800	23,000	27,200
Pump Capacity : 10m3/sec	7,000	9,900	11,900	14,000	18,100	21,900

Table J-3 ALTERNATIVE STUDY OF KAMPUNG BARU DRAINAGE PLAN

Design Recurrence Intervals = 2 years

Item	Case No.					
	1-2	2-2	4-2	6-2	8-2	10-2
I. Pump Capacity (m3/s)	1	2	4	6	8	10
II. Direct Construction Cost (1,000M$)						
1. Preparatory Works	681	601	502	464	442	442
2. Underground Pondage	3,303	2,690	1,856	1,408	1,037	819
3. Pump Station	675	758	930	1,128	1,348	1,570
4. Internal Drainage System	560	560	560	560	560	560
5. Pumping Equipments	2,482	3,036	4,450	5,807	7,183	8,560
Total Direct Cost (1,000M$)	7,701	7,645	8,298	9,367	10,570	11,951
III. Annual Benefit (1,000M$)	1,648	1,668	1,706	1,740	1,768	1,785
IV. Annual Benefit / Direct Cost	0.214	0.218	0.206	0.186	0.167	0.149

Design Recurrence Intervals = 5 years

Item	Case No.					
	1-5	2-5	4-5	6-5	8-5	10-5
I. Pump Capacity (m3/s)	1	2	4	6	8	10
II. Direct Construction Cost (1,000M$)						
1. Preparatory Works	773	680	572	524	492	479
2. Underground Pondage	3,915	3,213	2,321	1,805	1,370	1,062
3. Pump Station	675	758	930	1,128	1,348	1,570
4. Internal Drainage System	560	560	560	560	560	560
5. Pumping Equipments	2,482	3,036	4,450	5,807	7,183	8,560
Total Direct Cost (1,000M$)	8,405	8,247	8,833	9,824	10,953	12,231
III. Annual Benefit (1,000M$)	1,807	1,812	1,824	1,835	1,844	1,851
IV. Annual Benefit / Direct Cost	0.215	0.220	0.207	0.187	0.168	0.151

Design Recurrence Intervals = 10 years

Item	Case No.					
	1-10	2-10	4-10	6-10	8-10	10-10
I. Pump Capacity (m3/s)	1	2	4	6	8	10
II. Direct Construction Cost (1,000M$)						
1. Preparatory Works	894	789	644	570	534	508
2. Underground Pondage	4,723	3,942	2,803	2,112	1,651	1,254
3. Pump Station	675	758	930	1,128	1,348	1,570
4. Internal Drainage System	560	560	560	560	560	560
5. Pumping Equipments	2,482	3,036	4,450	5,807	7,183	8,560
Total Direct Cost (1,000M$)	9,334	9,085	9,387	10,177	11,276	12,452
III. Annual Benefit (1,000M$)	1,855	1,857	1,861	1,865	1,869	1,871
IV. Annual Benefit / Direct Cost	0.199	0.204	0.198	0.183	0.166	0.150

Design Recurrence Intervals = 20 years

Item	Case No.					
	1-20	2-20	4-20	6-20	8-20	10-20
I. Pump Capacity (m3/s)	1	2	4	6	8	10
II. Direct Construction Cost (1,000M$)						
1. Preparatory Works	984	877	715	624	570	536
2. Underground Pondage	5,325	4,531	3,277	2,470	1,894	1,446
3. Pump Station	675	758	930	1,128	1,348	1,570
4. Internal Drainage System	560	560	560	560	560	560
5. Pumping Equipments	2,482	3,036	4,450	5,807	7,183	8,560
Total Direct Cost (1,000M$)	10,026	9,762	9,932	10,589	11,555	12,672
III. Annual Benefit (1,000M$)	1,877	1,878	1,878	1,879	1,880	1,880
IV. Annual Benefit / Direct Cost	0.187	0.192	0.189	0.177	0.163	0.148

Design Recurrence Intervals = 50 years

Item	Case No.					
	1-50	2-50	4-50	6-50	8-50	10-50
I. Pump Capacity (m3/s)	1	2	4	6	8	10
II. Direct Construction Cost (1,000M$)						
1. Preparatory Works	1,099	995	819	702	628	594
2. Underground Pondage	6,093	5,312	3,968	2,995	2,278	1,830
3. Pump Station	675	758	930	1,128	1,348	1,570
4. Internal Drainage System	560	560	560	560	560	560
5. Pumping Equipments	2,482	3,036	4,450	5,807	7,183	8,560
Total Direct Cost (1,000M$)	10,909	10,661	10,727	11,192	11,997	13,114
III. Annual Benefit (1,000M$)	1,887	1,887	1,887	1,887	1,887	1,887
IV. Annual Benefit / Direct Cost	0.173	0.177	0.176	0.169	0.157	0.144

Design Recurrence Intervals = 100 years

Item	Case No.					
	1-100	2-100	4-100	6-100	8-100	10-100
I. Pump Capacity (m3/s)	1	2	4	6	8	10
II. Direct Construction Cost (1,000M$)						
1. Preparatory Works	1,203	1,085	899	774	691	648
2. Underground Pondage	6,784	5,914	4,506	3,469	2,701	2,189
3. Pump Station	675	758	930	1,128	1,348	1,570
4. Internal Drainage System	560	560	560	560	560	560
5. Pumping Equipments	2,482	3,036	4,450	5,807	7,183	8,560
Total Direct Cost (1,000M$)	11,704	11,353	11,345	11,738	12,483	13,527
III. Annual Benefit (1,000M$)	1,888	1,888	1,888	1,888	1,888	1,888
IV. Annual Benefit / Direct Cost	0.161	0.166	0.166	0.161	0.151	0.140

Table J-4 ECONOMIC COST AND BENEFIT FLOW FOR DRAINAGE PLAN IN KAMPUNG BARU AREA

EIRR= 15.1% (Unit : Million M$)

No.	Year	Cost				Benefit	B - C
		Const.	O & M	Replace.	Total		
1	1994	5.270			5.270		-5.270
2	1995	5.270			5.270		-5.270
3	1996		0.095		0.095	1.747	1.652
4	1997		0.095		0.095	1.765	1.670
5	1998		0.095		0.095	1.784	1.689
6	1999		0.095		0.095	1.802	1.707
7	2000		0.095		0.095	1.821	1.726
8	2001		0.095		0.095	1.839	1.744
9	2002		0.095		0.095	1.858	1.763
10	2003		0.095		0.095	1.876	1.781
11	2004		0.095		0.095	1.895	1.800
12	2005		0.095		0.095	1.913	1.818
13	2006		0.095		0.095	1.913	1.818
14	2007		0.095		0.095	1.913	1.818
15	2008		0.095		0.095	1.913	1.818
16	2009		0.095		0.095	1.913	1.818
17	2010		0.095		0.095	1.913	1.818
18	2011		0.095		0.095	1.913	1.818
19	2012		0.095		0.095	1.913	1.818
20	2013		0.095		0.095	1.913	1.818
21	2014		0.095		0.095	1.913	1.818
22	2015		0.095	2.966	3.061	1.913	-1.148
23	2016		0.095		0.095	1.913	1.818
24	2017		0.095		0.095	1.913	1.818
25	2018		0.095		0.095	1.913	1.818
26	2019		0.095		0.095	1.913	1.818
27	2020		0.095		0.095	1.913	1.818
28	2021		0.095		0.095	1.913	1.818
29	2022		0.095		0.095	1.913	1.818
30	2023		0.095		0.095	1.913	1.818
31	2024		0.095		0.095	1.913	1.818
32	2025		0.095		0.095	1.913	1.818
33	2026		0.095		0.095	1.913	1.818
34	2027		0.095		0.095	1.913	1.818
35	2028		0.095		0.095	1.913	1.818
36	2029		0.095		0.095	1.913	1.818
37	2030		0.095		0.095	1.913	1.818
38	2031		0.095		0.095	1.913	1.818
39	2032		0.095		0.095	1.913	1.818
40	2033		0.095		0.095	1.913	1.818
41	2034		0.095		0.095	1.913	1.818
42	2035		0.095	2.966	3.061	1.913	-1.148
43	2036		0.095		0.095	1.913	1.818
44	2037		0.095		0.095	1.913	1.818
45	2038		0.095		0.095	1.913	1.818
46	2039		0.095		0.095	1.913	1.818
47	2040		0.095		0.095	1.913	1.818
48	2041		0.095		0.095	1.913	1.818
49	2042		0.095		0.095	1.913	1.818
50	2043		0.095		0.095	1.913	1.818

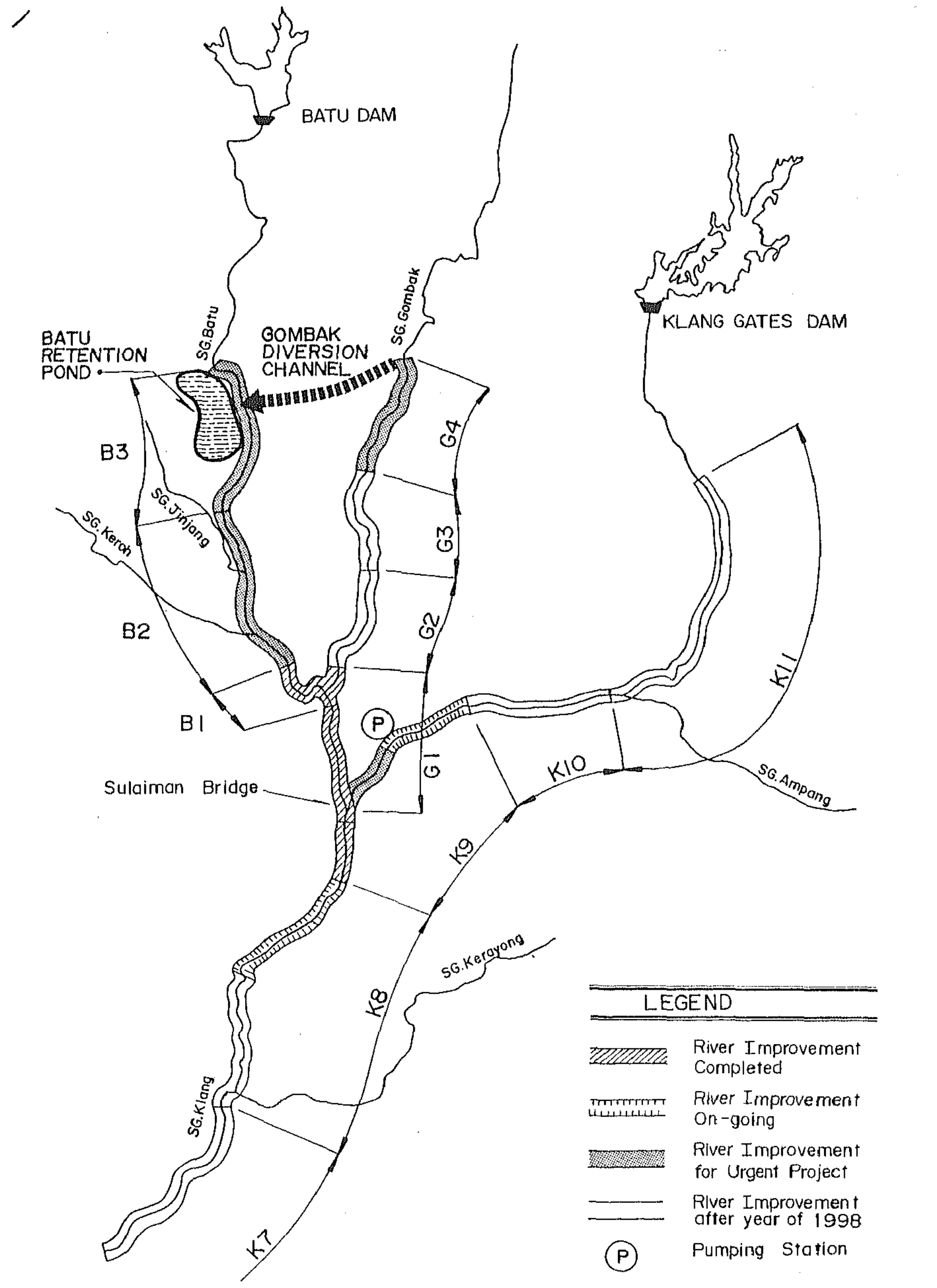
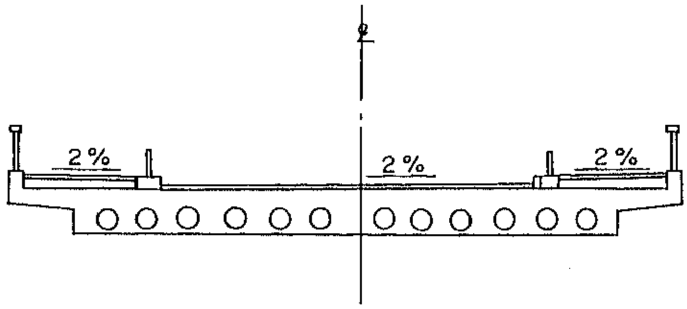
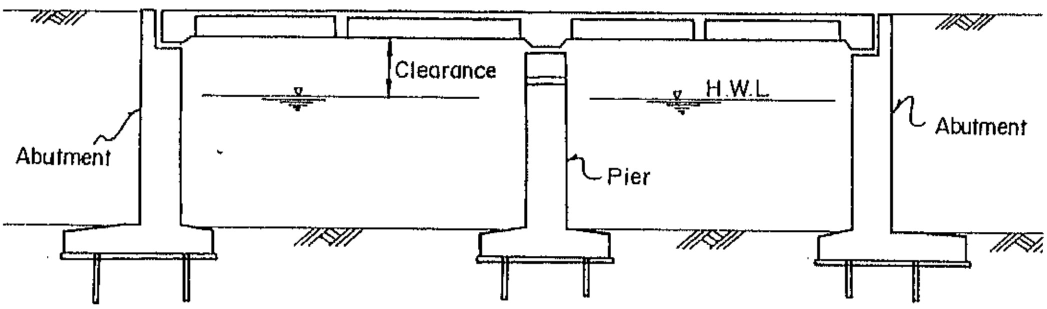


FIG. J-1 **FLOOD MITIGATION FACILITIES OF URGENT PROJECT**

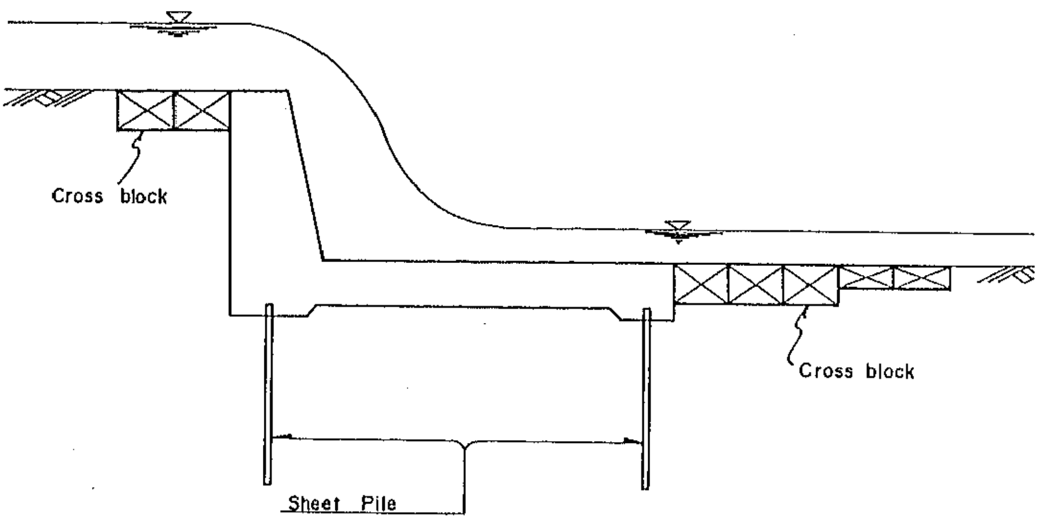
THE STUDY ON THE FLOOD MITIGATION OF THE KLANG RIVER BASIN



