NO. 1

GOVERNMENT OF MALAYSIA

JB-TRANSPLAN

THE FEASIBILITY STUDY ON ROAD CONSTRUCTION AND IMPROVEMENT PROJECT IN JOHOR BAHRU AND ITS CONURBATION

FINAL REPORT

MAIN VOLUME

MARCH 1984

JAPAN INTERNATIONAL COOPERATION AGENCY

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PREFACE

The Japan International Cooperation Agency (JICA) has conducted an Urban Transport Master Plan Study for Johor Bahru and its Conurbation and formulated a list of high priority transportation projects. The Government of Malaysia has agreed to that list and requested the Government of Japan to conduct a Feasibility Study on Road Construction and Improvement Project in Johor Bahru and its Conurbation.

In response, the Government of Japan has decided to conduct the feasibility study and entrusted it to JICA. JICA sent to Malaysia a joint survey team comprising Fukuyama Consultants International Co., Ltd. and Cho-dai Consultants Co., Ltd., headed by Mr. Toshio Kimura, from August 1982 to December 1983 under the guidance of the Japanese Supervisory Committee chaired by Prof. Moriyuki Hirose, Meisei University.

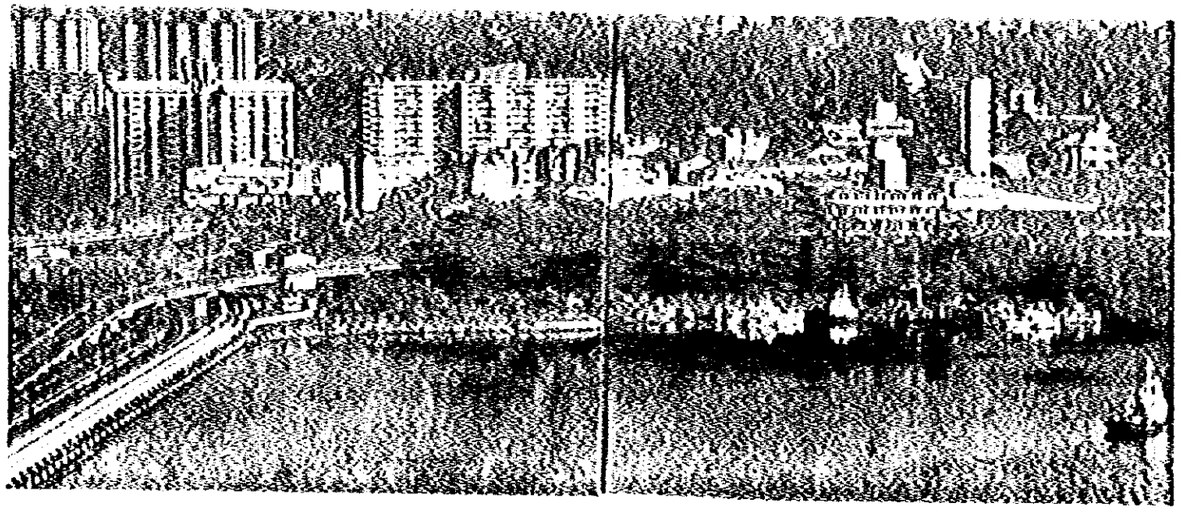
The team held discussions with the officials concerned of the Government of Malaysia on the Project and conducted the study in Malaysia. Subsequently, further studies were made in Japan and this report has been prepared.

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

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

March 1984

Keisuke Arita
President
Japan International Cooperation Agency



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CHAPTER 1

INTRODUCTION

1-1 BRIEF DESCRIPTION OF THE PROJECT

The Project involves the following road construction and improvement packages:

(1) Johor Bahru-Pasir Gudang Southern Link

The Johor Bahru-Pasir Gudang Southern Link will provide a direct link between the Johor Bahru Business District and Pasir Gudang Industrial and Seaport Area. This Southern Link is approximately 20 kilometers long.

The road begins from the intersection of Jalan Kebun Teh with Jalan Larkin on Federal Route 1. It runs in the east-west direction via Jalan Kebun Teh and Jalan Bakar Batu, and over Sungai Tebrau before terminating at Pasir Gudang Seaport Area.

(2) Causeway Traffic Dispersal Scheme

The proposed Causeway Traffic Dispersal Scheme will consist of the improvement of the road system to provide traffic entering and leaving the Causeway with a better access to major corridors.

In carrying out the Study of the Causeway Traffic Dispersal Scheme, the Study Team has taken into account both the Short-Term Layout Plan by Perunding Alam Bina and the Long-Term Layout Plan which has been formulated preliminarily in this Study.

(3) Johor Bahru Toll Expressway Access Road (East Link)

The proposed Ayer Hitam-Johor Bahru Expressway, planned by the Highway Authority of Malaysia, will enter Johor Bahru along two (2) corridors — Jalan Tebrau to the east and Jalan Kempas to the west. The Feasibility Study will be undertaken only for the section between the intersection of Jalan Tebrau with Johor Bahru-Pasir Gudang Southern Link on the East Link of the Toll Expressway Access Road.

(4) Inner Ring Road Including Lorry Route

The Inner Ring Road has been proposed in order to provide a circumferential route around the hub of the town centre. The route will consist of improved existing roads and newly constructed ones. It will provide a link between Jalan Tun Abdul Razak and Jalan Tebrau; Jalan Bukit Meldrum and Jalan Selat Tebrau.

The Lorry Route has been proposed in order to provide a direct connection between Federal Route 1 at Jalan Tun Abdul Razak and Commercial Vehicles Custom Inspection Complex at Tanjung Putri.

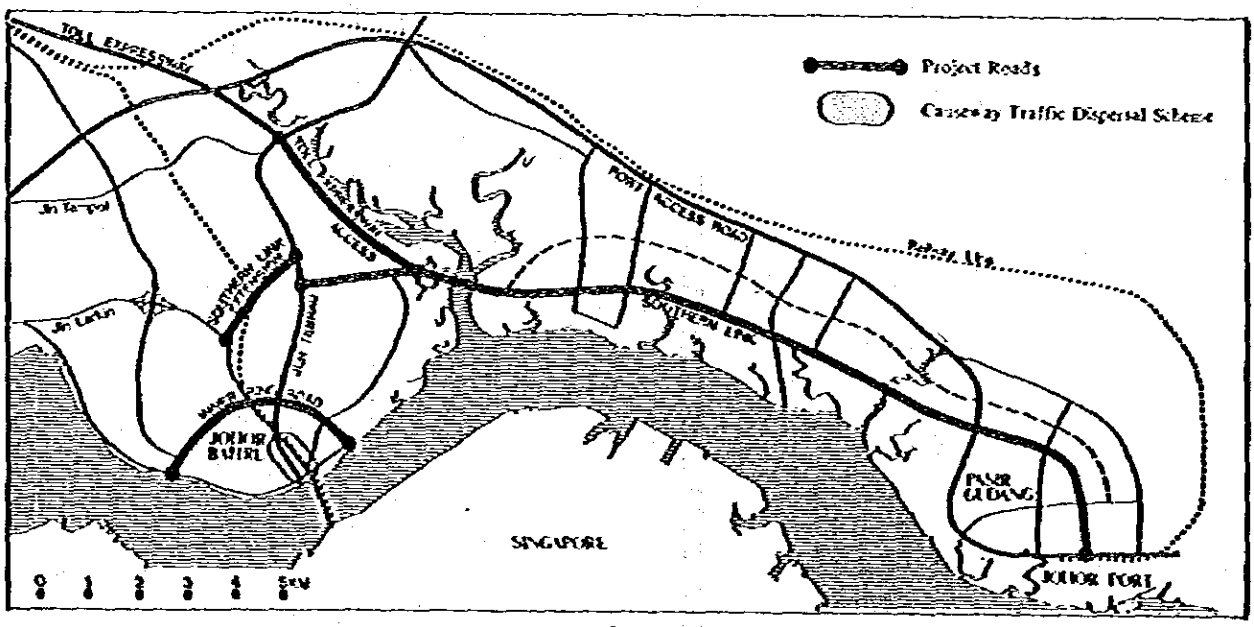


FIG. 1-1 LOCATION MAP OF PROJECT ROADS

TABLE 1-1 OUTLINE OF THE PROJECT PACKAGES

	Project Area		Road Length or Area Coverage
	Starting Point	Ending Point	
Johor Bahru-Pasir Gudand Southern Link	Intersection of Jalan Kebun Teh with Jalan Larking	Pasir Gudang Seaport Area	20,140 m
Causeway Traffic Dispersal Scheme	Area covered from the eastern part of Jalan Yahya Awal and within Inner Ring Road		310 ha
Toll Expressway Access	Intersection of Toll Expressway Access with Jalan Tebrau	Intersection	4,150 m
Inner Ring Road including Lorry Route			
Inner Ring Road	Intersection of Jalan Selat Tebrau with Inner Ring Road	Intersection of Jalan Bukit Meldrum with Inner Ring Road	4,850 m
Lorry Route	Intersection of Federal Route 1 with Lorry Route	Custom Inspection Complex at Tanjung Putri	3,000 m

1-2 STUDY APPROACH

The following are the principal steps involved in the Study process:

a. Alternative Route Alignment
b. Traffic Projection
c. Preliminary Engineering and Environmental Study
d. Cost Estimates
e. Economic Evaluation
f. Implementation Programme

In this Study, drafted alternatives for the following items have been evaluated from the technical, environmental and economic standpoints before the best alternatives are decided upon:

a. Route
b. Structure Type
c. Causeway Layout
d. Type of Interchange
e. Cross-Section
f. Staged Construction

TABLE 1-2 EVALUATION VIEWPOINTS AND ITEMS

	Route	Structure Type	Causeway Layout	Type of Interchange	Cross-Section	Staged Construction
Transport and Town Planning, Environmental Study	○		○			
Engineering	○	○	○	○	○	○
Traffic Study	○		○	○	○	○
Economic Evaluation	○	○	○	○	○	○

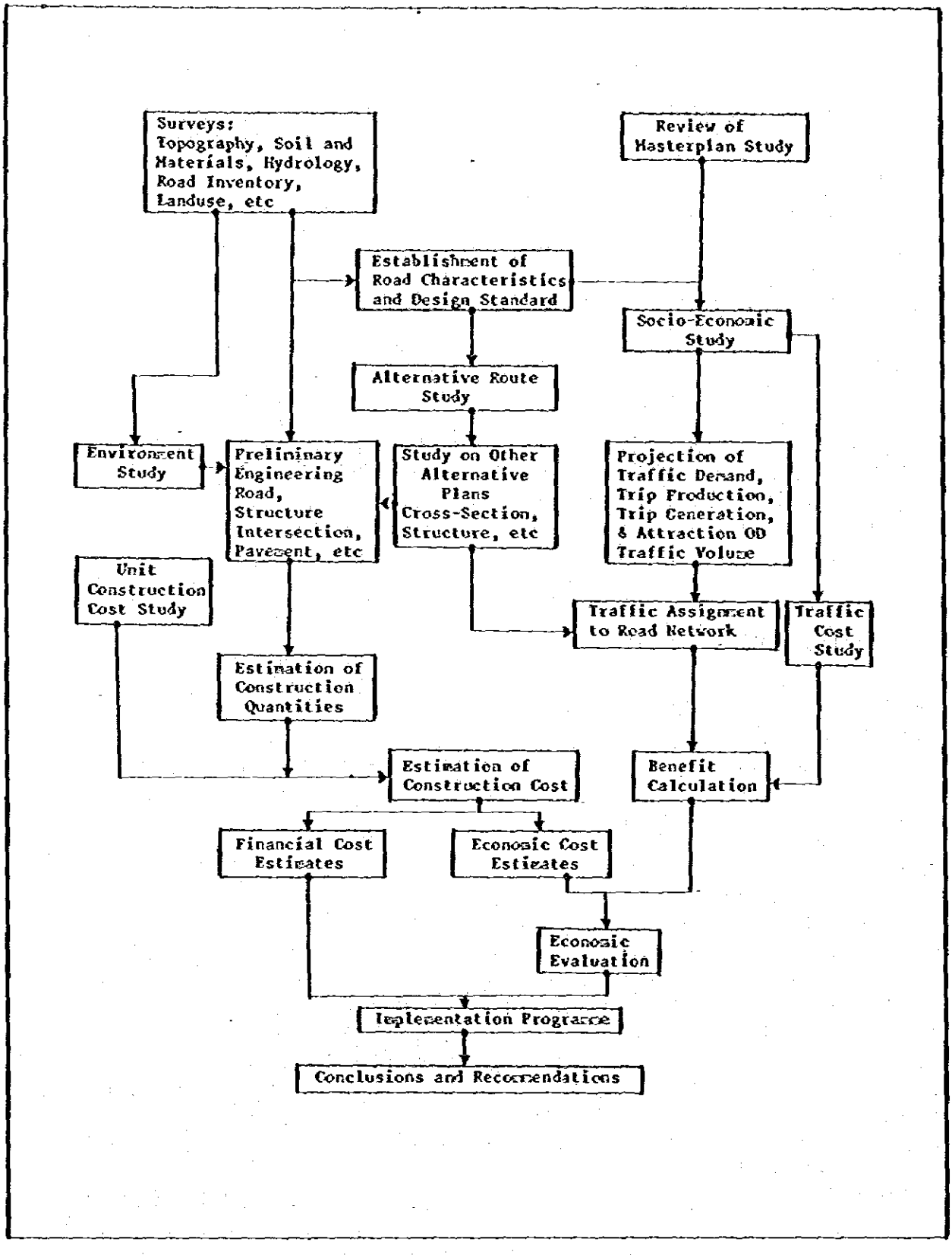


FIG. 1-2 GENERAL FLOW CHART

CHAPTER 2

PROJECT BACKGROUND

2-1 NATURAL BACKGROUND

2.1.1 Topography

The topography within the Study Area is generally undulating. The high areas consist of isolated hills are composed mainly of granite.

The coastal areas along the Straits of Malacca and the Straits of Johor as well as the banks of the various major rivers are generally low-lying and occasionally subject to tidal influence. The coastal plains on the west particularly, are only a few feet above sea level. On low-lying areas away from the coast, peat swamps and mangrove swamps are predominant.

2-1-2 Climate

The region has a hot humid climate, with little seasonal variation. The most important influences are the Northeast and Southwest Monsoons.

The temperatures for most of the months range from 25.5°C to 27.8°C. The extreme temperatures are around 35°C and 18°C. The hottest period of the year is from March to May and the coolest is December to January.

The mean daily maximum and minimum value of relative humidity are 99% and 61% respectively. The relative humidity tends to be slightly lower in the first three (3) months of the years.

2-1-3 Precipitation

The mean annual precipitation in the vicinity of the Straits is about 2600 mm. However there is considerable variation (120%) from station to station and from year to year. The distribution of rainfall over the year is not constant but there is a tendency for the period from November to December which corresponds with the Northeast Monsoon to have the highest precipitation and for the period around April which corresponds with the Southwest Monsoon to be wetter than the remainder of the year.

2-1-4 Geology

In the Project Area, the ground is generally covered by alluvial deposits ranging from 10 m to 20 m in depth.

The proposed alignment of Johor Bahru – Pasir Gudang Southern Link crosses over several rivers such as Sungai Tebrau.

The bedrock lying in the river sections are composed of the following three (3) geological formations.

a) Permian Volcanics
b) Granitic Intrusives and
c) Old Alluvium

The Permian Volcanics consist manily of acidic tuff such as andesitic and rhyolitic tuff, and are commonly metamorphosed by the granitic intrusions taking place later. The main granitic intrusions took place in the Triassic period. The intrusives consist of granite, granodiorite, etc. Acidic and basic dyke rocks are commonly seen in this granitic bodies. The top portions of the intrusives have been heavily weathered into lateritic clayey soils characterized by their reddish colour. Boulders with one to several meters in diameter were also produced as a result of this weathering process. The Old Alluvium contains particles decomposed mainly from granite including quartz-felspathic coarse sand, gravel and sometimes silty or clayey size fine particles. The Old Alluvium is generally semi-cemented and its top portions are heavily weathered into lateritic soils. The weathered zones of these bedrocks sometimes exceed 30 m in depth below the ground surface.

Along the river valleys, recent sediments consisting of soft compressible clays, loose sand and gravel are deposited.

For a better understanding of the geological features in the area, the geological map prepared based on the publication of the Geological Survey of Malaysia is shown in Fig. 2-1.

More detailed geological condition of the Project site obtained from the exploratory drilling works is shown in the Supplementary Volume.

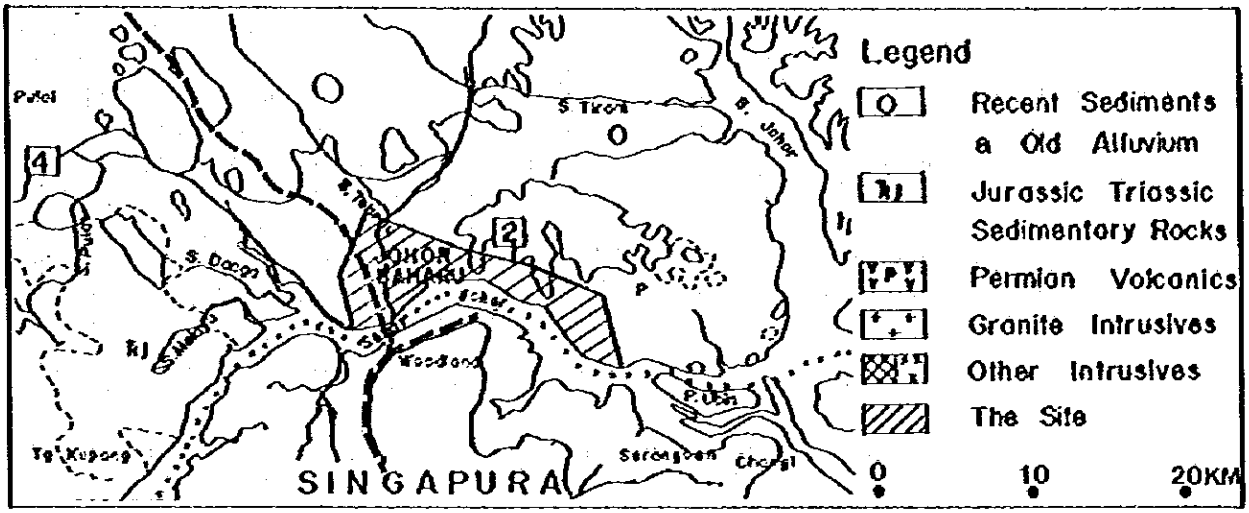


FIG. 2-1 GEOLOGICAL MAP AROUND THE SITE

2-2 SOCIO-ECONOMIC BACKGROUND

2-2-1 Population

The population of the Study Area in 1980 was approximately 459,000, and there was an increase of about 152,000 with the growth rate of 4.1% per annum during the decade 1970—1980.

This growth rate is much higher when compared with the growth rates of Peninsular Malaysia or Johor State.

The population distribution in the Study Area is as shown in Table 2-1. It is found that MPJB houses more than half of the total population in the Study Area.

The relative importance of MPJB as well as Plentong to the State has increased during the past decade and is expected to further increase with similar trend due to various development schemes that have been planned for these areas.

TABLE 2-1 POPULATION IN STUDY AREA

Mukims	1970	1980	Average Annual Growth (%)
MPJB	150.8	247.0	5.1
Jelutong/Pulai	19.8	23.7	1.8
Plentong	22.1	37.7	5.5
Sedenak	18.1	22.6	2.2
Senai/Kulai	36.3	52.1	3.7
Sg. Tiram	8.3	9.1	0.9
Tg. Kupang	4.5	4.7	0.4
Tebrau	15.6	17.6	1.2
Kota Tinggi	23.2	30.8	2.9
Ulu Sg. Johor	8.4	10.7	2.4
Study Area	307.1	458.9	4.1

Source : Population Census 1970, 1980.

2-2-2 Employment

The current total employment in the Study Area is estimated at about 160,000. Of this total, about one-third each is equally engaged in the primary, secondary and tertiary industries. However, in MPJB most of the job opportunities are in the secondary or tertiary sectors.

Current employment opportunity is concentrated in the urbanized area, mainly MPJB, and Pasir Gudang.

2-2-3 Gross Regional Product

The economy of the Johor State has experienced rapid growth rates during the years from 1971 to 1980 in proportion to the Gross Domestic Products (GDP) growth.

The average annual growth rate during the period is about 8.0%. The recent economic report, however, shows that the GDP growth is rather stagnant in recent years due to the recession of the world economy. In accordance with GDP, the economic growth in the State is also envisaged to have slowed down.

TABLE 2-2 CROSS REGIONAL PRODUCT, JOHOR STATE ($MILLION IN 1970 PRICES)

	Johor State		Malaysia	
Year	GRP	Average Annual Growth (%)	GDP	Average Annual Growth (%)
1971	1,476	–n.a.	13,016	–n.a.
1980	2,941	8.0	26,228	8.1
1982	–n.a.	–n.a.	29,131	5.4

Source : Fourth Malaysia Plan.
Economic Report 82/83, Ministry of Finance.

2-3 LANDUSE

2-3-1 Regional Landuse Pattern

The present regional landuse pattern in the Study Area is predominantly agricultural. Agricultural use accounts for nearly 63% of the total area in 1980 (see Table 2-3).

Rubber and oil palm are the two most widely cultivated crops; their cultivated areas together make up 91% of the total cultivated land area. Other crops such as coconut, pineapple, cocoa, coffee, orchard fruits, and spices are grown on the remaining 9% of the agricultural area.

Within the non-agricultural category, forests and swamps cover up to 18% of the Study Area while grassland/cleared land take up 13%. Urban land, which includes housing schemes, estate buildings etc, occupies only 5% of the total land area.

TABLE 2-3 LANDUSE IN THE STUDY AREA (1980)

		Area (Ha)	%
Non-Agricultural Use	Urban land	13,734	5.5
	Forest/Swamp	45,269	18.2
	Minin	1,340	0.5
	Grassland/Cleared land	32,195	13.0
Sub-Total	Sub-Total	92,538	37.2
Agricultural Use	Rubber	80,598	32.4
	Oil Palm	61,303	24.7
	Coconut	870	0.4
	Marketing-Gardening	430	0.2
	Other Crops	12,673	5.1
	Sub-Total	155,876	62.8
Total		248,414	100.0

Source :
Department of Land and Mines Johor (1981).
Resource Maps (1979).
Department of Agriculture, Annual Report (1980).

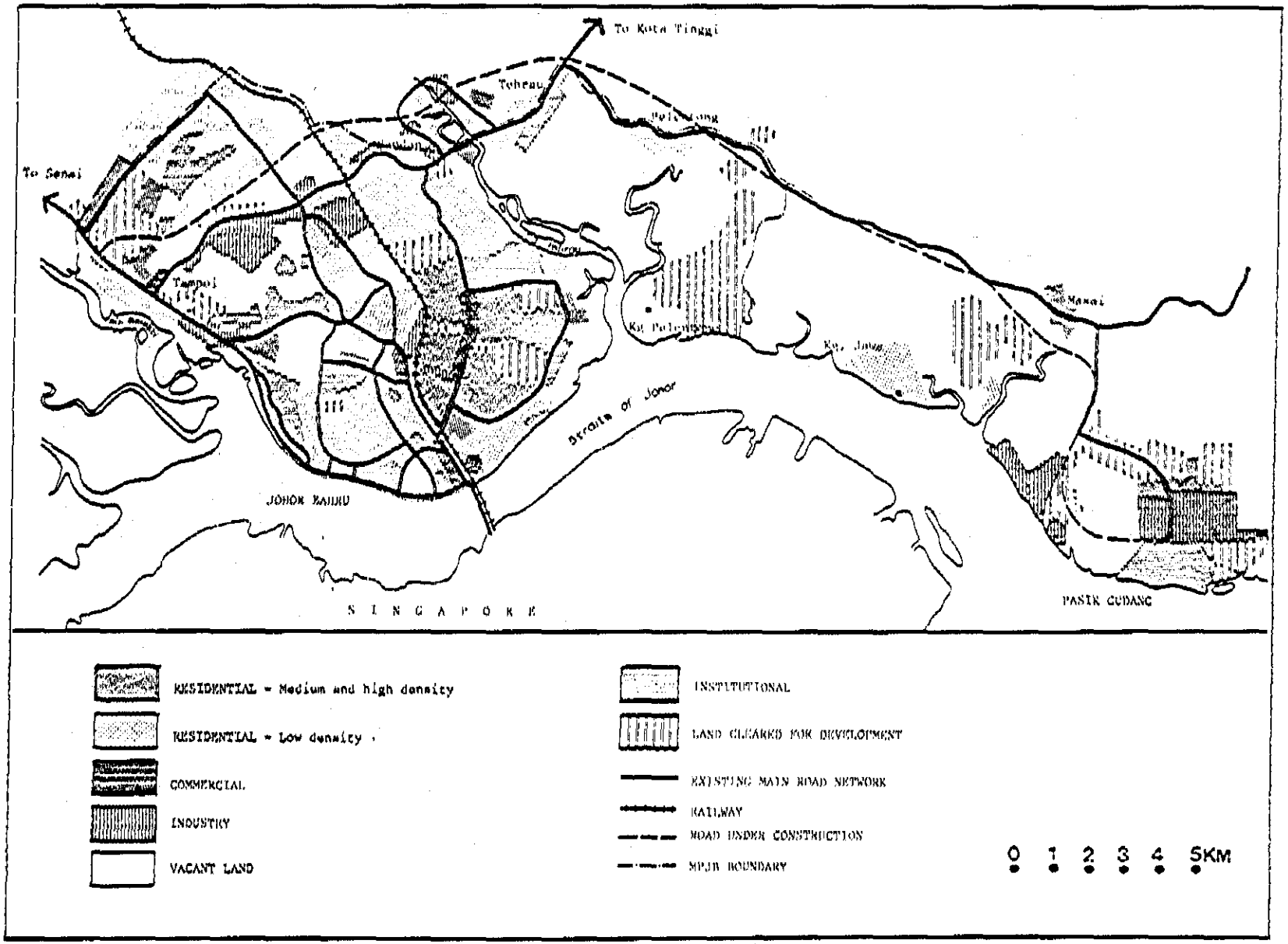


FIG. 2-2 EXISTING LANDUSE IN THE JOHOR BAHRU-PASIR GUDANG CORRIDOR (1980)