CROSS SECTION OF BRIDGE



LONGITUDINAL SECTION OF BRIDGE



TYPICAL SECTION OF DROP STRUCTURE

FIG. J-2	TYPICAL SECTIONS OF RIVER STRUCTURES

THE STUDY ON THE FLOOD MITIGATION OF THE KLANG RIVER BASIN

JICA

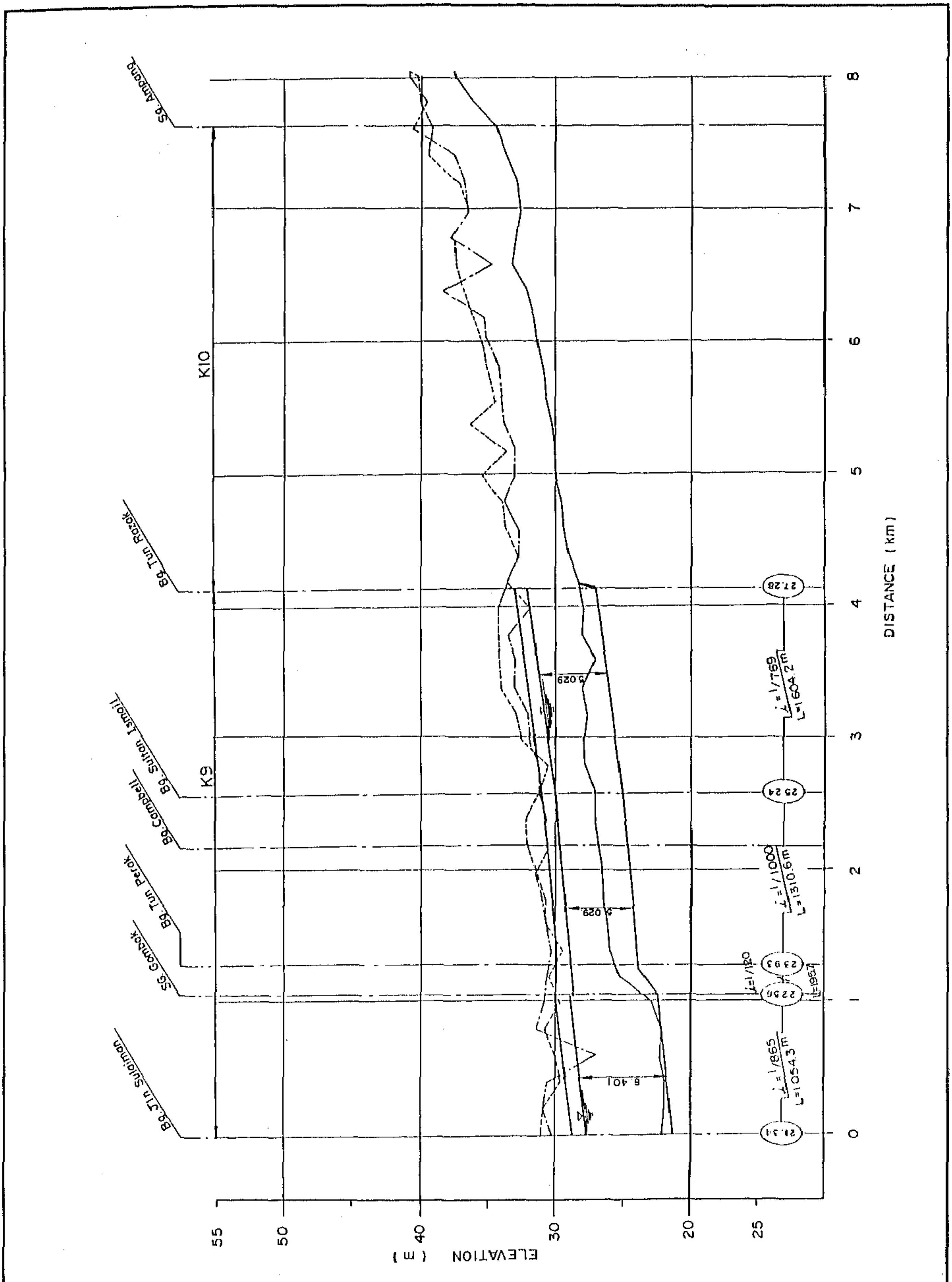


FIG. J-3 **PROPOSED LONGITUDINAL PROFILE OF SG. KLANG**

THE STUDY ON THE FLOOD MITIGATION OF THE KLANG RIVER BASIN

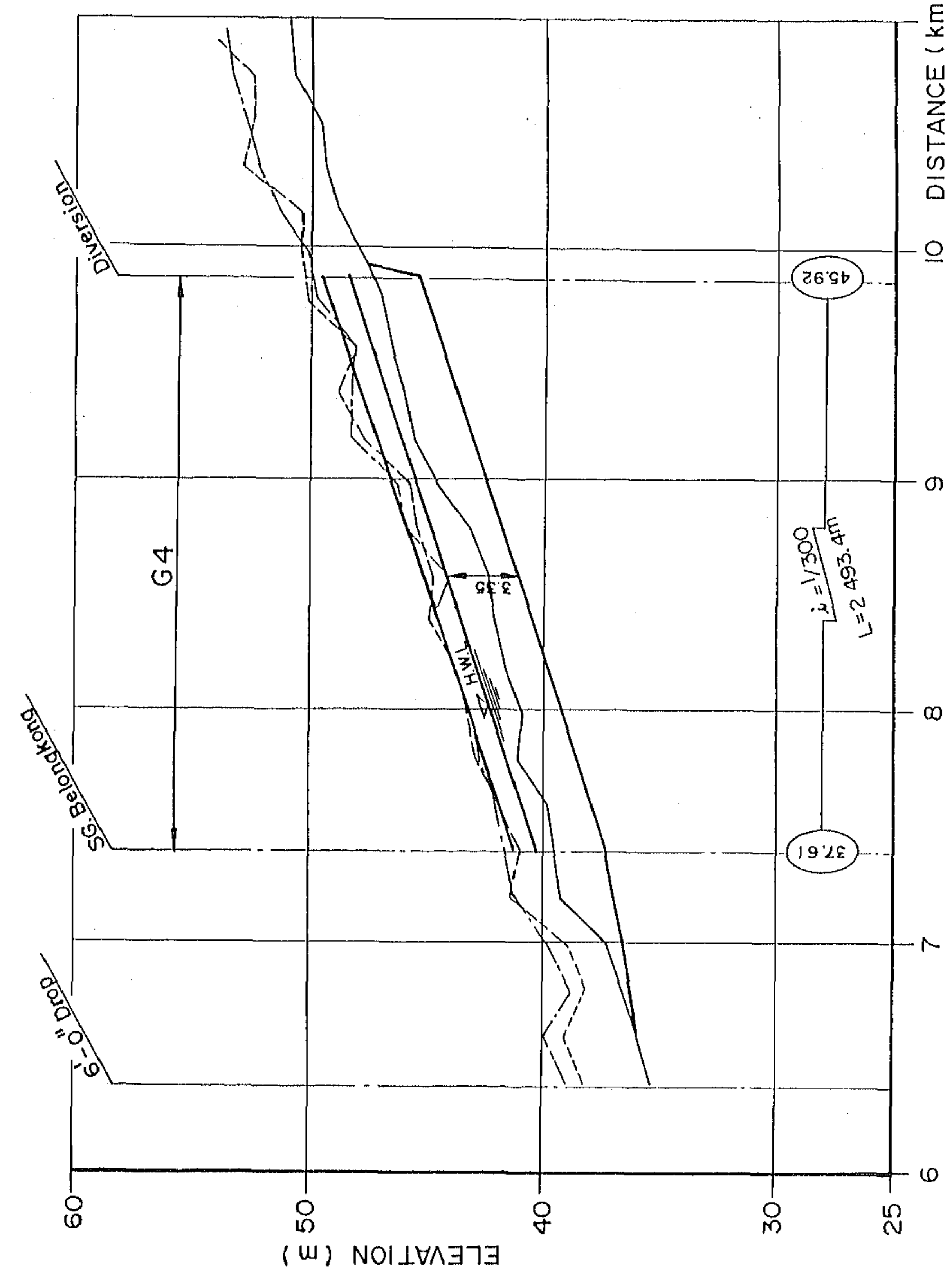


FIG. J-4	PROPOSED LONGITUDINAL PROFILE OF SG.GOMBAK

THE STUDY ON THE FLOOD MITIGATION OF THE KLANG RIVER BASIN

JICA

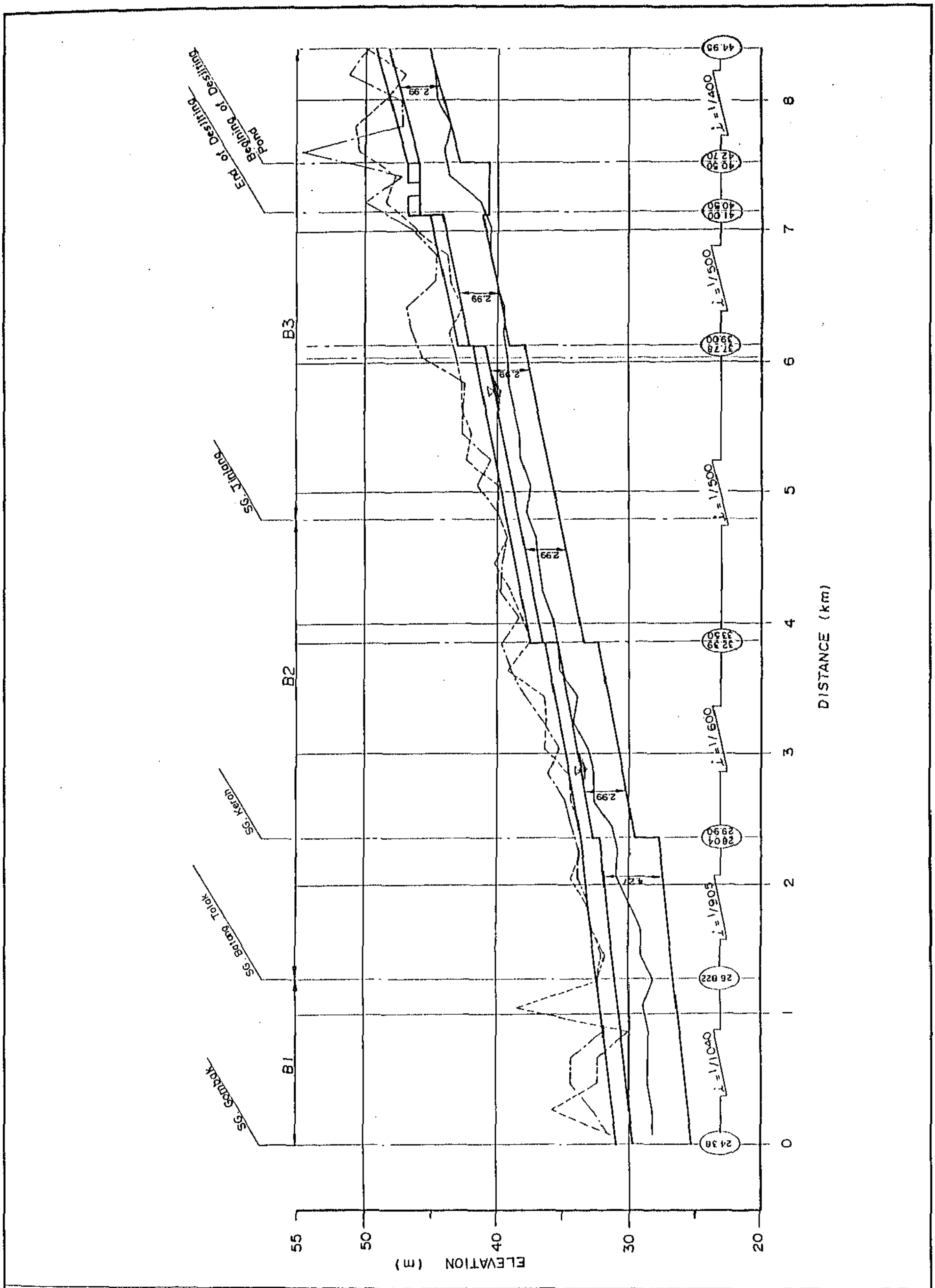
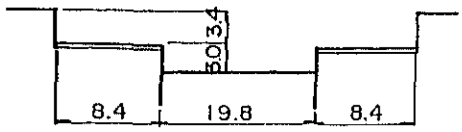


FIG. J-5 PROPOSED LONGITUDINAL PROFILE OF SG. BATU

THE STUDY ON THE FLOOD MITIGATION OF THE KLANG RIVER BASIN

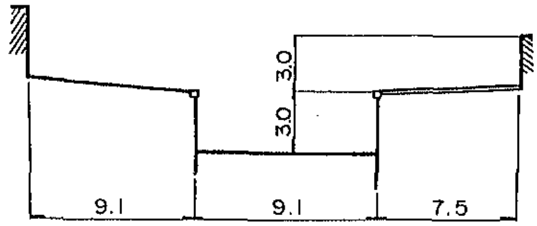
THE KLANG RIVER

Q= 730 m^3/s
V= 4.11 m/s
I= 1/865



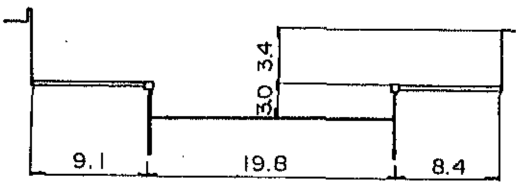
Suilaiman Bridge - Leboh Pasar

Q= 300 m^3/s
V= 3.79 m/s
I= 1/120



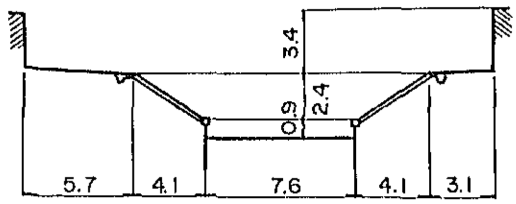
Sg.Gombak Confluence - Jln Tun Perak Bridge

Q= 730 m^3/s
V= 4.11 m/s
I= 1/865



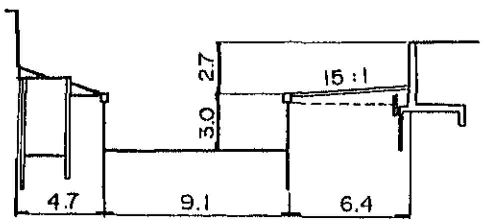
Leboh Pasar - Sg.Gombak Confluence

Q= 300 m^3/s
V= 3.56 m/s
I= 1/120



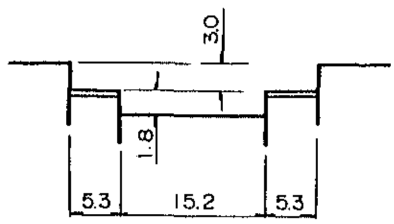
Sg.Gombak Confluence - Jln Tun Perak Bridge

Q= 300 m^3/s
V= 4.57 m/s
I= 1/120



Sg.Gombak Confluence - Jln Tun Perak Bridge

Q= 300 m^3/s
V= 2.96 m/s
I= 1/1000

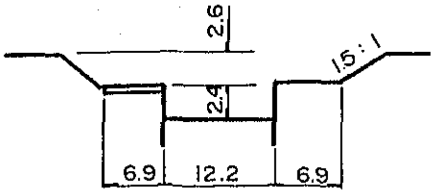


Jln Tun Perak Bridge - Jln Sultan Ismail Bridge

FIG. J-6 CROSS SECTIONS OF RIVER IMPROVEMENT (1/5)

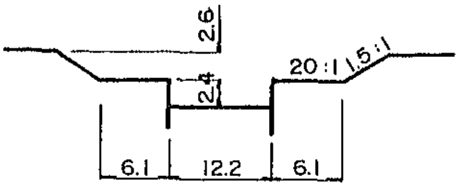
THE KLANG RIVER

Q= 300 m^3/s
V= 2.90 m/s
I= 1/769



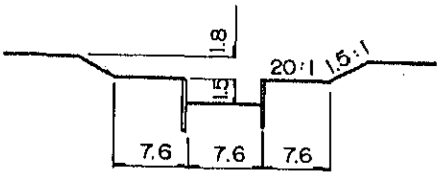
Jln Sultan Ismail Bridge - Jln Tun Razak Bridge

Q= 300 m^3/s
V= 3.18 m/s
I= 1/640



Jln Tun Razak Bridge - Sg.Ampang Confluence

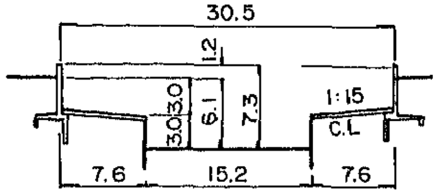
Q= 130 m^3/s
V= 2.65 m/s
I= 1/422



Sg.Ampang Confluence - Ulu Klang Bridge near Zoo

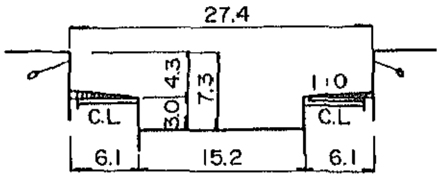
THE GOMBAK RIVER

Q= 430 m^3/s
V= 3.02 m/s
I= 1/1370



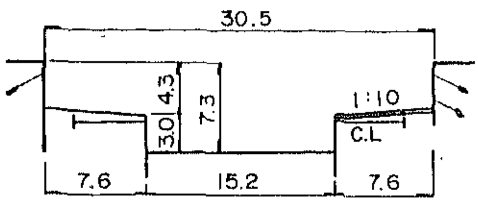
Sg.Klang Confluence - Raja Bridge

Q= 430 m^3/s
V= 3.13 m/s
I= 1/1100



Raja Bridge - Sg.Batu Confluence

Q= 430 m^3/s
V= 3.01 m/s
I= 1/1100



Raja Bridge - Sg.Batu Confluence

FIG. J-6	**CROSS SECTIONS OF RIVER IMPROVEMENT (2/5)**

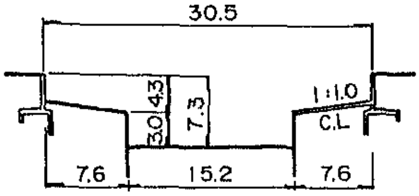
THE STUDY ON THE FLOOD MITIGATION OF THE KLANG RIVER BASIN

THE GOMBAK RIVER

Q= 430 m^3/s

V= 3.11 m/s

I= 1/1100

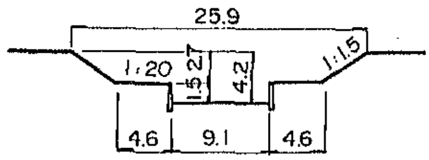


Raja Bridge - Sg.Batu Confluence

Q= 180 m^3/s

V= 2.85 m/s

I= 1/600

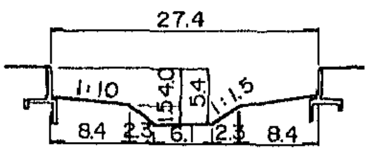


Wooden Bridge - Drop 6'-0

Q= 200 m^3/s

V= 2.79 m/s

I= 1/655

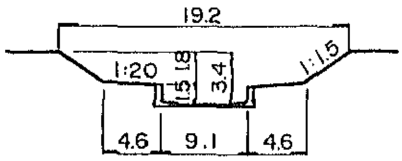


Sg.Batu Confluence - Tun Razak Bridge

Q= 160 m^3/s

V= 3.26 m/s

I= 1/400

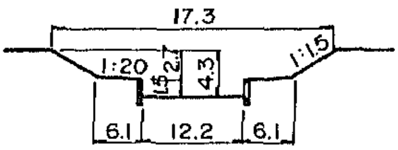


Drop 6'-0 - Sg.Belongkong Confluence

Q= 200 m^3/s

V= 2.80 m/s

I= 1/692

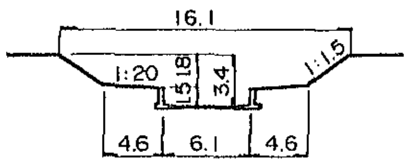


Tun Razak Bridge - Wooden Bridge

Q= 120 m^3/s

V= 3.14 m/s

I= 1/300



Sg.Belongkong Confluence - Retention Pond

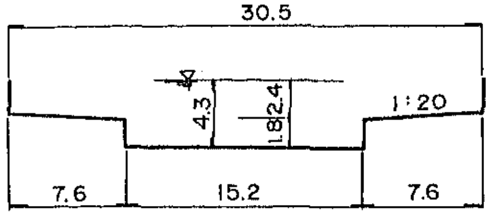
FIG. J-6	CROSS SECTIONS OF RIVER IMPROVEMENT (3/5)

THE STUDY ON THE FLOOD MITIGATION OF THE KLANG RIVER BASIN

JICA

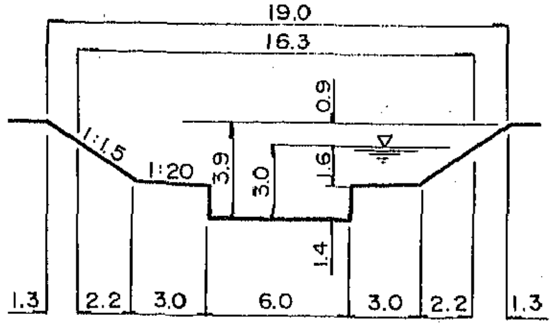
THE BATU RIVER

Q= 240 m³/s
V= 2.43 m/s
I= 1/1040



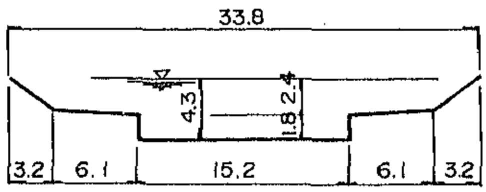
Sg. Gombak Confluence - Sg.Batang Tolak

Q= 70 m³/s
V= 2.36 m/s
I= 1/500



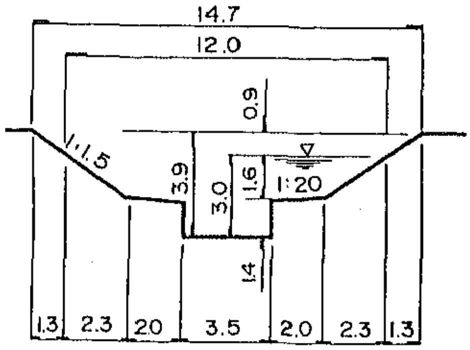
Sg.Jinjang - Outlet of Batu Pond

Q= 240 m³/s
V= 2.53 m/s
I= 1/905



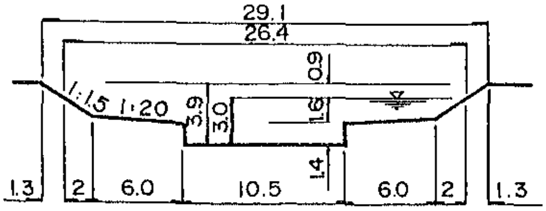
Sg.Batang Tolak - Sg. Keroh

Q= 40 m³/s
V= 2.03 m/s
I= 1/500



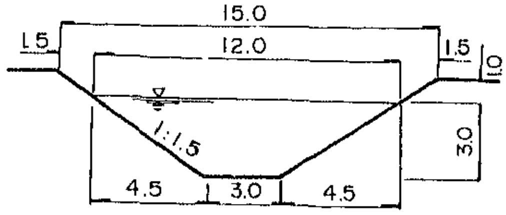
Outlet of Batu Pond - Regulation Pond

Q= 120 m³/s
V= 2.37 m/s
I= 1/600



Sg.Keroh - Sg.Jinjang

Q= 60 m³/s
V= 2.92 m/s
I= 1/400



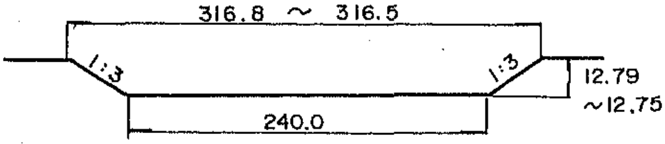
Regulation Pond - End of improvement Works

FIG. J-6	CROSS SECTIONS OF RIVER IMPROVEMENT (4/5)

THE STUDY ON THE FLOOD MITIGATION OF THE KLANG RIVER BASIN

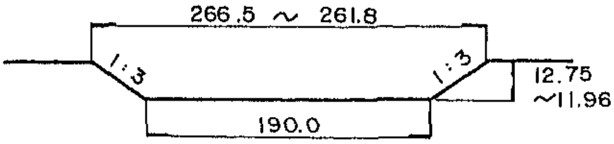
THE KLANG RIVER

NO.-49.0 ~ NO.-48.5



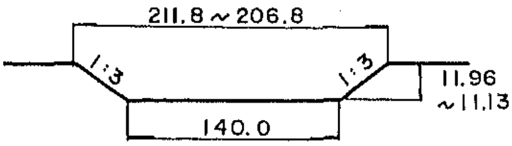
Q = 1,200 m³/s
I = 1/10,000

NO.-48.5 ~ NO.-39.0



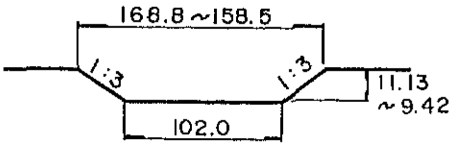
Q = 1,200 m³/s
I = 1/10,000

NO.-39.0 ~ NO.-29.0



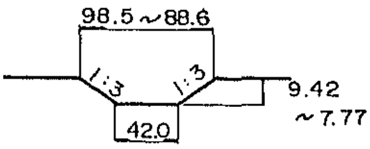
Q = 1,200 m³/s
I = 1/10,000

NO.-29.0 ~ NO.-15.5



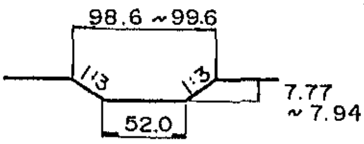
Q = 1,200 m³/s
(NO.-29.0 ~ NO.-27.0) ~ I = 1/10,000
(NO.-27.0 ~ NO.-15.5) ~ I = 1/ 5,000

NO.-15.5 ~ NO.-6.4



Q = 800 m³/s
I = 1/2,000

NO.-6.4 ~ NO. 0.0



Q = 1,150 m³/s
I = 1/2,000

Downstream Stretch of Puchong Drop

FIG. J-6	CROSS SECTIONS OF RIVER IMPROVEMENT (5/5)

THE STUDY ON THE FLOOD MITIGATION OF THE KLANG RIVER BASIN

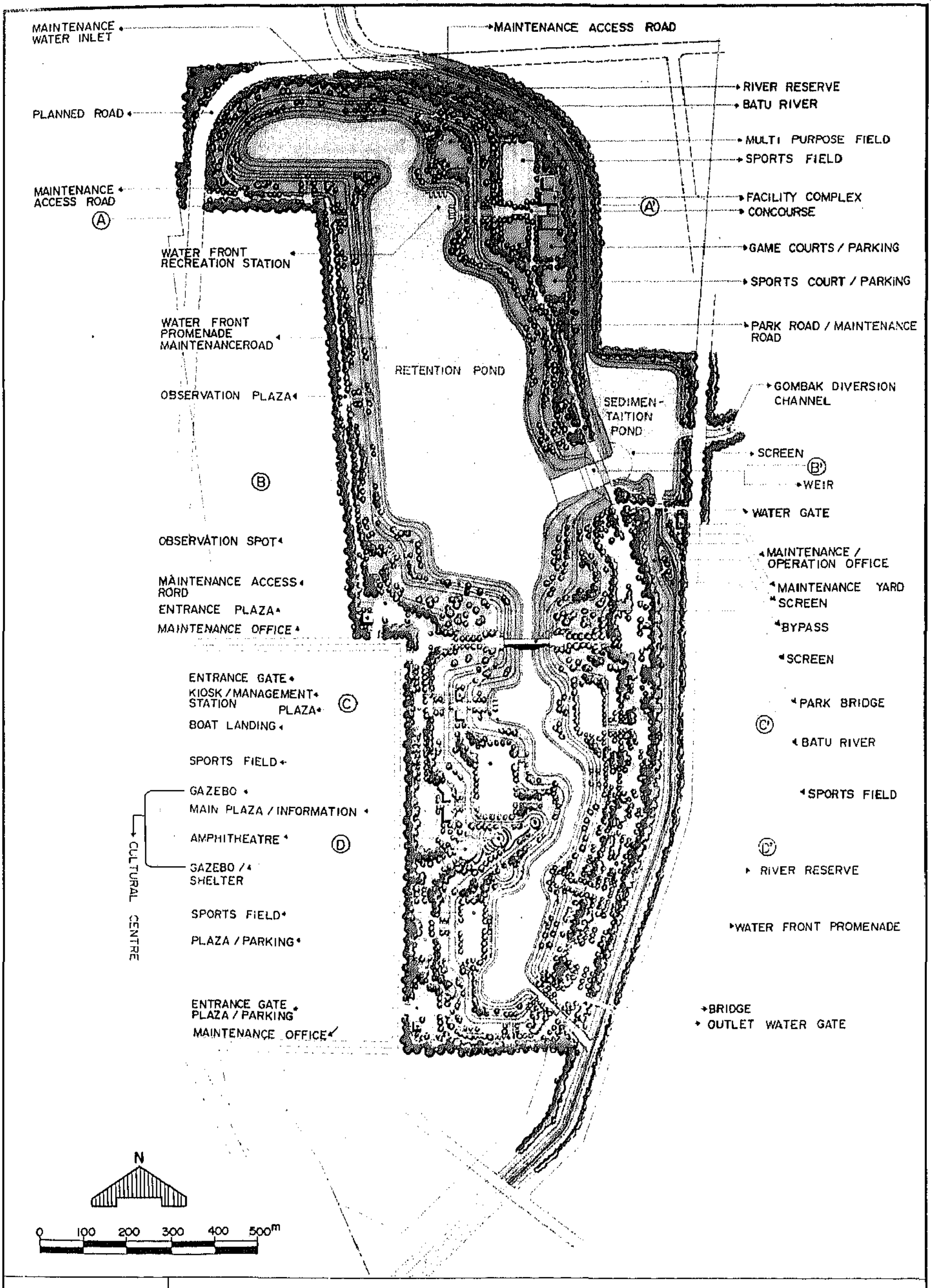


FIG. J-7 **LAYOUT PLAN OF BATU RETENTION POND**

THE STUDY ON THE FLOOD MITIGATION OF THE KLANG RIVER BASIN

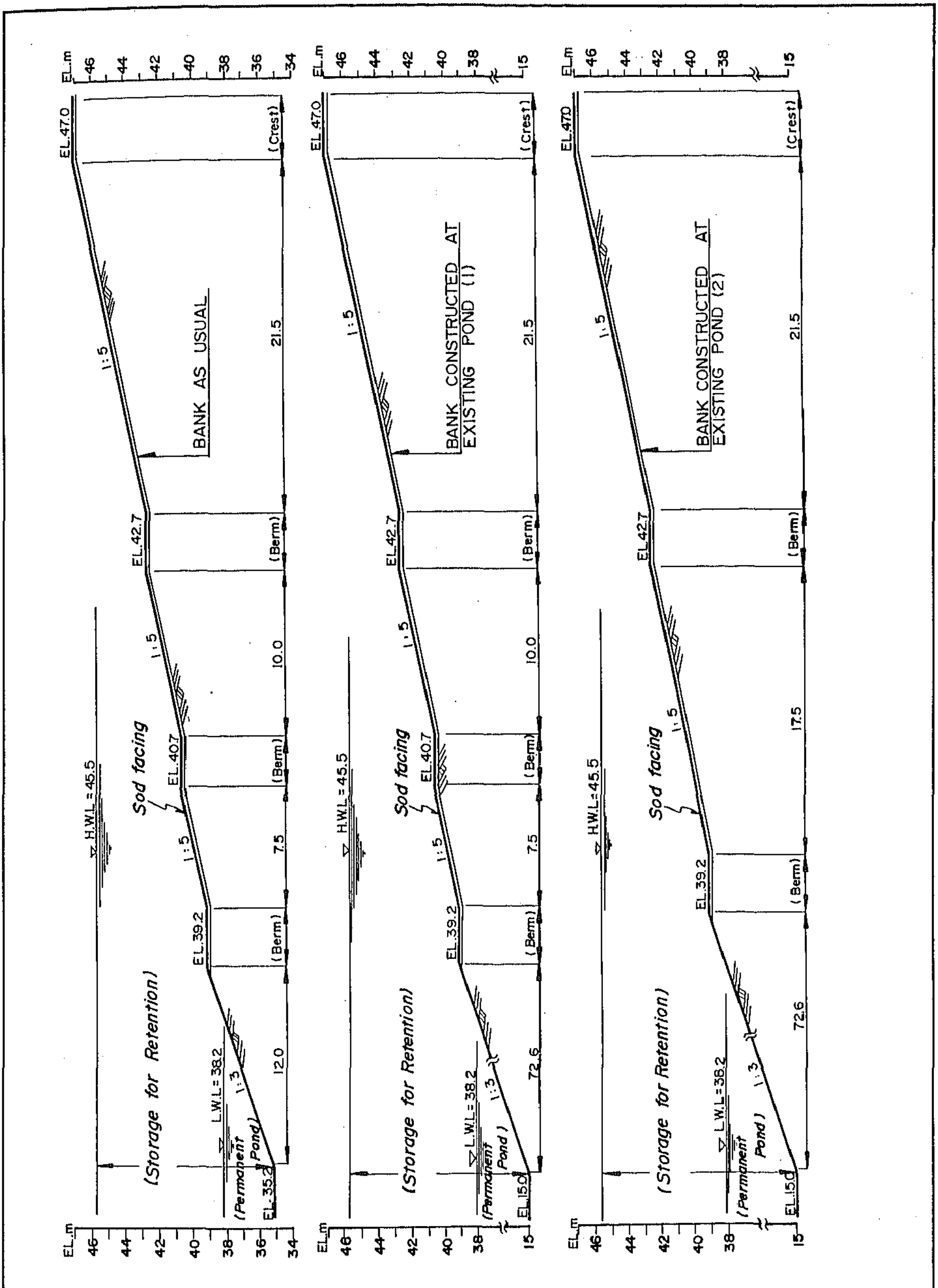


FIG. J-8	TYPICAL SECTIONS OF BATU RETENTION POND

THE STUDY ON THE FLOOD MITIGATION OF THE KLANG RIVER BASIN

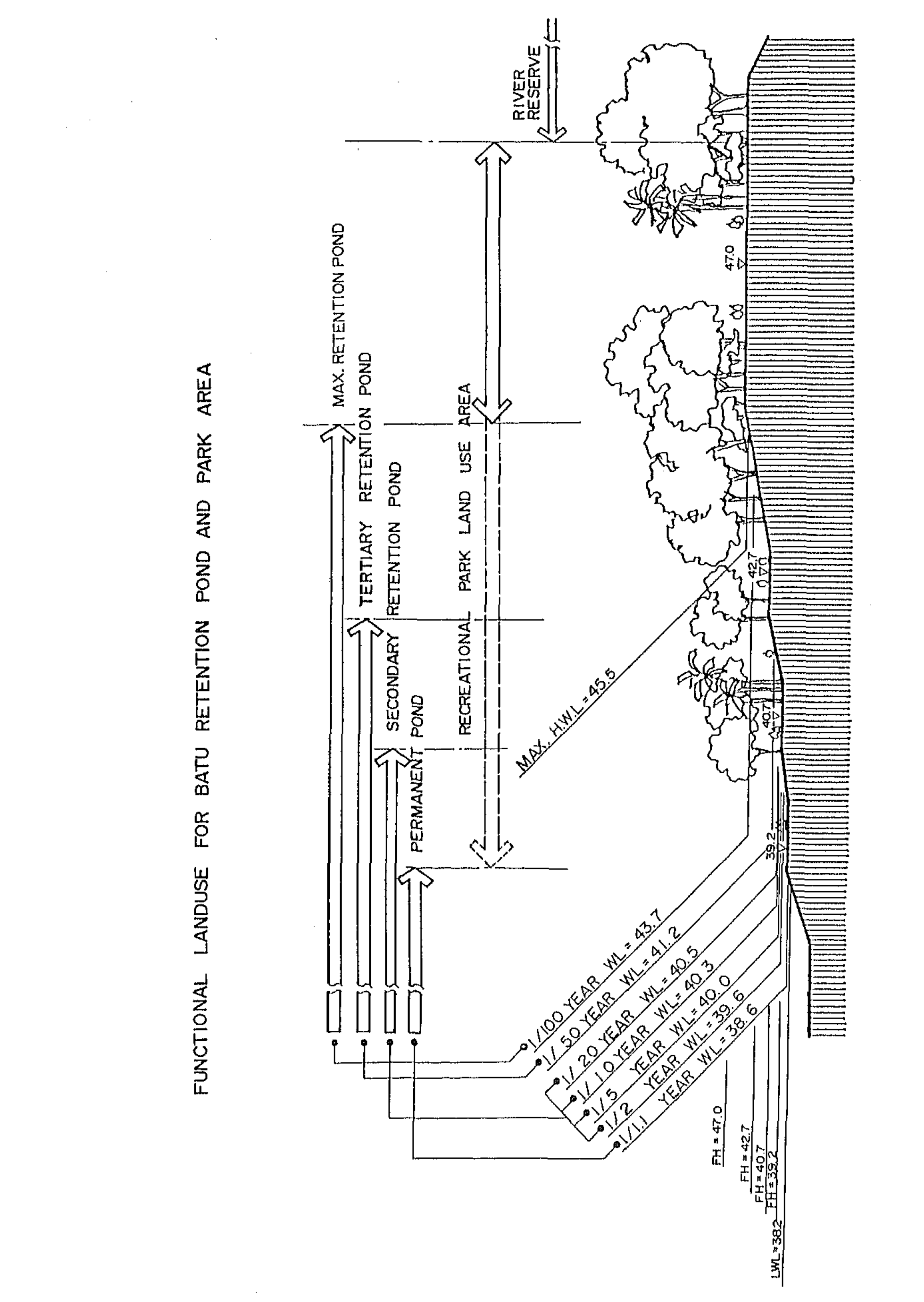


FIG. J-9	WATER LEVELS AND PARK AREA

THE STUDY ON THE FLOOD MITIGATION OF THE KLANG RIVER BASIN

TOTAL AREA		* 1,133,700 m^2
PERMANENT POND	(LWL=38.2, up to WL < 39.2)	305,600 m^2
SECONDARY RETENTION POND AREA	(40.7>WL≧39.2)	405,600 m^2
TERTIARY RETENTION POND AREA	(42.7>WL≧40.7)	549,400 m^2
Max. RETENTION POND AREA	(45.5>WL≧42.7)	* 670,000 m^2
SEDIMENTATION POND		* 55,600 m^2
PARK LAND AREA	(GL ≧ 45.5)	* 408,100 m^2