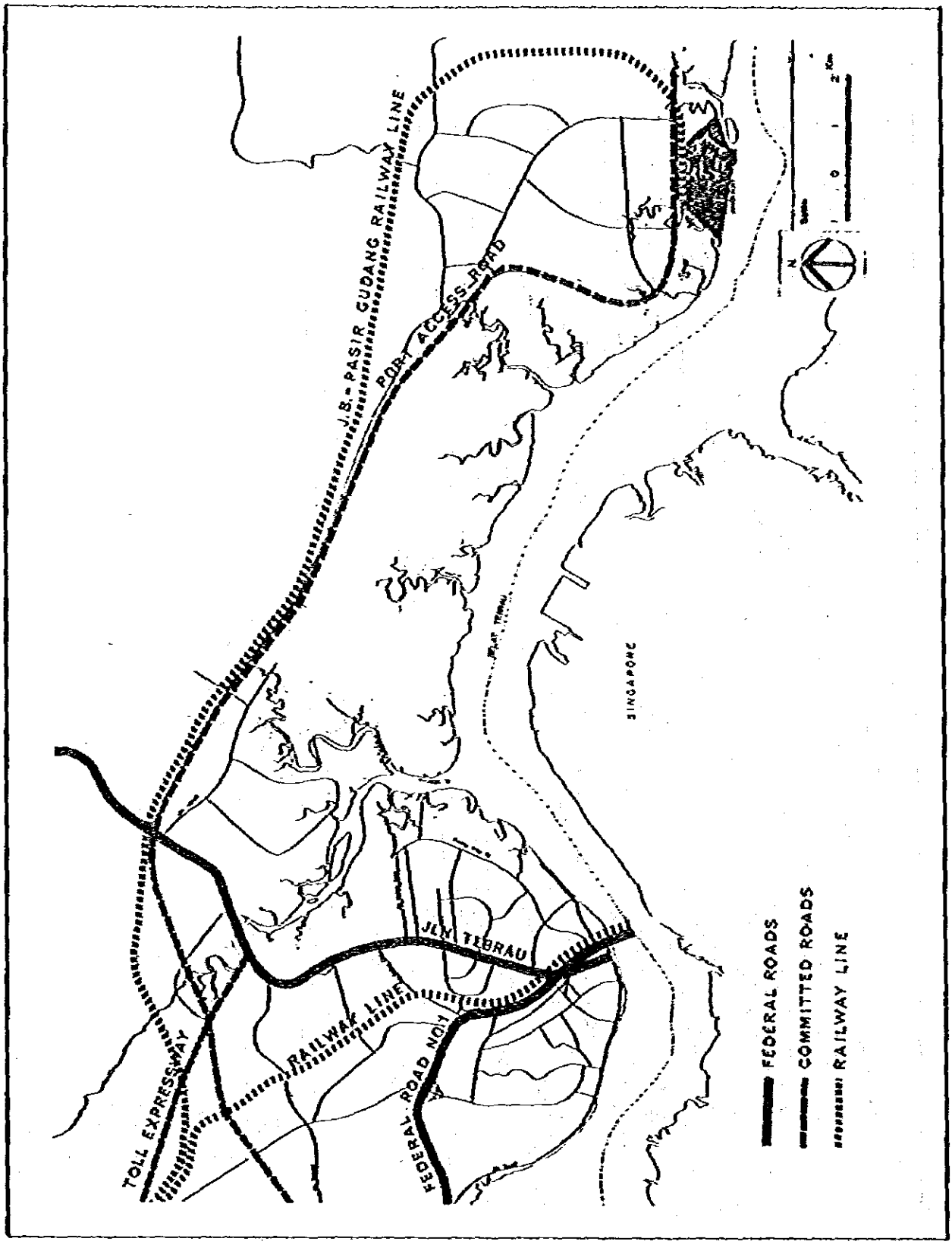


FIG. 2-3 EXISTING TRANSPORT SYSTEM AND COMMITTED PROJECT

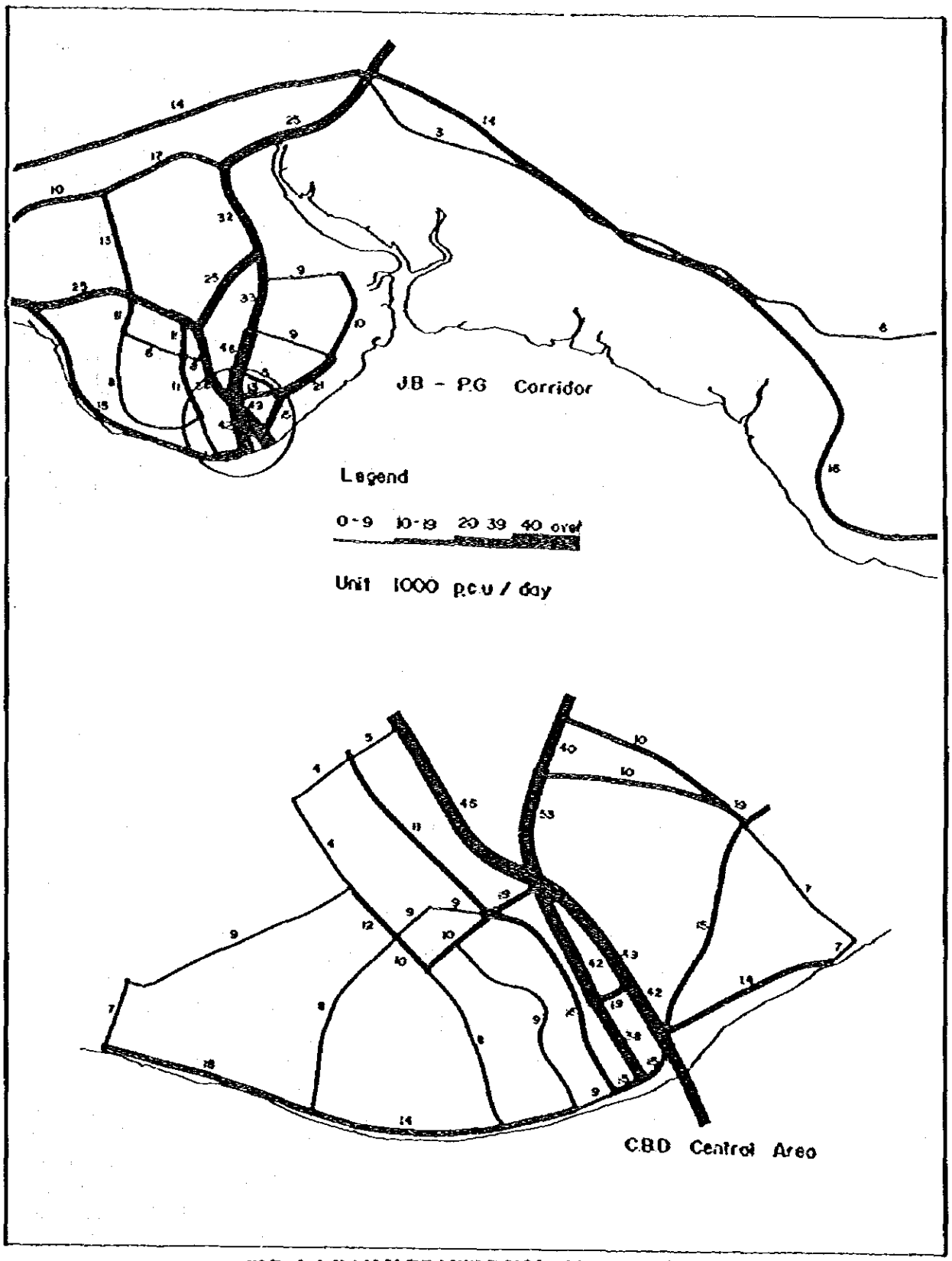


FIG. 2-4 DAILY TRAFFIC VOLUME IN 1982

2-3-2 Johor Bahru–Pasir Gudang Corridor

The urban area of Johor Bahru has been expanding rapidly over the last ten (10) years. In 1976, the Majlis Perbandaran Johor Bahru (MPJB) extended its town limits to cover an additional 4,955 ha (29,510 acres). Subsequently, the MPJB limits now encompasses an area of approximately 12,000 ha (see Table 2-4).

Over the years, much agricultural land has been converted for housing purposes. In 1980, housing utilised 27.0% of the MPJB land area followed closely by institutional uses (Government reserve, schools, religious uses) which make up 11.6%. There is still much land available for future development as 37.2% of the total area is non-built-up area.

Generally it is observed that the decrease in residential density corresponds with increase distance away from the CBD. Residential development within the CBD is typified by the usual traditional shophouses and medium density housing at a density of fifteen (15) units per hectare.

The Central Business District (CBD) is located in a tight package about the causeway area. The CBD itself is a contrasting combination of traditional shophouses and modern office-shopping-hotel multi-use complexes.

Within the MPJB area, the CBD commands only 38% of total commercial floorspace, while 23% are located in the outlying sub-centres of Tampoi, Century Garden and Taman Sri Tebrau. These sub-urban centres have thrived mainly in response to the rapid growth of residential development in those areas.

As for industry, large scale industries are located mostly at Tampoi and Larkin areas; small scale industries tend to be dispersed within the MPJB area.

TABLE 2-4 LANDUSE DISTRIBUTION IN MPJB (1980)

Landuse/Area	Landuse		%
	Acres	Hectares	
Residential	7,944	3,215	27.0
Commercial	657	266	2.2
Institutional	3,437	1,392	11.6
Industry	1,010	408	3.4
Open Space	920	372	3.1
Others	4,569	1,849	15.5
Built-Up Area	18,537	7,502	62.8
Non-Built-Up Area	10,967	4,438	37.2
Total MPJB Area	29,504	11,940	100.0

Source : Structure Plan Unit, Johor State Town and Country Planning (1981).

In the Pasir Gudang area, a large scale development program, mainly for industry and residential purposes is now on-going, about 800 ha of land has already been developed and built-up.

Additional land of more than 500 ha has been cleared for the further development of the Pasir Gudang New Town.

The massive investment by the public sector has resulted in enhancing the development potential of large areas of land around Johor Bahru and along the land corridor between Johor Bahru and Pasir Gudang, especially so for housing development.

Two (2) major housing schemes, Permas Jaya (207 ha) and Gunung Hijau (136 ha) are under construction along the Johor Bahru–Pasir Gudang Corridor while several others totalling an area of about 1,226 ha planned along the same corridor are planned.

2-4 EXISTING TRANSPORT CONDITION

2-4-1 General

There exist four (4) types of transport mode in the Study Area; road, railway, air and sea. Among them the road transport is predominant in the Study Area, particularly for the urban transport.

Accordingly the road transport is mainly dealt with in this Study.

2-4-2 Existing Road Network and Committed Projects

The major road network in the Study Area is composed of the Federal Roads for Kuala Lumpur and for the East Coast and the subordinate regional roads as shown in Fig. 2-3. Most of the existing roads are of single carriageway, except for Federal Route 1 and several intra-urban trunk roads which are of dual carriageway. The existing network forms primarily a radial pattern converging onto Johor Bahru.

A number of development projects to improve the road network in the Study Area are already at various stages of implementation.

The most prominent ones are:

(1) Construction of Johor Port Access Road
(2) Construction of Toll Expressway
(3) Widening of Jalan Tebrau

Among the above, the Port Access Road is already open to traffic as a single carriageway tentatively.

2-4-3 Traffic Characteristics

(1) Daily Traffic Volume on Major Road

Daily traffic volumes on the major roads derived from traffic counting survey in October, 1982 are illustrated in Fig. 2-4. The heaviest traffic is found on the trunk roads in MPJB at Jalan Tun Abdul Razak, Jalan Ah Fook, Jalan Larkin and Jalan Tebrau with volume ranging from 35,000 p.c.u/day to 53,000 p.c.u/day.

Regarding the vehicle composition, passenger car traffic is predominant at any road, followed by motorcycles.

Relatively large numbers of lorries are found on Jalan Larkin and Federal Route 1 since these roads are a part of the designated lorry route for Singapore as mentioned below.

(2) Hourly Fluctuation

The hourly fluctuation of traffic flow observed at two (2) major roads, Jalan Larkin and Jalan Tebrau is shown in Fig. 2-5.

In general, the hourly variation tends to be relatively flat, however small peaks can be observed during 6 to 8 a.m. and 5 to 7 p.m.

(3) Lorry Route

One of the noticeable traffic condition in Johor Bahru is the existence of the lorry route for Singapore.

The lorries with exporting goods to Singapore are forced to follow the designated Lorry Route as shown in Fig. 2-6.

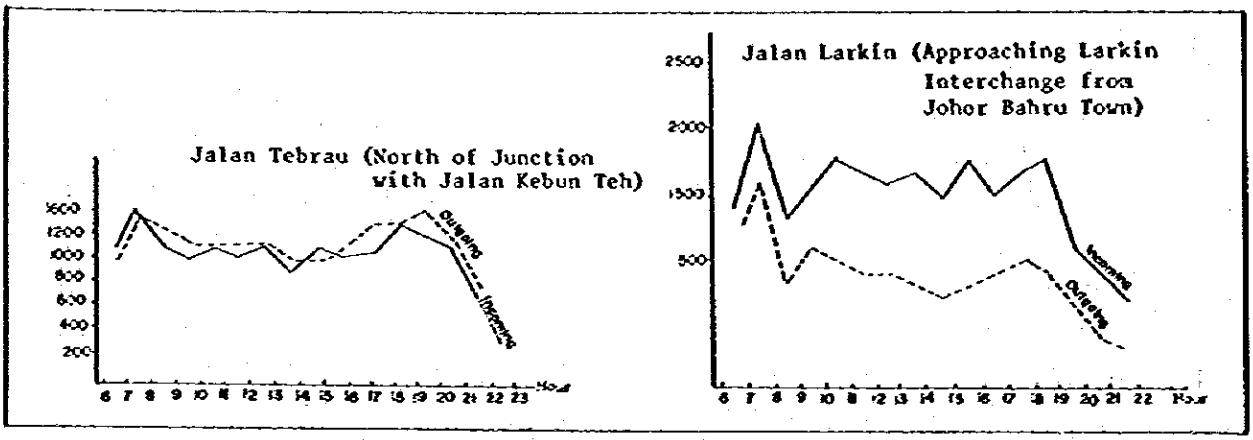


FIG. 2-5 HOURLY FLUCTUATION OF TRAFFIC VOLUME

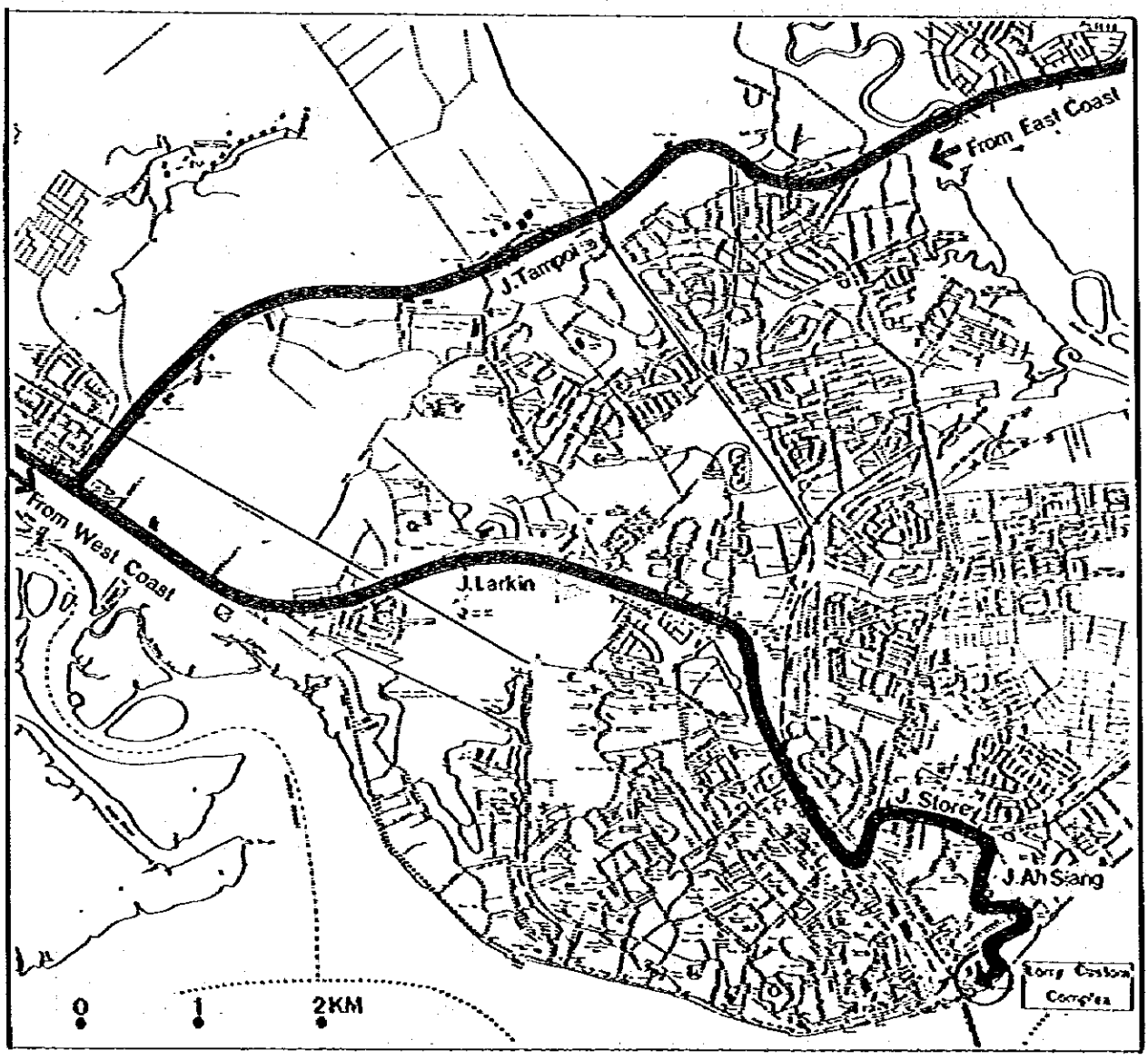


FIG. 2-6 THE EXISTING LORRY ROUTE

2-4-4 Public Transport

At present, the public transport available in the Study Area takes the following form:

(1) Buses — Scheduled Bus, Express Bus, Factory Bus, School Bus
(2) Taxi
(3) Rail Services
(4) Air Services

Among the existing public transport facilities, buses play the most important role for the urban transport.

There are twenty-seven (27) scheduled bus routes in operation within and outside of Johor Bahru.

The bus service is characterized as follows:

(1) Almost all the bus routes are destinating at CBD.
(2) New housing estate area such as the east side of Jalan Tebrau is not covered by the network.
(3) Frequent bus services of several times per hour are limited to few routes such as Jalan Tebrau, and Jalan Skudai.

2-4-5 Johor Port

In terms of tonnage, the volume of cargo handled at Pasir Gudang Johor Port has increased very rapidly during the past several years in comparison with other ports in Peninsular Malaysia.

The cargo handled at Johor Port has grown from 587 tons in 1976 to 1,870 tons in 1980 with a growth rate of 33.6% p/a, which is much higher than the average growth rate of 10.1% p.a of all Peninsular Malaysia Port.

The construction of the Johor Port for Phase 1 was completed in 1977, and the construction of the Phase 2 is underway. With this expansion of the port facilities, the cargo handled at the port is expected to grow rapidly in 1980s.

Table 2-5 shows the actual and forecast cargo handled at Johor Port.

TABLE 2-5 ACTUAL AND FORECAST CARGO HANDLED AT JOHOR PORT (THOUSAND TON/YEAR)

	1976[1]	1980[1]	1985[1]	1990[1]	2000[2]	Average Annual Growth Rate (%) '76 – '80	'80 – '90	'90 – '00
Import	272.0	889.0	2,718.0	4,300.0	9,770.0	34.5	17.1	8.6
Export	315.0	981.0	2,282.0	2,770.0	4,010.0	32.8	10.9	3.8
Total	587.0	1,870.	5,000.	7,070.0	13,780.0	33.6	14.2	6.9

Note : (1) Johor Port Authority.
(2) Estimated by Study Team.

CHAPTER 3

TRAFFIC DEMAND PROJECTION

3-1 SOCIO-ECONOMIC FRAMEWORK AND LANDUSE PLAN

3-1-1 Socio-Economic Framework

The socio-economic framework of the Study Area as premises for traffic projection is entirely based on the Transport Masterplan Study in 1982. This framework is summarized as follows:

a. Population

The population size of the Johor Bahru region in 2000 will be almost the same as that of Kuala Lumpur in 1980 with the annual growth rate of 4.0 per cent.

TABLE 3-1 POPULATION IN STUDY AREA (IN THOUSAND)

	1980(1)	1990(2)	2000
Johor Bahru	417	655	1,000(3)
Kota Tinggi (Part)	41	53	67
Study Area	459	708	1,067

Source :
(1) 1980 Population Census.
(2) Study Team Estimates.
(3) Target Population made by the Structure Plan Study.

b. Employment

The annual growth of employment in the Study Area is projected at 4.6 per cent per annum from 1980 to the year 2000 with employment expected to increase from 160 thousand in 1980 to 417 thousand in the year 2000.

c. Gross Regional Product

The Gross Regional Product (GDP) of Johor State is estimated on the basis of the Fourth Malaysia Plan, and is expected to grow at an annual rate of 8.0 per cent from 1980 to the year 2000. In terms of value, it is estimated that the GRP will thereby expand from M$2,941 million in 1980 to M$6,460 million in 1990 and M$13,697 million in the year 2000 (see Fig. 3-1).

d. Household Income

Mean monthly household incomes in the State and the Peninsular are expected to grown in view of the anticipated economic growth, of increased productivity per employed persons and decreasing household sizes but with increasing number of employed persons per household.

The average monthly household income in Johor State is expected to increase from M$766 in 1980 to M$41,876 in the year 2000, and hence, based on 1981 prices, the average growth rate of real income will be 4.6 per cent (see Fig. 3-2).

e. Vehicle Ownership

The future volume of vehicle ownership is estimated by using the correlation with the growth of household income.

The number of the vehicles in the Study Area is expected to increase from 88,000 in 1980 to 273,000 in the year 2000 (see Fig. 3-3).

The above socio-economic framework is projected on the basis of the assumptions that the national target growth demonstrated in the Fourth Malaysia Plan (FMP) would be attained and be applicable for the projection of the regional socio-economy in the Study Area in future.

TABLE 3-2 ALTERNATIVE SCENARIO FOR THE GDP GROWTH (M$ IN 1970 PRICES)

	1980[1]	1981[1]	1982[1]	1983[2]	1990	2000	2007
Original Scenario (Masterplan Scenario)	26,228	28,038	29,131	31,206	56,760[3] +9.2%[4]	118,100 +7.6%	–
Alternative Scenenario	–	+6.9%	+3.9%	+5.6%	46,822 +6.0%	80,740 +5.6%	118,100 +5.6%

Notes : 1) Economic Report 1982/83.
2) New Straits Times 20th. October, 1983.
3) Target Figure presented in FMP.
4) Represents Annual Growth Rate.
5) The others are estimated by the Study.

The target growth rate of Gross Domestic Product (GDP) in the FMP is an average of 7.8% *per annum* until the year 2000. However, it is uncertain whether the above target can be achieved on considering the prevailing worldwide economic recession in recent years. In spite of the Government's efforts to improve the economic situation, an immediate recovery from the recent recession might be difficult. This situation can be represented by postponing the target year without changing the framework itself, to say, the year 2007 instead of the year 2000 as shown in Table 3-2.

Notes: 1) Economic Report 1982/83.
2) New Straits Times 2[illegible]h. October, 1983.
3) Target Figure presented in FMP.
4) Represents Annual Growth Rate.
5) The others are estimated by the Study.

The above alternative scenario will be examined as a sensitivity test of the project feasibility as described in Chapter 6.

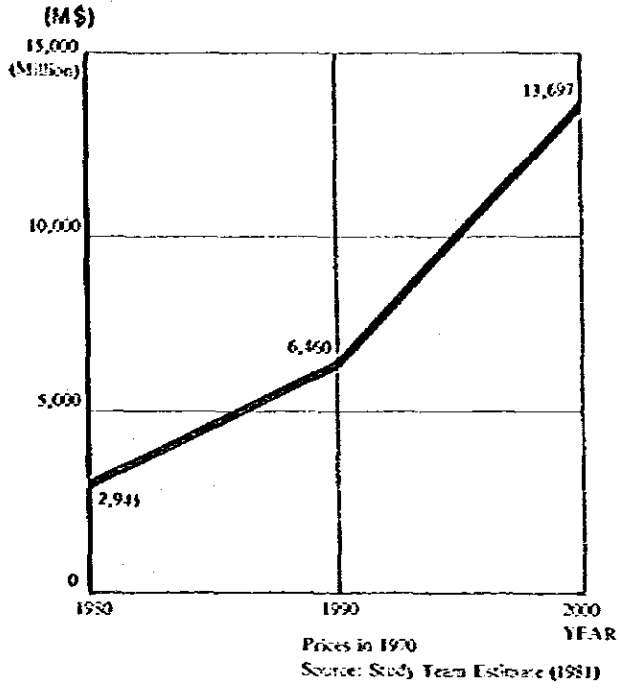


FIG. 3-1 GROSS REGIONAL PRODUCT IN JOHOR STATE

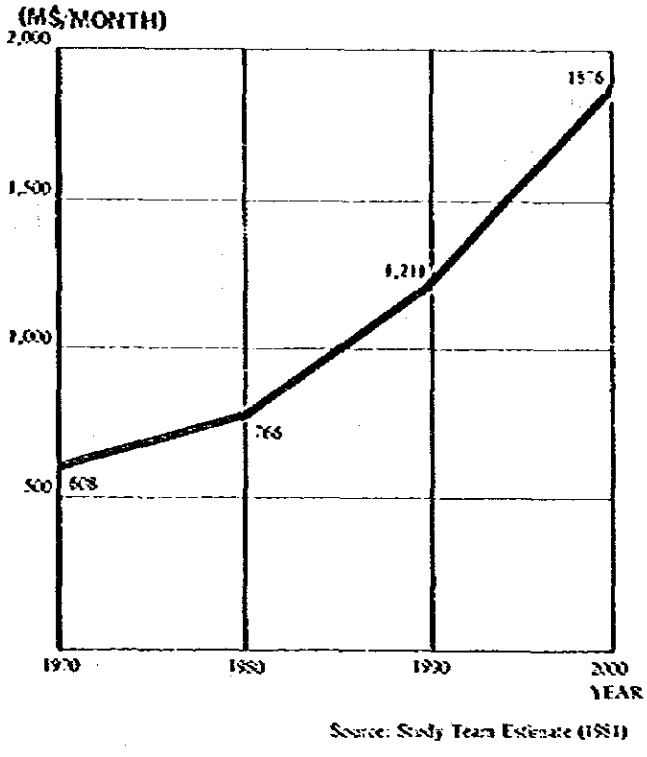


FIG. 3-2 HOUSEHOLD INCOME TREND (JOHOR STATE)

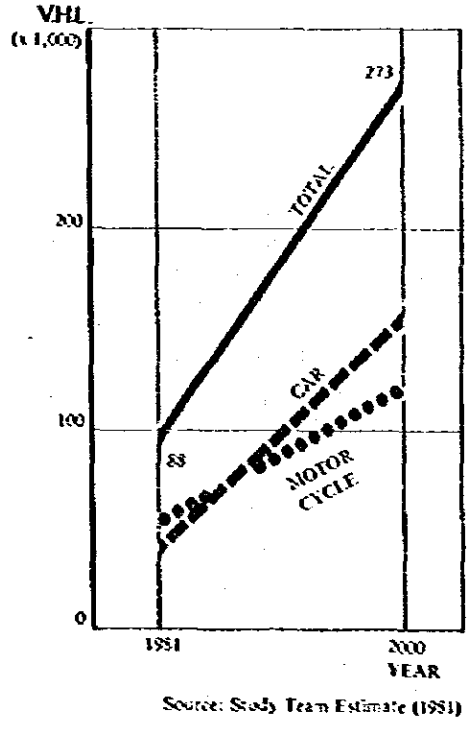


FIG. 3-3 . PROJECTED NUMBER OF CARS AND MOTORCYCLES (PRIMARY AREA)

3-2 LANDUSE PLAN

3-2-1 The Masterplan and Socio-Economic Growth

The Study Team's landuse plans has already been formulated and is as presented in Johor Bahru Transplan: The Urban Transport Masterplan Study in Johor Bahru Conurbation. At the same time, the Structure Planning Unit (SPU) for Johor Bahru under the supervision of Johor State Town and Country Planning has also been executing a comprehensive development study to prepare the structure plan for Johor Bahru and Pasir Gudang area. Needless to say, both studies were carried out in close collaboration.