AREA RATIO OF BATU RETENTION POND / PARK AREA

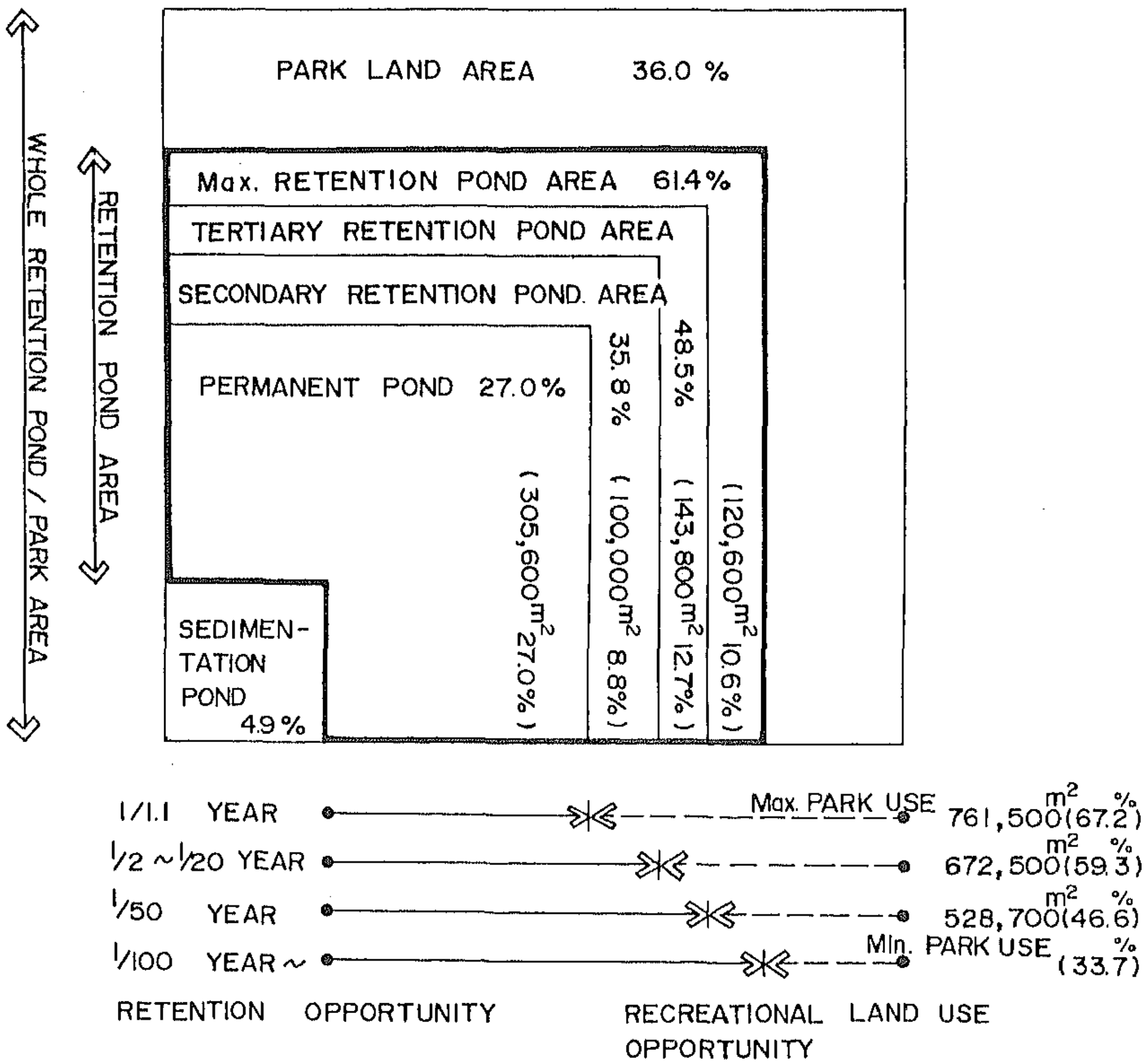


FIG. J-10 **AREA OF BATU RETENTION POND/PARK AREA**

THE STUDY ON THE FLOOD MITIGATION OF THE KLANG RIVER BASIN

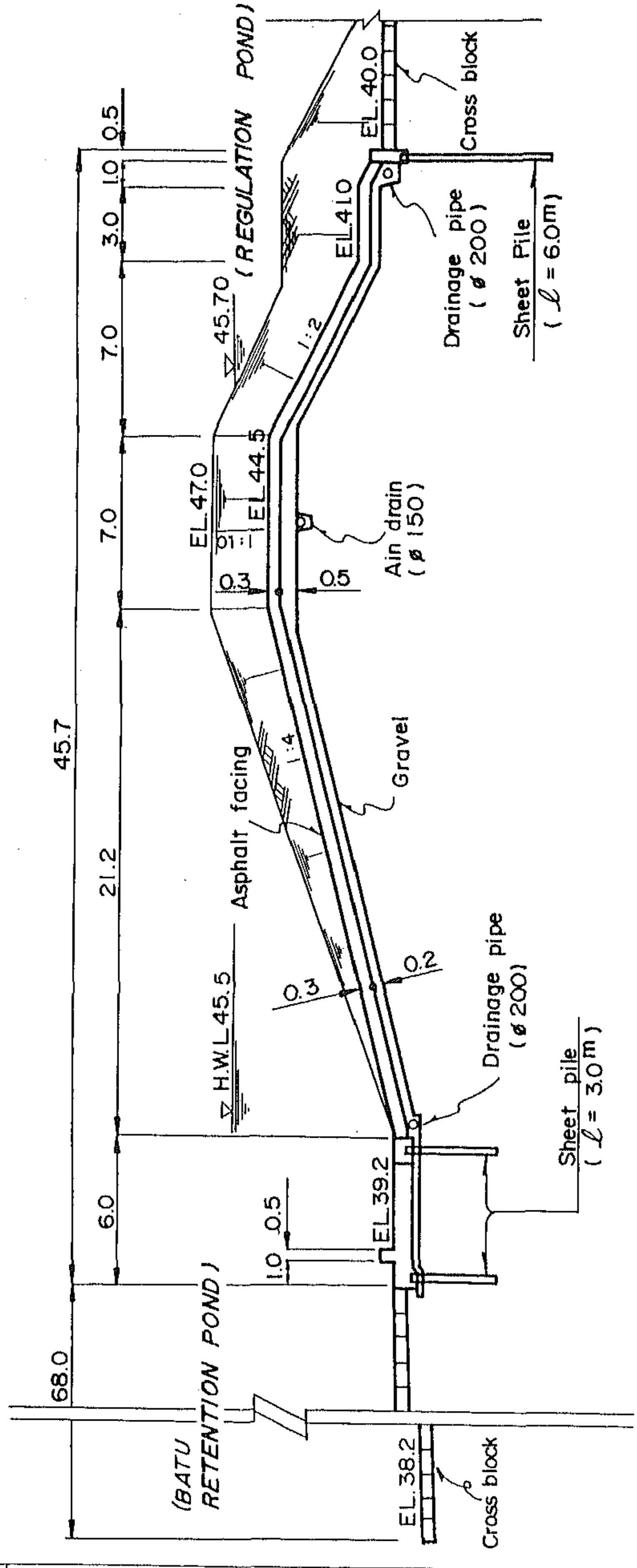


FIG. J-11	LONGITUDINAL SECTION OF DIVERSION WEIR

THE STUDY ON THE FLOOD MITIGATION OF THE KLANG RIVER BASIN

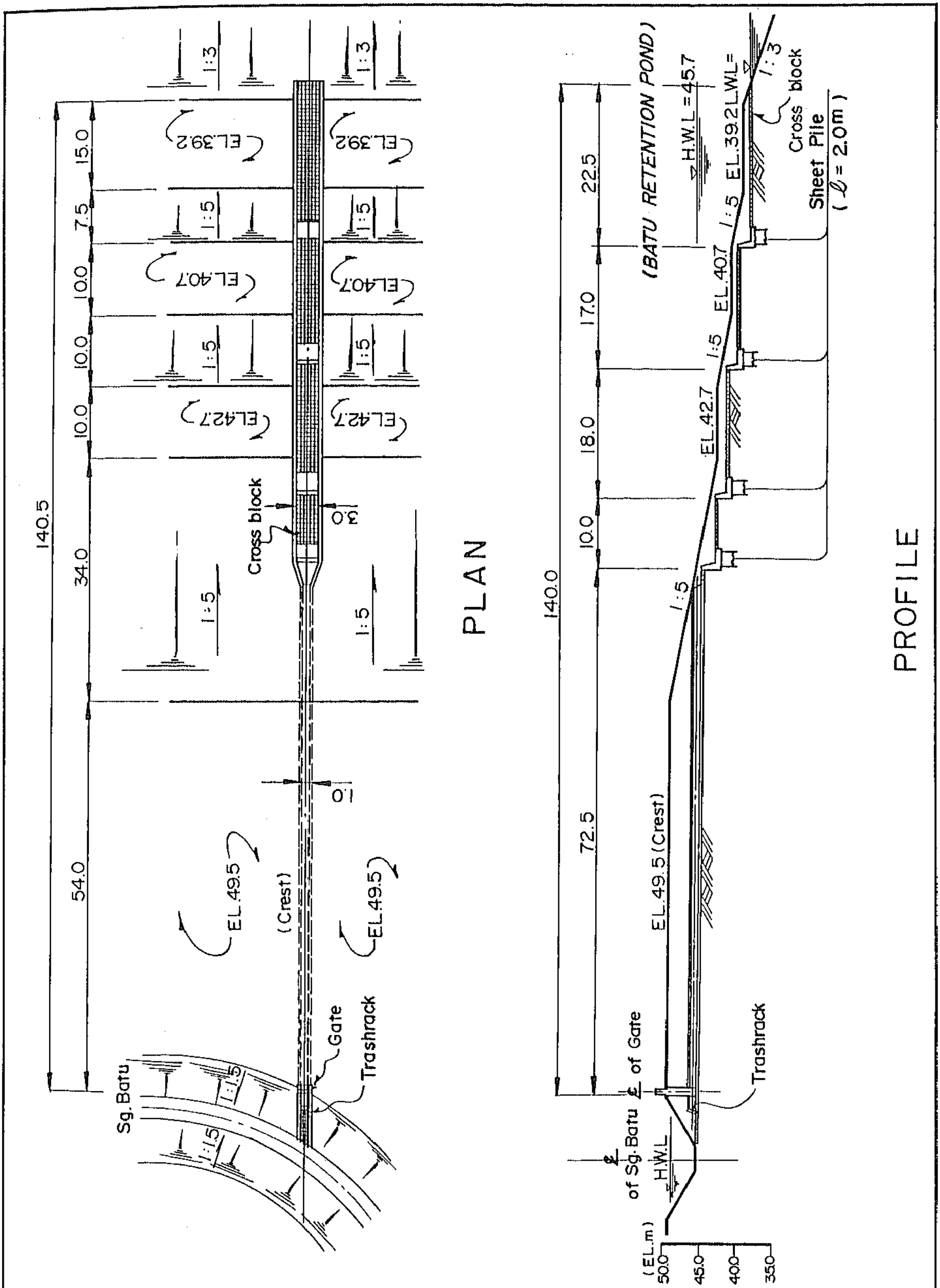


FIG. J-12	PLAN AND PROFILE OF INLET SLUICE GATE

THE STUDY ON THE FLOOD MITIGATION OF THE KLANG RIVER BASIN

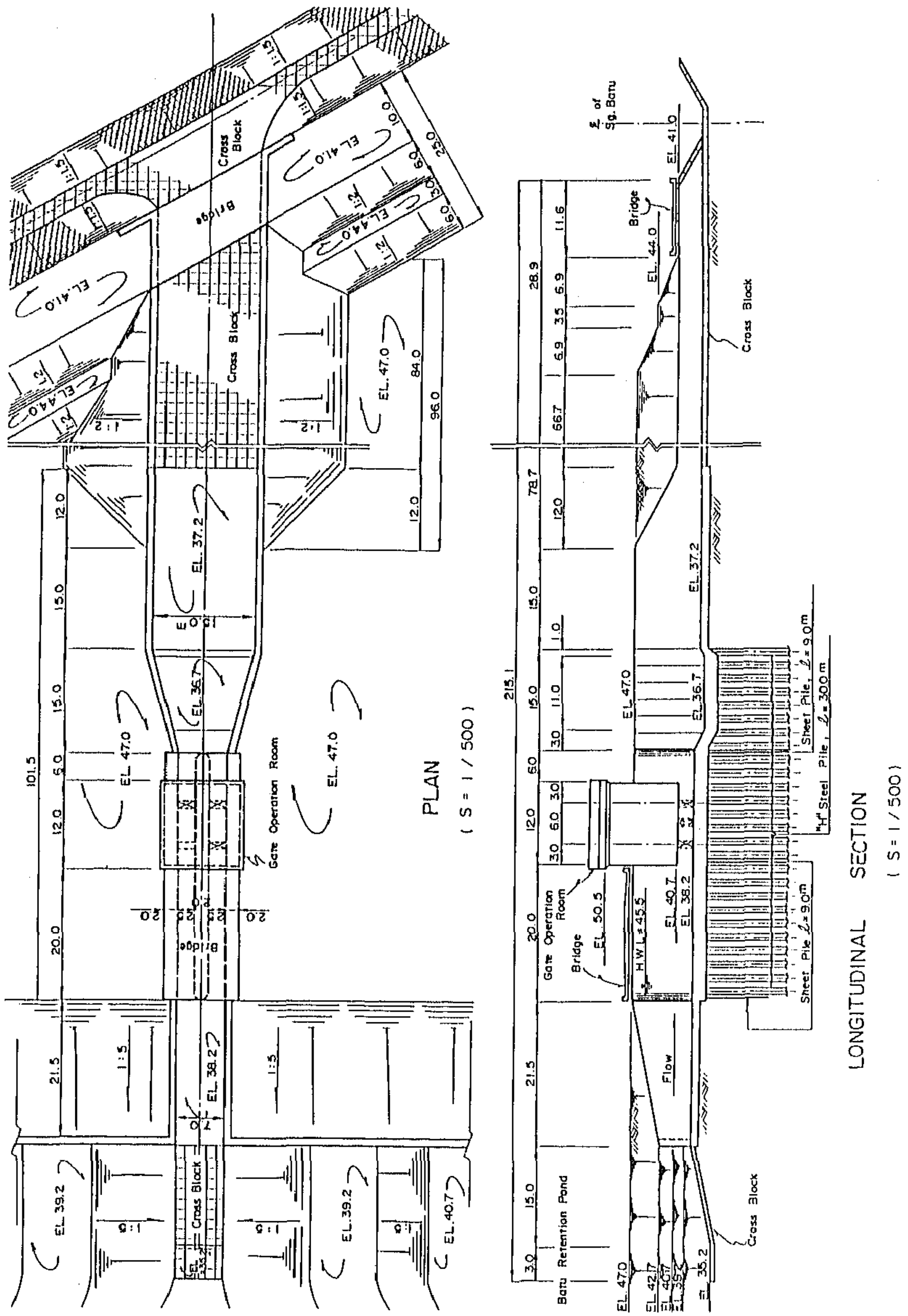


FIG. J-13 **PLAN AND SECTION OF BATU OUTLET SLUICE GATE**

THE STUDY ON THE FLOOD MITIGATION OF THE KLANG RIVER BASIN

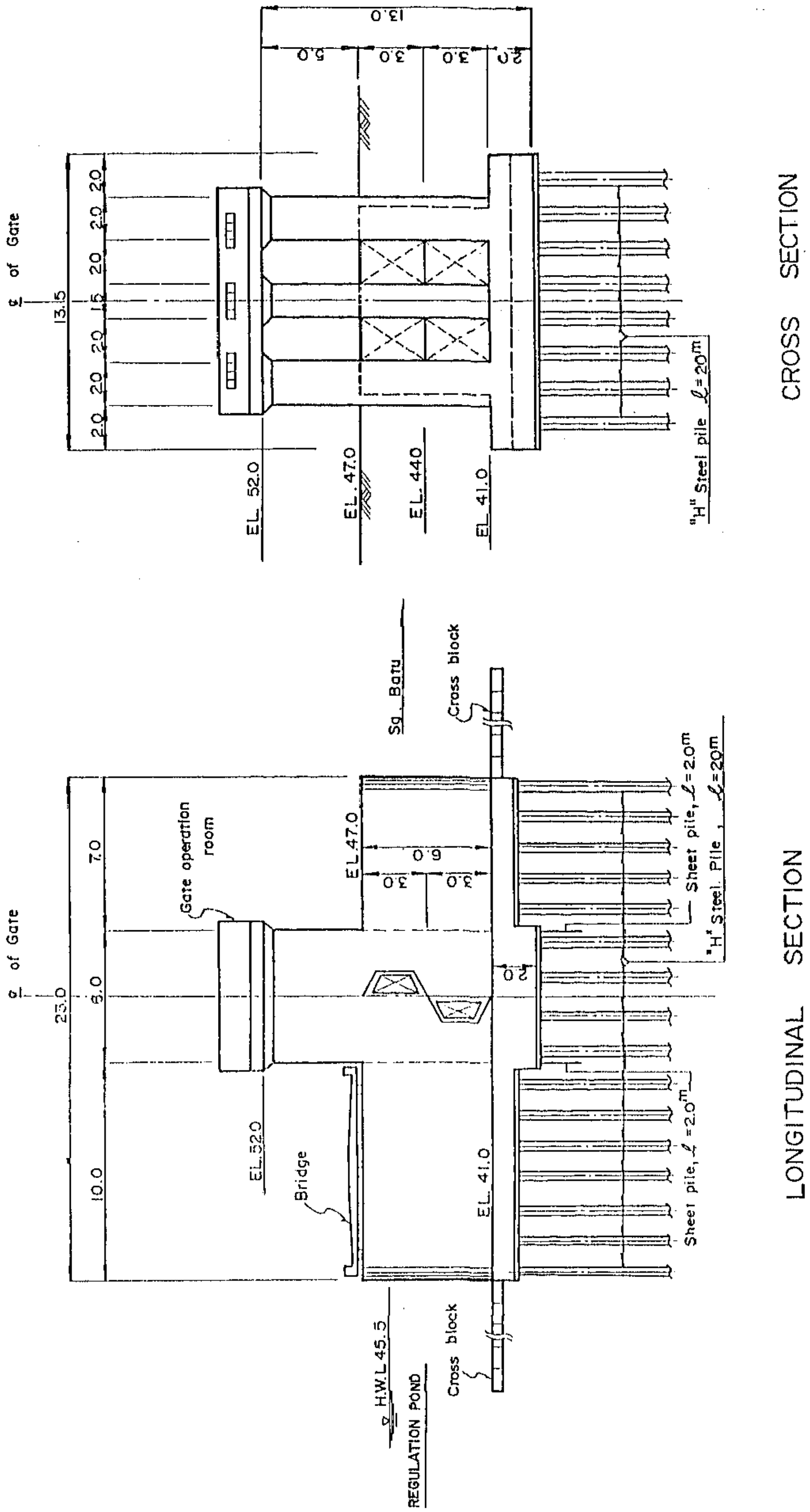


FIG. J-14 TYPICAL SECTION OF BATU WATER GATE

THE STUDY ON THE FLOOD MITIGATION OF THE KLANG RIVER BASIN

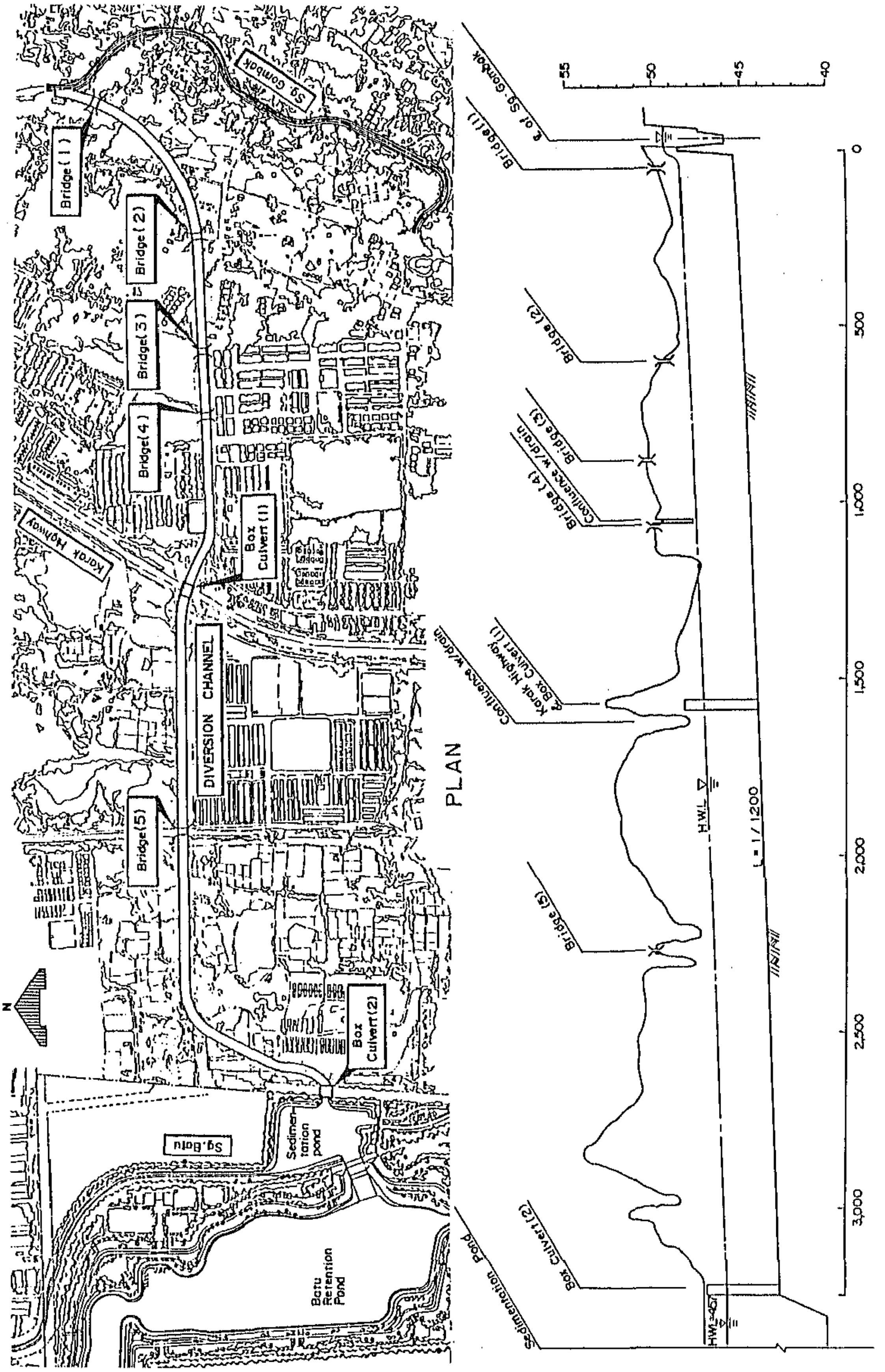
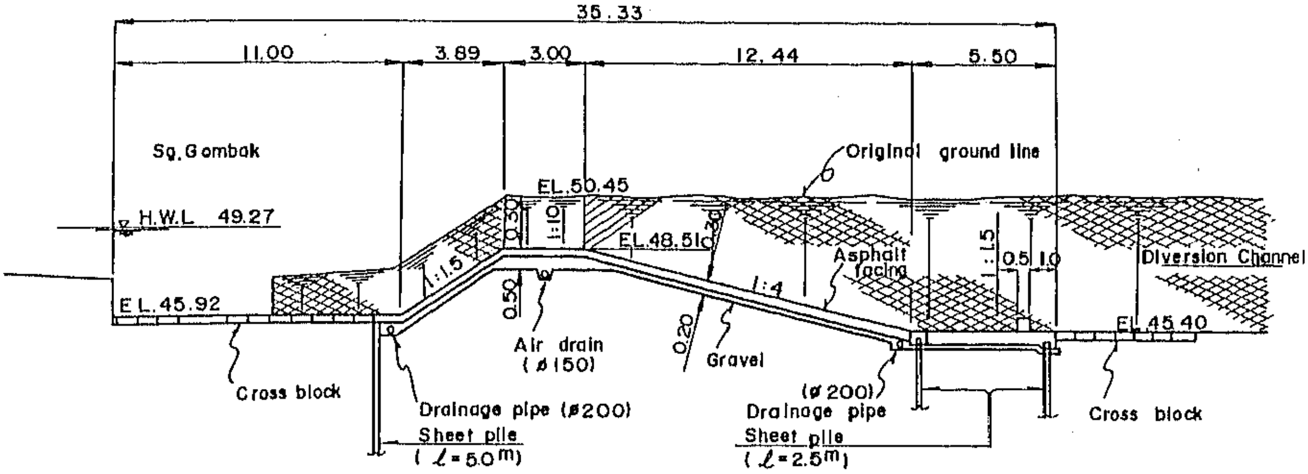
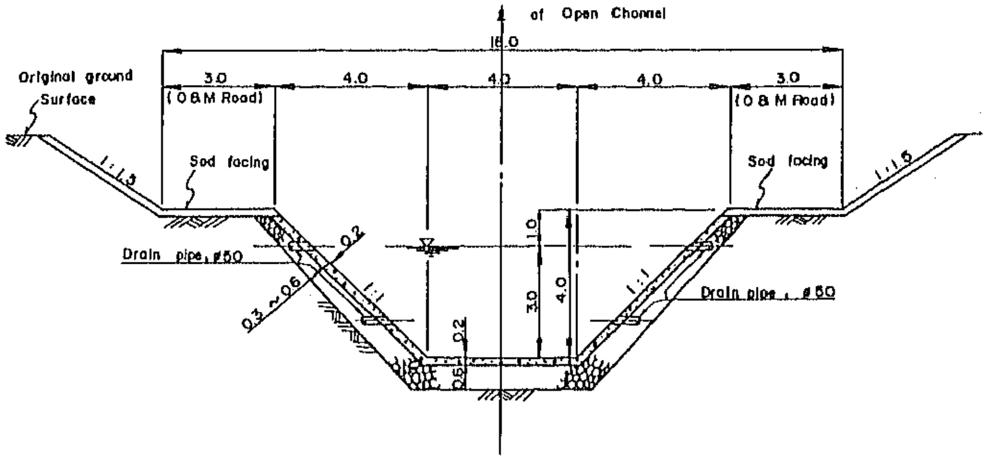


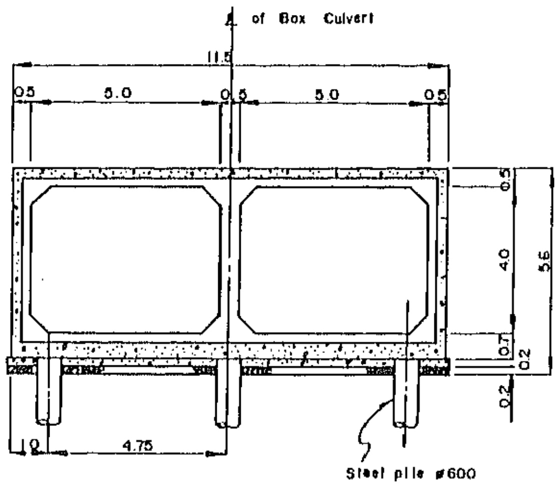
FIG. J-15	PLAN AND PROFILE OF DIVERSION CHANNEL

THE STUDY ON THE FLOOD MITIGATION OF THE KLANG RIVER BASIN





TYPICAL SECTION OF OPEN CHANNEL



TYPICAL SECTION OF BOX CULVERT

FIG. J-16 TYPICAL SECTION OF DIVERSION CHANNEL

THE STUDY ON THE FLOOD MITIGATION OF THE KLANG RIVER BASIN

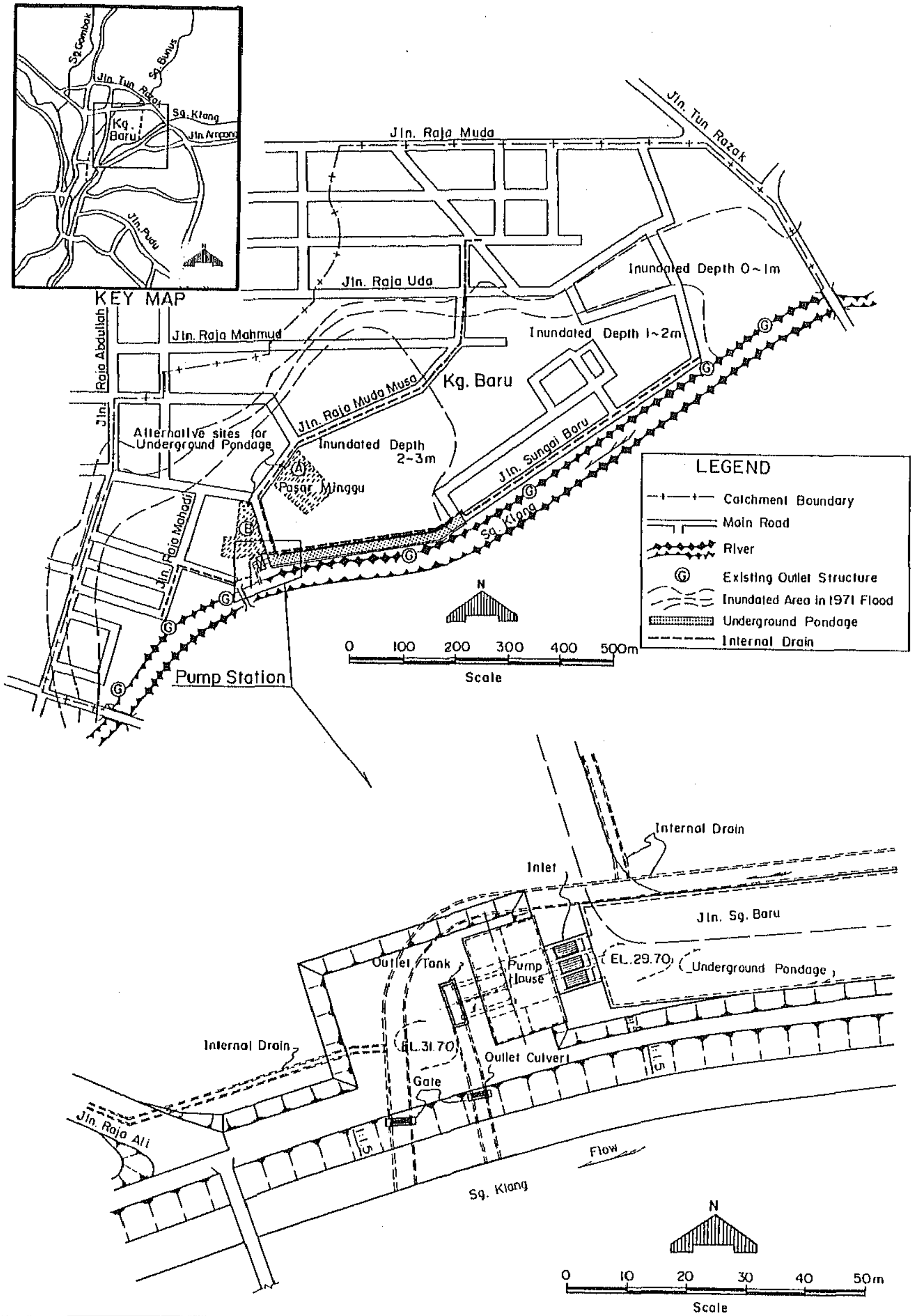


FIG. J-17	LOCATION OF EXISTING OUTLET STRUCTURES AND PROPOSED DRAINAGE STRUCTURES IN KAMPUNG BARU

THE STUDY ON THE FLOOD MITIGATION OF THE KLANG RIVER BASIN

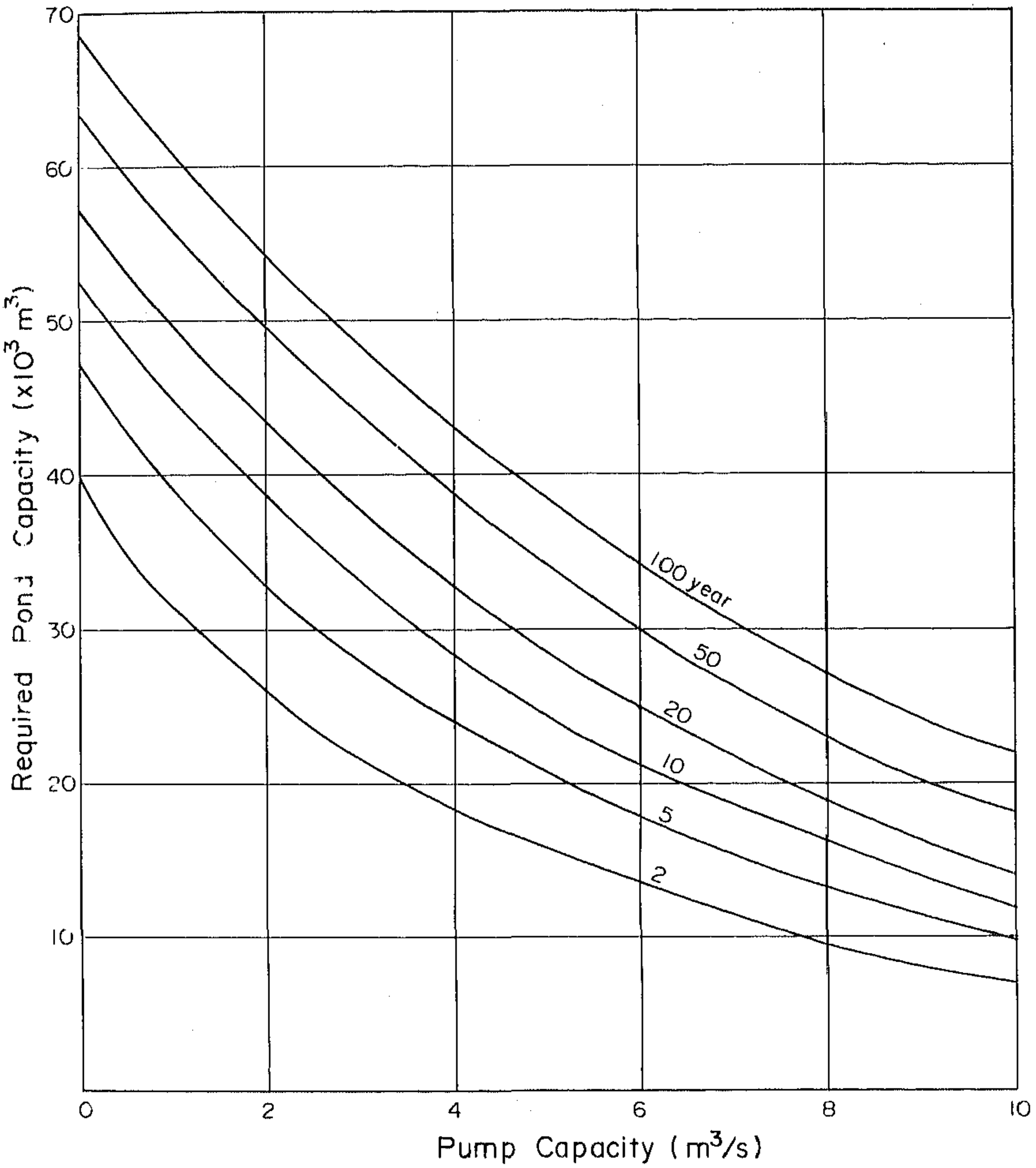


FIG. J-18 **PUMP CAPACITY VS. POND CAPACITY AT VARIOUS RAINFALL FREQUENCIES**

THE STUDY ON THE FLOOD MITIGATION OF THE KLANG RIVER BASIN

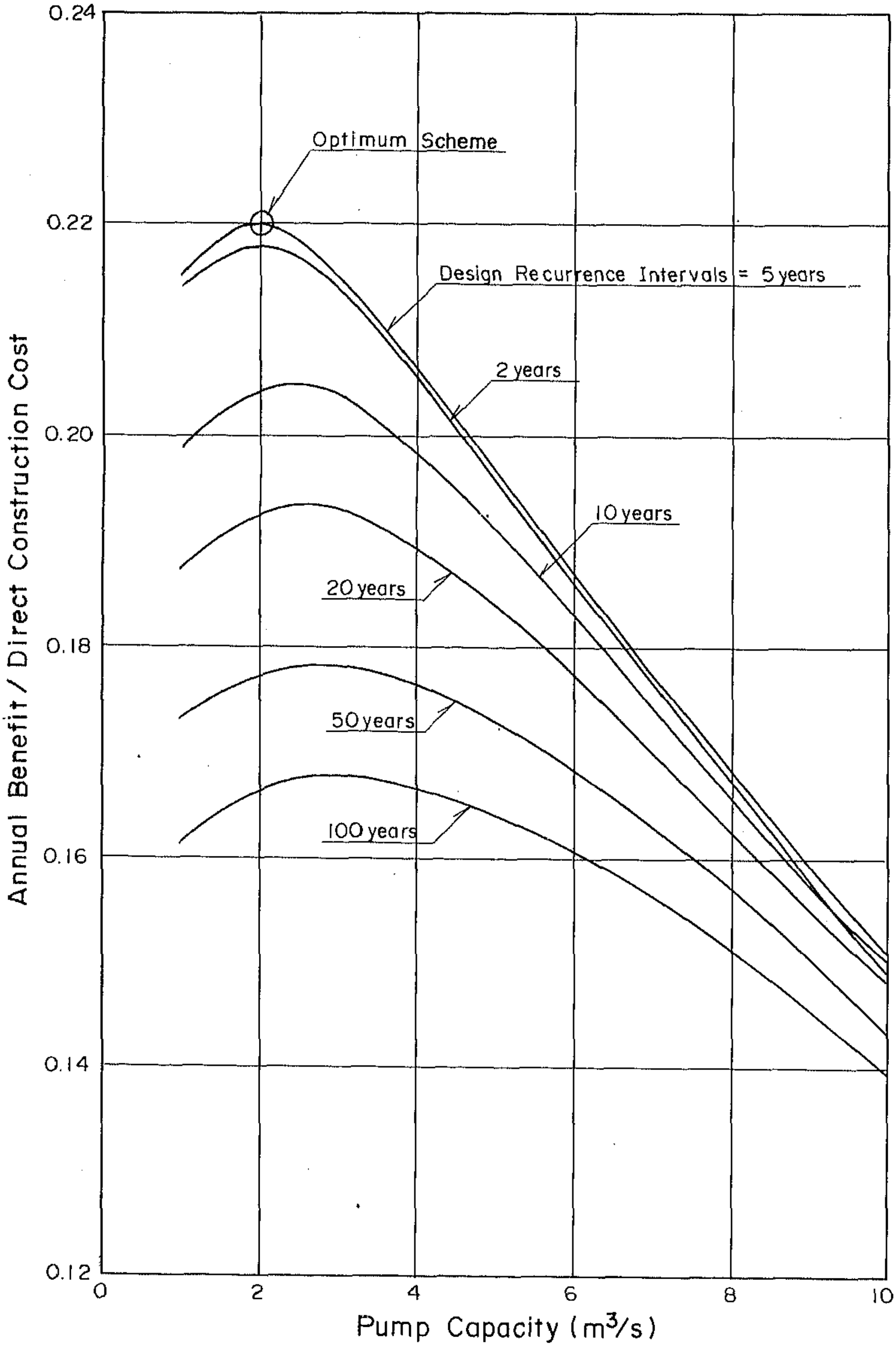


FIG. J-19	ECONOMIC COMPARISON RESULTS FOR KAMPUNG BARU DRAINAGE PLAN

THE STUDY ON THE FLOOD MITIGATION OF THE KLANG RIVER BASIN

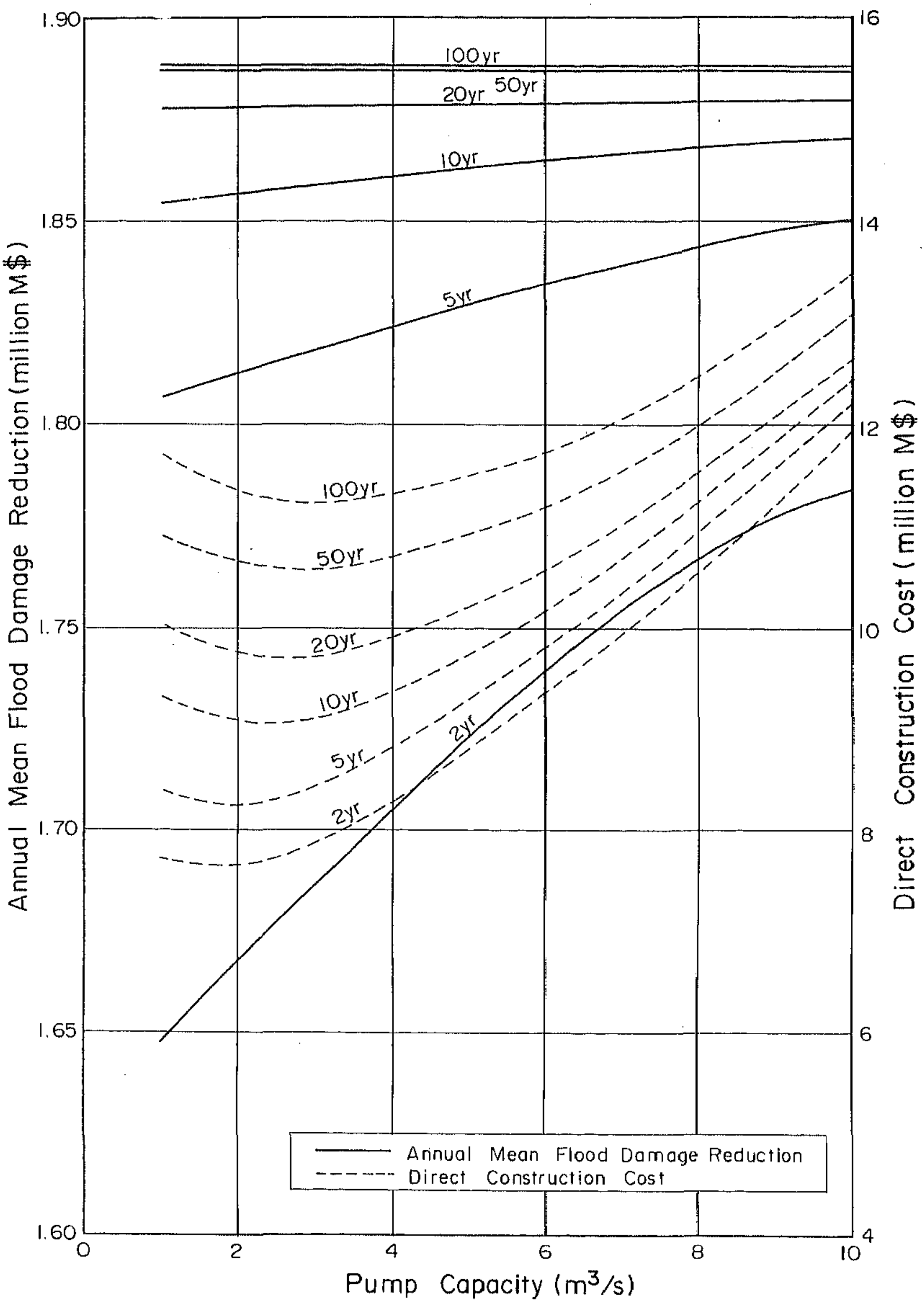
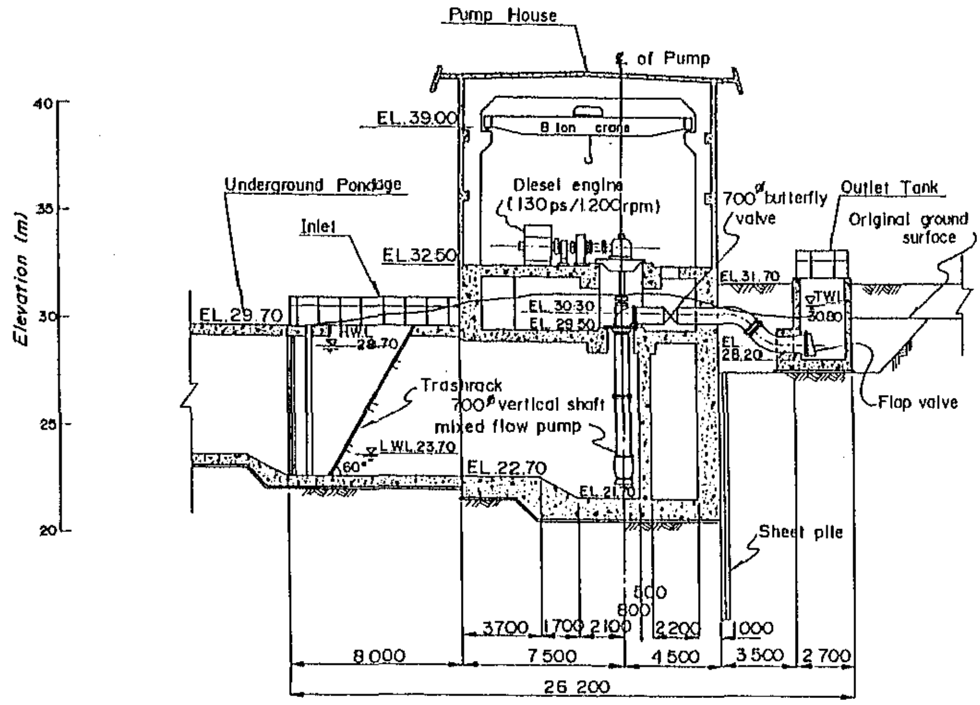
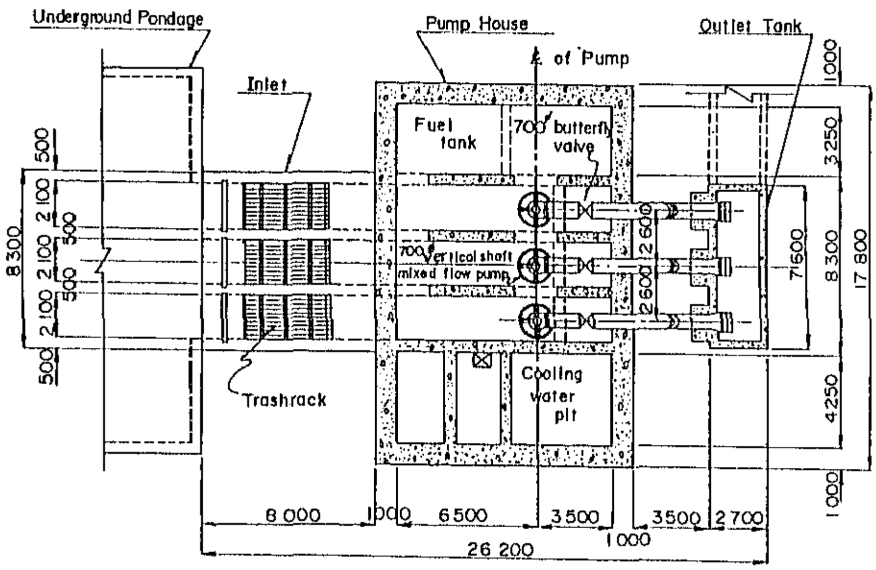


FIG. J-20	COST AND BENEFIT OF ALTERNATIVE CASES

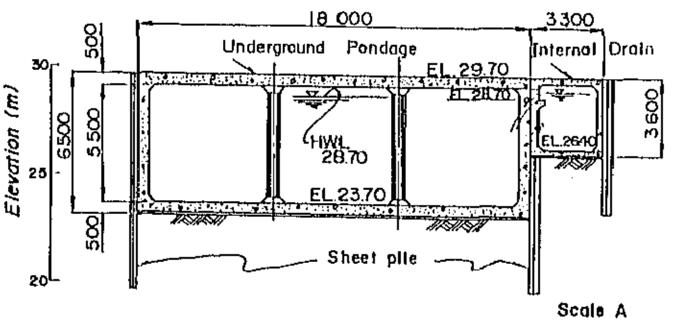
THE STUDY ON THE FLOOD MITIGATION OF THE KLANG RIVER BASIN



TRANSVERSE SECTION OF PUMP STATION Scale A

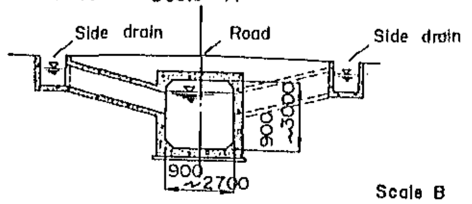


PLAN OF PUMP STATION Scale A



Scale A

TYPICAL SECTION OF UNDERGROUND PONDAGE



Scale B

TYPICAL SECTION OF INTERNAL DRAIN

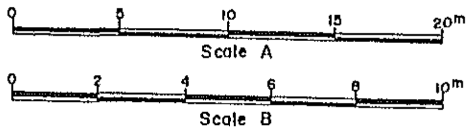


FIG. J-21	STRUCTURES FOR KAMPUNG BARU DRAINAGE PLAN

THE STUDY ON THE FLOOD MITIGATION OF THE KLANG RIVER BASIN

APPENDIX K: CONSTRUCTION PLAN AND COST ESTIMATE

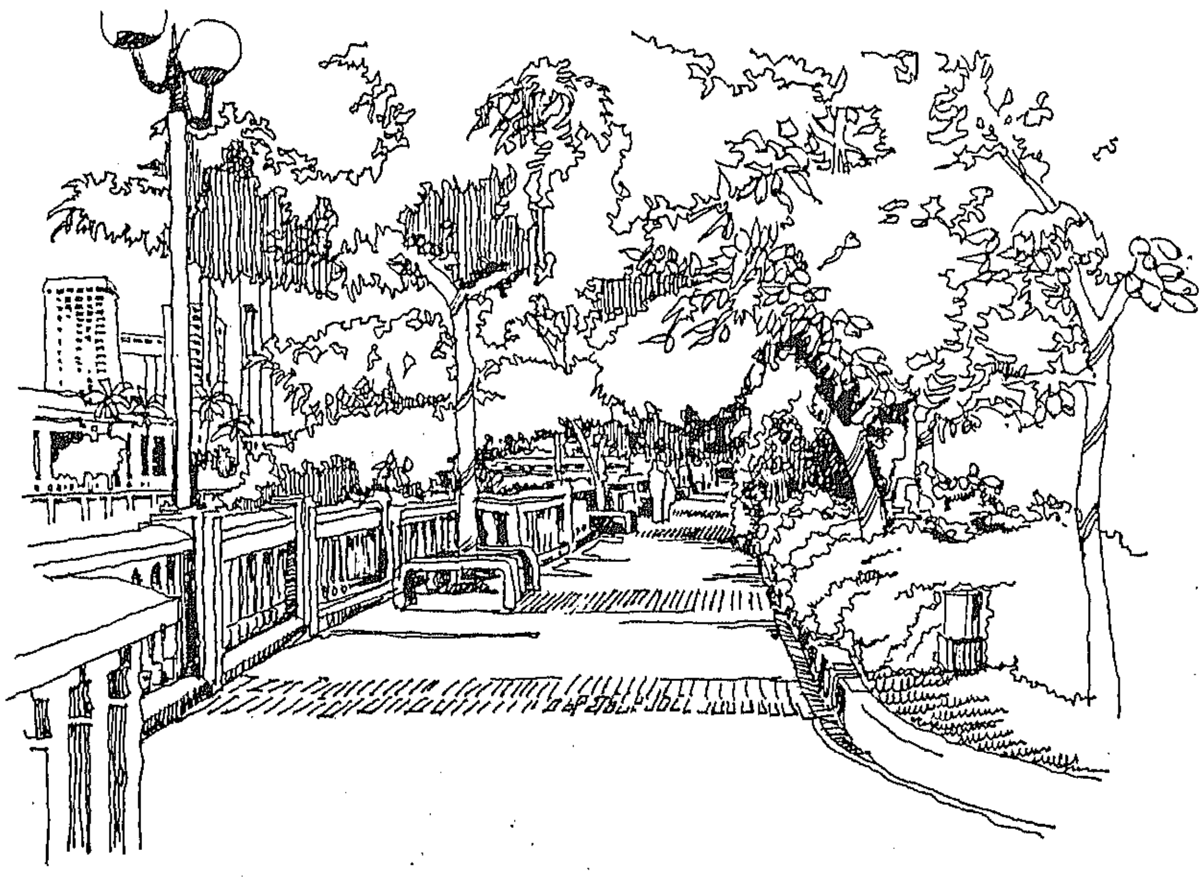


TABLE OF CONTENTS

APPENDIX K. CONSTRUCTION PLAN AND COST ESTIMATE

1. INTRODUCTION

This chapter presents the proposed construction plan and cost estimate necessary to implement the civil engineering and the hydromechanical construction works. The objective of this chapter report is to provide a guide for the execution of the construction works and for the construction cost estimate.

The construction plan is drawn up on the basic assumptions made in the preparation of the construction schedule. This plan gives an outline of possible procedures, construction method, and type of construction equipment which are normally used in such works.

The description of the construction method and equipment to be used is developed by assuming that the major construction works will be performed by international contractors which will be selected through an international competitive tender. They should be fully capable of employing modern construction methods, managing the construction, and have sufficient equipment to complete construction work on this scale.

Each bidder will be responsible for his own construction plan and method of implementation.

2. EXECUTION OF THE CONSTRUCTION

The project is to be implemented by the DID (the state of Malaysia Drainage and Irrigation Department) and assisted by an international consulting engineer. The construction works for the project will be carried out by selected contractors through international and local competitive tenders. The execution of the works will be made by the following basic implementation plan:

Executive Body

DID will be the executing agency for the implementation of the project. The supervision and administrative works will be performed by DID with the assistance of the consulting engineer.

Financial Source

The local currency component of the construction cost will be covered by the national budget. The foreign currency component will be financed by the overseas fund.

2.1 Conditions and Assumption for Construction Planning

The following condition and assumption were applied to the planning for construction works:

2.1.1 Site Condition

(1) Topography

The Klang River Basin is located in the central part of Selangor State on the West Coast of Peninsular Malaysia. It is bounded by latitudes of 2.55N and 3.25N and longitudes of 101-20E and 101-50E. It covers about 55 km from east to west. There are two major tributaries on the upper basin. These are the Gombak and Batu Rivers. The ground elevation of the Klang River varies from 11.0 m to 65 m, while the

Gombak River varies from 97 m to 24 m and the Batu River from 65 m to 25 m.

(2) Meteo-Hydrology

The project area lies within the tropical zone, and it is not divided clearly into dry and wet seasons. The annual mean rainfall in the area is estimated at 2,250 mm ranging from 2,700 mm in the mountainous areas upstream of the Klang River to 1,880 mm along the main river course, for the period from 1975 to 1985. The maximum annual temperature is 32°C.

Other characteristics on the meteo-hydrological data along the stretch in this study are shown in Table K-1.

(3) Geology

With regard to general geological conditions along the main river course, the base rock formation can be classified as follows:

KUALA LUMPUR	:	Massive bedded limestone with dolomitic lenses and metamorphic marbles.
KENNY HILL	:	Uppermost bedrock is granite and the least metamorphosed consists of quarzite, phyllite, shale and sand stone.
RIVER PLAIN AREA	:	Alluvial deposits comprising clay, sand and gravel.

(4) Access to Site

Access to the site from the Port Klang is primarily provided by the state road, which connects the port to both the Gombak and Batu Rivers. Other branch roads are available for access to various project sites. The state road is paved with asphalt and varies from 6 m to 20 m in overall width.

Port Klang is the main seaport of the Klang River Basin situated on an estuary and has 21 berths, each of about 200 m long which can accommodate vessels up to 60,000 tonnes displacement.

The major equipment installed in this port are gantry cranes with a maximum capacity of 30 tons, forklifts, and carts with the capability for unloading berthed vessels.

The handling of equipment heavier than 35 tons is done by cranes installed on the respective ships. This port is controlled and administered by the Federal Marine Department (F.M.D.). Distances between this port and the project sites range from 5 km to 100 km.

	BERTH	DEPTH (M)
South Port	#1-3	10
	#4	9.1
	#5	6
	#6-7	5.5
	7a	5.5
Tongkang	8	2.2

(5) Communication

S.T.M (Syarikat Telekom Malaysia) maintains a well developed telephone system in the study area. Telephone communication will serve as the link between the main office in Kuala Lumpur and the various site offices during the construction period.

Portable 2-way radios can be used for communication within the project area with permission from the relevant authorities.

(6) Construction Plant and Equipment

A construction plant and equipment required for the implementation of the project are available mostly in the local market.

For concrete works, ready mixed concrete factories having daily (12 hour per day) production capacities ranging from 300 to 500 cu.m are available in and around Kuala Lumpur.

(7) Electricity

Electricity in the project area is supplied by Lembaga Letrik Negara (L.L.N.) and transformed to low-voltage (220 V) from the primary high-voltage lines. The distribution lines in and around the project areas can be utilized for construction.

(8) River Crossing Facilities

Since the project sites are scattered throughout the river basin, many public utilities such as roads, electric power lines, and water, oil, and gas pipelines will be encountered.

The contractors are required to cooperate closely with the following agencies for the diversion or relocation of these works, and to provide temporary supply of such facilities during construction.

- For road bridge : JKR (Jabatan Kerja Raya)
- For railway bridge : KTM (Keretapi Tanah Melayu)
- For electric cable : LLN (Lembaga Letrik Negara)
- For water pipe : BAS (Bekalan Air Selangor)
- For telephone cable : STM (Syarikat Telekom Malaysia)
- And other relevant district offices

(9) Construction Material

Required construction materials such as cement, steel, wood, fuel and lubricants, and reinforced concrete pile for the foundation works of related structures are available in and around Kuala Lumpur. They are listed in Table K-2.

(10) Construction Equipment

Major mechanized construction works required for the project include earth work and revetment (sheet pile or pre-cast concrete wall) works. Mechanized construction using light or middle class construction equipment will be adopted for the execution of the works. This construction equipment is usually available in Kuala Lumpur city for leasing or outright purchase. (See Table K-3) Hydro-mechanical equipment such as pumps and gates are being manufactured at Kuala Lumpur.

(11) Labor Source

Skilled and semi-skilled labor may be recruited in the project area, with the bulk of technicians hired from Kuala Lumpur. Common labor in sufficient number can be recruited in the project area without seasonal variation. (See Table K-5)

(12) Availability of Contractors in Malaysia

The building and construction industry is one of the fastest developing sections of the Malaysian economy. The growth rate of the construction industry was 9.6 per cent per year during the last decade.

Contractor registration is regulated by PUSAKABUMI* under the Prime Minister's Department. As of March 1988, the following were registered according to their class.

CLASS	REGISTERED	PROJECT COST (M$)
A	146	>$4,000,001
B	345	2,000,001 - 8,000,000
Bx	435	1,000,001 - 4,000,000
C	475	750,001 - 2,000,000
D	678	150,000 - 750,000
E	473	100,001 - 350,000
Ex	380	50,001 - 150,000
F	-	<$100,000

* Authority over the registration of all classes of contractors bidding for government job or projects.

(13) Land Acquisition

The present progress of land acquisition and house evacuation along the Klang, Gombak, Batu River Basin includes retention pond, diversion channel and inner drainage area etc. are as follows:

RIVER	SECTION	LAND AQUISITION	HOUSE EVACUATION
Batu	R2	90% of all	Completed
	R3	90% of all	Not started yet
	R4	90% of all	- do -
	N1	Not started yet	- do -
Gombak	R7	Not started yet	On-going
	N2	Not started yet	Not started yet
Klang	K10	Completed	On-going
	K12	Not started yet	Not started yet
Batu Retention Pond	-	Not started yet	-
Diversion Channel	-	Not started yet	Not started yet
Inner Drainage	-	Not started yet	Not started yet

2.1.2 Mode of Construction

It is essential to realize the river improvement plan as early as possible to protect areas in and around Kuala Lumpur from probable floods in the future. Therefore, the project is planned to be divided into three (3) stages, i.e., urgent term, mid term, and long term. In this feasibility study, only the urgent term stage is planned.

Considering the scale of the works involved in the terms of the expected contract, the construction works can be broken down into the following packages: (See APPENDIX I)

- Improvement of the upper reaches of the Klang River Section K9 from Jln Tun Perak Bridge upstream for about 3.1 km.

- Improvement of the upper reaches of the Gombak River Section G4 from Jln Tun Razak to upward for about 3.5 km.

- Improvement of the upper reaches of the Batu River Section B2 and B3, they extend for 6.1 km upstream from the Jln Kolom Air Empat Bridge.

- Construction of the Batu Retention Pond. It is to be a re-use of the existing ex-mining pond area about 70 ha.

- Construction of the Diversion Channel connecting the Gombak and Batu Rivers, and will be about 3.2 km in length.