The urban and regional development of an area depends largely upon the public and private investment that exploits potentials in the area concerned. Where the public sector is concerned, the Government which has been promoting many projects such as the Johor Tenggara Scheme, the Pasir Gudang Port, Industry and New Town Development, Malayan Railway Extension, the Toll Expressway and the Port Access Road Project, all of which compose the essential infrastructures that are indispensable for achieving the future development pattern, has displayed no apparent changes in its regional development policy. The private sector has also seemed to display a stable increasing concern for development. The number of planning applications in Johor State in the past years shows a stable increase in yearly applications as observed in major districts (see Table 3-3).

Johor Bahru, in particular, shares about 37% of the total number of planning applications in Johor State. In addition, the number of building applications in Johor Bahru also shows a consistent yearly increase except for the 1981 - 1982 period, when the number dropped slightly (see Table 3-4).

Other basic factors such as the socio-economic relationship with Singapore, which indirectly affects the future development pattern of the area seems to remain unchanged for the time being.

Therefore, the region is anticipated not to undergo any drastic changes in its development trend due to consistency in policy of both the public and the private sectors. The physical structure of the future development pattern in the Study Area will thus be maintained along the same frame work as was assumed in the Masterplan although there is a possibility that development implementation will be slightly slowed down.

TABLE 3-3 SUMMARY OF NUMBER OF PLANNING APPLICATION BY YEAR AND DISTRICT IN JOHOR BAHRU

District	No. of Application		
	1980	1981	1982
Segamat	389	296	361
Muar	595	691	813
Batu Pahat	715	763	1,090
Kluang	295	287	328
Mersing	118	114	251
Johor Bahru	1,677	1,859	2,047
Pontian	438	418	436
Kota Tinggi	124	159	223
Total Johor State	4,351	4,587	5,549

TABLE 3-4 BUILDING APPLICATION RECEIVED AND PROCESSED IN CBD

	1977	1978	1979	1980	1981	1982
No. of File Received	877	1,117	1,326	1,534	2,101	1,862
No. of File b/d from last year	705	1,077	1,472	1,260	991	1,263
Total No. of File for Processing	1,582	2,194	2,798	2,794	3,092	3,125
No. of File Approved	505	722	1,538	1,803	1,829	1,878
No. of File c/f to next year	1,077	1,472	1,260	991	1,263	1,247
% No. of File Approved	31.9%	32.9%	54.9%	64.5%	59.15%	60.1%

Source : Building Engineering Section, MPJB, 1983.

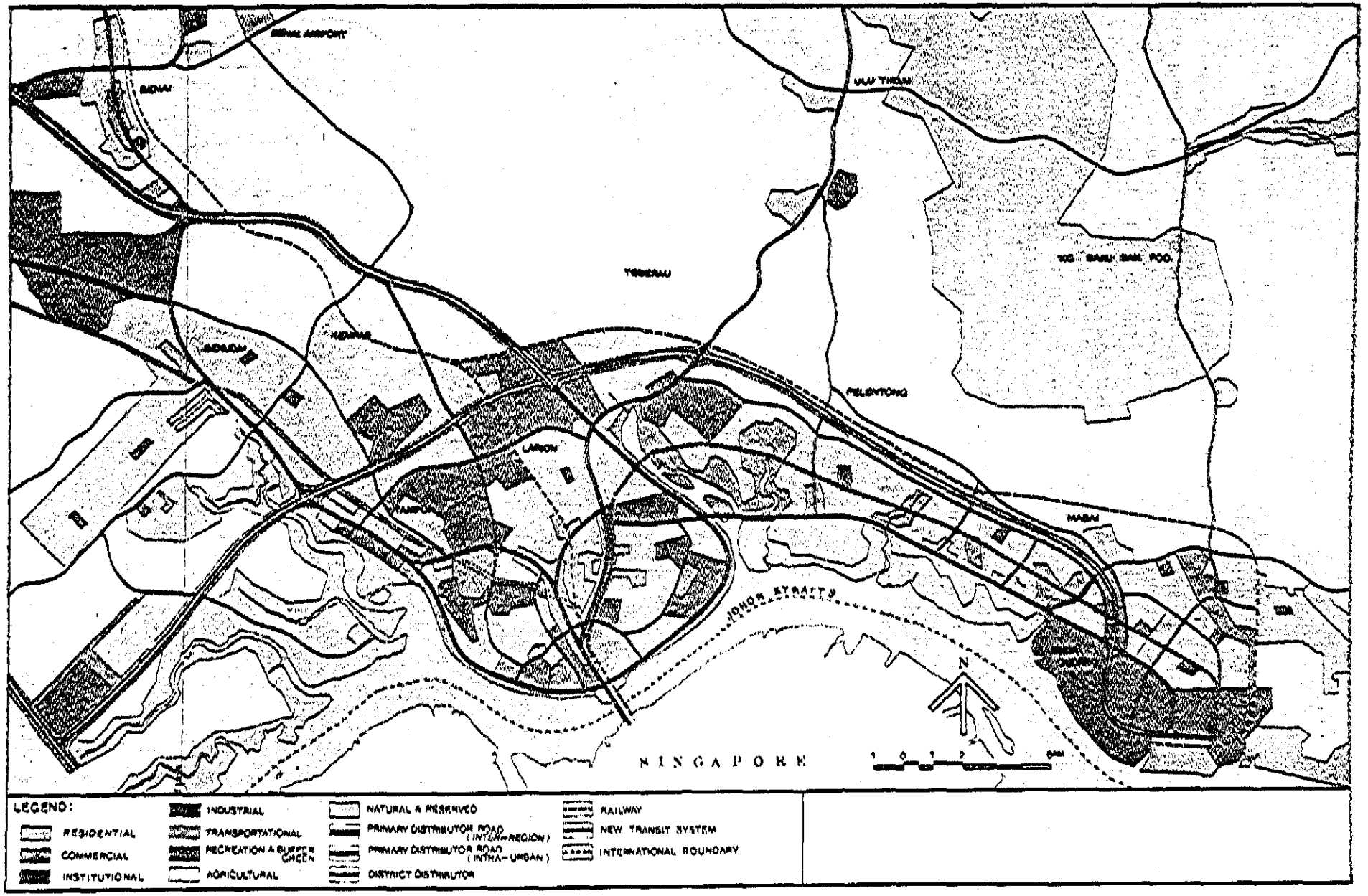


FIG. 3-4 FUTURE LANDUSE PLAN

3-2-2 The Landuse Plan in the Corridor

The committed projects in the corridor cover a wide region of the area, and the overall landuse pattern has been based on these projects (see Fig. 3-4).

Any amendments to the landuse and road network pattern can only be effected after the necessary administrative procedure is taken. Beside, the issue on land acquisition has to be considered too. Therefore, it can be concluded that there will not be any major changes or amendments to the landuse pattern in the corridor, although the development speed will differ according to the rate of economic recovery from the recent worldwide recession (see Fig. 3-5).

3-2-3 The Landuse in the Central Area of Johor Bahru

The SPU has been conducting detailed landuse planning in the Central Planning Area of Johor Bahru, however, this has not been finalized as yet. The landuse plan in the Central Area of Johor Bahru proposed by SPU is mainly adopted for the formulation of the Causeway Traffic Dispersal Plan. The comparison shows negligible difference between both studies at the traffic zonal level. This implies that traffic demands studied by JICA in the Central Area can be considered as being compatible with that of SPU's landuse (see Fig. 3-6).

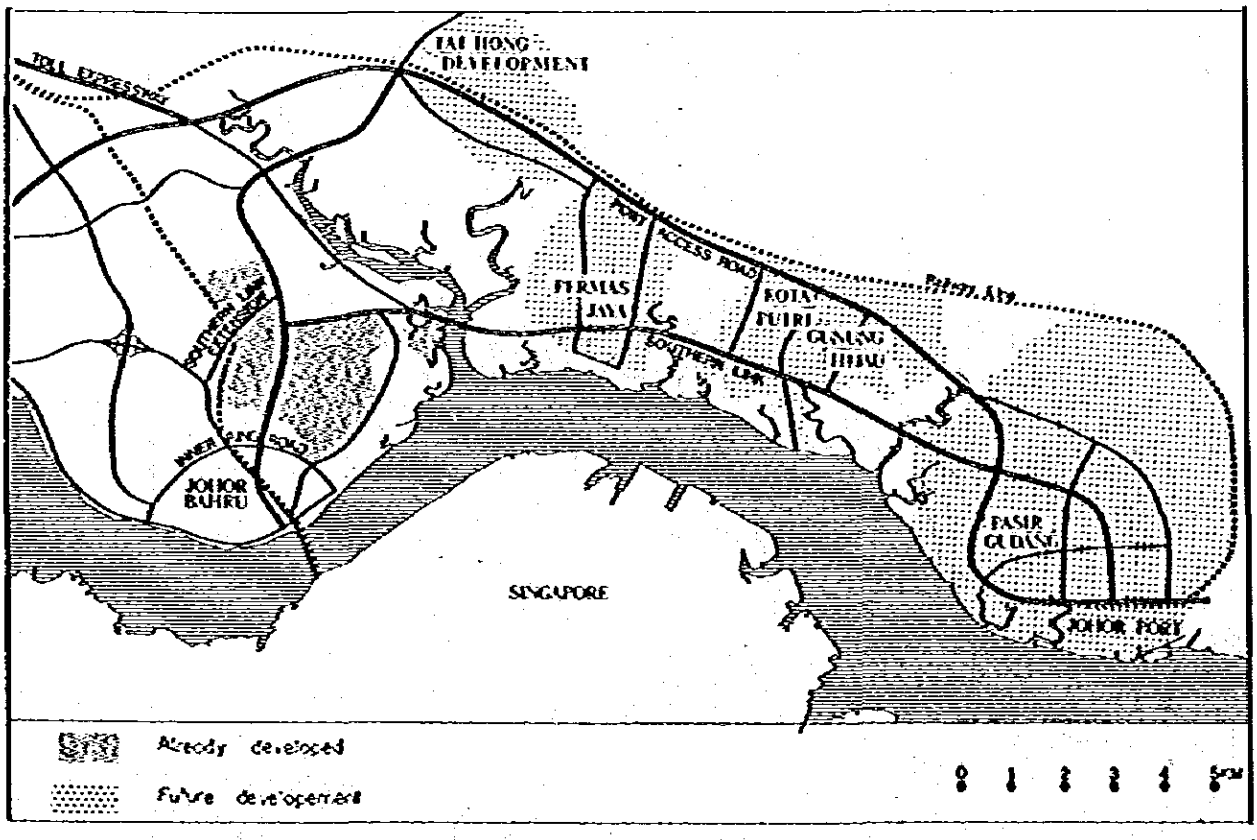


FIG. 3-5 MAJOR DEVELOPMENT IN JOHOR BAHRU-PASIR GUDANG CORRIDOR.

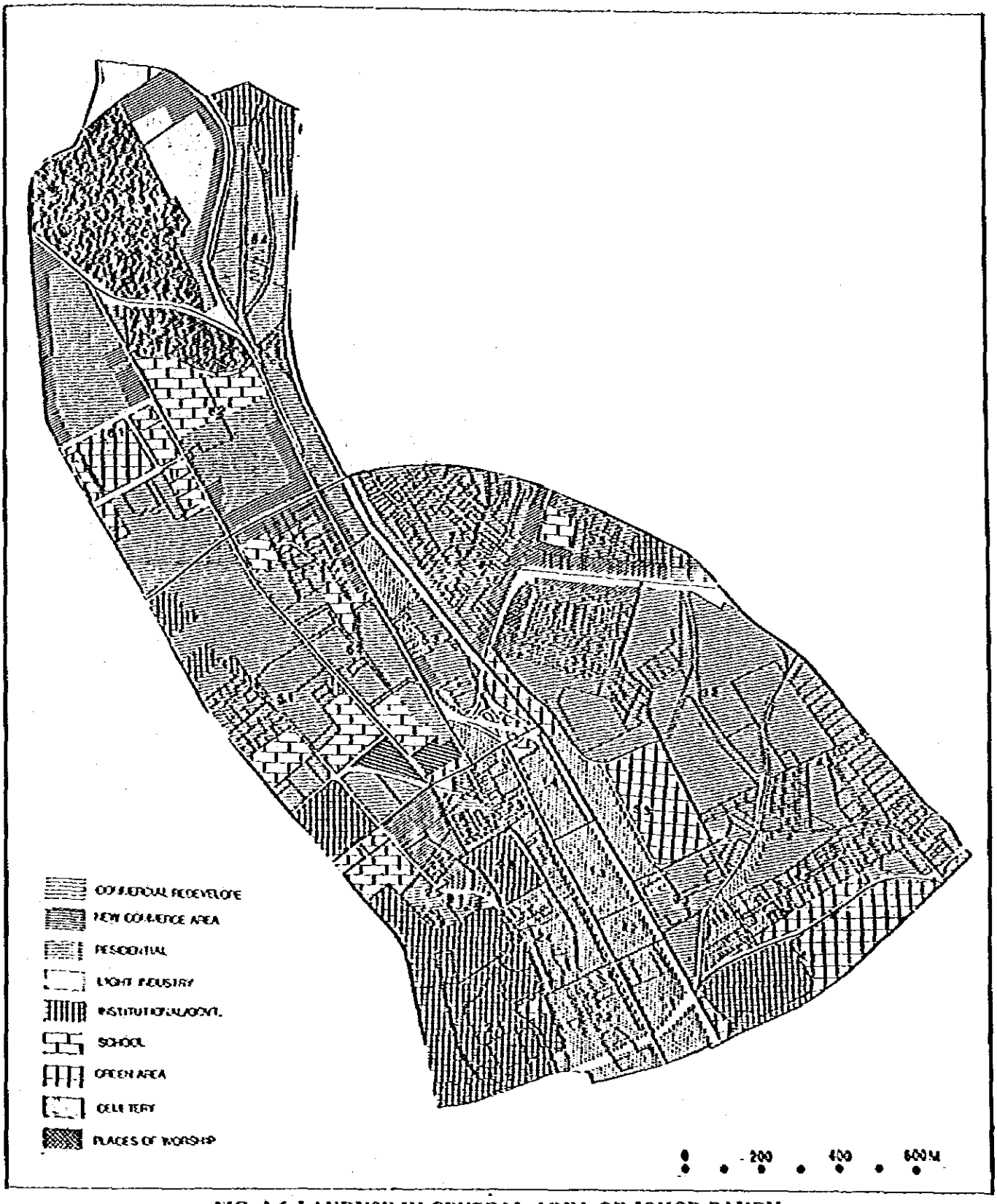


FIG. 3-6 LANDUSE IN CENTRAL AREA OF JOHOR BAHRU

3-3 FUTURE TRAFFIC DEMAND

3-3-1 Procedure

The procedure for the traffic demand projection is illustrated in Fig. 3-7.

As already explained in the previous Section 3-2, there is no major change from the Masterplan Study in the future landuse pattern.

Therefore, the traffic projection is made on the basis of the socio-economic framework stated in 3-1, whose target growth corresponds to the Masterplan.

The methodologies and the estimation models developed in the Masterplan Study are also employed in this Study.

As for the zoning system, however, the zones in the area directly affected by the project roads are sub-divided so as to estimate the traffic demand more accurately as stated in Chapter 1.

In accordance with the revised zoning system, zonal indicators, trip generation/attraction and trip distribution are re-estimated.

3-3-2 Trip Production

The total trip production in the Study Area is projected by type of vehicles on the basis of the results of traffic surveys and vehicle ownership projection.

The total trip production in terms of passenger car unit (p.c.u.) is projected to grow from 430,900 in 1981 to 741,800 in 1990 and 1,340,800 in 2000.

3-3-3 Trip Generation and Attraction

The future trip generation and attraction at new traffic zones are estimated by using the trip generation and attraction model which was developed in the Masterplan Study.

Fig. 3-8 shows the average daily trip generation by zone. A high rise in trip generation can be found in Pasir Gudang and the peripheral area of MPJB while the growth in the CBD and the surrounding rural area of Johor Bahru–Pasir Gudang Corridor remains at a relatively low level, reflecting their respective population growths.

TABLE 3-5 TRIP PRODUCTION IN STUDY AREA

	No. of Trips (1000 pcu/day)				Average Annual Growth Rate (%)
	1981	1985	1990	2000	
Car					
Work, School	63.4	77.1	98.4	160.2	5.0
Business	24.1	31.8	45.3	89.6	7.2
Private	43.0	56.7	79.6	157.1	7.1
Home	81.7	107.8	152.1	300.4	7.1
Sub-Total	212.2	273.4	375.4	707.3	6.5
Stage Bus	9.3	16.6	26.9	48.0	9.0
School/Factory Bus	16.2	18.8	22.8	28.8	3.1
Lorry	87.8	114.9	160.8	315.1	6.9
Motorcycle	105.4	125.2	155.9	241.6	4.5
Total	430.9	548.9	741.8	1,340.8	6.2

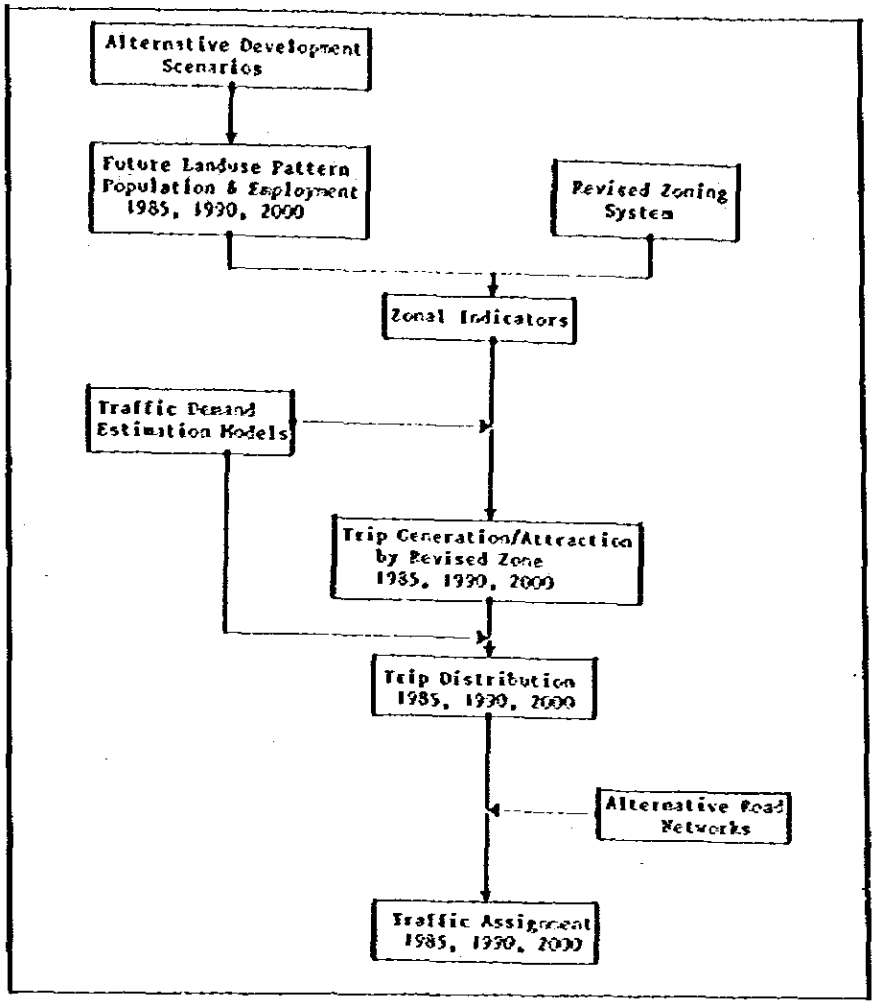


FIG. 3-7 PROCEDURE FOR TRAFFIC DEMAND PROJECT

3-3-4 *Trip Distribution*

The future trip distribution is obtained by using the future trip generation and attraction estimated above.

Table 3-6 shows the estimated traffic demand by corridor originating from MPJB in 1981 and 2000.

The result indicates that the demand in the MPJB–Pasir Gudang Corridor increases remarkably due to the industrial and housing development projects in the Pasir Gudang area.

TABLE 3-6 TRAFFIC DEMAND BY CORRIDOR

Corridor	Traffic Demand (1000 pcu/day)		Traffic Growth '00/'81
	1981	2000	
Internal Traffic within MPJB	282.8	759.5	2.7
MPJB – Senai	25.8	136.8	5.3
MPJB – Pasir Gudang	21.8	161.5	7.4
MPJB – Kota Tinggi	22.5	46.8	2.1
MPJB – Singapore	26.9	86.6	3.2

3-3-5 Traffic Demand on the Project Road

The figures from Fig. 3-9 to Fig. 3-12 show the estimation results of traffic demand on the Project Roads for the years 1990 and 2000.

It is found that all the Project Roads have sufficient capacity to meet the traffic demand in 1990.

However for the year 2000, the demand is expected to slightly exceed the capacity at several sections of the Project Roads such as the bridge section of the Johor Bahru–Pasir Gudang Southern Link on Sg. Tebrau, several critical sections of the Inner Ring Road and Lorry Route.