- Construction of a pumping station for the underground pondage of 60,000 cu.m. It is located in and around Kampung Baru.

- Removal and re-construction of crossing facilities such as the bridges, water pipes, footpaths.

The "Bill of Quantities" contract system can be used for international open competitive bids, accompanied by a prequalification of the bidders.

The construction works will be administered and supervised by DID, in association with an international engineering consulting firm.

2.1.3 Work Items and Quantities

Major works items for the project are tabulated as follows:

WORK ITEMS	UNIT	WORK QUANTITIES
(1) River Improvement Work Klang River Section K9		
Excavation, in Common	m^3	74,350
Embankment	m^3	300
Concrete facing in berm	m^3	8,770
Sod facing in slope	m^2	26,250
Revetment		
- Sheet pile	m^2	31,000
Miscellaneous	L.S	-

(To be continued)

WORK ITEMS	UNIT	WORK QUANTITIES
Gombak River Section G4		
Excavation	m^3	32,750
Embankment	m^3	1,960
Back fill	m^3	22,800
Sod facing	m^2	46,750
Revetment		
- Sheet pile	m^2	7,520
- Pre-cast	m^3	18,800
Drop structure		
- Concrete	m^3	200
- Cross block	m^2	170
Bridge		
- Removed	m^2	80
- Construction	m^2	100
Miscellaneous	L.S	-
(2) Batu Retention Pond		
Retention Pond		
Excavation	m^3	2,261,300
Embankment		
- Reclamation	m^3	445,000
- Embankment	m^3	2,024,600
- Displacement	m^3	100,400
Sod facing	m^2	501,700
Landscape	m^2	200,000
Miscellaneous	L.S	-
Batu Outlet Gate		
Excavation	m^3	61,200
Embankment	m^3	5,400
Back fill	m^3	14,400
R. Concrete	m^3	7,930
Cross block	m^2	1,830
Sheet pile	m^2	945
H-pile	m	19,200
Gravel	m^3	150
Foot protection block	m^3	500
Gate	t	14.4
Bridge	m^2	440
Stop log (2.5mx2.5mx150t)	t	1.3
Miscellaneous	L.S	-
Batu Sluice Way		
R. Concrete	m^3	280
H-Pile	m	375
Sheet pile	m^2	70
Gate (1mx1m)	t	0.6
Cross block	m^2	230
Excavation	m^3	2,100
Back fill	m^3	1,000
Miscellaneous	L.S	-

(To be continued)

WORK ITEMS	UNIT	WORK QUANTITIES
(3) Diversion Channel		
Channel Intake		
Excavation	m^3	24,300
Embankment	m^3	1,900
Gravel bedding	m^3	750
Asphalt facing	m^3	350
Air drain pipe (ø150mm)	m	60
Drainage pipe (ø200mm)	m	120
R. Concrete	m^3	170
Cross block	m^2	3,200
Foot protection block	m^2	1,800
Sheet pile	m^2	150
Miscellaneous	L.S	-
Diversion Channel		
Excavation	m^3	260,000
Embankment	m^3	4,000
Back fill	m^3	12,500
Sod facing	m^2	49,500
R. Concrete	m^3	11,100
Gravel bedding	m^3	24,200
Drain pipe (ø50mm)	m	5,550
Bridge	m^2	828
Steel pile (ø600mm)	t	39
Paving	m^2	5,800
Miscellaneous	L.S	-
Batu River Section B2,B3		
(B2)		
Excavation, in Common	m^3	325,900
embankment	m^3	1,070
Revetment		
- Sheet pile	m^2	42,560
Sod facing	m^2	73,160
Drop structure		
- Concrete	m^3	420
- Cross block	m^2	510
Bridge		
- Removed	m^3	1,240
- Construction	m^3	1,740
Miscellaneous	L.S	-
(B3)		
Excavation	m^3	107,700
Embankment	m^3	4,150
Revetment		
- Sheet pile	m^2	25,930
Sod facing	m^2	34,870
Drop structure		
- Concrete	m^3	200
- Cross block	m^2	70
Miscellaneous	L.S	-

(To be continued)

WORK ITEMS	UNIT	WORK QUANTITIES
(4) Kampung Baru Drainage		
<u>Underground Pondage</u>		
Excavation	m^3	49,000
Concrete	m^3	9,130
Paving	m^2	11,000
Miscellaneous	L.S	-
<u>Inlet structure</u>		
Excavation	m^3	520
Concrete	m^3	150
Stop log	set	1
Trash rack	set	3
Miscellaneous	L.S	-
<u>Pump House</u>		
Excavation	m^3	2,040
Concrete	m^3	1,210
Superstructure	m^3	1,900
Pump	nos	3
Diesel engine	nos	3
Overhead crane	nos	1
Diesel engine generation	nos	2
Ancillary facilities	set	1
Miscellaneous	L.S	-
<u>Sedimentation Pond</u>		
Excavation	m^3	13,500
Embankment	m^3	13,200
Displacement of soil	m^3	600
Sod facing	m^2	600
Sheet pile	m^2	3,080
Gravel bedding	m^3	290
Asphalt facing	m^2	20
Foot block	m^2	900
Cross block	m^2	31,300
Trash rack (2.5mx2mx1set)	t	0
R. Concrete	m^3	55
Miscellaneous	L.S	-
<u>Overflow weir</u>		
R. Concrete	m^3	190
Asphalt facing	m^3	620
Gravel bedding	m^3	550
Drainage pile (ø200)	m	110
Air-drain pile (ø150)	m	55
Cross block	m^2	3,500
Sheet pile	m^2	720
Miscellaneous	L.S	-

(To be continued)

WORK ITEMS	UNIT	WORK QUANTITIES
Gate		
R. Concrete	m^3	1,640
Cross block	m^2	170
Sheet pile	m^2	60
H-pile	m	1,600
Gate (2mx3mx2set)	t	5.2
Bridge	m^2	55
Miscellaneous	L.S	-
Outlet tank		
Excavation	m^3	160
R. concrete	m^3	40
Miscellaneous work	L.S	-
Outlet Culvert/Gate Structure		
Excavation	m^3	320
R. Concrete	m^3	70
Miscellaneous	L.S	-
Internal Drainage System		
Excavation	m^3	10,900
R. Concrete	m^3	2,300
Outlet gate	L.S	-
Miscellaneous	L.S	-

2.2 Major Construction Plan

2.2.1 General

The construction method is prepared as a basic idea and a guideline for implementing the project work to be carried out by the contractors. However, the individual planning will be provided by the contractor in detail before commencement of the works. The urgent term total construction period is planned to be 5 years from the time of contract award for preparatory works to the final commissioning of the project.

The construction method and sequence described hereinafter are provided on the basis of the proposed mode of construction system and the target schedule. In addition to the above, the following conditions affecting the implementation of the project are considered.

- Construction capability in local contractor
- Availability of construction plant and equipment in local market
- Geological and topographical condition
- Weather condition
- Conventional mechanized construction method

The Klang River Flood Mitigation Project (hereinafter called "the project") is composed four (4) elements of:

i) River Improvement (Klang, Gombak, Batu)
ii) Diversion channel (Gombak-Batu)
iii) Retention Pond (Batu)
iv) Inner Drainage (Kampung Baru)

The locally financed river improvement work of Klang, Gombak and Batu has been implemented partially, and is expected to be completed in 1990. Therefore, only supplementary parts of river improvement plan are stipulated in this study. The diversion channel will be constructed from the Gombak to the Batu River. It is to be located in the Gombak district near the Federal Territory of Kuala Lumpur and parallel to the boundary. The Batu retention pond will be a conversion of the existing tin ex-mining pond for the sake of economy and ease of construction. This 70 ha retention pond will be located along the right side of the Batu River. The inner drainage system to be provided will consist of underground pondage and pump station with gate facilities located in the Kampung Baru area.

2.2.2 Preparatory Works

Prior to the commencement of construction, site preparation and temporary works must be carried out or arranged. Major items of work are:

i) Access to the site
ii) Traffic control
iii) Power supply
iv) Water supply

v) Fuel supply

vi) Communication system

vii) Offices

viii) Quarters

ix) Laboratory

x) Motor pool and workshop

xi) Warehouse and temporary stockyard

xii) Stockpile and spoil bank

xiii) Arrangement for railway bridge construction

xiv) Arrangement for road bridge construction

xv) Arrangement for replacement of crossing facilities

xvi) First aid, safety and security

In general, the preparatory works may be described in terms of mobilization and temporary works.

(1) Mobilization and Temporary Works

a) Mobilization

The following mobilization works are to be conducted prior to the commencement of main civil works.

- Establishment of the traffic control system. A control system is proposed to JKR (Jabatan Kerja Raya) during the detailed design stage resulting from discussion with the project.
- Arrangement, spoil bank and stockpile
- Arrangement for bridge construction and replacement of the crossing facilities with the agencies concerned.

It is expected that the selected contractor should provide the detailed construction plan and the time schedule, including the preparatory and mobilization schedule such as the items stipulated above. The mobilization of the construction works will be commenced immediately after the award of contract.

b) Temporary Works

- Drainage system for river improvement works

  Basically, the works will be conducted with dry condition at the respective job sites. Drainage system is required at those sites during construction.

  Drain discharge from the Klang, Gombak and Batu rivers are estimated as follows:

Klang river	:	300 m^3/s
Gombak river	:	190 m^3/s
Batu river	:	120 m^3/s

  A partial coffering method will be applied using sheet piles or other equivalent for those construction works.

- Temporary bridges

  During construction of river improvement works, temporary bridges must be constructed for maintenance of traffic. Individual conditions are to be planned in subsequent stages.

2.2.3 River Improvement Works

The river improvement work for each of the three branches of the Klang River System which are defined in the scope of work are divided into sections and illustrated in Figure K-1 . For a clear understanding of the sections mentioned here, refer to that figure.

i) Klang River : Section K9 of the upper reach of the river system from Jln Tun Perak Bridge and continuing upstream for about 3.1 km

ii) Gombak River : Section G4 of the upper reach from Jln Razak upstream for about 3.5 km

iii) Batu River : Section B2 and B3 of the upper reach from Jln Kolom Air Empat upstream for about 6.1 km (B2 = 3.7 km and B3 = 2.4 km)

The required river improvement works are widening, deepening, revetment by steel pile or pre-cast concrete wall with sod facing, and related river structures.

The construction equipment required for each construction works are listed in Table K-3.

The river improvement work is scheduled to be begun in the beginning of January 1993 and completed by the end of December 1997.

(1) Channel Excavation

The total volume to be excavated for this 12.7 km long project is estimated as follows:

River	Section	Section length (km)	Excavation volume (cu.m)
Klang river	K9	3.1	74,390
Gombak river	G4	3.5	32,750
Batu river	B2	3.7	325,900
	B3	2.4	107,700
Total		12.7	540,740

To minimize the construction cost, the construction plan for this work is based on the following principles:

- The hauling distance between the excavation site and spoil bank should be reduced as far as possible.

- The excavation material from the river channel should be used for construction of berms for the high water channel and for the construction work at the Batu retention pond.

Work will be executed using equipment already available in the area of the project. It is believed that all excavation work can be performed by common construction equipment and a dredger will not be necessary. In addition to expense, the operation would be difficult to perform with a dredger in the river channel due to the large number of bridges and other facilities which cross the river. Another problem is the difficulty in dealing with effluent material.

Therefore, the excavation works will be conducted using the following construction equipment.

Excavation	:	Drag line,	
		Bulldozer,	18 t
Loading	:	Crawler loader,	1.5 m^3
Hauling	:	Dump truck,	10 t

(2) Revetment Works

The cross section of the river is planned as a trapezoidal compound cross-section with a lower "dry weather" flow channel and a wide upper channel for flood control. Construction work is to be carried out by either the "sheet piling method" or the "pre-cast concrete method".

a) Sheet Piling Method

This is the preferred method of construction, as the sheet piling method is the fastest and easiest method for the construction of channel works. This method should be used if conditions permit.

When using steel sheet piles to line or canalize a river, a Mackintosh probe must first be carried out to determine the suitability of the subsurface conditions. It must be ascertained that the bedrock does not lie too close to the surface. The pile depth must be sufficient to allow for the piles to achieve a cantilever effect to resist hydrostatic pressure of the retained soil above the piles.

Before the steel piling is driven, it must be painted with two coats of epoxy as a rust prevention measure. When it is ready, it should be picked up with an excavator, swung into position and driven into place. The sheet pile is to be driven initially with a vibro-hammer to a depth of about 4 meters. A diesel hammer will then be used to drive the piles to final depth.

b) Pre-cast Method

Concrete piling units are to be precast by the contractor at a casting yard. Judging from the expected rate of installation, the casting yard should be able to produce eight units per day.

Coffer dams along the channel must be built from channel excavation material to protect construction activities from flooding. Behind the dams, high volume centrifugal pumps with a 6" output should be available for water removal. After construction, the dams will be eroded away after a period of time. Subsequently, desilting should be carried out to achieve the design specifications.

(3) Drop Structures

Four (4) drop structures are to be constructed at the following points;

RIVER	SECTION	HEIGHT (m)	LOCATION
Klang river	K9	-	-
Gombak river	G4	1.2	Confluence of Sg. Belongkong
Batu river	B2	1.9 1.1	Confluence of Sg. Keroh Sg. Keroh upward 1.5 km
	B3	1.2	End of Batu pond

This work will be done after the widening and deepening work and is to be done in conjunction with the revetment work of the channel. Since the drop structure work is to be done simultaneously with the revetment work and requires the same type of equipment, then construction equipment can be shared between the two operation for the sake of economy. Basically, construction will be done under dry conditions using a sheet pile shuttering method. This will allow for full face construction. The work is scheduled to be performed within 5 months.

2.2.4 Retention Pond

Earth works are of four major categories:

- Aqueous filling of the deep portions of the existing abandoned tin mining quarry. The ex-mining pond should be filled from the current bottom at 5 m elevation up to the 15 m level. (Estimated total fill volume of about 450,000 cubic meters)

- Slope protection work. The bank will consist of slopes of two different gradients. The first being a 1:3 slope up from the bottom at 15 m to a crest at 38 m elevation. From that point, the slope should be a 1:5 slope from 38 m to 47 m elevation.

- Embankment work on the periphery to create a dike for the pond. This work will be done along the Batu River, where the embankment crest width of the upstream portion will be about 80 m and the downstream width about 100 m, with the elevation of the top being a minimum elevation of 47 m. (Estimated total fill volume is about 2.5 million cu.m.)

- Excavation works of the pond will result in a total volume of cut material of about 2.3 million cubic meters, which will be used for the fill work.

The earth works for the retention pond will result in the cut and fill works preceding simultaneously and are expected to take about three years to complete.

(1) Aqueous Filling Work

The aqueous filling work for the deep portions of the old mining quarry (or ex-mining pond) will necessarily be done while the pond is inundated. The method of choice is the "submerged dumping method" where barges will be used for hauling and dumping the fill material. Simultaneous to this activity, "dewatering work" must be carried out to keep the surface of the pond from overflowing into other areas during construction. This dewatering will be carried out by submersible pumps set up on the barges being used for dumping.

(2) Slope Protection Work

After the completion of the pond filling work up to the 15 m elevation, the entire volume of water in pond is to be pumped out before any of the slope protection or embankment work beings. The dewatering is expected to take about 1.5 months after completion of the pond filling work. Under these conditions, the slope protection work may be carried by normal construction equipment currently available at the site. This type of equipment will be able to do all the loading, hauling, spreading, compacting, and so on. For the reinforcement of the surface of the slope, the existing soil will be replaced by a more cohesive soil up to an elevation of around 38 m.

(3) Embankment Work

Embankment work for the dike is also to be done with standard equipment. A minimum elevation of 47 m is to be kept in all locations, and the dike design is to be of two types. The downstream part around the outlet gate will be about 200 m long and is to be constructed to a 100 m width. The remaining part of the dike is to be an 80 m width. The embankment material will be spread by a 20 tonne class bulldozer at the specified thickness and compacted by a suitable compacting machine.

2.2.5 Gombak Diversion Channel

The Gombak Diversion Channel is to be a channel connecting the Gombak and Batu Rivers, and is to be located in the Gombak District near and parallel to the boundary with the Federal Territory of Kuala Lumpur. It is intended to be used in storm water management to divert water from the Gombak to the Batu River and the previously described retention pond. The overall design of the facility will consist of five primary elements:

i) Free flow intake weir on the right bank of the Gombak River
ii) Diversion channel and box culvert
iii) Sedimentation pond
iv) Free flow outlet weir from the sedimentation pond to the retention pond
v) Bridge and road construction

(1) Intake Weir

The intake weir to the diversion channel, planned as a free overflow type weir is located on the right saddle of the Gombak River. Construction is scheduled from early 1994 to the end of 1995, and is to be simultaneous with the diversion channel itself.

At the start of this portion of the project, temporary steel sheet piling may be driven to divert the Gombak River, affording dry conditions to speed construction. The weir itself will be surfaced with asphalt facing on top of a gravel bedding, and is to be protected on both sides by steel piling for the prevention of seepage. Subsequently cross block will be bedded on both the river side and the channel side of the weir.

(2) Channel and Box Culvert

The overall diversion channel is to be designed to handle a maximum capacity of 60 cubic meters of water per second. Construction is estimated to take about 2 years including the intake weir. The channel profile is to be of two types which are described below.

Type 1 : Open channel with a trapezoidal compound cross section and a concrete or sod facing. The cross section is to be 10 meters wide on top with a 5 meter bottom width. Section 1 is to be 3200 meters in total length.

Type 2 : Box culvert (2 cell type) resting on steel support pilings. The box is to be 11.5 meters wide, and 5.6 meters high. The steel pilings are to be 600 mm in diameter. The entire section is to be 200 meters long.

The total excavated volume of material, including the weir, is estimated to be about 300,000 cubic meters, and is to be applied to the construction of retention pond. Construction equipment planned to be used for the earthwork should take into account the existing soil conditions of the area. Concrete used for slope protection is estimated at about 20,000 cubic meters. Ready mix concrete will be used after completion of the slope compaction and gravel bedding works.

Traffic currently using streets and roads crossing the right-of-way for the diversion channel must be rerouted to temporary bridges. The Kuala Lumpur to Karak Highway will cross over the box culvert portion of the diversion channel, and must also be diverted during construction. Temporary access roads must be provided for construction.

(3) Sedimentation Pond

A sedimentation pond will be planned at the location of an existing pond, which will be both widened and deepened. The pond is to function as a crossing of the Gombak Diversion Channel and the Batu River. The facility is to comprise the following:

- Sedimentation Pond and connecting channel
- Outlet weir to Batu River
- Inlet weir and approach channel of Batu River

The construction sequence will be divided into two stages by use of the shuttering work method. The first stage will begin with the shuttering work by steel piling composed of closing off areas for the upstream and downstream approach channels and a long section to connect them running parallel to the Batu River. Thus protected, a half section of the sedimentation pond, the outlet and inlet approach channels, and the outlet and inlet gates may be worked together at the same time as the Gombak Diversion Channel work. On the completion of the above works, the diversion sheet piles are to be removed on both ends of the project. Thus, the Batu River flow will be redirected through the inlet gate to the approach channel to the sedimentation pond, and then return to the Batu River through the outlet approach channel. With the flow of the Batu River thus diverted, the second stage may be carried out.

In the second stage, the second half of the sedimentation pond and the outlet weir to the retention pond may be constructed simultaneously. On completion of this portion, the long section of the steel piling shutter may be removed, completing the project.

Total construction time is estimated at one year.

(4) Outlet Weir

The free flow outlet weir to the retention pond will be constructed to divert water from the sedimentation pond to the retention pond. The weir is to be asphalt surfacing over a gravel bed, and protected on both sides from seepage by sheet pile like the inlet weir. Cross block is to be bedded on both sides of the weir. Outlet weir construction is to take place simultaneously with the construction of the retention pond.

(5) Bridges Crossing the Channel

After completion of the diversion channel, permanent bridges crossing the channel must be constructed, and the Kuala Lumpur - Karak Highway must be opened over the box channel portion of the diversion channel.

2.2.6 Inner Drainage Works

The urban inner drainage work is to cover about 0.73 square kilometers in the Kampung Baru along the Klang River and is planned to relieve the area from flood water during heavy rainfall.

Major works required for this drainage system are:

- Total 2 km long internal drain
- Box culvert type underground regulating pondage
- Dewatering pumping system including pump house, inlet trash rack, outlet rack, and culvert
- Outlet gate

The principal topographic feature of the Kampung Baru area is the low lying flat land. The main feature of construction is the large underground storage pond along the banks of the Klang River. Due to the constant danger of flooding in the area, at the start of construction, coffering and dewatering works around the pondage must be installed using interlocking sheet steel piling. The sheet piling is to be driven all around the periphery of the pondage before excavation begins. A second row of piling is to be driven on the land side of the pondage for the dewatering works. The head of this piling is to be kept at a 1.0 meter height above the ground level of for the retention of flood flow.

After completion of the driving of the sheet pile, the excavation works will be performed. The total excavation of about 63,000 cu.m of underground pondage, pump house, inlet, outlet tank, and gate can be done with 0.6 cubic meter backhoe, a 10 tonne bulldozer, tractor shovel, 1.2 cubic meter clam shell, and dump trucks.

Subsequently, concrete work will be carried out in two stages of substructure and superstructure concrete work. Included in work will be the machine room, service room, and overhead crane. The concrete can be transported by 5 cubic meter agitator trucks from the batching plant. The mass of concrete can be transferred into a concrete hopper by 20 tonne truck crowned with 1 cubic meter concrete bucket and distributed in the placement portion through a chute extending from the hoppers.

The substructure concrete work is scheduled to be completed in 12 months with superstructure work in 2 additional months. Subsequently, mechanical work of installation of pumps, a 700 mm diameter vertical shaft with valve, trash rack, and outlet gate are to be installed. The construction period is scheduled for 6 months.

3. CONSTRUCTION SCHEDULE

Implementation period of this project is planned total at 15 years. It is to consist of:

- Urgent plan (Phase-I) : 5 years from 1993 to 1997
- Mid term plan (Phase-II) : 5 years from 1998 to 2002
- Long term plan (Phase-III) : 5 years from 2003 to 2007

The construction works are to be conducted by a contract system in phases. The phases are scheduled as a series, where one phase will begin after completion of the previous phase.

The implementation of this plan will require the expenditure of a large amount of money over a long construction period. Therefore, the implementation program proposed here will be prepared taking into account the economic effect (comparison of damage and construction cost (Figure K-1)) and priority of the projects as referred Appendix I of Chapter 3.9. The implementation program will consist of a long term plan, a middle term, and an urgent plan. The long term plan will be the ultimate target of the flood mitigation program; the urgent plan will require immediate implementation; and a middle term target lies between the two extremes.

The implementation program will propose the overall implementation schedule and sequence as shown in Figures K-2 and K-3.

4. CONSTRUCTION COST ESTIMATE

4.1 General

The financial project cost will consist of the cost for the preparatory works, main civil works, mechanical works, compensation, engineering (if any), administration, and physical contingency.

The preparatory works comprise the cost for:

i) Temporary construction plants and equipment,
ii) Temporary power, water supply and communication systems for the construction work,
iii) Office and camps,
iv) Stores, workshop and laboratory, etc.

The cost for the preparatory works is approximately proportional to the scale of main civil works, and thus will be estimated as a percentage of the main civil work cost and by referring to similar projects in the past.

The main civil works consist of the work items such as:
(a) Excavation, (b) Embankment, (c) Concreting, (d) Revetment, (e) miscellaneous.

Each of the above work items includes the cost items such as:
(a) Labor cost, (b) Material cost, (c) Machinery operation cost (Fuel cost), (d) Equipment cost (Depreciation and repair cost), and (e) Contractors general expense.

4.2 Conditions for Construction Cost Estimate

The construction cost of the project work is estimated by the following conditions:

i) Price level : July 1988

ii) Exchange rate : 1US$ = M$2.55 = ¥125

iii) The construction cost consist of 3 main items, namely, direct cost, indirect cost, and contingencies. The direct cost is estimated based on the requested work items and quantities derived from the feasibility design. The indirect cost includes the cost of land acquisition and house evacuation, government administration cost, and engineering services cost for detail design and supervision. The physical contingency is counted into direct and indirect costs accordingly. The price contingency is estimated for escalation on the final cost estimated.

iv) The direct cost for civil works is estimated by multiplying the unit cost and corresponding work quantity. The preparatory works and minor work items are estimated by lump sum basis with a certain percentage of main works. The unit cost for each work item consists of the cost of construction materials, labor and equipment. The contractors indirect cost is incorporated to the unit cost for each work item.

v) Prices of construction materials in local market were surveyed at Kuala Lumpur. They are principally counted in the local currency component but their certain proportions are considered into foreign currency component according to their usage of imported raw materials and production facilities. Table K-2 shows the unit price of construction materials divided into the foreign and local currencies.

vi) Equipment costs consist of depreciation and interest, maintenance and repair cost, and management cost. An operations charge is incorporated to the labor cost. Fuel and lubricant costs are incorporated to the material cost. The following concept is applied to the estimation of foreign currencies of equipment cost upon dividing to imported or local product equipment.

Cost Items	Classification of F.C and L.C	
	For Import Equipment	For Local Product Equipment
• Depreciation and interest cost	100% of F.C	100% of the depreciation cost
• Maintenance and repair cost	100% of F.C for spare parts. Material cost is F.C and L.C by certain percentage of each material. 100% of labor cost is L.C.	Spare parts and material cost are F.C and L.C by certain percentage. 100% of labor cost is L.C.
• Fuel, lubricant and consumables	Fuel and lubricant cost are F.C and L.C by certain percentage. 100% of consumable cost is F.C.	These cost are F.C and L.C by certain percentage.
• Operator's cost	100% of L.C	100% of L.C
• Management cost	100% of L.C	100% of L.C

Note: F.C and L.C mean the foreign currency and local currency respectively.

Daily cost per each equipment is tabulated in Table K-4.

vii) A 30% of direct cost is assumed as the contractor's indirect cost (Contractor's overhead and profit), and added to the direct cost in the unit cost of each work item.

viii) Cost estimate is based on market research and past tendered record of similar works.

ix) Land acquisition and house evacuation costs are estimated on the basis of the prevailing state or DID's expropriation cost for land, houses and other private properties. All of these costs are estimated as the local currency component.

x) Administration cost for the implementation of the project is estimated at 5% of total direct cost.

xi) Engineering services cost is estimated at 5% of direct cost for detailed design and construction supervision with 70% and 30% for foreign and local components respectively.

xii) Physical contingency and price contingency is provided to cope with the unpredictable physical conditions amounting 20% of total cost include for land acquisition government administration, and engineering service costs.

xiii) Price contingency is provided for the reflection of inflational effect against the implementation of the project. Price contingency for financial cost is estimated assuming the inflational rate is 5% per annum for the foreign currency and 12% per annum for the local currency.

The direct constructions cost divided into foreign and local currency portions was estimated by multiplying the work quantities by the respective unit costs. The bill of quantities with unit cost are tabulated in Tables K-6, 7, 8, 9 and 10.

REFERENCE

1. SENARAI PENERBITAN (LIST OF PUBLICATIONS), by Statistics Department of Malaysia, April, 1987

2. QUOTATION FOR SUPPLY AND DELIVERY OF READYMIXED CONCRETE IN K.L., by Local Contractors, March, 1988

3. THE SURVEYOR by the Professional Journal of the Institution of Surveyors Malaysia Fourth Quarterly, 1987

4. CONTRACT PRICE LIST ON KUALA LUMPUR FLOOD MITIGATION PROJECT, March, 1988

5. KELANG CONTAINER TERMINAL (Harbour Klang)

6. EXECUTIVE SUMMARY ON K.L. FLOOD MITIGATION PROJECT, by Bureau of Reclamation United States Department of the Interior, November, 1979

7. INDICATIVE PRICE FOR EQUIPMENT BY TRACTOR MALAYSIA

8. WAGE RATE BY J.K.R., June, 1988

9. SPECIAL RELEASE 1 FOR CIVIL ENGINEERING WORKS, January to April, 1988

Table K-1 MONTHLY METEOROLOGICAL DATA

Item	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
Temperature °C (mean)	26.6	27.0	27.3	27.4	27.6	27.6	27.1	27.1	26.9	26.9	26.5	26.5	27.0
Humidity %	78.4	78.9	79.7	81.8	81.1	78.8	79.6	78.6	81.1	82.1	84.1	82.3	80.5
Evaporation mm/day	3.5	3.9	4.0	3.9	3.6	3.4	3.4	3.6	3.4	3.4	3.1	3.0	3.5
Sunshine hours hour	5.9	6.3	6.5	6.1	6.2	5.5	6.1	5.9	5.2	5.3	4.4	4.7	5.7
Wind Speed m/s	1.0	1.0	1.1	1.0	1.1	1.1	1.2	1.2	1.1	1.2	1.0	0.9	1.1

Station: Petaling Jaya (Lat: 03° 06' N, long: 101° 39' E, Alt: M.S.L. + 45.7m)

Source: Malaysia Meteorological Service

Table shows the observation period of daily/hourly Water level and discharge respectively.
Data from these gauges have been compiled by DID at the intervals of 5 years showing monthly summaries, maximum, minimum and mean values.

Table K-2 UNIT PRICE OF MATERIALS (1/4)
(AS OF 1988)

Unit: M$

Description	Unit	Average Market Price Local (M$)	Imported	Remarks
1. Fuel and Lubricant				
Gasoline	1	0.95	-	
Diesel Oil	1	0.45	-	
Heavy Oil	1			
Motor Oil (Engine Oil)	1	5.00	-	
Gear Oil	1	14.00	-	
Hydraulic Oil	1			
Grease	kg.	3.00	-	
2. Electric Power	kwh.	0.24	-	
3. Portlnd Cement				
Bag (40kg)	Bag	9.10	-	
Bulk	t	180.00	-	
4. Concrete Admixture				
Air Entraining Agent	kg.	3.50	-	
Water Reducing Agent	kg.	4.00	-	(30%)
Retarder	kg.	2.00	-	
Accelerator	kg.	2.00	-	
Non-shrinkage Agent	kg.	80.00	-	
5. Aggregate and Sand				
River Run	m3	15.00	-	Non-screened
River Run	m3			Screened
Crushed Aggregate	m3	32.00	-	Non-screened
Crushed Aggregate	m3			Screened
Sand	m3	13.00	-	
Boulder (20-30 cm)	m3			
6. Asphalt				
Straight	t			
Cutback	t	276.27	-	
Asphalt Emulsion	1			
7. Steel Material				
Reinforcement	t	891.00	-	Round Bar
Reinforcement	t	891.00	-	Deformed Bar
Steel Sheet Pile	t	680.00	-	U type Standard
I Shape Steel	t	680.00	-	400^1m
H Shape Steel	t	680.00	-	
Steel Pipe Pile	t			
ø400mm - 500mm	t			
ø600mm - 700mm	t			
ø800mm - Over	t			

Table K-2 UNIT PRICE OF MATERIALS (2/4)
(AS OF 1988)

Unit: M$

Description	Unit	Average Market Price Local : Imported (M$)		Remarks
Rail				
9 kg	m			
15 kg	m			
22 kg	m			
30 kg	m			
Angle	t	1000.00	-	
Channel	t	1000.00	-	
Steel Plate	t	1000.00	-	
Steel Pipe ø	m			
ø 1/2"	m	3.32	-	
ø 3/4"	m	4.63	-	
ø 1'	m			
ø 1-1/2"	m			
ø 2"	m			
ø 4"	m			
ø 6"	m			
ø 8"	m			
ø 10"	m			
ø 12"	m			
ø 16"	m			
Espansion Coupling for the above Metal Form	Pc			
8. Wood				
Coconut Trunk	m			
Log	m3			
Plywood	m3	25.60	-	
Timber, Plank	m3	450.00	-	
Timber, Square	m3	600.00	-	
Timber, Plank	m3			
Bamboo	m			
Bamboo Net	m2			
9. Metal Form & Access				
300mm x 1500mm	Pc			
200mm x 1500mm	Pc			
100mm x 1500mm	Pc			
Form Tie	Pc			
Separator	Pc			
Cone	Pc			
Washer	Pc			
Pipe Support	m			
Base Plate	Pc			
Clamp, Cross	Pc			
Clamp, Universal	Pc			
Joint	Pc			
Release	l			

Table K-2 UNIT PRICE OF MATERIALS (3/4)
(AS OF 1988)

Unit: M$

Description	Unit	Average Market Price Local (M$)	Average Market Price Imported (M$)	Remarks
10. Explosive				
Dynamite	Pc	-	9.25	BT 25
Detonator	Pc	-	1.90	
AN-FO Powder	kg	-	0.87	
11. Bit and Rod				
Cross Bit 32 ø	Pc	-	418.00	
Cross Bit 65 ø	Pc	-	562.00	
Rod ø 22mm, 1.7m	Pc	-	388.00	
Rod ø 22mm, 1.0m	Pc			
Rod for Crawler Drill	Pc			3m
Pick Steel	Pc			
Boring Rod	m			
Metal Bit, ø 46	Pc			
Metal Bit, ø 66	Pc			
Metal Bit, ø 76	Pc	-	370.00	
Diamond Bit, ø 46	Pc			
Diamond Bit, ø 66	Pc			
Diamond Bit, ø 77	Pc			
Pipe Casing	m			
12. Concrete Products				
R.C.Pipe, ø 1m	m	193.80	-	
R.C.Pipe, ø 0.6m	m	84.80	-	Class 'x'
R.C.Pipe, ø 0.4m	m	62.30	-	
R.C.Pipe, ø 0.2m	m			
R.C.Pipe, 200mm x 300mm	m			
R.C.Pipe, 250mm x 250mm	m	50.00	-	
R.C.Pipe, 300mm x 300mm	m	70.00	-	
R.C.Pipe, 350mm x 350mm	m	98.00	-	
R.C.Pipe, 400mm x 400mm	m	110.00	-	
Concrete Block	Pc	0.70	-	
Brick	Pc	0.15	-	
13. Water Stop				Less 15%
P.V.C. Flat 150mm	m	14.00	-	
P.V.C. Flat 200mm	m	21.00	-	
P.V.C. Flat 300mm	m			
P.V.C. Center Valve 150mm	m	19.00	-	
P.V.C. Center Valve 200mm	m			
P.V.C. Center Valve 300mm	m	31.00	-	
				ø 48.6mm
14. Others				
Barbed Wire	kg	225.00	-	
Nail	kg	2.50	-	
Machine Bolt & Nut	kg	3.00	-	

Table K-2 UNIT PRICE OF MATERIALS (4/4)
(AS OF 1988)

Unit: M$

Description	Unit	Average Market Price Local : Imported (M$)		Remarks
Tire, 8.25-20-14	Pc	418.90	-	
Tire, 9.0 -20-14	Pc	508.00	-	
Tire, 11.0-20-14	Pc	640.00	-	
Tire, 18.0-24-20	Pc			
Tire, 20.5-25-12	Pc			
Tire, 23.5-25-20	Pc			
Tire, 33.5-20-14	Pc			
Rock Bolt	Pc			Expansion Type
Rock Bolt	Pc			Grout Type
Tire Rod ø 28	m			
Wire Rope ø 8mm	m			Hemp Core 6 x 24
Wire Rope ø12mm	m			Hemp Core 6 x 24
Wire Rope ø19mm	m			Hemp Core 6 x 24
Wire Rope ø24mm	m			Hemp Core 6 x 24
Wire Rope ø 8mm	m			Iron Core 6 x 25 Fi
Wire Rope ø12mm	m			Iron Core 6 x 25 Fi
Wire Rope ø19mm	m			Iron Core 6 x 25 Fi
Wire Rope ø24mm	m			Iron Core 6 x 25 Fi
Welding Rod ø 3.2	kg			For Steel
Welding Rod ø 4	kg			For Steel
Welding Rod ø 5	kg			For Steel
Iron Wire	kg			For Steel
Annealed Iron Wire	kg			For Steel

Table K-3 MAJOR CONSTRUCTION EQUIPMENT

No.	Description	Capacity	Quantity
1.	Anchor barge	40 ps	5
2.	Swamp bulldozer (Low contact pressure type)	18 t	2
3.	Swamp bulldozer (Low contact pressure type)	18 t	5
4.	- do -	13 t	5
5.	Bulldozer	20 t	1
6.	- do -	11 t	3
7.	Crawler loader	1.5 cu.m	10
8.	Backhoe	0.6 cu.m	6
9.	Dragline	0.6 cu.m	2
10.	Clamshell attachment	0.6 cu.m	2
11.	Dump track	10 t	32
12.	- do -	8 t	8
13.	Diesel pile hammer with base machine	3.5 t	1
14.	Vibration hammer	22 kw	2
15.	Crawler crane	30 t	2
16.	Truck crane	10 t	2
17.	Concrete pump car	30 cu.m/h	2
18.	Tire roller	20 t	2
19.	Vibration roller	5 t	2
20.	Road roller	8 t	2
21.	Water tanker	8 kl	2
22.	Fuel tanker	8 kl	2
23.	Motor grader	3.7 m	2
24.	Ordinary truck with crane	6 t	2
25.	Welder	200 A	2
26.	Submersible pump	ø= 100 mm	15
27.	Port. concrete mixer	0.3 cu.m	3
28.	Pneumatic breaker	20 kg	6
29.	Diesel generator	80 kVA	2
30.	- do -	20 kVA	5
31.	Micro bus	30 persons	2

Table K-4 DAILY COST PER EACH EQUIPMENT

Description	Daily Cost
1. Bitumen heating and spraying plant	60 / - $/day
2. Compression per 2.8 m3/min	60 / - $/day
3. Concrete Mixer 0.6 m3 output	20 / - $/day
4. Concrete Mixer 0.3 m3 output	10 / - $/day
5. Excavator per 0.4 m3 capacity	130 / - $/day
6. Grout pumps	100 / - $/day
7. Lorry 4-6 ton ripper	180 / - $/day
8. Lorry 6-10 ton ripper	200 / - $/day
9. Mobile crane 5 ton	180 / - $/day
10. Mobile crane 10 ton	200 / - $/day
11. 8m pile frame, Boiler, which and 1ton Drop Hammer or equivalent equipment.	80 / - $/day
12. 20m pile frame, Boiler , which and 3ton Drop Hammer or equivalent equipment.	100 / - $/day
13. Pump 75mm diameter, centrifugal	20 / - $/day
14. Pump 150mm diameter, centrifugal	30 / - $/day
15. Roller 1.5ton	150 / - $/day
16. Roller 8ton	150 / - $/day
17. Vibrating Roller 3ton	120 / - $/day
18. Guaden (Self proposed) 90-140 drawbar H.P.	120 / - $/day
19. Welding or cutting gear	20 / - $/day
20. Backhoe (case) 0.4 m3 capacity	130 / - $/day
21. Pneumatic hand breaker	50 / - $/day
22. Hydraulic excavation 0.6 m3 capacity	200 / - $/day
23. Dumper, 0.4 m3 capacity	50 / - $/day
24. 3ton vibro-hammer including generator	20 / - $/day
25. 5ton Diesel Hammer	30 / - $/day

Table K-5 LABOR WAGES (8 hours/day)

Description	M$
1. Foreman	50
2. Operator for dredger	35
3. Operator for equipment	30
4. Assistant operator	25
5. Driver	30
6. Mechanic	40
7. Electrician	30
8. Welder	35
9. Carpenter	30
10. Concrete worker	30
11. Mason	30
12. Steel worker	30
13. Semi-skilled labour	25
14. Common labour	20
15. Plumber	30
16. Rigger	30
17. Blaster	30
18. Surveyor	50

Table K-6 SUMMARY OF FINANCIAL COST

Unit: M$ x 10^3

Cost Items	Foreign Currency (M$)	Local Currency (M$)	Total (M$)
1. Direct cost	29,791	60,454	90,245
2. Land acquisition and compensation cost	-	62,138	62,138
3. Administration cost	-	4,422	4,422
4. Engineering service cost	3,095	1,326	4,421
5. Contingency	6,377	25,506	31,883
Total	42,358	150,751	193,109

Table K-7 SUMMARY OF DIRECT CONSTRUCTION COST

Unit: M$ x 10^3

Item No.	work	F.C M$	L.C M$	Total
1.	River improvement	15,500	18,750	34,251
	Klang river	4.102	2.820	6.923
	Gombak river	2.231	10.227	12.458
	Batu river	9.167	5.703	14.870
2.	Batu retention pond	7,349	22,596	29,945
	Retention pond	4.727	18.973	23.700
	Batu outlet gate	2.551	3.495	6.046
	Batu sluice way	0.071	0.128	0.199
3.	Diversion channel	3,375	14,427	17,802
	Channel intake	0.213	1.158	1.371
	Diversion channel	1.281	5.097	6.378
	Sedimentation pond	1.369	6.818	8.187
	Overflow weir	0.221	0.818	1.039
	Batu gate	0.291	0.536	0.827
4.	Kampong Baru drainage plan	3,566	4,681	8,247
	Underground pondage	0.597	2.616	3.213
	Inlet structure	0.082	0.113	0.195
	Pump house	2.808	1.419	4.227
	Outlet tank	0.001	0.009	0.010
	Outlet culvert/Gate st.	0.002	0.015	0.017
	Internal drainage system	0.076	0.509	0.585
	Total	29,791	60,454	90,245

* F.C and L.C mean foreign and local currency respectively

Table K-8 SUMMARY OF INDIRECT CONSTRUCTION COST

Unit: M$ x 10^3

Item No.	work	F.C M$	L.C M$	Total
1.	Land acquisition & house compensation cost	-	62,138	62,138
2.	Government Administration cost	3,095	1,327	4,422
3.	Engineering service cost	3,095	1,326	4,421
4.	Contingency	6,377	25,506	31,883
	Total	12,567	90,297	102,864

F.C and L.C mean foreign and local currency respectivelly

Table K-9 DETAILED CONSTRUCTION COST ESTIMATE (1/7)

Description	Unit	Quantity	Foreign Unit Cost (M$)	Currency Amount (M$)	Local Unit Cost (M$)	Currency Amount (M$)	Total Unit Cost (M$)	Total Amount (M$)
(1) River Improvement work								
Klang River Section K9								
Excavation, in Common	m3	74,350	0.7	52,045	1.6	118,960	2.3	171,005
Embankment	m3	300	0.8	240	1.7	510	2.5	750
Concrete facing in berm	m3	8,770	20.0	175,400	180.0	1,578,600	200.0	1,754,000
Sod facing in slope	m2	26,250	-	-	1.5	39,375	1.5	39,375
Revetment								
- Sheet pile	m2	31,000	120.0	3,720,000	15.0	465,000	135.0	4,185,000
Miscellaneous	L.S	-	-	154,500	-	618,020		772,520
Sub total				4,102,185		2,820,465		6,922,650
Gombak River Section G4								
Excavation	m3	32,750	0.7	22,925	1.6	52,400	2.3	75,325
Embankment	m3	1,960	0.8	1,568	1.7	3,332	2.5	4,900
Backfill	m3	22,800	0.8	18,240	1.7	38,760	2.5	57,000
Sod facing	m2	46,750	-	-	1.5	70,125	1.5	70,125
Revetment								
- Sheet pile	m2	7,520	120.0	902,400	15.0	112,800	135.0	1,015,200
- Pre-cast	m3	18,800	50.0	940,000	450.0	8,460,000	500.0	9,400,000
Drop structure								
- Concrete	m3	200	23.0	4,600	207.0	41,400	230.0	46,000
- Cross block	m2	170	20.0	3,400	185.0	31,450	205.0	34,850
Bridge								
- Removed	m2	80	0.5	40	4.5	360	5.0	400
- Construction	m2	100	130.0	13,000	1,160	116,000	1,290	129,000
Miscellaneous	L.S	-	-	325,000	-	1,299,920		1,624,920
Sub total				2,231,173		10,226,547		12,457,720

Table K-9 DETAILED CONSTRUCTION COST ESTIMATE (2/7)

	Unit	Quantity	Foreign Unit Cost (M$)	Currency Amount (M$)	Local Unit Cost (M$)	Currency Amount (M$)	Total Unit Cost (M$)	Total Amount (M$)
Batu River Section B2,B3								
(B2)								
Excavation, in Common	m3	325,900	0.7	228,130	1.6	521,440	2.3	749,570
Embankment	m3	1,070	0.8	856	1.7	1,819	2.5	2,675
Revetment								
- Sheet pile	m2	42,560	120.0	5,107,200	15.0	638,400	135.0	5,745,600
Sod facing	m2	73160	-	-	1.5	109,740	1.5	109740
Drop structure								
- Concrete	m3	420	23.0	9,660	207.0	86,940	230.0	96,600
- Cross block	m2	510	20.0	10,200	185.0	94,350	205.0	104,550
Bridge								
- Removed	m3	1,240	0.5	620	4.5	5,580	5.0	6,200
- Construction	m3	1,740	130.0	226,200	1160.0	2,018,400	1,290.0	2,244,600
Miscellaneous	L.S	-	-	271,700	-	1,087,230		1,358,930
Sub total of (B2)				(5,854,566)		(4,563,899)		10,418,465
(B3)								
Excavation	m3	107,700	0.7	75,390	1.6	172,320	2.3	247,710
Embankment	m3	4,150	0.8	3,320	1.7	7,055	2.5	10,375
Revetment								
- Sheet pile	m2	25,930	120.0	3,111,600	1.5	388,950	135.0	3,500,550
Sod facing	m2	34,870	-	-	1.5	52,305	1.5	52,305
Drop structure								
- Concrete	m3	200	23.0	4,600	207.0	41,400	230.0	46,000
- Cross block	m2	70	20.0	1,400	185.0	12,950	205.0	14,350
Miscellaneous	L.S	-	-	116,130	-	464,565		580,695
Sub total of (B3)				(3,312,440)		(1,139,545)		4,451,985
Sub total of (B2)+(B3)				9,167,006		5,703,444		14,870,450
Total of (1)								**34,250,820**

Table K-9 DETAILED CONSTRUCTION COST ESTIMATE (3/7)