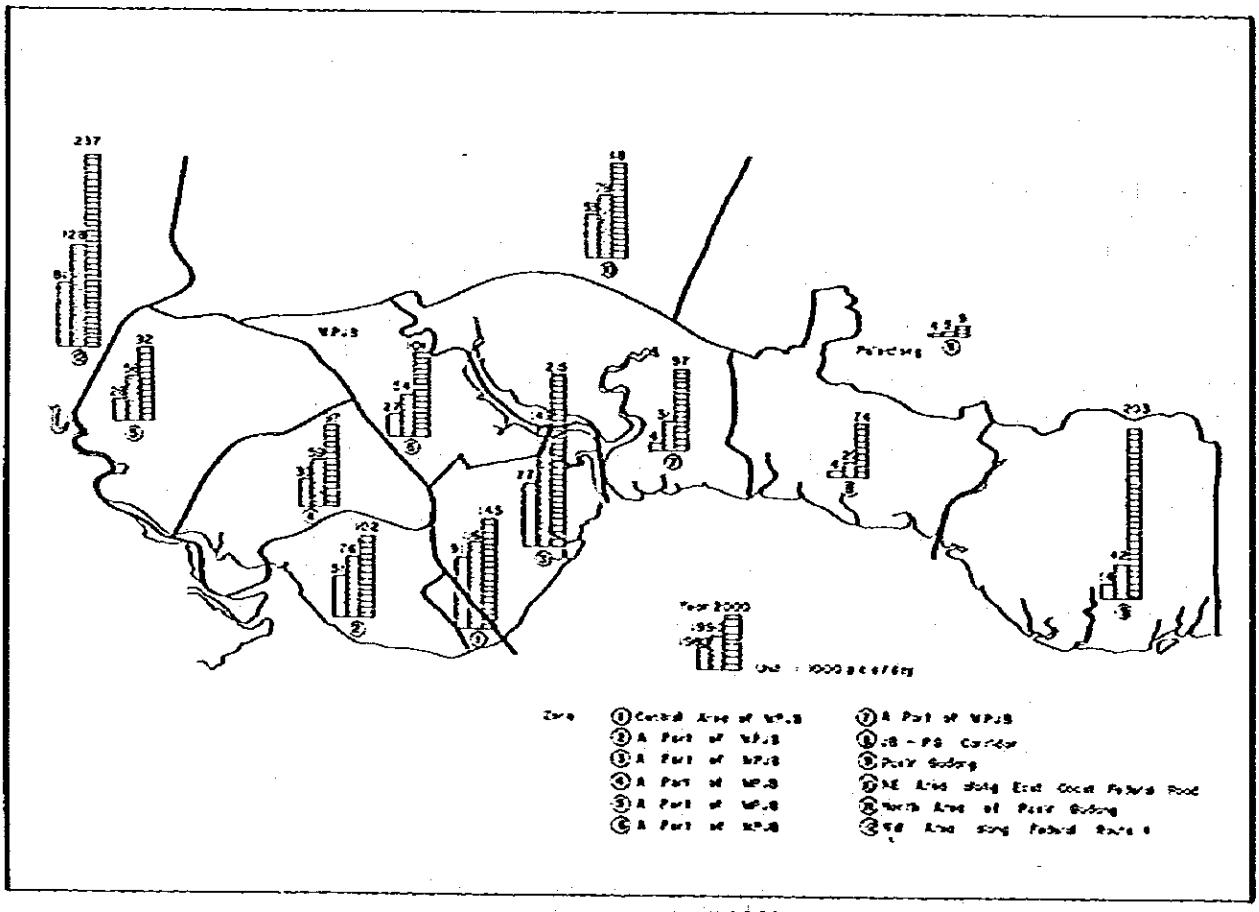


FIG. 3-8 TRIP GENERATION

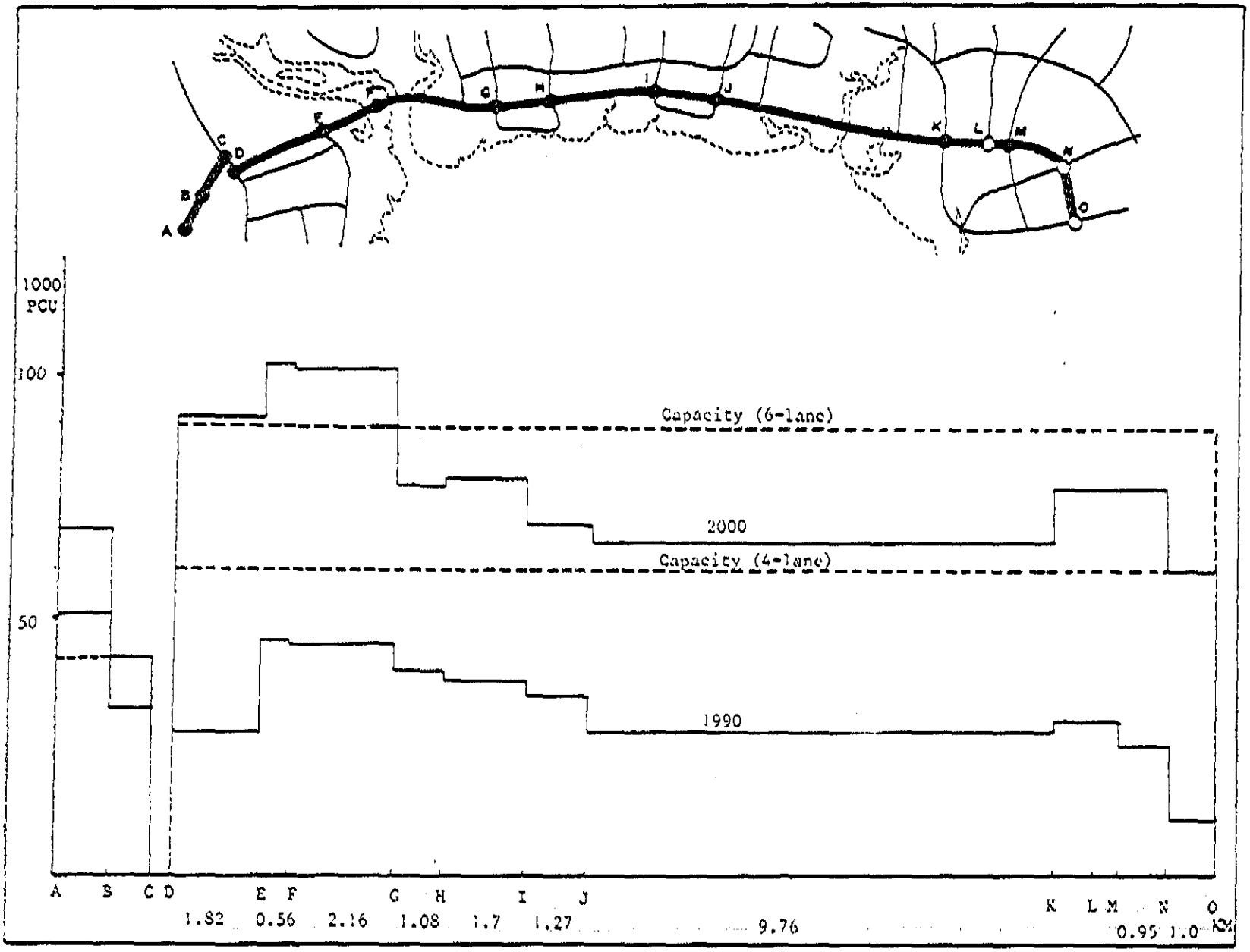


FIG. 3-9 COMPARISON BETWEEN PROJECTED TRAFFIC VOLUME BY SEGMENT AND ROADWAY CAPACITY — JOHOR BAHRU-PASIR GUDANG

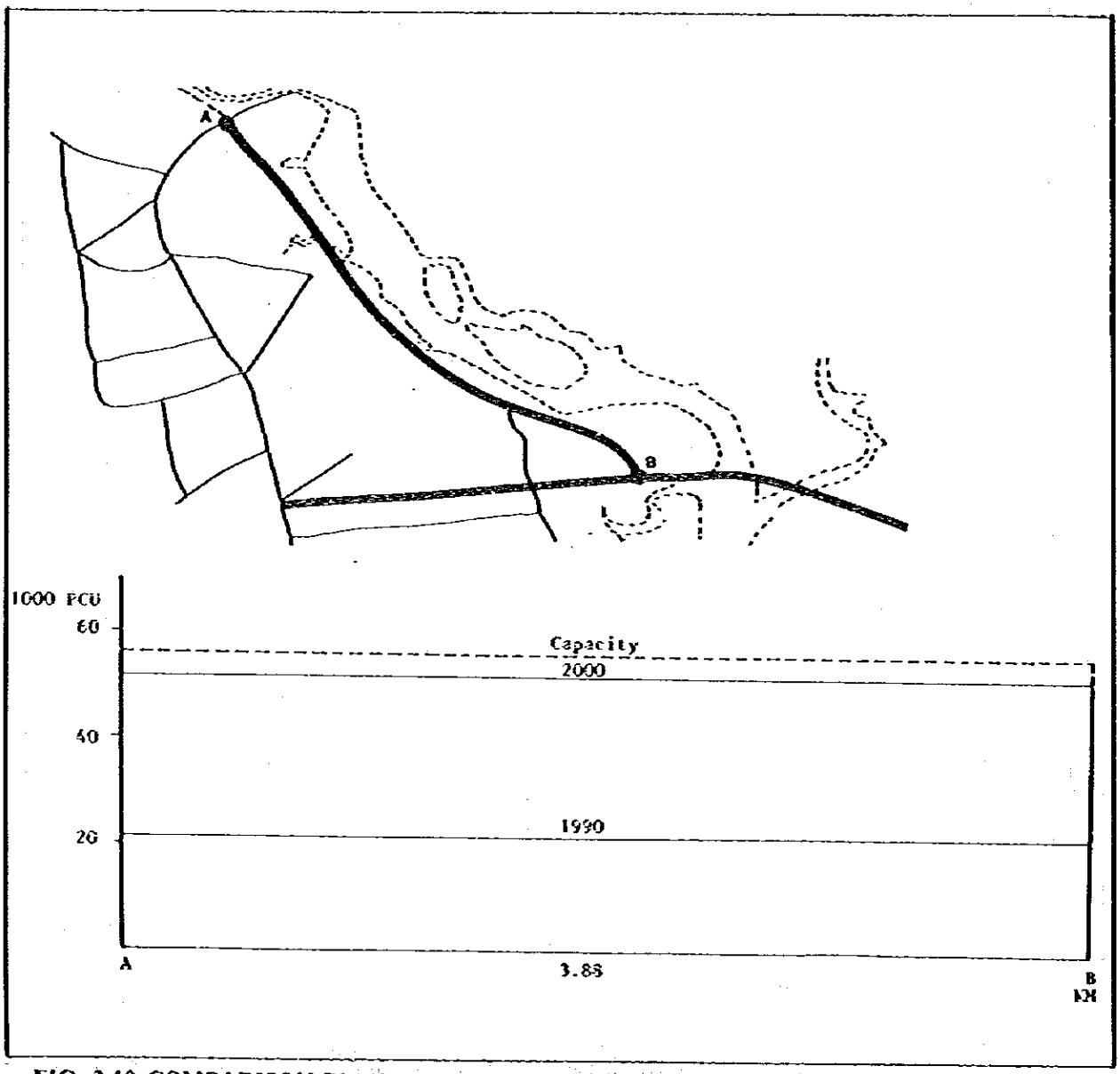


FIG. 3-10 COMPARISON BETWEEN PROJECTED TRAFFIC VOLUME BY SEGMENT AND ROADWAY CAPACITY — TOLL EXPRESSWAY ACCESS..

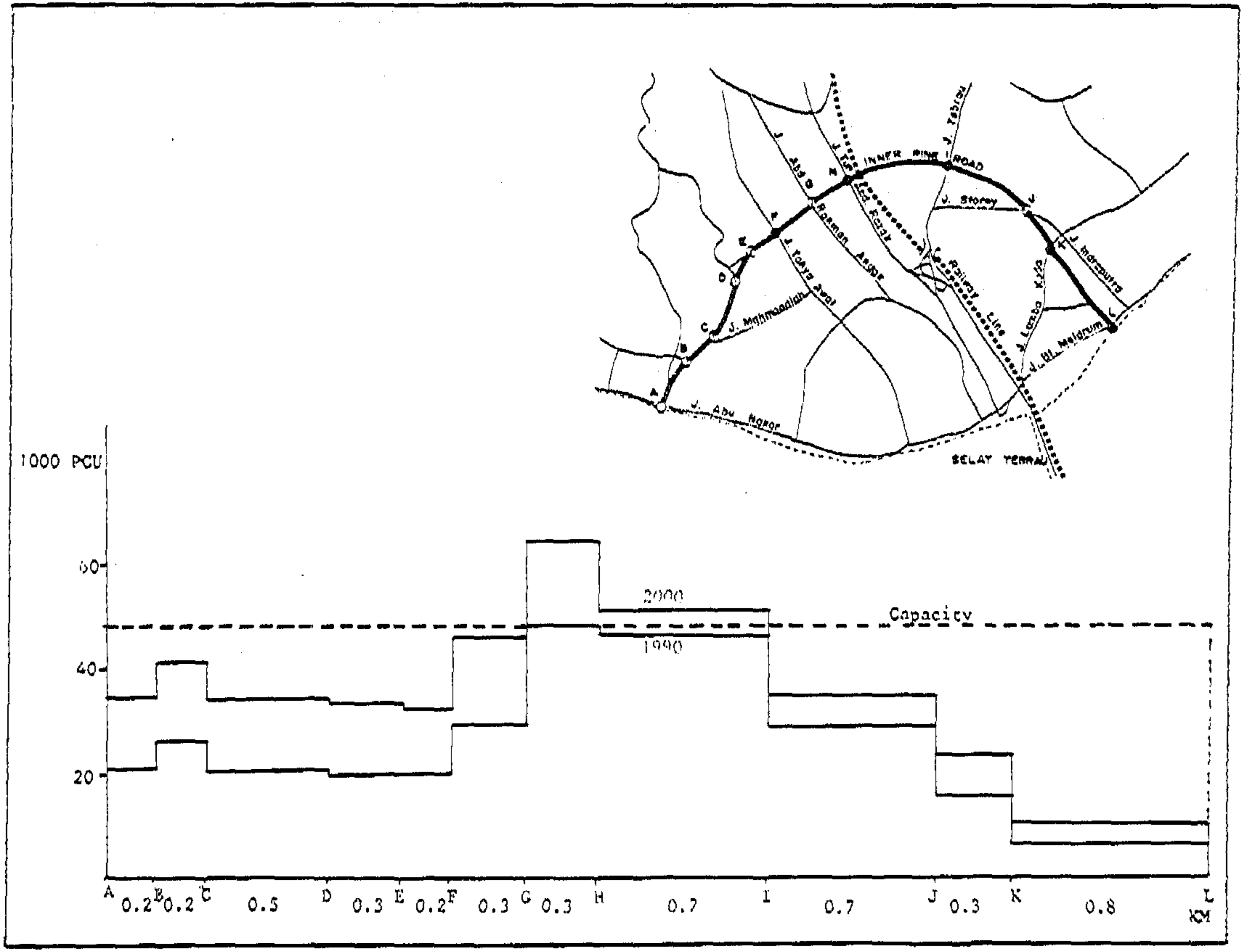


FIG. 3-11 COMPARISON BETWEEN PROJECTED TRAFFIC VOLUME BY SEGMENT AND ROADWAY CAPACITY — INNER RING ROAD

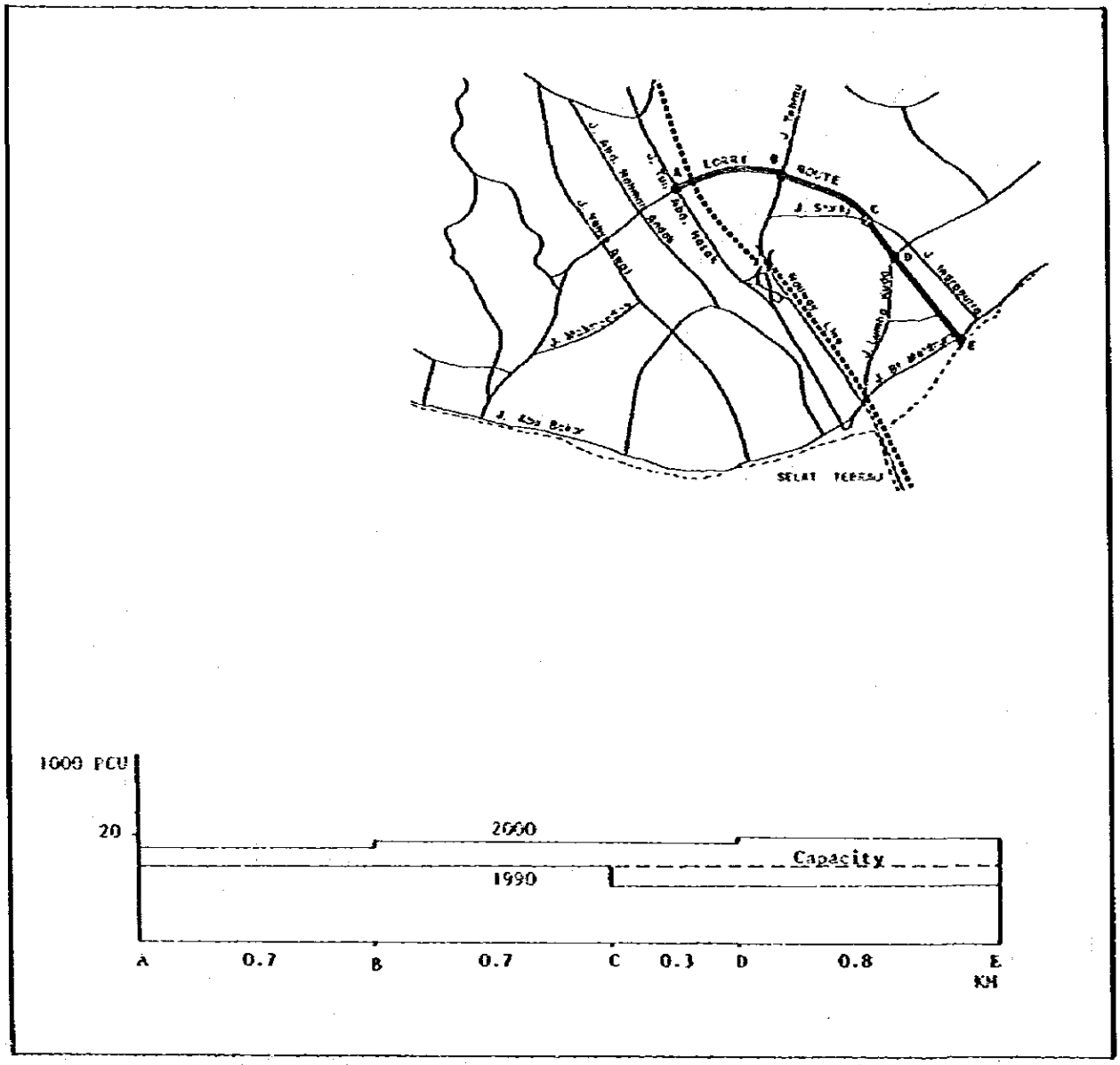


FIG. 3-12 COMPARISON BETWEEN PROJECTED TRAFFIC VOLUME BY SEGMENT AND ROADWAY CAPACITY — LORRY ROUTE

3-3-6 Traffic Characteristics of the Project Roads

The results of traffic assignment indicate the following traffic characteristics of the Project Roads as shown in Table 3-7.

1) The traffic on the Toll Expressway and Lorry Route are mainly of long distance trips, whereas short distance trips are dominant on the Inner Ring Road and Jalan Kebun Teh.

2) The main origins and destinations of the traffic on Johor Bahru – Pasir Gudang Southern Link are either Johor Bahru or Pasir Gudang whereas the composition rate of trips related to areas outside the Johor Bahru – Pasir Gudang Corridor is extremely low.

3) As for the Inner Ring Road, the main traffic are those running between the South – East part and the South – West part of Johor Bahru Town, whereas the traffic related to the CBD area of Johor Bahru is relatively minor.

4) The composition rate of lorries on the Johor Bahru – Pasir Gudang Southern Link is relatively low, since the lorries heading for Singapore are regulated to use the Port Access.

5) The composition rate of lorries on the Inner Ring Road is even lower since traffic demand for lorries is not high on the West Ring, whereas the demand on the East Ring is met by the Lorry Route.

TABLE 3-7 TRAFFIC CHARACTERISTICS OF THE PROJECTED ROADS

Project Road	Year	Traffic Volume (p.c.u/day)					Average Trip Length (km)
		Car	Motorcicle	Lorry	Bus	Total	
Johor Bahru – Pasir Gudang Southern Link (Sg. Tebrau)	1990	26,900	6,600	13,300	3,100	49,900	24.4
	2000	67,500	10,900	30,600	6,600	115,600	22.8
Toll Expressway Access	1990	12,700	1,800	7,300	100	21,900	39.8
	2000	30,500	4,300	17,300	300	52,400	37.9
West Half of Inner Ring Road (Jalan Sg. Chat – Jalan Yahya Awal)	1990	14,400	2,100	2,000	800	19,300	7.7
	2000	25,100	3,700	1,800	2,000	32,600	10.5
East Half of Inner Ring Road (Federal Route 1 – Jalan Tebrau)	1990	29,400	13,000	0	3,800	46,200	8.9
	2000	33,900	11,600	0	5,200	50,700	11.0
Lorry Route (Jalan Tebrau – Jalan Lumba Kuda)	1990	0	0	14,500	0	14,500	35.7
	2000	0	0	17,000	0	17,000	48.2

CHAPTER 4

ALTERNATIVE STUDY AND PRELIMINARY ENGINEERING

4-1 PREMISES

This section deals with the premises of the Feasibility Study of the Project. In the Master-plan Study, three (3) Phases of the urban transport system, each commencing from the years 1985, 1990 and 2000, are proposed. The Feasibility Study, therefore, follows the proposals made.

In the proposals, there are two (2) options, namely Option 1 which does not include the East Coast Road in MPJB and the Middle Link in Johor Bahru–Pasir Gudang Corridor and Option 2 which includes both of the Projects. This Study is based on the recommended Option 1.

In addition, the following assumptions are set up based on the decision of the Steering Committee.

1. Widening of Jalan Tebrau

The widening of Jalan Tebrau into six (6) lanes is expected to be implemented within a few years.

2. Causeway Renovation Plan

The Causeway Renovation Plan, which aims at reducing traffic congestion at the Entry and Exit Points, was formulated by the JEEP Committee and will be completed in 1983.

3. Preliminary Causeway Layout Plan

The Preliminary Causeway Layout Plan, which was compiled following the comments on the Preliminary Causeway Study of the Progress Report (1), was submitted in February, 1983.

The proposed Causeway Layout Plan, which is based on the estimated traffic demand in 2000 with the understanding that the Causeway Renovation Plan was formulated to meet the traffic demand until around 1987, comprises four (4) concept plan alternatives.

a) Concept A: Horizontal Expansion Concept
To expand the existing Causeway and Immigration and Custom Complex horizontally by the reclamation of land.

b) Concept B: Second-Deck Concept
To construct a second deck on the existing Causeway and Immigration and Custom Complex.

c) Concept C: Site Relocation Concept
To transfer both the entry and exit points to the seashore of the SEDC land.

d) Concept D: Second Linkage Concept
To construct a second linkage at some other location.

The Study Team recommends Concept C as the best and most acceptable among the alternatives because it will disperse the Causeway traffic away from the CBD, is flexible in phasing and expansion and provides enough waiting space for traffic queues. However, Concept A is employed in the Feasibility Study because of its cheaper implementation cost, effective utilization of the existing and planned Immigration and Custom facilities and relatively easier construction.

4. Toll Expressway

The Toll Expressway which connects Johor Bahru–Air Hitam is expected to be completed in the year 1986. It will be a four (4)-lane road with provisions made for six (6)-lane.

5. Port Access

The Port Access is expected to be completed in the year 1984. This Access is a four (4)-lane road with the possibility of being widened into a six (6)-lane one.

4-2 ENGINEERING SURVEYS CONDUCTED

4-2-1 Geotechnical Investigation

(1) Investigation Conducted

The geotechnical investigation consisted of:

a. Exploratory Drilling with Standard Penetration Test and Undisturbed Sampling (see Fig. 4-1).

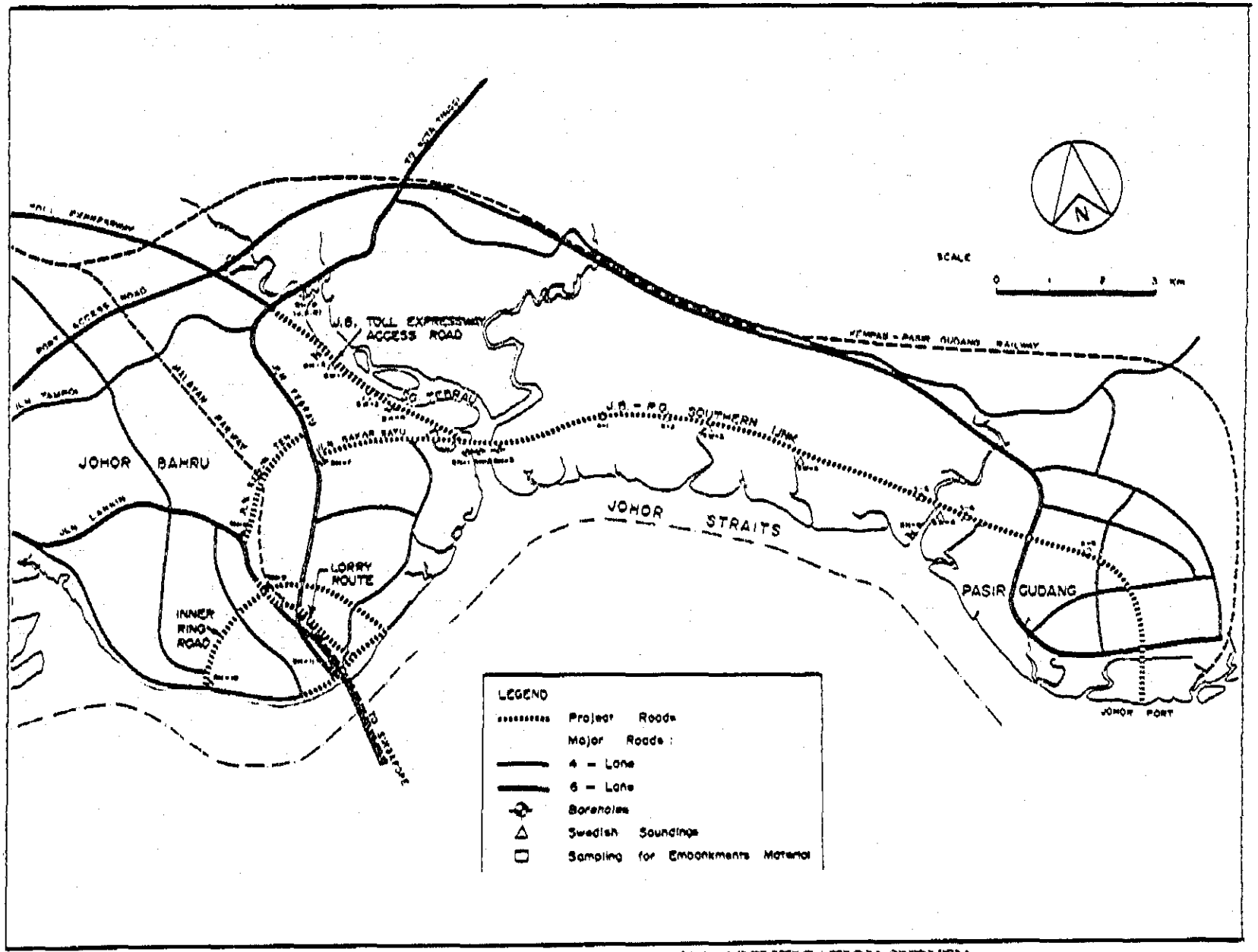


FIG. 4-1 LOCATION OF SOIL INVESTIGATION SURVEY

b. Laboratory Tests on Soil and Material Samples obtained from the Site.

c. Study for Coarse and Fine Aggregate and Embankment Material

The brief descriptions of the geotechnical investigation are presented below.

(2) Ground Conditions along the Project Routes

The soil profile at the crossing of Sungai Tebrau, along the Toll Expressway Access Road, and in the hilly and lowland areas in Johor Bahru are shown in Fig. 4-2, 4-3, 4-4 and 4-5.

1. *Johor Bahru–Pasir Gudang Southern Link road*

The proposed alignment will be constructed to join the eastern part of Johor Bahru and Pasir Gudang and will be parallel to the coastline of Johor Strait. The road will cross several rivers along its route.

To determine the ground conditions for the construction of a bridge and approach embankments at the crossing of Sungei Tebrau, three (3) boreholes were sunk. The soil profile prepared is shown in Fig. 4-2. Swedish sounding performed at three (3) other river bank locations along the route indicates that soft clayey soils are 3 m to 6 m thick. The subsoils at the crossing of Sungei Tebrau can be chiefly classified into the following eight (8) layers, namely, fill, soft organic clay, soft clayey layer, loose sandy layer I, loose sandy layer II, medium dense sandy layer, weathered rock and hard rock.

2. *Johor Bahru Toll Expressway Access Road*

The proposed road runs along the west bank of Sg. Tebrau. Fig. 4-3 shows the soil profile along this road obtained from four (4) boreholes including the one (1) sunk previously by JKR. As evident, the ground conditions vary considerably from one (1) location to another. The soil layers encountered are fill, loose sandy layer I, soft organic clay, loose sandy layer II, soft clayey layer, medium dense sandy layer, stiff to hard clayey layer, weathered rock and hard rock.

3. *Inner Ring Road and Alternative Road*

The Inner Ring Road runs through the southern tip of Johor Bahru and encircles the entire Causeway area.

A total of five (5) boreholes were sunk to determine ground conditions in this area. Due to variations in ground elevation in this area, the project road can be divided into two (2) areas according to topography ie:

(a) hilly area (central portion of project road) and
(b) lowland area (near the coastline).

Hilly Area

In this area, the subsurface ground consists of the old alluvial deposits mainly medium to stiff clay at depths of 10 m to 20 m. The hard layer was encountered at depths of 20 m to 30 m. (see Fig. 4-4).

Lowland Area (near the Coastline)

Two (2) boreholes, B10 and B11, were sunk. B10, located at the west side of the Causeway and B11 at the junction of Jalan Tun Dr. Ismail and Abdul Samad, have a distance of more than 2 km between them. However the ground conditions in between are difficult to estimate. Fig. 4-5 shows the ground condition of the Lowland area. Generally it consists of fill, organic clay layer, loose sandy soil layer I, soft to medium clay layer, very soft silty clay, loose to medium sandy soil layer and old alluvium.

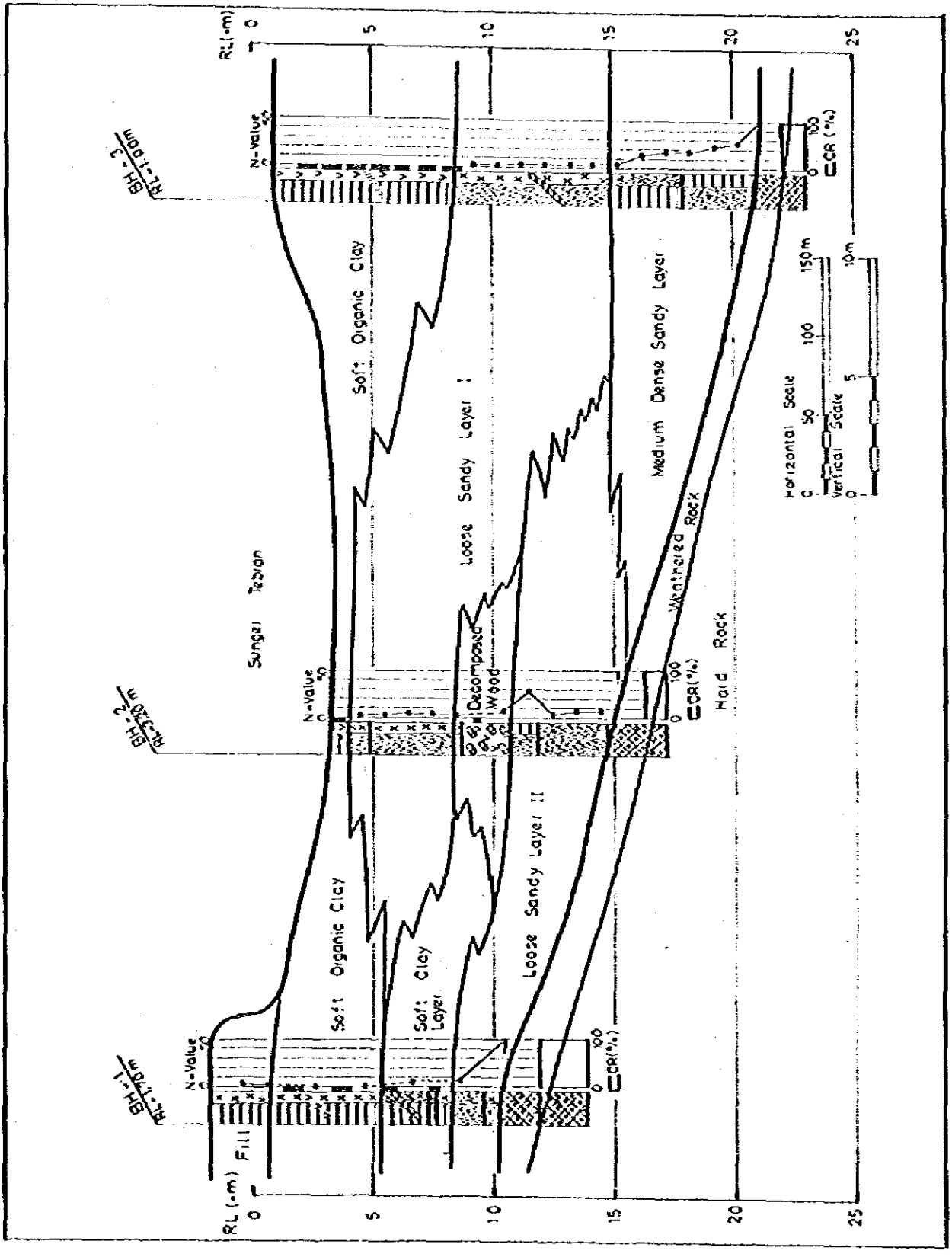


FIG. 4-2 SOIL PROFILE AT THE CROSSING OF SG. TEBRAU, JOHOR BAHRU-PASIR GUDANG SOUTHERN LINK ROAD

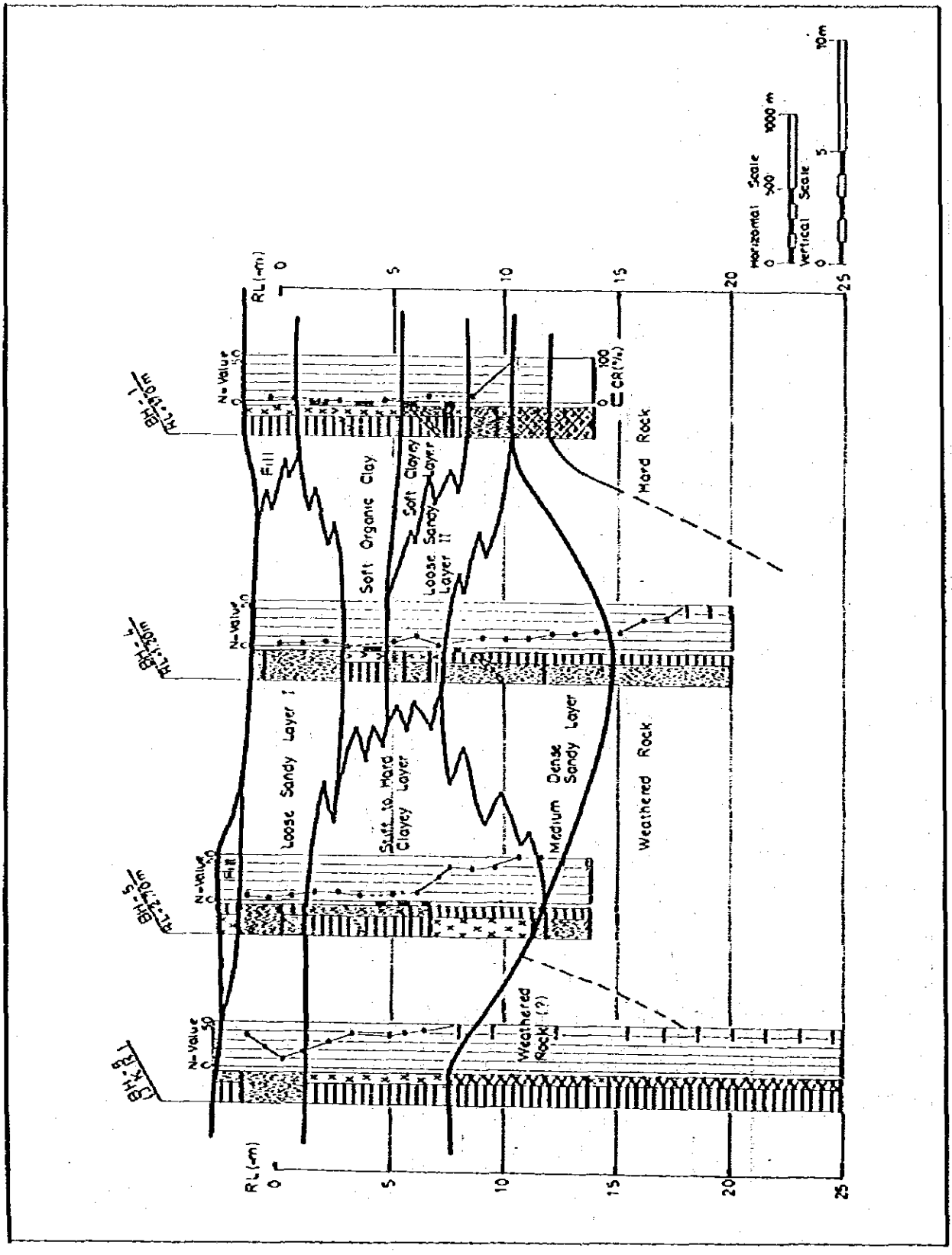


FIG. 4.3 SOIL AND JOHOR BAHRU TOLL EXPRESSWAY ACCESS ROAD

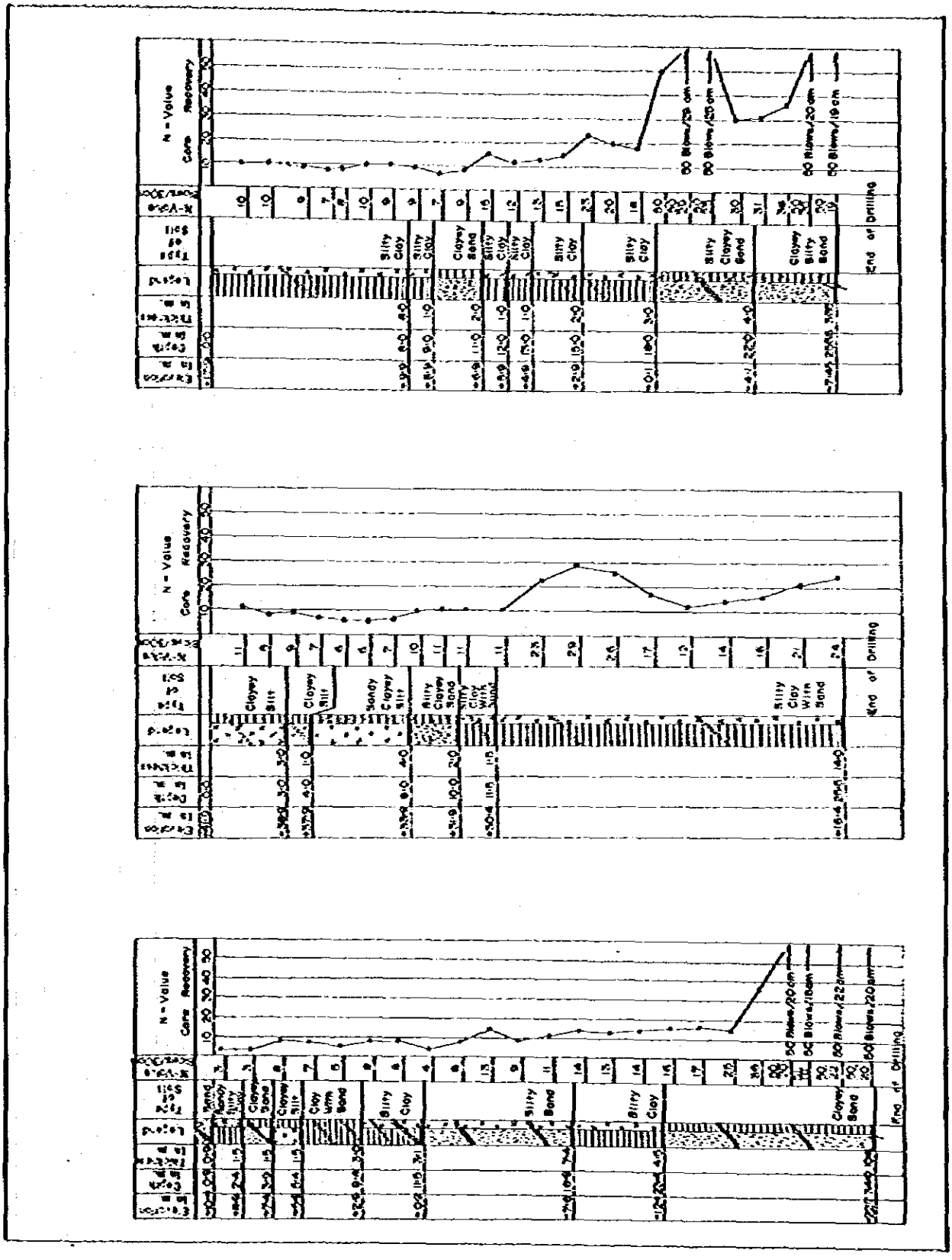


FIG. 4-4 GROUND CONDITION OF HILLY AREA (CENTRAL PORTION OF PROJECT ROAD)

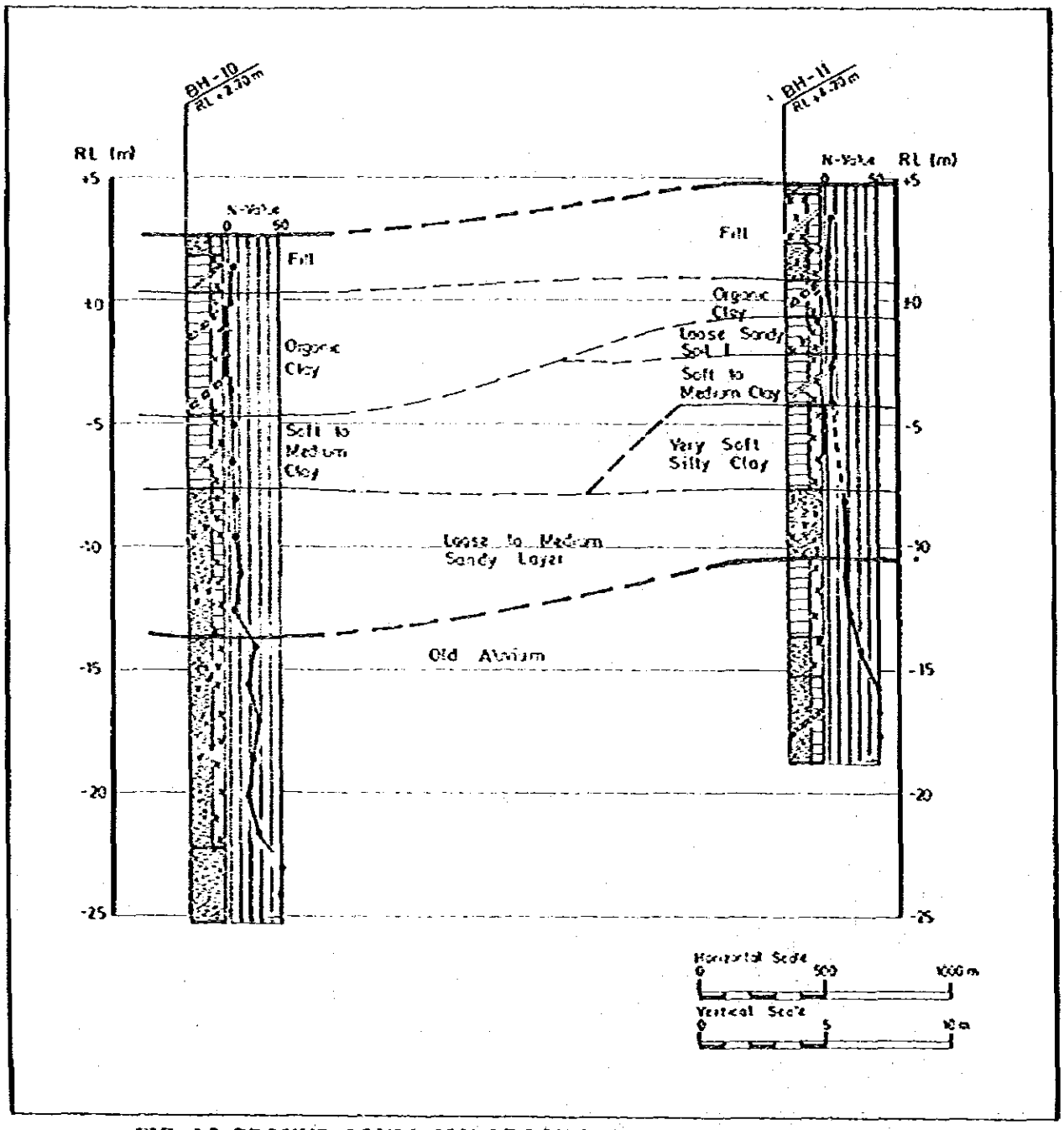


FIG. 4-5 GROUND CONDITION OF LOWLAND AREA (NEAR THE COASTLINE)

4-2-2 Investigation for Construction Materials

The construction of road requires concrete materials and earth which are described briefly below:

a. Fine Aggregates

Many sand quarries are located near Kota Tinggi town more or less northeast of Johor Bahru (see Fig. 4-6).

Silica sand produced by the quarries is used for glass production. Usually the sand used for the construction is a by-product of tin-mining.

Each sand pit can produce, on the average, about thirty (30) sixty (60) lorries of sand per day.

b. Coarse Aggregates

Granite quarries are available in Masai and Ulu Choh (see Fig. 4-6).

The output of JKR Lunchu Quarry (Masai) is about 1,000 tons per day. The other private companies in Masai together yield about 3,500 to 5,000 tons per day. The output by the two (2) private companies in Ulu Choh (Pontian) amounts to about 900 to 1,400 tons per day.

c. Embankment Materials

Earth materials are available in abundance from the hilly area. The residual soils along the Projects which were tested for their suitability as embankment materials revealed that the soils vary from clayey sand to sandy clay types and consists of 30% to 70% of sand and gravel.

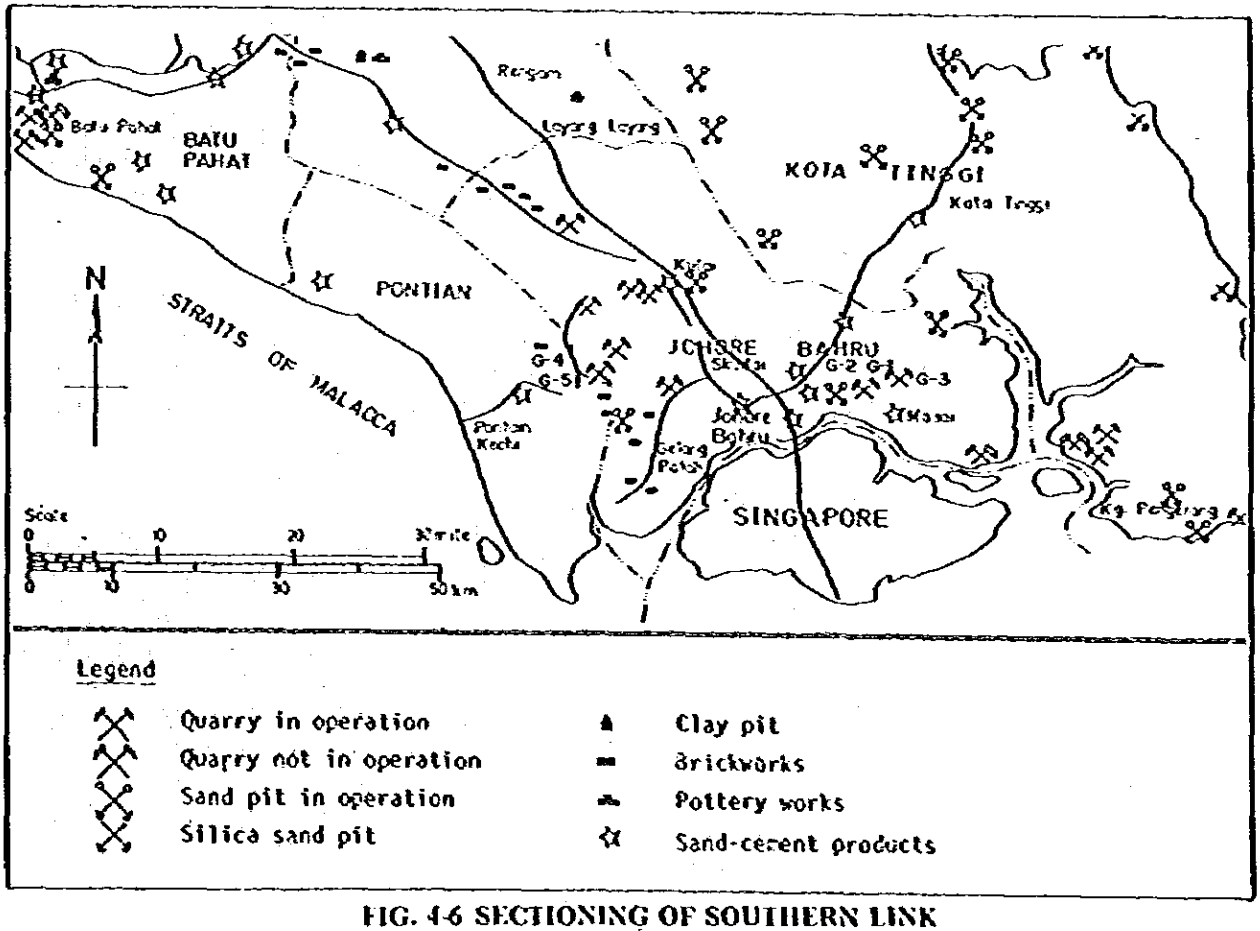


FIG. 4-6 SECTIONING OF SOUTHERN LINK

4-2-3 Topographic Survey

The following topographic surveys were conducted in this Study in order to supplement the topographic map.

1) Water Depth Sounding Survey

The water depth sounding survey for Tebrau River was conducted for an area of 20 hectares and that for the minor bridge area was about 5 hectares.

2) Centerline and Cross-Section Surveys

These surveys were conducted along the Project Roads. The length surveyed was about 33 kilometers.

3) Profile Levelling

This survey was also conducted along the Project Roads. The total length surveyed was about 33 kilometers.

4) Plane Table Survey

The plane table survey, covering an area of 95 hectares was conducted at major intersection sites as well as at bridge sites.

4-3 CONCEPT AND CHARACTERISTICS OF THE PROJECT

4-3-1 Johor Bahru–Pasir Gudang Southern Link

The Southern Link was proposed as an Intra-Urban Primary Distribution in the Masterplan Study. This road is expected to play a role in promoting in particular the planned housing schemes and development project along this corridor. It will also provide an important link between the road network in the Johor Bahru–Pasir Gudang Corridor and the Port Access. (The Port Access is expected to be completed by 1984). Taking the function of roads between the Port Access and this Project Road into consideration, this road is expected mainly to serve the private vehicles rather than heavy ones.

In order for the Southern Link to function effectively in serving the traffic and at the same time be able to maintain a good environment with the surrounding area, the characteristics of the Projected Road are proposed to be:

a. Partial controlled access,
b. Limited number of at-grade intersections and/or grade-separated intersections,
c. Service roads which are to be basically provided,
d. U-turns which are only allowed at limited medium openings; and
e. Beautifully landscaped.

However, the extension of the Southern Link to Jalan Larkin can be defined as a District Distributor considering the landuse along the corridor and the road network configuration.

The characteristics proposed for the extension are:

a. Uncontrolled access, but restricted traffic crossing at minor intersections; and provision be made to enable access to and from the Inner Ring Road; and
b. U-turns which are allowed only at limited median openings.

4-3-2 Causeway Traffic Dispersal Scheme

The concept adopted for the Causeway Traffic Dispersal Scheme involves the following:

a. The provision of a better, safer and more scenic transport environment in the Central Area of Johor Bahru.
b. Improvement of the existing road and traffic conditions and operational system so as to make possible the most effective road usage for the Causeway traffic as well as the Central Area's traffic.
c. Construction of roads and intersections/interchanges in providing a most effective road network.

Bearing in mind these concepts, the adoption and enforcement of traffic engineering and management measures as well as infrastructures provision measures are necessary.

4-3-3 Toll Expressway Access

In the Masterplan Study, the Toll Expressway Access was originally proposed as an Intra-Urban Primary Distributor linking the Toll Expressway with the Causeway. However, this road was shortened to link the Toll Expressway with the proposed Southern Link due to some institutional problems.

This road is mainly expected to serve traffic coming in and out of the planned Toll Expressway, eastern part of Johor Bahru Town and the Johor Bahru–Pasir Gudang Southern Link Corridor; and to form an effective network link with the Southern Link.

In order for the Toll Expressway Access to be able to function more efficiently in serving the traffic and to maintain the surrounding environment the characteristics of this road are proposed to be:

a. Partial controlled access,
b. Limited number of at-grade intersections and/or grade-separated interchanges,
c. U-turns which are allowed only at limited median openings; and
d. Beautifully landscaped.

4-3-4 Inner Ring Road Including Lorry Route

(1) Inner Ring Road

Presently, the road network in Johor Bahru is characterized by radiating routes which originate from the Central Business District (CBD) with the existence of only one (1) minor ring road, Jalan Gertak Merah and Jalan Trus.

The traffic flow pattern on the road network, formed from traffic surveys conducted by the Study Team in the period 1981–1982, shows that heavy traffic flow is found on the major radial roads such as Jalan Larkin and Jalan Tebrau. It can safely be deduced that this situation is caused by traffic flow to and from the CBD and the Causeway. Taking into account future CBD development and the increasing Causeway traffic, the need for the construction of the Inner Ring Road is justified as it serves to collect and distribute traffic into the CBD and to the Johor Entry and Exit Point.

The Inner Ring Road is defined as a District Distributor as proposed in the Masterplan Study. The characteristics of this road are:

a. Uncontrolled access, but restricted traffic-crossing at minor intersections and provision made for access to and from the Inner Ring Road,
b. Provision of grade-separated intersections intersected with major radial roads; and
c. U-turns which are to be allowed only at limited median openings.

(2) Lorry Route

Presently, lorries enroute to the Custom Complex at Tanjong Putri from Kota Tinggi and Pasir Gudang, pass through Jalan Kota Tinggi, Jalan Tampoi; and for the remaining of the journey it follows the Kuala Lumpur–Johor Bahru route which is Federal Route 1, Jalan Storey, Jalan Ah Siang and Jalan Bukit Meldrum as shown in Fig. 2-6 on page 00.

The lorry traffic causes serious problems in the town of Johor Bahru. They are as follows:

a. Traffic congestion for road network in CBD.
b. Environmental problems caused by noise, vibration, and exhaust.
c. Social problems such as community disruption.

In order to solve these problems, the construction of a lorry route, therefore, was recommended in the Masterplan Study. Following the recommendation, further investigation regarding the lorry route has been conducted in the Feasibility Study.

4-4 DESIGN STANDARDS

4-4-1 Geometric Design Standard

The Malaysian Design Standards incorporated with AASHTO and Japanese Design Standard is principally adopted in the design of the Project Road. The design elements adopted are as follows:

TABLE 4-1 GEOMETRIC DESIGN STANDARD

Items	Units	Primary Distributor • Johor Bahru – Pasir Gudang Southern Link • Toll Expressway Access	District Distributor • Extension of Southern Link • Inner Ring Road	Lorry Route
Adopted Group	–	06	05	–
Design Speed	km/h	80	60	40
Maximum Gradient	%	4	6	6
Minimum Radius	m	350	120	120
Carriageway width (per lane)	m	3.50 (3.65)	3.25	3.75
Median Width	m	10.00	2.00	–
Shoulder Width Inner Shoulder	m	0.50	0.50	–
Outer Shoulder	m	2.50	2.00	0.75

Note: Figure in bracket means that the carriage width in Pasir Gudang is the same as that adopted by J.K.R. (12 feet/lane (3.65m))

4-4-2 Bridge Design Standard

(1) Standard Specifications

The standard specifications for bridges and other structures, as adopted by the Malaysian Design Standard in corporation with the British Standard and Japanese Design Standard, are used as principal guidelines for structural design.

(2) Loads

a. Live Load

Design HA Loading or Design HA Loading combined with Design HB Loading of forty-five (45) units.

b. Impact on Bridges

No allowance for impact shall be made.

c. Longitudinal Force on Bridges

d. Wind Load

On unloaded structures: 150 kg/m^2
On loaded structures: 45 kg/m^2

e. Temperature Effect

The temperature variation is assumed to be within 50°F to 80°F.

f. Effect of Earthquakes

Not considered.

Girder Span	HA Loading	HB Loading
below 3 meters	10 tons	–
above 3 meters	10 tons plus 1/2 tons for each 0.3 meter of span over 3 meters but not exceeding 25 tons	45 tons for all spans

(3) Navigation Opening

The navigation opening for the passage of ships is an important design criteria for the bridge across the Tebrau River. The following cases of navigation opening used in the Study is decided upon after discussion with Marine Department.

Case A: Minimum Clearance Width
45 meters
Vertical Clearance Height
12 meters above HHW

Case B: Minimum Clearance Width
25 meters
Vertical Clearance Height
6 meters above HHW

4-4-3 Intersection/Interchange Design Standard

(1) Intersection Design Standard

The intersection design standard is basically adopted from "A Policy on Design of Highways and Arterial Streets" by the AASHTO, with references made to "Manual on Design of Intersection At-Grade" by the Japan Society of Traffic Engineering.

(2) Interchange Design Standard

The interchange design standard is principally adopted from "A policy on Geometric Design of Highway and Arterial Streets" by the AASHTO, with references made to "Design Standard of Geometric Design of Highway and Related Facilities" by Japan Highway Public Corporation.

4-4-4 Pavement Design Criteria

The asphalt concrete pavement design standard is principally based on the "Manual for Design and Construction of Asphalt Pavement", by Japan Road Association (1980). In addition, references to the "Asphalt Institute of U.S.A." and "Shell Pavement Design Manual" are made.

4-4-5 Drainage Design Criteria

The Malaysian Drainage Standard, as stated in "Urban Drainage Design Standards and Procedures for Peninsular Malaysia" is basically adopted.

4-5 ALTERNATIVE ROUTES AND PRELIMINARY ENGINEERING ON THE JOHOR BAHRU–PASIR GUDANG SOUTHERN LINK

4-5-1 General

Prior to proceeding with the Study on alternative alignments and preliminary design, sectioning of this Project will be described below.

The Johor Bahru–Pasir Gudang Southern Link can be divided into two (2), one is the Southern Link between Jalan Tebrau and Pasir Gudang Port and the other is the Southern Link Extension (Jalan Kebun Teh) between Jalan Larkin and Jalan Tebrau. The former, is further divided into four (4) sections and eleven (11) segments (see Fig. 4-7).

Based on the sectioning of the Project Road, their respective alternative alignments and the preliminary design will be discussed below.

4-5-2 Alternative Route Alignment Study

(1) Conceptual Routes of the Southern Link

The alternative alignments of the Southern Link proposed in the Interim Zoning Plan were reviewed in the first stage of the Study, Fig. 4-8 displays the comparison of alternative conceptual alignments.

Judging from the comparative analysis made, it is concluded that Scheme 'B' of the Southern Link is the most viable considering the technical, landuse, environmental and economic factors among the three (3) alternatives, and is also found to be applicable for the site where major committed projects pose as constraints to the road alignments.

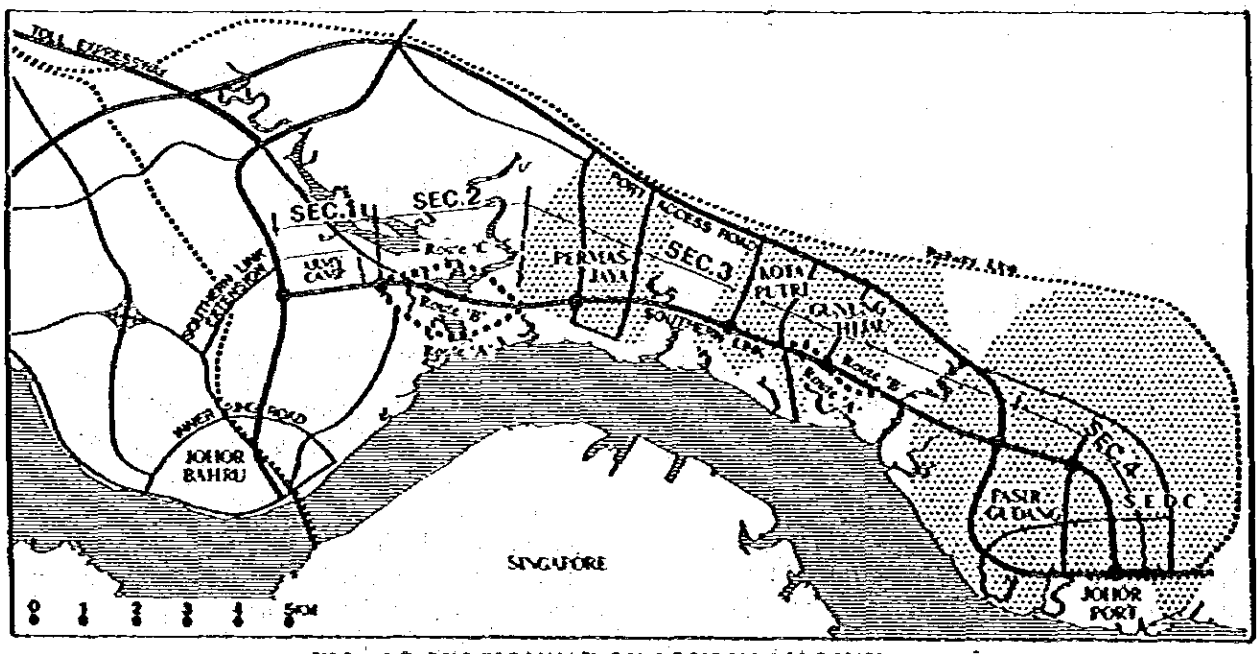


FIG. 4-7 SECTIONING OF SOUTHERN LINK

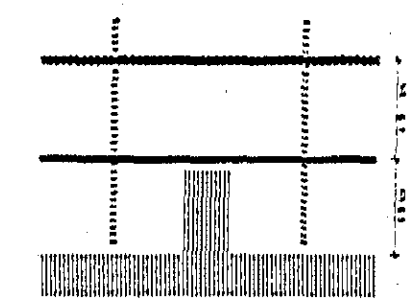
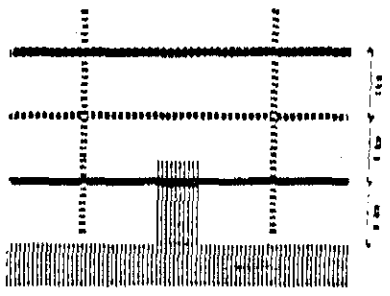
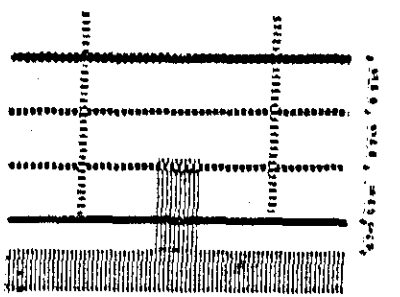
	SCHEME A	SCHEME B	SCHEME C
NETWORK CONCEPT			
SERVICE AREA OF THE SOUTHERN LINK / THE PORT ACCESS	d ≒ 1.5km d ≒ 0.75km	d ≒ 1km (OPTIMUM)	d ≒ 0.5km
SIZE OF NEIGHBOURHOOD UNIT	1.5km X 1km (150ha) (TOO LARGE)	1km X 1km (100ha) (OPTIMUM)	0.8km X 0.8km (81ha) (ACCEPTABLE)
TRIP CHARACTORISTICS ON THE SOUTHERN LINK	MIXED USE OF SHORT AND LONG TRIP TRAFFIC	SEGREGATION OF SHORT AND LONG TRIP TRAFFIC (OPTIMUM)	SPECIFIED IN HEAVY LONG TRIP / THOUGH TRAFFIC
ENVIRONMENTAL MITIGATION ZONE	3 SIDES OF THE ROADS	3 SIDES OF THE ROADS	2 SIDES OF THE ROADS
ENGINEERING REQUIREMENTS FOR THE CORRIDOR AREA	· CONSIDERABLE AMOUNT OF CUT AND FILL OF THE EARTH	· FITS TOPOGRAPHICAL FEATURE AND MINIMUN EARTH WORK	· MUCH RECLAMATION OF SWAMP AREA AND BRIDGE CONSTRUCTION
LENGTH OF SECTION	9.1km	8.8km	8.8km
CUTTING AND EMBANKMENT	6.7km	6.8km	4.7km
SWAMP AREA	1.9km	1.7km	3.5km
BRIDGES	0.5km , 5 BRIDGES	0.5km , 4 BRIDGES	0.6km , 6 BRIDGES
CONSTRUCTON COST (MILL.M$)			
	SOUTHERN LINK	TOTAL / SOUTHERN LINK / ONE DISTRIBUTOR	TOTAL / SOUTHERN LINK / TWO DISTRIBUTORS
ROADWAY	33.00	40.29 / 22.34 / 17.95	48.71 / 25.52 / 24.19
BRIDGE	46.00	41.25 / 20.25 / 21.00	55.95 / 36.45 / 19.50
INTERCHANGE	9.60	12.80 / 6.40 / 6.40	12.80 / 6.40 / 6.40
R.O.W	6.89	11.26 / 7.01 / 3.45	4.22 / 1.97 / 2.25
TOTAL	95.09	105.60 / 56.80 / 48.80	120.68 / 72.34 / 48.34

FIG. 4-8 CONCLUSION OF THE COMPARISON OF ALTERNATIVE CONCEPTS

(2) Alternative Routes of the Southern Link

The Southern Link — Section '1'

Along this section, on the northern side of Jalan Bakar Batu is the Army Camp and on the southern side, the developed housing estate, Taman Sentosa. With these land uses already established, one possible route, in this section is to utilize the existing Jalan Bakar Batu.

The Southern Link — Section '2'

Three (3) alternative routes on the section '2' of the Southern Link have been established in the first stage of the Study (see Fig. 4-9 (i)).

These alternative routes were evaluated by a comparative analysis of the following factors:

a. Technical Aspect
b. Socio Environmental Aspect
c. Construction Cost

The results of the comparative analysis are shown in Table 4-2. It was initially found that Route 'B' is better than the others.

Based on Route-B, and additional information obtained from the water depth sounding survey; 3 variations of Route-B, namely Route B-1, B-2 and B-3 were proposed (see Fig. 4-9 (ii)). These three variations of Route-B were further evaluated on the same set of evaluation criteria. Finally, it is found that Route B-3 fares the best.

The Southern Link — Section '3'

Two (2) alternative routes on Section '3' of the Southern Link were established and presented in Fig. 4-10.

These two (2) alternative routes are also evaluated by the comparative analysis on the basis of the technical aspects.

The results of comparative analysis are shown in Table 4-4. Based on the technical standpoint, Route 'B' is better than Route 'A'.

The Preliminary Zoning Plan alignment in the Permas Jaya section has been modified to enable a smooth connection between the west bank and east bank of Tebrau River through the proposed bridge (see Fig. 4-10). The modified alignment has been agreed by the housing developer concerned.

The Southern Link — Section '4'

As far as Section '4' is concerned, the State Economic Development Corporation (SEDC) of Johor has already established the route and plan of the Southern Link. The planned roadway for the Section '4' is a dual-carriageway. Therefore, this Study has only considered widening this section into a six (6)-lane road. Hence, no alternative route is considered for this section.

(3) Southern Link Extension

Several alternative routes on the Southern Link Extension were established and presented in both the Steering Committee and the Technical Committee Meetings. Based on the Study Team's recommendations, two (2) alternative routes were selected, namely Route 'A' and Route 'B'. Both the routes are further comparatively analysed on the following factors:

a. Landuse
b. Technical Aspect
c. Socio-Environmental Aspect
d. Construction Cost

From the results of the comparative analysis made, it is concluded that Route 'A' is superior to Route 'B' even though staggered junctions remain at the intersections of Route 'A' with Jalan Tebrau.

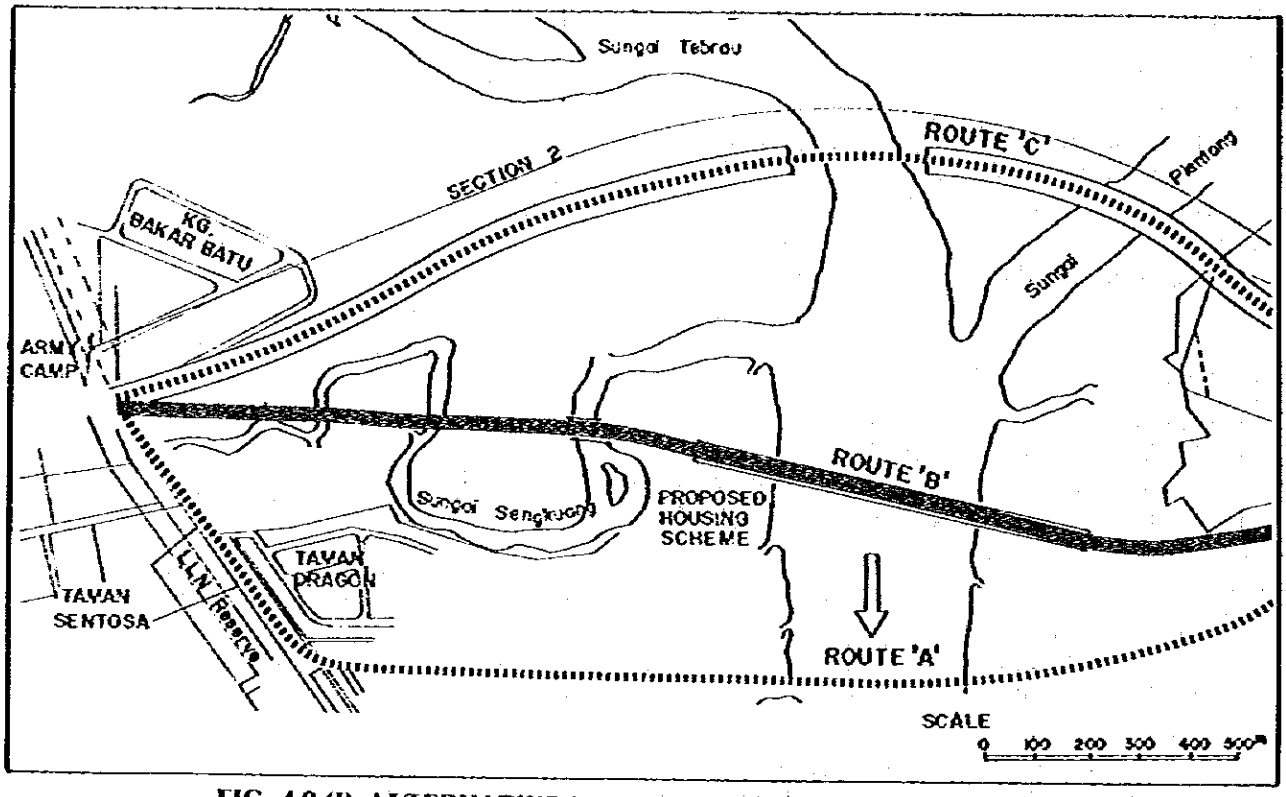


FIG. 4-9 (I) ALTERNATIVE ROUTES OF SECTION '2' — FIRST SCREENING

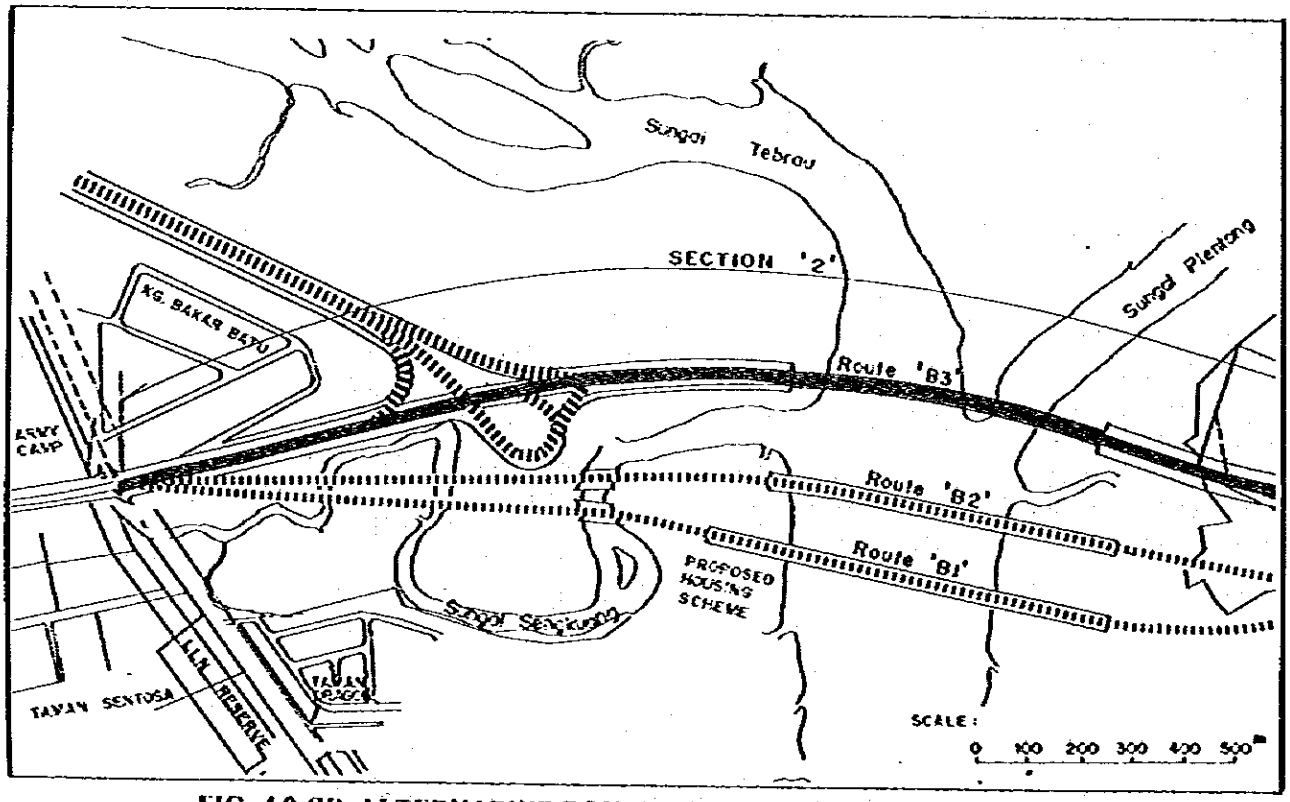


FIG. 4-9 (II) ALTERNATIVE ROUTES OF SECTION '3' — SOUTHERN LINK

TABLE 4-2 COMPARISON OF ALTERNATIVE ROUTES — SOUTHERN LINK (SECTION 2) — FIRST SCREENING

		Route 'A'	Route 'B'	Route 'C'
Outline	Length	4,250 m	3,690 m	3,750 m
	Plan	• Following the proposed alignment of the Preliminary Zoning Plan	• Direct link between Jalan Bakar Batu and Permas Jaya across Sg. Tebrau	• Direct link between Jalan Bakar Batu and Permas Jaya across Sg. Tebrau and Sg. Pelentong
	Length	• Swampy and Residential	• Swampy and Residential	• Swampy and Residential
Technical Aspect	Construction Condition	• Comparatively Easy	• Comparatively difficult	• Comparatively difficult
	Traffic Flow & Network	• Not smooth	• Smooth	• Smooth
	Major Structure	• Sg. Tebrau Bridge : 550 m	• Sg. Tebrau Bridge : 660 m • Improvement of River Mouth • Relocation of Sg. Sengkuang	• Two Bridges • Sg. Tebrau Bridge : 500 m • Sg. Pelenton Bridge : 350 m
	Alignment	• Almost flat	• Almost flat	• Almost flat
	Other Technical Features	• Soft ground treatment required partially	• More soft ground treatment required than Route 'B'	• More soft ground treatment is required than in Route 'A' and 'B'
Socio Environmental Aspect	Disruption of Community	• Anticipated	• Anticipated but minor	• Anticipated but minor
	Impact of Development	• Taman Dragon affected	• None	• None
	Impact on Urban Development	• Many houses affected : 45 units	• Less houses affected : 10 units	• Less houses affected : 10 units
	Impact on Natural Environmental	• Anticipated, but not much	• Anticipated, but not much	• Anticipated
Construction Cost	Construction Cost	M$ 50,700,000	M$ 58,400,000	M$ 72,700,000
	Land Acquisition	14,100,000	3,800,000	3,700,000
	Total	64,800,000	62,000,000	76,800,000
Recommendation		Not Recommendable	Most Recommendable	Recommendable

TABLE 4-3 COMPARISON OF ALTERNATIVE ROUTES — SOUTHERN LINK (SECTION 2) — SECOND SCREENING

		Route 'B-1'	Route 'B-2'	Route 'B-3'
Outline	Length	3,890 m	3,860 m	3,830 m
	Length of Tebrau Bridge	790 m	680 m	680 m
	Plan	* Direct link between Jalan Bakar Batu and Permas Jaya	* Direct link between Jalan Bakar Batu and Permas Jaya	* Direct between Jalan Bakar Batu and Permas Jaya across Sg. Tebrau and Sg. Pelentong
Technical Aspect	Construction Condition	Comparatively difficult	Comparatively difficult	Comparatively difficult
	Consideration for Traffic Flow	Some obstruction	Much obstruction	Minor obstruction
	Sg. Sengkuang Relocation	Relocation is required : 200 m	Relocation is required : 200 m	Not necessary
	Traffic Flow and Road Network	Smooth	Smooth	Smooth
	Other Technical Features	Soft ground treatment required partially	More soft ground treatment required than Route 'B-1'	More soft ground treatment required than Route 'B-1'
Socio Environmental Aspect	Disruption of Community	Anticipated but minor	Anticipated but minor	Anticipated
	Proposed Housing Scheme affected	Horg Huat Housing Scheme is affected	Horg Huat Housing Scheme is affected	Not affected
	Sultanate Land affected	Largely affected	Largely affected	Not affected
	Kg. Bakar Batu affected	Some of area is affected	Some of area is affected	Some of area is affected
Project Cost (in M$ million)		77.9	71.5	68.5

TABLE 4-4 COMPARISON OF ALTERNATIVE ROUTES -- SOUTHERN LINK (SECTION 3)

		Route 'A'	Route 'B'
Outline	Length	10,270 m	10,230 m
	Length of Bridges Required	525 m	505 m
	Plan	Following the proposed route of the Interim Zoning Plan	Minor Modification of the Route 'A' of the Interim Zoning Plan
	Horizontal Curvature	'S' curve with 160 m and 400 m in radius	Almost straight alignment
	Consideration on Traffic Accident	Anticipated	Not Anticipated
	Visual Illusion	Anticipated	Not Anticipated
	Driving Confort	Un comfortable	Comfortable
	Proposed Housing Scheme Affected	No affected	Both housing schemes are affected:— Kota Putri Gunong Hijau

TABLE 4-5 COMPARISON OF ALTERNATIVE ROUTES — SOUTHERN LINK EXTENSION

		Route 'A'	Route 'B'
Outline	Length	3,120 m	2,840 m
	Plan	•Indirect connection between Jln. Kebun Teh and Southern Link. •Widening of Jln. Kebun Teh	•Direct connection between Jln. Kebun Teh and Southern Link. •Widening of Jalan Kebun Teh
	Landuse	Developed Residential	Develop Residential
Technical Aspect	Construction Condition	Easy	Comparatively difficult
	Traffic Flow and Network	•Not smooth from Sothern Link to Jln. Kebun Teh •Staggered junction	•Not smooth but possible to access directly •Skew junction
	Major Structure	•1 interchange on Jln. Larking	•1 overpassing bridge on Jln. Tebrau •1 interchange on J. Larkin
Socio Environmental Aspect	Disruption of Community	Anticipated, but not much	Anticipated
	Area Required	3.86 has.	4.82 has.
	Number of housing units affected	15 units	24 units
Construction Cost	Construction Cost Land	M$ 10,800,000	M$ 20,900,000
	Land Acquisition	6,600,000	8,100,000
	Total	17,400,000	29,000,000

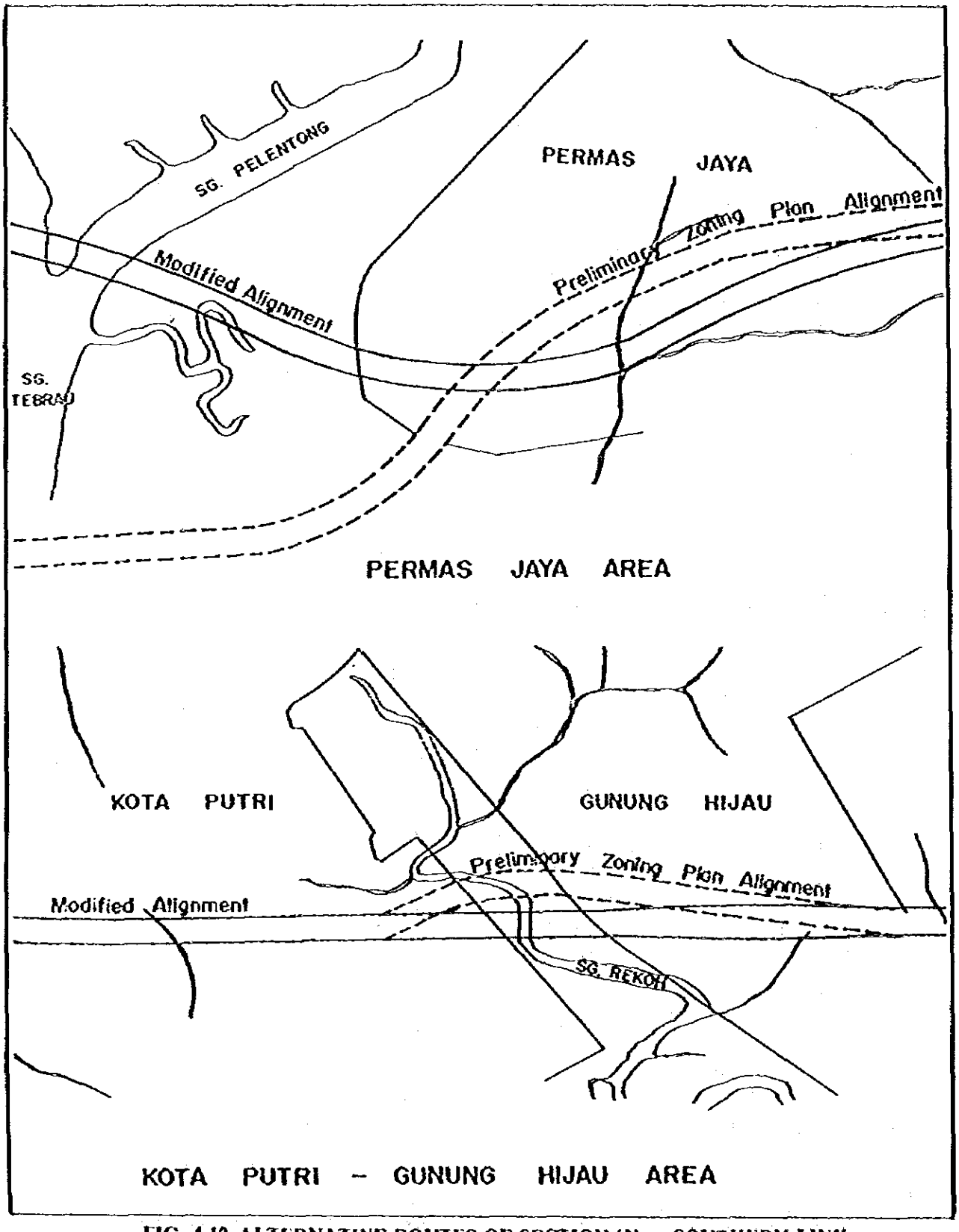


FIG. 4-10 ALTERNATIVE ROUTES OF SECTION '3' — SOUTHERN LINK

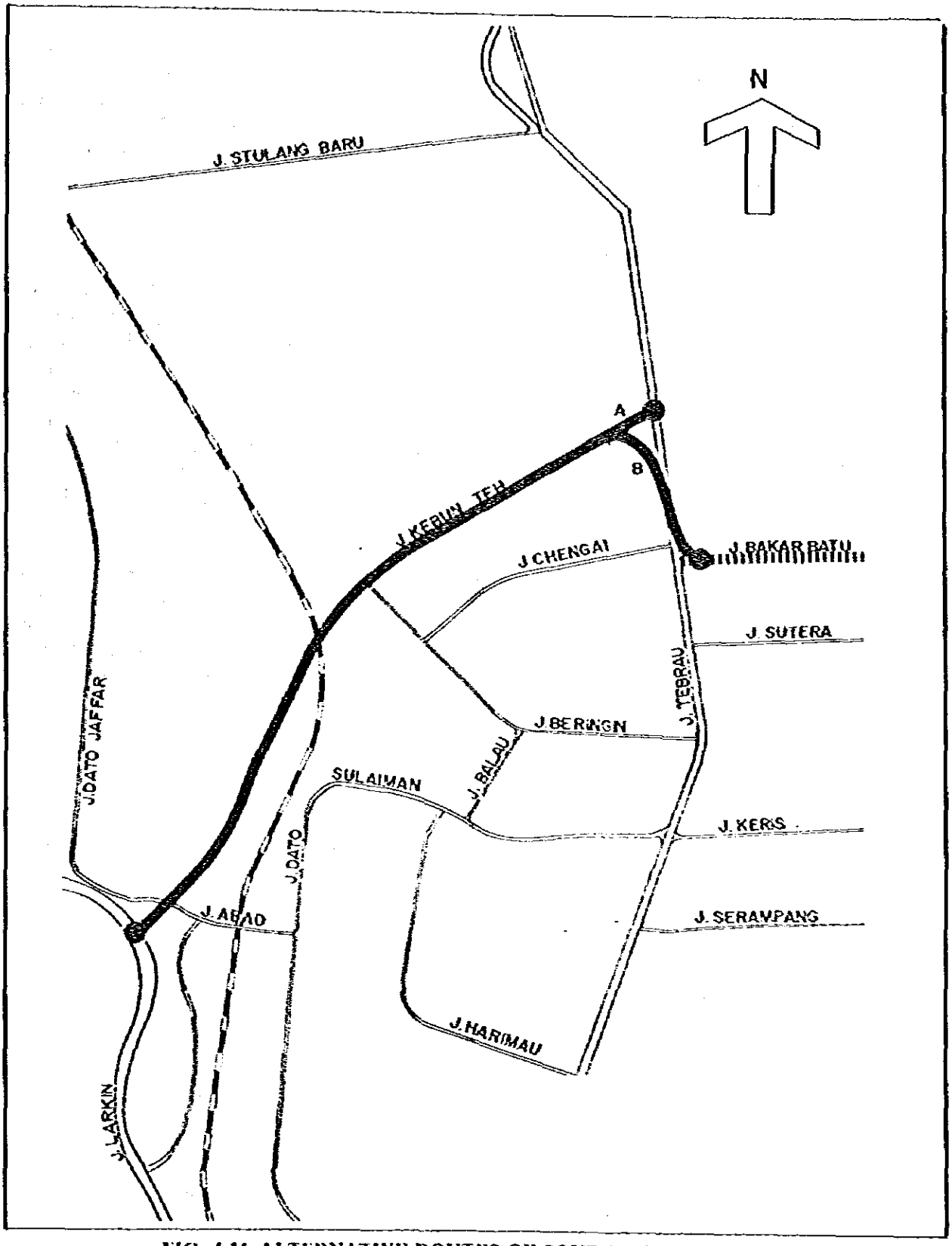


FIG. 4-11 ALTERNATIVE ROUTES OF SOUTHERN LINK EXTENSION

4-5-3 Study of Alternative Bridges on the Tebrau River

(1) General

The Tebrau River, running in the North–South direction has its origin at Tebrau and flows into the Johor Strait.

The width of the river at the bridge site varies from 300 meters to 400 meters depending upon the tidal flow. Thus the Tebrau River can be identified as an inlet of the Selat Tebrau.

Based on the topographic and water depth sounding surveys, geotechnical survey and other investigations conducted, an alternative bridge study on the Tebrau River has been done and presented below.

(2) Consideration of the Navigation Opening

The most important condition in the design of the Tebrau River Bridge is the navigation opening. In this respect, based on the discussion with the Marine Department, the following alternatives are considered:

a. A clearance height of 12 meters (High-level bridge)
b. A clearance height of 6 meters (Low-level bridge)

Based on this alternative navigation openings, the alternative bridge study of the Tebrau River has been made and is shown in Table 4-6.

The conclusions of the results of the comparatively analysis are as follows:

a. From the viewpoint of construction cost, the low level bridge is clearly cheaper than the high level one.
b. However, the low level bridge would be limited to the passage of most ships on the Tebrau River.
c. Taking the passage of ships on the Tebrau River into account, it is concluded that the high level bridge is more favourable than the low level one.

(3) Alternative Bridge Study

Based on the conclusions made in paragraph (2), six (6) alternative bridge designs for the Tebrau River were established in the first stage and presented in Fig. 4-12.

The alternatives were then evaluated by a comparison analysis on the following aspects:

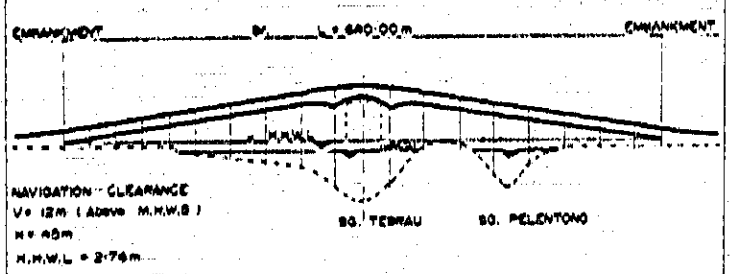
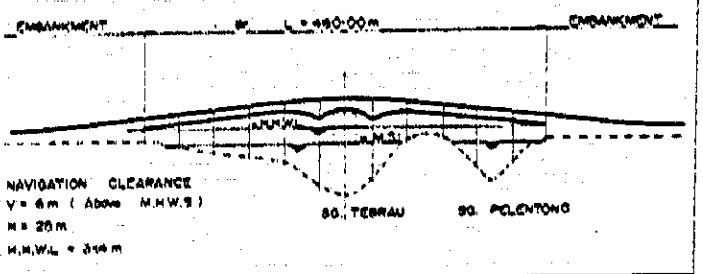
a. Technical Aspect
b. Aesthetic Aspect
c. Construction Cost

Table 4-7 shows the comparison of these alternative structures. From the results of the first screening of the alternatives, it was initially concluded that PC 3-span continuous Box Girder is a more advantageous design.

In the second stage, three (3) further alternative structures were established based on the conclusion made in the first stage and the water depth sounding survey conducted and presented in Fig. 4-13.

These alternatives are also evaluated by a comparative analysis on the above-mentioned aspects. From the results of the second screening, it was finally concluded that PC 3-span continuous Box Girder with a 60 meters main span is the best among the alternatives (see Table 4-8).

TABLE 4-6 COMPARISON OF HIGH LEVEL AND LOW LEVEL BRIDGES

	HIGH LEVEL BRIDGE	LOW LEVEL BRIDGE
Plan		
Design Features	Vertical clearance under main span of bridge = 12m (from MHWS) Length of bridge designed = 640m	Vertical clearance under main span of bridge = 6m (from MHWS) Length of bridge designed = 440m
Navigation	* Free passage of all ships	* Limited passage of most of ships
Dockyard (Slipway)	* Relocation is not required * Compensation to dockyard is not necessary	* Relocation is necessary * Compensation to dockyard is necessary
Other Aspects	* Even during heavy rains, low land area not affected * Sultan's boats can sail upstream	* Upstream low-land areas of the Tebrau River Bridge would be submerged during heavy rains * Sultan's boats cannot sail upstream
Construction Cost (M$ million)	* Superstructure M$ 21.4 Million Sub-Structure M$ 14.2 Million Total M$ 35.6 Million	Superstructure M$ 15.6 Million Sub-Structure M$ 12.2 Million Compensation to Dockyard M$ 1.0 Million Total M$ 28.8 Million

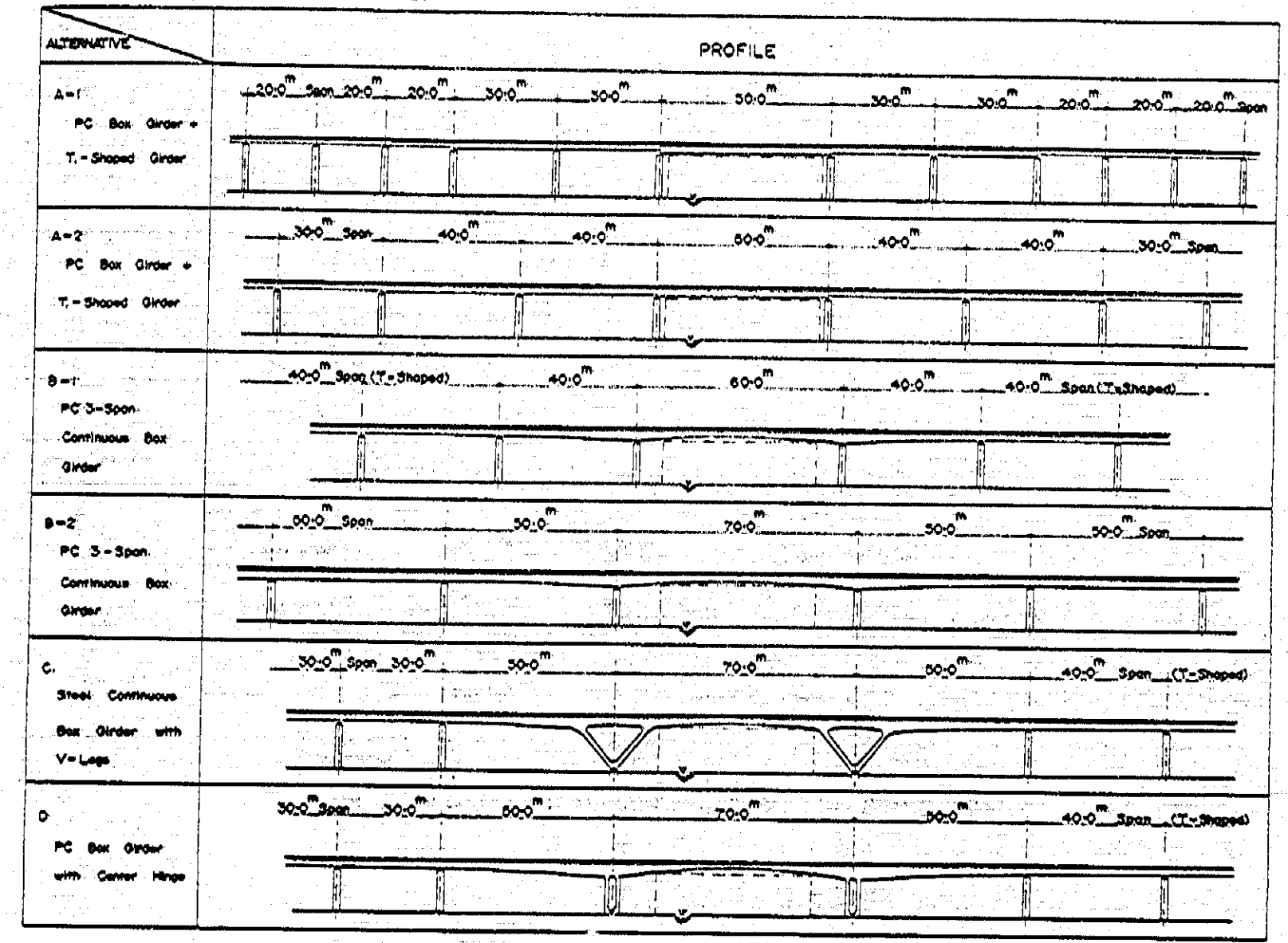


FIG. 4-12 COMPARISON OF ALTERNATIVE BRIDGES FOR TEBRAU RIVER

TABLE 4-7 COMPARISON OF ALTERNATIVE BRIDGES FOR TEBRAU RIVER

TYPE OF BRIDGE	CONSTRUCTION COST (10^3MS)		DIFFICULTY IN CONSTRUCTION	MAINTENANCE	AESTHETICS	DRIVING CONDITION
PC Box Girder + T-Shaped Girder	Superstructure Substructure Total Unit Cost (MS/m^2)	22 070 21 130 43 200 (21 149)	. Erection of box girder shall be necessary large equipment or temporary bent piers. . In case of both approach spans, it is easier to use scaled erection	. Almost not required	. Monotonous	. Number of expansion joint (EJ) is 31. It may give discomfort to motorists.
PC Box Girder + T-Shaped Girder	Superstructure Substructure Total Unit	24 200 14 740 38 940 (1 966)	girder . As relatively large number of piers is involved construction period is longer.	. Almost free	. Monotonous	. E.J. 21
PC 3-Spans Continous Box Girder	Superstructure Substructure Total Unit	29 050 12 350 41 400 (2 091)	. Fixing main piers temporarily main ginder may be erected by the balanced cantilever method. . It is relatively easy.	. Almost free	. Relatively slenderness	. E.J. 15
PC 3-Spans Continous Box Girder	Superstructure Substructure Total Unit	36 470 10 760 47 230 (2 369)	. same as in Alternative (3)	. Almost free	. Slenderness	. E.J. 12
Steel Continous Box Girder with V - Legs	Superstructure Substructure Total Unit	37 260 10 510 47 770 (2 197)	. Erection of main girder is relatively difficult than others. . Temporary bent piers may be necessary in side spans	. Re-painting necessary about every 3 year It will cost about MS 700x10^3 each time	. Light in appearance . Flexibility	. Defflection by Live Load is the largest. But no problem for motorists.
PC Box Girder with Center Hinge	Superstructure Substructure Total Unit	32 240 11 910 44 150 (2 197)	. Main girder is erected by the balanced cantilever method that is used often in other projects. . It is relatively easy.	. Almost not required	. Heavy in appearance	

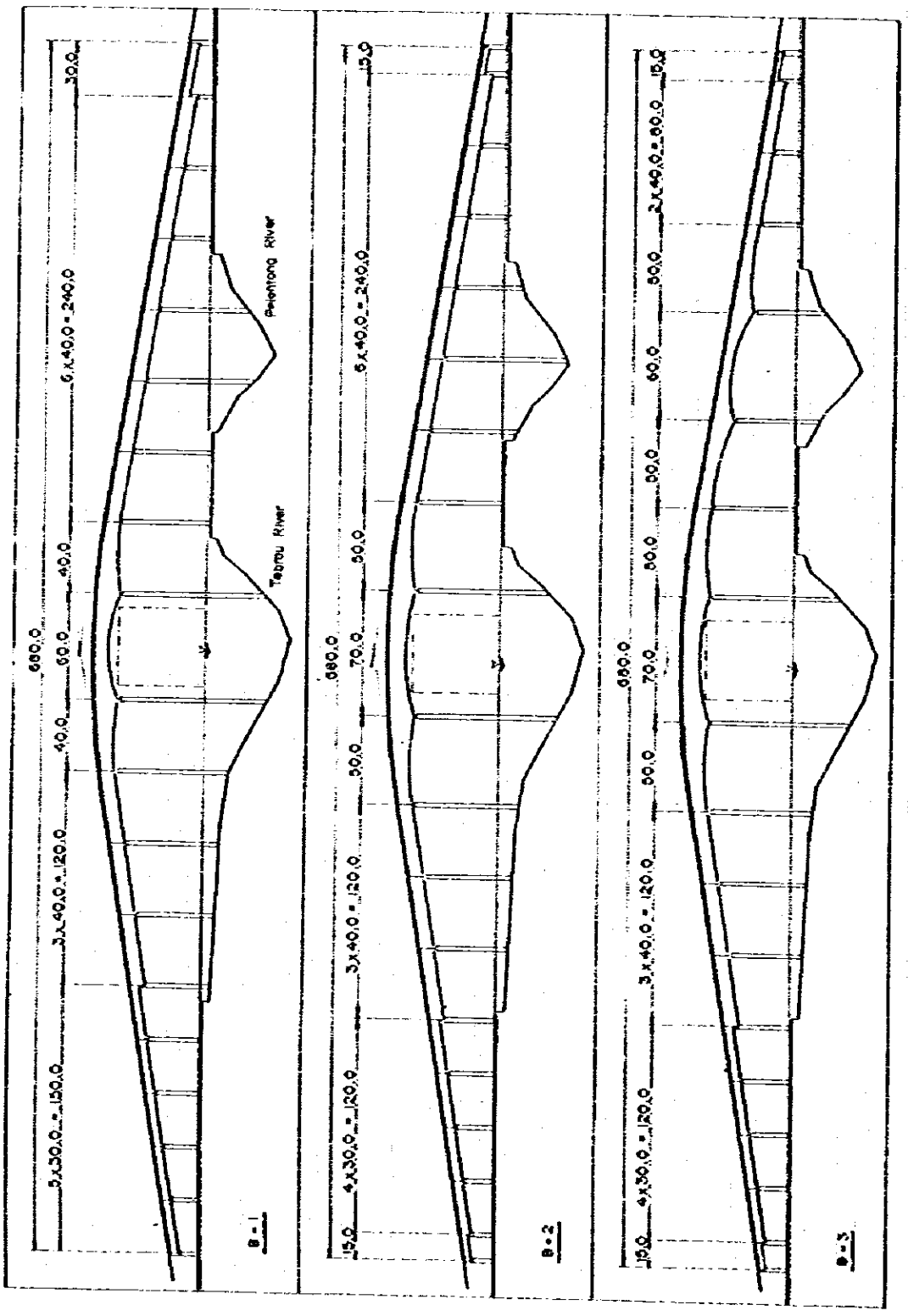


FIG. 4-13 COMPARISON OF GENERAL PROFILE FOR TEBRAU RIVER

TABLE 4-8 COMPARISON OF ALTERNATIVE BRIDGES FOR TEBRAU RIVER

	B–1	B–2	B–3
	PC 3 Span Continous Box Girder with 60 meters Main Span	PC 3 Span Continuous Box Girder with 70 meters Main Span	Two (2) PC 3 Span Continuous Box Girder with 70 meters and 60 meters Main Spans
Total Length	680 meters	680 meters	680 meters
Technical Aspect	No Problem	Unsuitable location of pier at the center of the Pelentong River	No Problem
Aesthetic Aspect	Relatively slender and balanced	Slender and balanced	Slender and unbalanced
Construction Cost (Revised) (10^3 MS)	38,810	41,510	44,570
Recommendation	Most Recommendable	Recommendable	Recommendable

4-5-4 Preliminary Design

(1) General

The preliminary design of the recommended route selected is made on the topographic surveying sheets. The scale of each design is shown below:

TABLE 4-9 SCALE USED IN THE PRELIMINARY DESIGN

Items			Scale	Area Adopted
Road Design	Plan		1 : 2500	Johor Bahru and Pasir Gudang
			1 : 5000	Johor Bahru – Pasir Gudang Corridor
	Profile	Horizontal	1 : 2500	Johor Bahru and Pasir Gudang
			1 : 5000	Johor Bahru – Pasir Gudang Corridor
		Vertical	1 : 500	
Typical Cross-Section			1 : 150	
Intersection Design			1 : 1000	
Bridge Design			1 : 1000	

(2) Horizontal and Vertical Alignment

Following the route location study and its results, the horizontal and vertical alignment is designed on the surveyed sheets of scale of 1 : 2500 for areas in Johor Bahru and Pasir Gudang and of 1 : 5000 for Johor Bahru–Pasir Gudang Corridor.

Major factors considered in the horizontal and vertical alignment design are:

a) to conform as much as possible with the horizontal alignment of the development areas — Permas Jaya, Kota Putri, Gunung Hijau and SEDC.
b) to conform, as much as possible, with the vertical alignment of the Project Road to the planned alignment of the development areas — Permas Jaya, Kota Putri, Gunung Hijau, and SEDC.
c) to minimize the demolition of land properties in Kg. Bakar Batu and those along the Southern Link Extension.
d) to avoid passing through the reserves of power-lines and water pipes.
e) to avoid, absolutely, the demolition of the cemetery along the Southern Link Extension.

With regard to the planned power line in the Johor Bahru–Pasir Gudang Corridor, the proposed horizontal and vertical alignments has already been adjusted in consideration of the planned power line after consultation with LLN.

It is also noted that the alignment, cross-section and location and type of the grade-separated intersection in Pasir Gudang area has already been adjusted after consultation with the State Economic Development Corporation (SEDC).

(3) Cross-Section

1) Number of Lanes

Based on the results of assigned traffic volumes in the years 1990 and 2000 and design capacity, the following number of lanes are proposed and are shown in Table 4-10.

2) Proposed Cross-Section

Based on the elements of cross-section components applicable to the Southern Link and its Extension, the alternative cross-sections are presented in Fig. 4-14.

a. Four (4)-Lane Plan
   A four (4)-lane road for the Southern Link and its Extension.

b. Six (6)-Lane Plan
   A six (6)-lane road for the Southern Link and a four (4)-lane road for the Southern Link Extension.

These alternatives are evaluated based on the traffic and technical studies. From the results of the evaluation, the following conclusions can be initially made:

a. The carriageway for the Southern Link is to be initially constructed as a four (4)-lane road.
b. It is to be widened into six (6)-lanes around the year 1993.

However, the selection of the alternative cross-sections and the timing of implementation are subject to the economic evaluation mentioned in Chapter 6.

TABLE 4-10 DESIGN CAPACITY

	Number of Lanes	Capacity (pcu/day)	Level of Service	Design Capacity (pcu/day)
Southern Link	4-lane	70,600	0.85	60,000
	6-lane	105,900	0.85	90,000
Southern Link Extension	4-lane	49,500	0.85	42,000

Note: The level of service for the Project Roads is employed as Level IV.

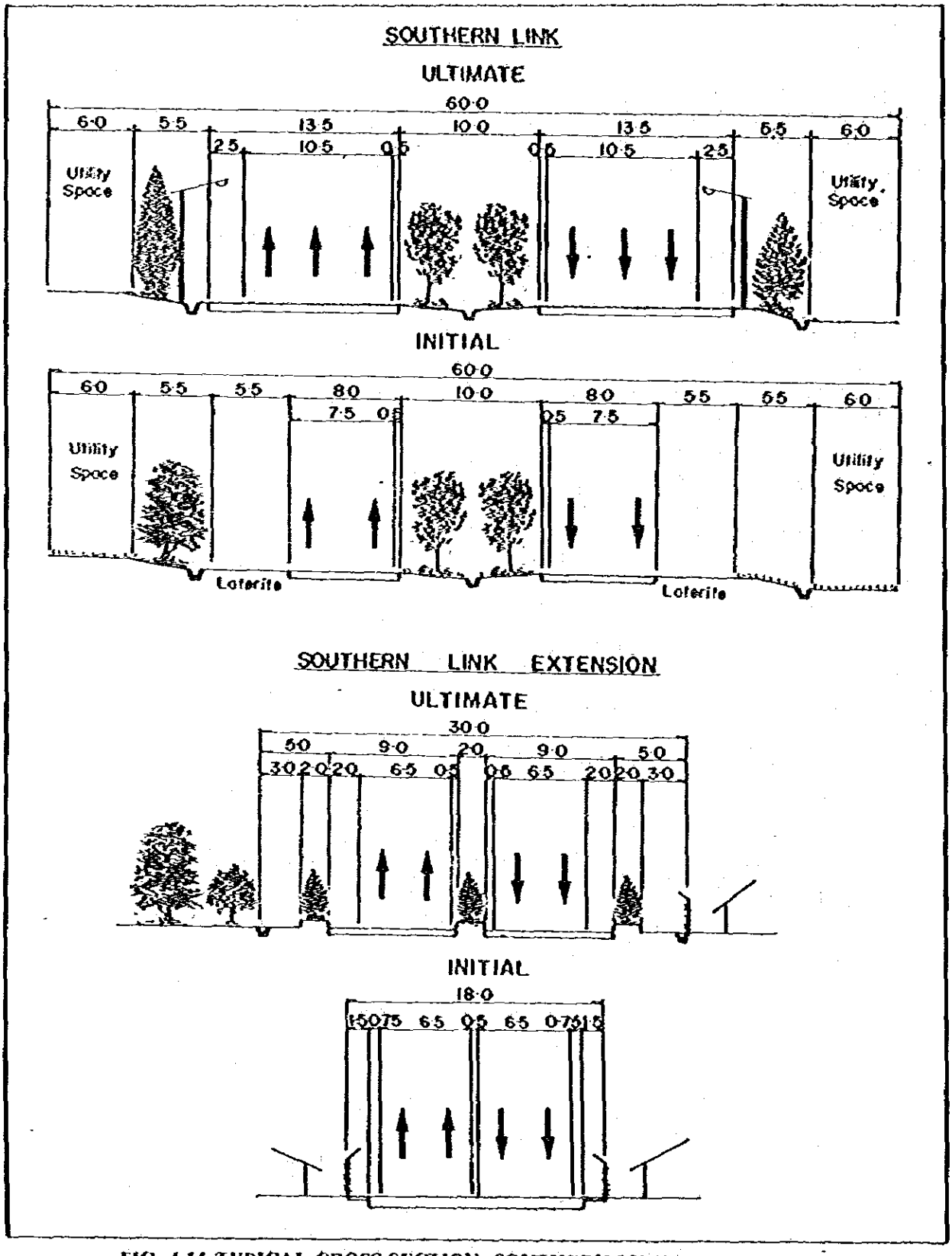


FIG. 4-14 TYPICAL CROSS SECTION: SOUTHERN LINK AND ITS EXTENSION

(4) Bridge Design

Five (5) bridges and one (1) bridge are required for the Southern Link and its Extension, respectively.

Locations of these bridges are shown in Fig. 4-15 and the general view of these recommended bridges is illustrated in Fig. 4-16.

1) Tebrau River Bridge

Based on the results of the alternative bridge study for Tebrau River, its preliminary bridge design is made and illustrated in Fig. 4-17.

a. Superstructure

As mentioned in Section 4-4-3, the PC 3-Span Continuous Box Girder Bridge, consisting of a main span of 60 meters, and side spans of either 40 meters or 30 meters, was recommended.

By experience, we would like to stress that a two (2)-cell Box Girder is superior to the other types. The depth of the Girder is determined as 3.20 meter at intermediate supports, 1.80 meters at mid-span and 2.10 meters at both support.

For both the approach sections, the post-tension T-shape PC Girder either of 40 meters or of 30 meters in length is recommended for the bridge taking into consideration their economical construction cost and low maintenance cost.

b. Substructure

Considering the height of abutment, the gravity type is the most appropriate design for the abutment. As for the pier shafts of the main span, the solid type is employed in order to support the large reaction force of the superstructure.

The other pier shafts are classified into two (2) types and are determined as follows:

i) For relatively high piers, the hammer headed type is adopted for reason of its economical construction cost.
ii) For low piers, the wall type is employed from its aesthetic viewpoint.

As for the foundation type, pile-foundation with PC pile ϕ 600 mm diameter is found to be economically superior than other types.

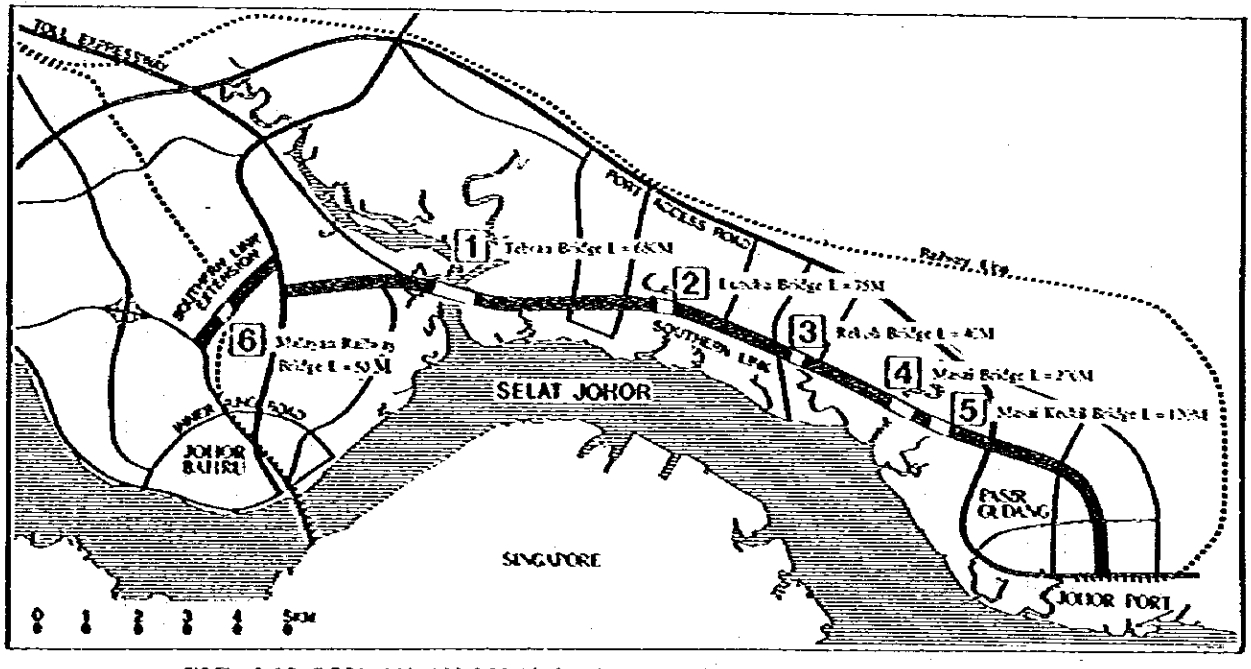


FIG. 4-15 SOUTHERN LINK & EXTENSION BRIDGES LOCATION

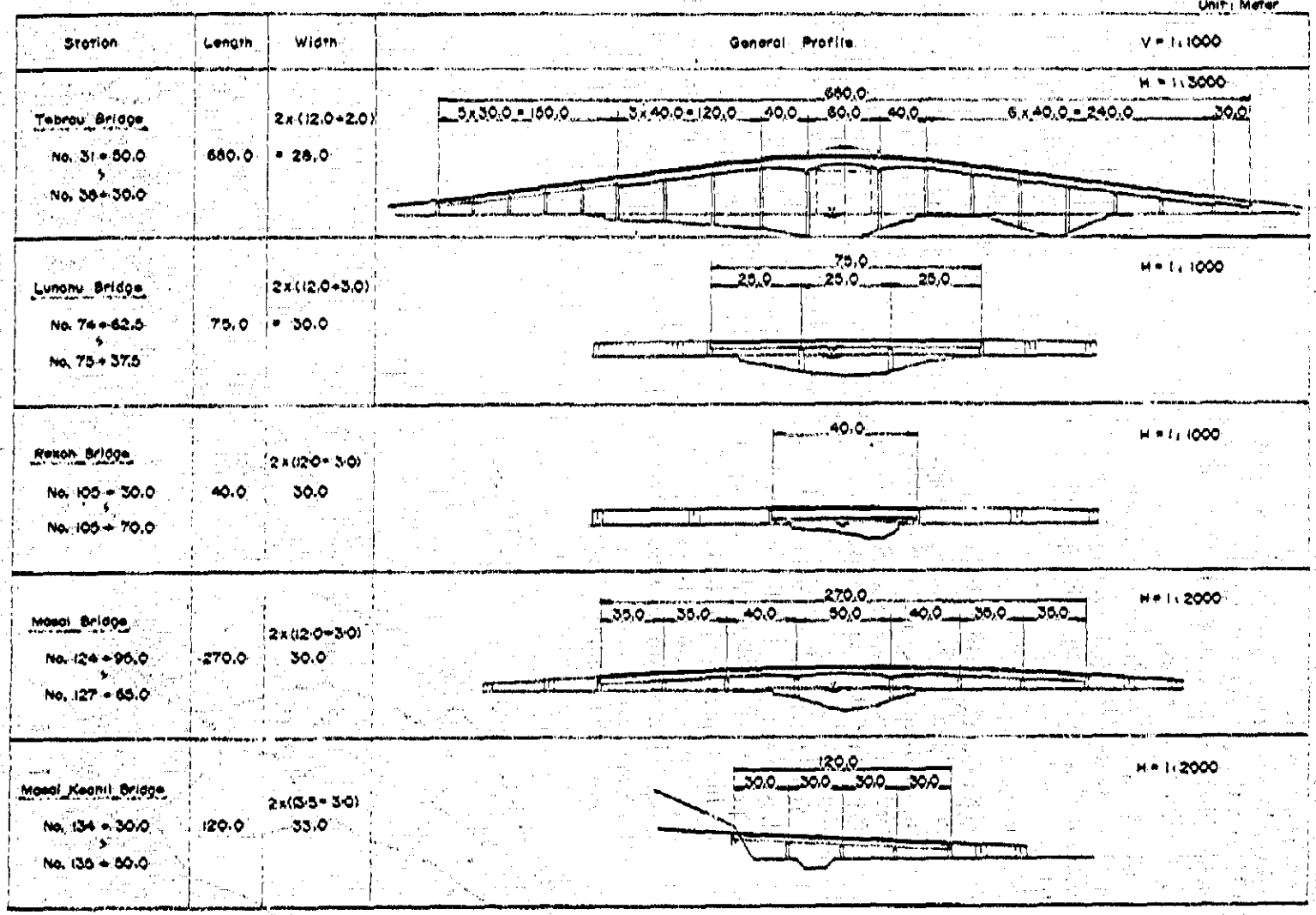


FIG. 4-16 GENERAL VIEW OF MAJOR BRIDGES

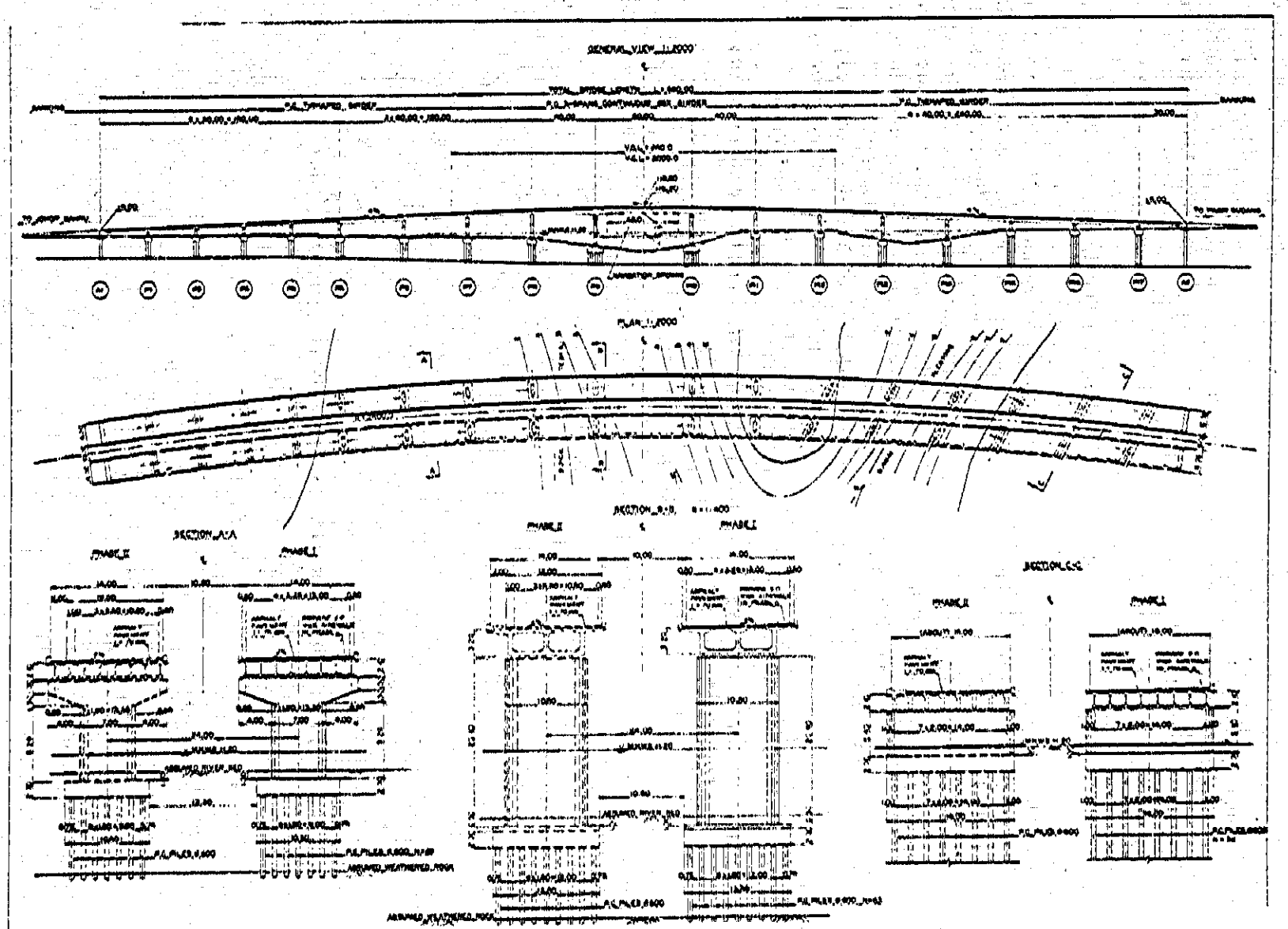


FIG. 4-17 TEBRAU RIVER BRIDGE — GENERAL VIEW

2) Other Bridges on the Southern Link

Consideration of designs for the other bridges on the Southern Link are as follows:

a. Superstructure and Superstructure

i) The type of superstructure is pres-stressed girder.
ii) For high pier shaft, either the solid or the hammer headed type is employed.
iii) For low pier shaft, the wall type is employed.

b. Foundation

i) The PC pile of ϕ 600 mm diameter for the foundation is employed in view of the swampy river sites.

c. Length of the Bridges

Total bridge length is determined such that the height of its adjacent banks are under +5.00 meter from MHWS.

(5) Intersection/Interchange Plan

1) General

Generally, the intersections on the Southern Link and its Extension are critical points in terms of smooth traffic flow. This is because the traffic capacity at the intersections is less than that on the roadway. To insure maximum road capacity, the important intersections should be grade-separated.

On the basis of the above-mentioned point, the general guideline for the intersection plan has been prepared as follows.

TABLE 4-11 PRINCIPLES FOR INTERSECTION PLAN OF THE INTRA-URBAN PRIMARY DISTRIBUTOR

Intersection of Intra-Urban Primary Distributor	At-Grade Intersection		Grade Separation
	Non-Signalized	Signalized	
With Inter-Urban Primary Distributor			O
With Intra-Urban Primary Distributor			O
With District Distributor		O	O
With Local and Access Road	O	O	

O Suitable

TABLE 4-12 PRINCIPLES FOR INTERSECTION PLAN OF THE DISTRICT DISTRIBUTOR

Intersection of District Distributor	At-Grade Intersection		Grade Separation
	Non-Signalized	Signalized	
With Inter-Urban Primary Distributor			O
With Intra-Urban Primary Distributor		O	O
With District Distributor		O	
With Local and Access Road	O	O	

O Suitable

2) Location of Intersection

Having established the principle for the Southern Link and its Extension and the predicted turning movements at the intersections, the location and the type of intersections are proposed and illustrated in Fig. 4-18. Seven (7) grade-separated intersections are proposed for the Southern Link and one (1) is proposed for its Extension in the Study.

However, in case the Four (4)-Lane Plan is implemented in the first stage, it is proposed that all the intersections be at-grade with traffic signals.

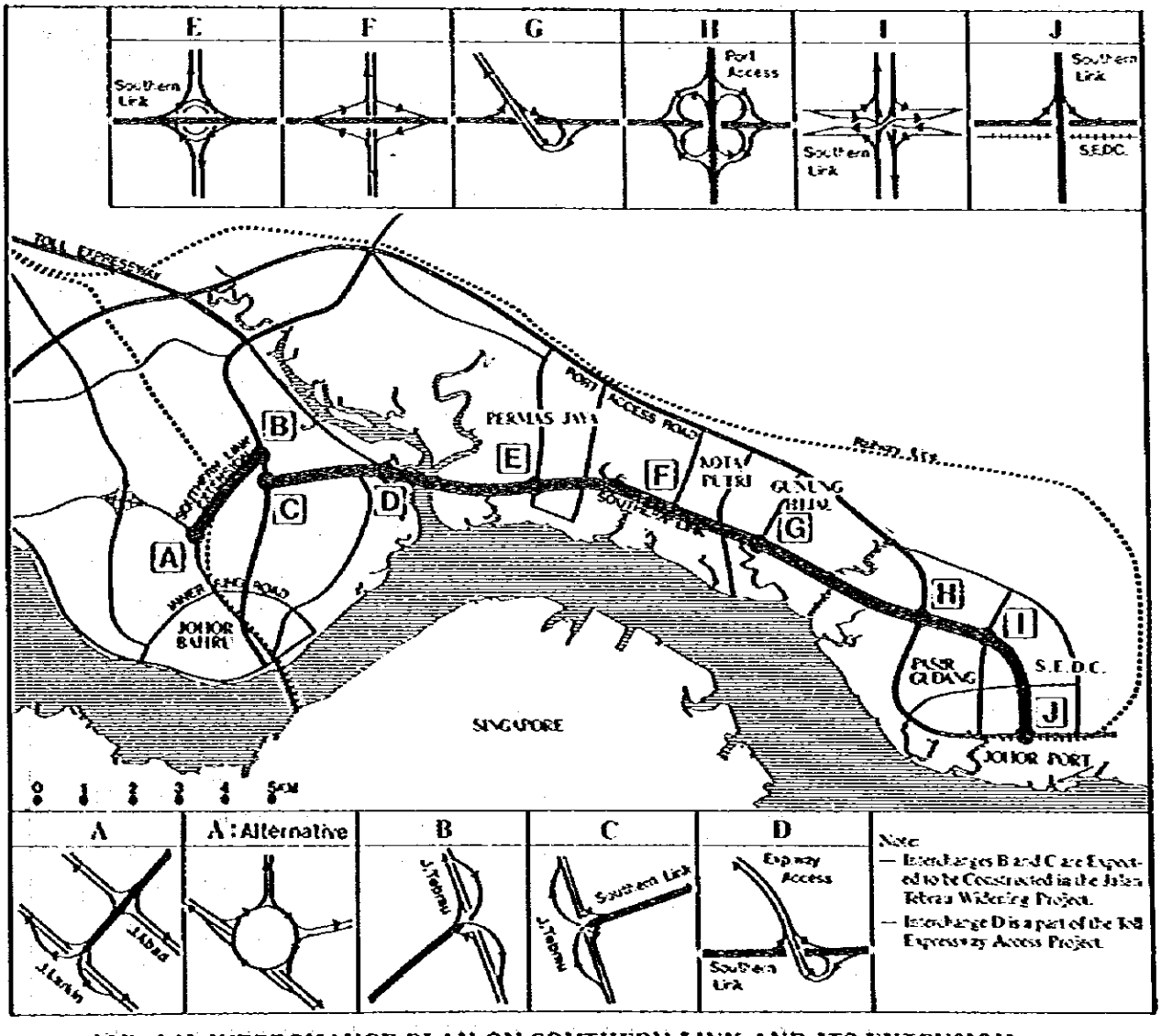


FIG. 4-18 INTERCHANGE PLAN ON SOUTHERN LINK AND ITS EXTENSION

3) Immediate Action of Intersection Treatment at Intersections of Jalan Kebun Teh with Jalan Larkin and Jalan Dato Jaafar - Jalan Abad

The most congested intersections during the morning and evening peaks hours in Johor Bahru are the ones at Jalan Kebun Teh with Jalan Larkin and Jalan Dato Jaafar – Jalan Abad due to the following reasons:

a. Three (3) consecutive road junctions with very short intervals on Jalan Kebun Teh.
b. Inefficient intersection design.
c. Large traffic volume converging at the two (2) intersections.
d. Improper intersection treatment.

Based on the traffic flow analysis conducted at the three (3) intersections, counter measures, as an immediate action, can be cited as follows:

a. The intersections of Jalan Larkin with Jalan Kebun Teh and Jalan Kebun Teh Lama with Jalan Abad are to be signalized.
b. Channelization at three (3) intersections has to be improved.
c. The signals at the three (3) intersections must be coordinated.

When the immediate actions are implemented, the capacities at the three (3) intersections are expected to increase 2.3 times more than the existing capacity.

(6) Pavement Design

1) Type of Pavement

There are two (2) common types of pavement, asphalt concrete and cement concrete, of which the former type is adopted for the Southern Link and its Extension on account of its lower construction cost, easy availability of materials needed, and easy maintenance.

2) Design of Pavement

Considering the CBR value of subgrade, amount of traffic volume, share of heavy vehicle to the total traffic volume and lifetime of pavement, the thickness of individual course for the Southern Link and its Extension is proposed and as shown in Fig. 4-19.

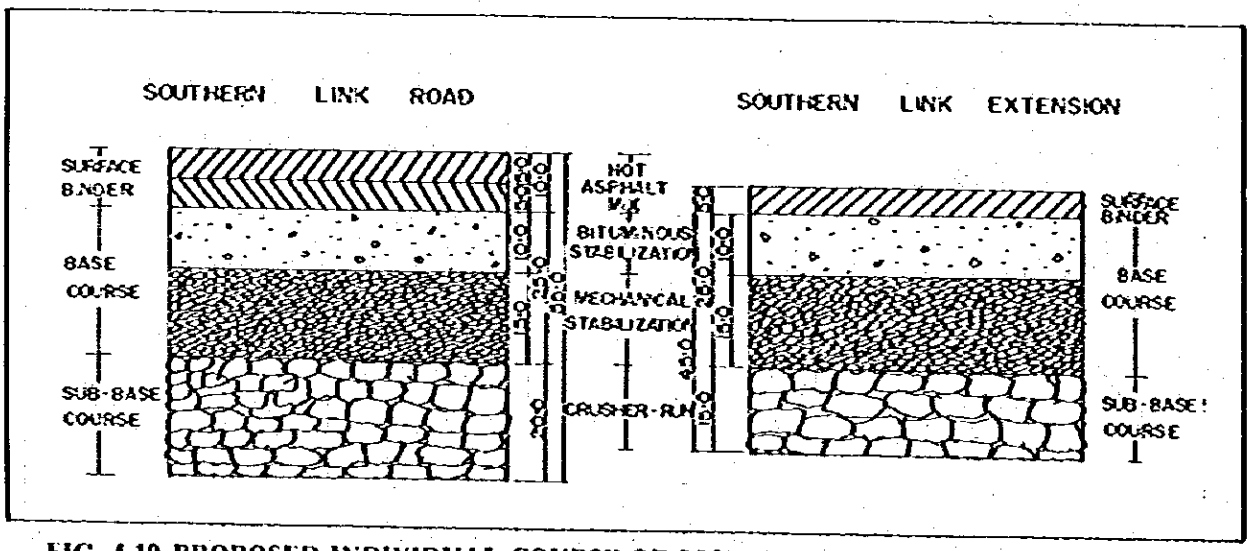


FIG. 4-19 PROPOSED INDIVIDUAL COURSE OF SOUTHERN LINK AND ITS EXTENSION

(7) Drainage Design

1) Box Culvert

The box culvert is to be located on the slopes of undulating land and narrow rivers, and the capacity volume of the box culvert have to be decided by the discharge volume in the undulating area. For a design storm recurrence of 10 years, the rainfall intensity for the period of 60 minutes is 97 mm.

The types of box culvert considered in this Feasibility Study projects are:

- 2.0 × 2.0 (Dimensions in meters)
- 3.0 × 3.0
- 2 — 2.0 × 2.0 (2 barrel type)
- 2 — 3.0 × 3.0 (2 barrel type)

For design purposes, larger size box culvert is adopted because of the possibility of soil, sand, gravel, branches of trees, and other obstructions flowing into the culvert.

2) Roadside Drainage

For roadside drainage, two types of drains are considered: the open channel drain and the covered drain. The size of the channel to be adopted for each section is dependent on several factors, namely: profile of the road, the crossfall of the road, the gradient of the drain, the size of the catchment area, the runoff coefficient and the intensity of rainfall. For a storm design of 2 years the rainfall intensity for a period of 10 minutes is 133 mm.

Block drains are considered in this study. The various sizes are:

- 12" (304.8 mm)
- 18" (457.2 mm)
- 24" (609.6 mm)
- 30" (762.0 mm)
- 36" (914.4 mm)

Suburban Areas

For suburban areas, open channel drains are considered. Where small drains from the developed areas are connected to the open channel, catchment basins shall be provided at suitable intervals to be decided by the volume of the discharge.

Urban Areas

In urban areas, the curb and gutter drain type (width = 50 cm) is considered. These shall collect the surface water and direct them into the curb inlet to be drained away. The figure below shows the way smaller drains are connected to the covered drain. Catchment basins shall be provided at adequate intervals to collect the excess discharge and enabling cleaning and maintenance works to be carried out.

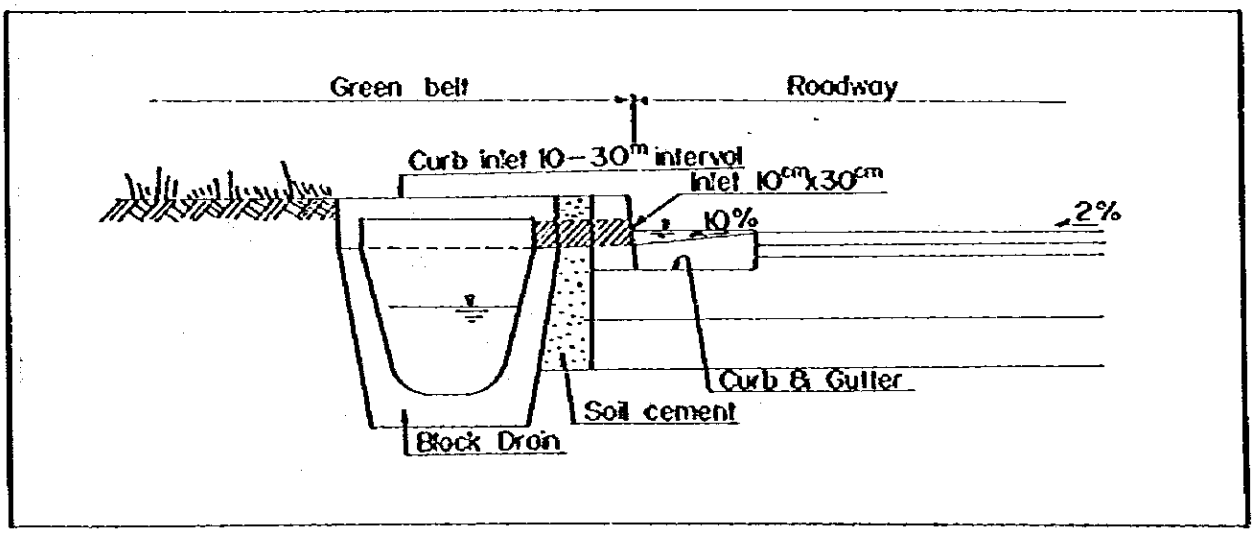


FIG. 4-10 ROAD SIDE DRAINAGE

(8) Consideration for Facilitating Public Utility Concerned Work

In order to maintain, repair and install the public utilities laid under the ground, very often the roadways in the urban area have to be excavated. This affects the road structures especially the pavement and also disrupts the flowing traffic. This is considered a very serious problem in the urban area.

Therefore, to avoid such inconveniences to the public along the Southern Link and its Extension, and to enable utilities to be maintained and installed smoothly and efficiently the Study Team suggests that space for the utilities be specially provided in the roadway reserve of this road to overcome any future inconveniences that may be encountered.

An example of the kind of planning desired can be seen in the drawing. In this case, the width set aside for the future utilities is 6.0 m on each side of the carriageway with the utilities sandwiched between the Green Belt and Service Road. Hence, any digging that may have to be done will not have to interfere with the flowing traffic at all (see Fig. 4-21).