	Unit	Quantity	Foreign Unit Cost (M$)	Currency Amount (M$)	Local Unit Cost (M$)	Currency Amount (M$)	Total Unit Cost (M$)	Amount (M$)
(2) Batu Retention Pond								
Retention Pond								
Excavation	m3	2,261,300	0.7	1,582,910	1.6	3,618,080	2.3	5,200,990
Embankment								
- Reclamation	m3	445,000	0.8	356,000	1.7	756,500	2.5	1,112,500
- Embankment	m3	2,024,600	0.8	1,619,680	1.7	3,441,820	2.5	5,061,500
- Displacement	m3	100,400	1.5	150,600	3.3	331,320	4.8	481,920
Sod facing	m2	501,700	-	-	1.5	752,550	1.5	752,550
Land scape	m2	200,000	2.0	400,000	38.0	7,600,000	40.0	8,000,000
Miscellaneous	L.S	-	-	618,300	-	2,473,120		3,091,420
Sub total				4,727,490		18,973,390		23,700,880
Batu Outlet Gate								
Excavation	m3	61,200	0.7	42,840	1.6	97,920	2.3	140,760
Embankment	m3	5,400	0.8	4,320	1.7	9,180	2.5	13,500
Back fill	m3	14,400	0.8	11,520	1.7	24,480	2.5	36,000
R. Concrete	m3	7,930	23.0	182,390	207.0	1,641,510	230.0	1,823,900
Cross block	m2	1,830	20.0	36,600	185.0	338,550	205.0	375,150
Sheet pile	m2	945	120.0	113,400	15.0	14,175	135.0	127,575
H-pile	m	19,200	85.0	1,632,000	10.0	192,000	95.0	1,824,000
Graval	m3	150	14.0	2,100	21.0	3,150	35.0	5,250
Foot protection block	m3	500	21.0	10,500	184.0	92,000	205.0	102,500
Gate	t	14 .4	12,500.0	180,000	3,100.0	44,640	15,600.0	224,640
Bridge	m2	440	15.0	6,600	1,275.0	561,000	1,290.0	567,600
Stop log (2.5m x 2.5m x 150t)	t	1 .3	10,400.0	13,520	2,600.0	3,380	13,000.0	16,900
Miscellaneous	L.S	-	-	315,500	-	473,165	-	788,665
Sub total				2,551,290		3,495,150		6,046,440
Batu Sluice way								
R. Concrete	m3	280	23.0	6,440	207.0	57,960	230.0	64,400
H-Pile	m	375	85.0	31,875	10.0	3,750	95.0	35,625
Sheet pile	m2	70	120.0	8,400	15.0	1,050	135.0	9,450
Gate (1m x 1m)	t	0 .6	11,440.0	6,864	2,864.0	1,716	14,300.0	8,580
Cross Block	m2	230	20	4,600	185.0	42,550	205.0	47,150
Excavation	m3	2,100	0.7	1,470	1.6	3,360	2.3	4,830
Back fill	m3	1,000	0.8	800	1.7	1,700	2.5	2,500
Miscellaneous	L.S	-	-	10,300	-	15,515	-	25,815
Sub total				70,749		127,601		198,350
Total of (2)								29,945,670

Table K-9 DETAILED CONSTRUCTION COST ESTIMATE (4/7)

	Unit	Quantity	Foreign Unit Cost (M$)	Currency Amount (M$)	Local Unit Cost (M$)	Currency Amount (M$)	Total Unit Cost (M$)	Total Amount (M$)
(3) Diversion Channel								
Channel Intake								
Excavation	m3	24,300	0 .7	17,010	1 .6	38,880	2 .3	55,890
Embankment	m3	1,900	0 .8	1,520	1 .7	3,230	2 .5	4,750
Gravel bedding	m3	750	14	10,500	26	19,500	40	30,000
Asphalt facing	m3	350	10	3,500	15	5,250	25	8,750
Air drain pipe (ø 150mm)	m	60	20	1,200	13	780	33	1,980
Drainage pipe (ø 200mm)	m	120	30	3,600	20	2,400	50	6,000
R. Concrete	m3	170	23	3,910	207	35,190	230	39,100
Cross block	m2	3,200	20	64,000	185	592,000	205	656,000
Foot protection block	m2	1,800	20	36,000	185	333,000	205	369,000
Sheet pile	m2	150	120	18,000	15	2,250	135	20,250
Miscellaneous	L.S	-	-	53,600	-	125,150	-	178,750
Sub total				212,840		1,157,630		1,370,470
Diversion Channel								
Excavation	m3	260,000	0 .7	182,000	1 .6	416,000	2 .3	598,000
Embankment	m3	4,000	0 .8	3,200	1 .7	6,800	2 .5	10,000
Back fill	m3	12,500	0 .8	10,000	1 .7	21,250	2 .5	31,250
Sod facing	m2	49,500	-	-	1 .5	74,250	1 .5	74,250
R. Concrete	m3	11,100	20	222,000	195	2,164,500	215	2,386,500
Gravel bedding	m3	24,200	14	338,800	26	629,200	40	968,000
Drain pipe (ø 50mm)	m	5,550	3 .5	19,425	2 .5	13,875	6	33,300
Bridge	m2	828	15	12,420	1,275	1,055,700	1,290	1,068,120
Steel pile(ø 600mm)	t	39	1,775	69,225	445	17,355	2,220	86,580
Paving	m2	5,800	30	174,000	20	116,000	50	290,000
Miscellaneous	L.S	-	-	249,600	-	582,300		831,900
Sub total				1,280,670		5,097,230		6,377,900

Table K-9 DETAILED CONSTRUCTION COST ESTIMATE (5/7)

	Unit	Quantity	Foreign Unit Cost (M$)	Currency Amount (M$)	Local Unit Cost (M$)	Currency Amount (M$)	Total Unit Cost (M$)	Total Amount (M$)
Sedimentation Pond								
Excavation	m3	13,500	0 .7	9,450	1 .6	21,600	2 .3	31,050
Embankment	m3	13,200	0 .8	10,560	1 .7	22,440	2 .5	33,000
Displacement of soil	m3	600	1 .5	900	3 .3	1,980	4 .8	2,880
Sod facing	m2	600	-	-	1 .5	900	1 .5	900
Sheet pile	m2	3,080	120	369,600	15	46,200	135	415,800
Gravel bedding	m3	290	16	4,640	24	6,960	40	11,600
Asphalt facing	m2	20	10	200	15	300	25	500
Foot block	m2	900	20	18,000	185	166,500	205	184,500
Cross block	m2	31,300	20	626,000	185	5,790,500	205	6,416,500
Trash rack (2.5mx2mx1set)	t	0	9,360	8,424	2,340	2,106	11,700	10,530
R. Concrete	m3	55	23	1,265	207	11,325	230	12,650
Miscellaneous	L.S	-	-	320,400	-	747,585	-	1,067,985
Sub total				1,369,439		6,818,456		8,187,895
Over flow weir								
R. Concrete	m3	190	23	4,370	207	39,330	230	43,700
Asphalt facing	m3	620	10	6,200	15	9,300	25	15,500
Gravel bedding	m3	550	16	8,800	24	13,200	40	22,000
Drainage pipe (ø 200)	m	110	30	3,300	20	2,200	50	5,500
Air-drain pipe (ø 150)	m	55	20	1,100	13	715	33	1,815
Cross block	m2	3,500	20	70,000	185	647,500	205	717,500
Sheet pile	m2	720	120	86,400	15	10,800	135	97,200
Miscellaneous	L.S	-	-	40,600	-	94,880	-	135,480
Sub total				220,770		817,925		1,038,695
Gate								
R. Concrete	m3	1,640	23	37,720	207	339,480	230	377,200
Cross block	m2	170	20	3,400	185	31,450	205	34,850
Sheet pile	m2	60	120	7,200	15	900	135	8,100
H-pile	m	1,600	85	136,000	10	16,000	95	152,000
Gate (2mx3mx2set)	t	5 .2	12,500	65,000	3,100	16,120	15,600	81,120
Bridge	m2	55	15	825	1,275	70,125	1,290	70,950
Miscellaneous	L.S	-	-	41,000	-	61,550	-	102,550
Sub total				291,145		535,625		826,770
Total of (3)								17,801,730

Table K-9 DETAILED CONSTRUCTION COST ESTIMATE (6/7)

	Unit	Quantity	Foreign Unit Cost (M$)	Currency Amount (M$)	Local Unit Cost (M$)	Currency Amount (M$)	Total Unit Cost (M$)	Total Amount (M$)
(4) Kampung Baru Drainage Plan								
Under Ground Pondage								
Excavation	m3	49,000	0 .7	34,300	1 .6	78,400	2 .3	112,700
Concrete	m3	9,130	23	209,990	207	1,889,910	230	2,099,900
Paving	m2	11,000	25	275,000	25	275,000	50	550,000
Miscellaneous	L.S	-	-	78,000	-	372,610	-	450,610
Sub total				597,290		2,615,920		3,213,210
Inlet structure								
Excavation	m3	520	0 .7	364	1 .6	832	2 .3	1,196
Concrete	m3	150	23	3,450	207	31,050	230	34,500
Stop log	set	1	25,500	25,500	25,500	25,500	51,000	51,000
Trash rack	set	3	14,000	42,000	14,000	42,000	28,000	84,000
Miscellaneous	L.S	-	-	10,230	-	13,958	-	24,188
Sub total				81,544		113,340		194,884
Pump House								
Excavation	m3	2,040	0 .7	1,428	1 .6	3,264	2 .3	4,692
Concrete	m3	1,210	23	27,830	207	250,470	230	278,300
Super structure	m3	1,900	150	285,000	-	-	150	285,000
Pump	nos	3	270,000	810,000	30,000	90,000	300,000	900,000
Diesel engine	nos	3	202,500	607,500	22,500	67,500	225,000	675,000
Overhead crane	nos	1	39,500	39,500	39,500	39,500	79,000	79,000
Diesel engine generation	nos	2	38,700	77,400	4,300	8,600	43,000	86,000
Ancillary facilities	set	1	-	580,500	-	580,500	-	1,161,000 *
Miscellaneous	L.S	-	-	378,900	-	378,878		757,778
Sub total				2,808,058		1,418,712		4,226,770

* Consisting of three Gear reduce
Consisting of three Butterfly Valve.
Consisting of three Discharge pipe
Consisting of one Electric pane
Consisting of three pump

Table K-9 DETAILED CONSTRUCTION COST ESTIMATE (7/7)

	Unit	Quantity	Foreign Unit Cost (M$)	Currency Amount (M$)	Local Unit Cost (M$)	Currency Amount (M$)	Total Unit Cost (M$)	Total Amount (M$)
Outlet tank								
Excavation	m3	160	0 .7	112	1 .6	256	2 .3	368
R. Concrete	m3	40	23	920	207	8,280	230	9,200
Miscellaneous work	L.S	-	-	102	-	-	-	102
Sub total				1,134		8,536		9,670
Outlet Culvert/Gate structure								
Excavation	m3	320	0 .7	224	1 .6	512	2 .3	736
R. Concrete	m3	70	23	1,610	207	14,490	230	16,100
Miscellaneous	L.S	-	-	504	-	-	-	504
Sub total				2,338		15,002		17,340
Internal Drainage system								
Excavation	m3	10,900	0 .7	7,630	1 .6	17,440	2 .3	25,070
R.Concrete	m3	2,300	23	52,900	207	476,100	230	529,000
Outlet gate	L.S	-	-	15,000	-	15,000	-	30,000
Miscellaneous	L.S	-	-	270	-	640	-	910
Sub total				75,800		509,180		584,980
Total of (4)				**3,566,164**		**4,680,690**		**8,246,854**
(A) Direct Cost Grand Total				29,791,921		60,454,153		90,245,074
Land Acquisition/compensation				-		62,138,000		62,138,000
Government Administration				3,095,085		1,326,465		4,421,550
Engineering Service				3,095,085		1,326,465		4,421,550
Contingency				6,376,500		25,506,000		31,882,500
(B) Indirect cost Grand Cost				12,566,670		90,296,930		102,863,600
Grand Total (A)+(B)				**42,357,591**		**150,751,083**		**191,336,154**

Table K-10 DISBURSEMENT SCHEDULE

Unit: M$x10^6

	PHASE - 1												
	1992		1993		1994		1995		1996		1997		Total
	F.C	L.C	F.C	L.C	F.C	L.C	F.C	L.C	F.C	L.C	F.C	L.C	
(1) *Direct Cost*													
- River Improvement	-	-	2.00	2.59	2.30	3.01	2.47	3.03	4.72	5.63	3.37	5.13	34.25
- Retention Pond	-	-	3.10	9.30	2.40	7.19	2.07	5.89	-	-	-	-	29.95
- Diversion Channel	-	-	0.20	0.85	0.90	3.59	1.20	4.86	1.50	4.70	-	-	17.80
- *Drainage Plan*	-	-	-	-	-	-	-	-	1.10	1.67	2.20	3.28	8.25
Sub total of (1)	0	0	5.30	12.74	5.60	13.79	5.74	13.78	7.32	12.00	5.57	8.41	
	0		18.04		19.39		19.52		19.32		13.98		90.25
(2) Land Acquisition	-	8.59	-	14.08	-	13.41	-	13.03	-	13.03	-	-	62.14
(3) Government Administration	-		-	1.08	-	0.88	-	0.88	-	0.88	-	0.70	4.42
(4) Engineering Service	-		1.08	-	0.88	-	0.88	-	0.88	-	0.70	-	4.42
(5) Contingency	-		1.20	4.80	1.20	4.80	1.30	5.20	1.36	5.44	1.32	5.26	31.88
Sub total of (2)+(3)+(4)+(5)	0	8.59	2.28	19.96	2.08	19.09	2.18	19.11	2.24	19.35	2.02	5.96	
	8.59		22.24		21.17		21.29		21.59		7.98		102.86
Ground total	0	8.59	7.58	32.70	7.68	32.88	7.92	32.89	9.56	31.35	7.59	14.37	
	8.59		40.28		40.56		40.81		40.91		21.96		193.11

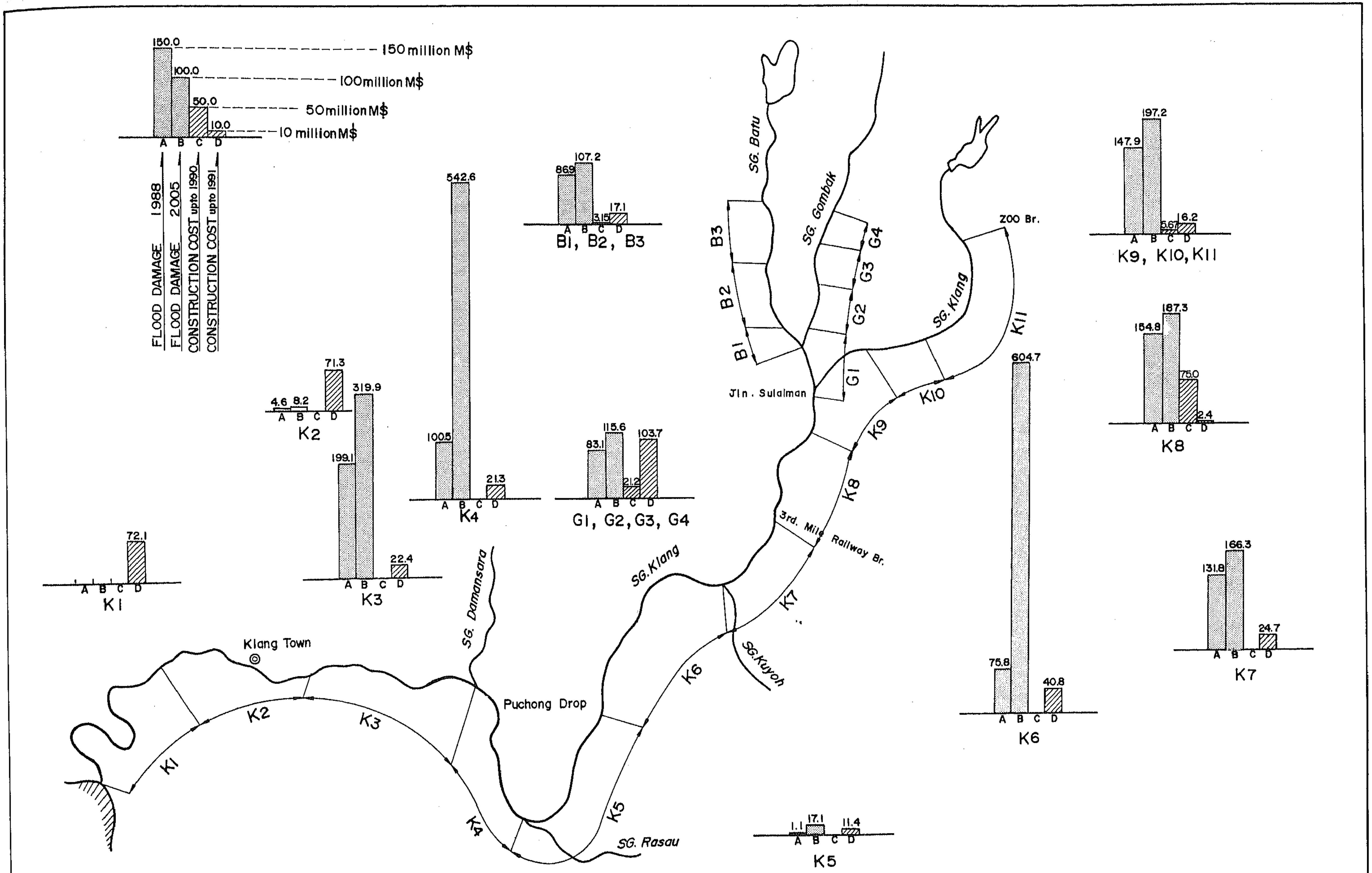


FIG. K-1	COMPARISON OF DAMAGE AND CONSTRUCTION COST
THE STUDY ON THE FLOOD MITIGATION OF THE KLANG RIVER BASIN	

JICA

	Discription	Unit	Q'ty	Short Term					Mid Term					Long Term				
				93	94	95	96	97	98	99	2000	2001	2002	2003	2004	2005	2006	2007
PHASE -1 (Urgent Project)	1. Batu retention pond	ha	113.4	—	—	—												
	2. Diversion channel	km	3.3	—	—	—	—											
	3. River improvement																	
	- Batu river																	
	B2 (R2, 3.4) Windening & Deepening	km	3.4				—	—										
	B3	km	3.2		—	—												
	- Gombak river																	
	G4 (R7) Widening & Deepening	km	2.5			—	—	—										
	- Klang river																	
	K9 (R10, 11) Widening & Deepening	km	4.1	—	—													
	4. Inner water Drainage	m3/sec	2.0				—	—										
PHASE -2	1. River improvement																	
	- Klang river																	
	K7 Widening	km	4.4						—	—								
	K6 Widening	km	10.1								—	—						
	K2 Widening & Deepening	km	8.4						—	—								
	K10 Widening & Deepening	km	3.3							—	—							
	K4 Widening & Deepening	km	9.1								—	—	—					
	K5 Widening & Deepening	km	6.4										—					
	K3 Embankment	km	13.5										—					
PHASE -3	1. Puchong Drop Removal													—	—			
	2. River Improvement																	
	- Klang river																	
	K6 Deepening	km	10.1											—	—			
	K7 Deepening	km	4.4												—			
	K8 Deepening	km	5.7													—		
	- Gombak river																	
	G1 Deepening	km	2.4													—		
	G2 Widening & Deepening	km	2.8														—	
	G3 Widening & Deepening	km	2.2															—
	- Klang river																	
	K1 Widening & Deepening	km	11.4												—	—		
	K3 Widening & Deepening	km	13.5														—	—
	K11 Widening & Deepening	km	6.2															—
	- Batu river																	
	B1 Deepening	km	1.4														—	

FIG. K-2 **OVERALL CONSTRUCTION TIME SCHEDULE**

THE STUDY ON THE FLOOD MITIGATION OF THE KLANG RIVER BASIN

JICA

Description	Work Period (mth)	PHASE - 1 1st Year 1993	2nd Year 1994	3rd Year 1995	4th Year 1996	5th Year 1997
(1) River Improvement						
1. Klang River Section K9 (3.1 km)	18					
2. Gombak River Section G4 (3.5 km)	20					
3. Batu River Section B2, B3 (6.1 km)	30		B3		B2	
(2) Batu Retention Pond						
1. Retention Pond	36					
2. Batu Outlet Gate	16					
3. Batu Sluice Way	8					
(3) Diversion Channnel						
1. Channel Intake	8					
2. Diversion Channel	24					
3. Regulation Pond	16					
4. Overflow Weir	12					
5. Batu River Gate	12					
(4) Drainage Plan of Kampung Baru						
1. Underground Pondage	20					
2. Inlet Structure	8					
3. Pump House	20					
4. Outlet Tank	8					
5. Outlet Culvert/ Gate Structure	8					
6. Inner Drainage System	12					

FIG. K-3 **CONSTRUCTION SCHEDULE OF PHASE-1**

THE STUDY ON THE FLOOD MITIGATION OF THE KLANG RIVER BASIN

APPENDIX L: ECONOMIC EVALUATION FOR URGENT FLOOD MITIGATION PROJECT

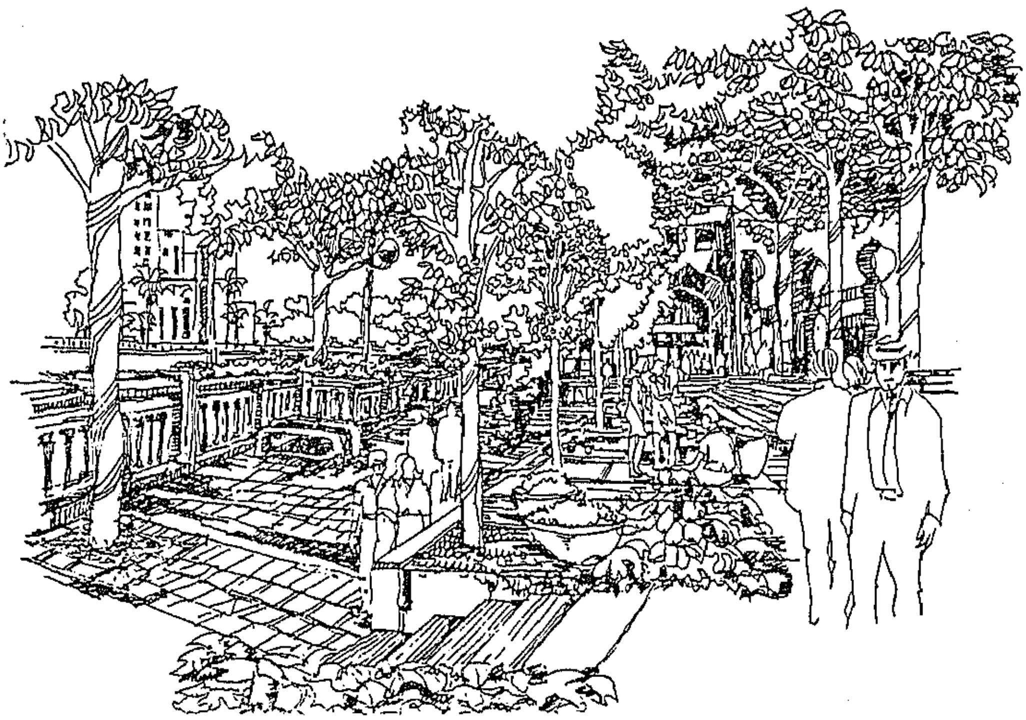


TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES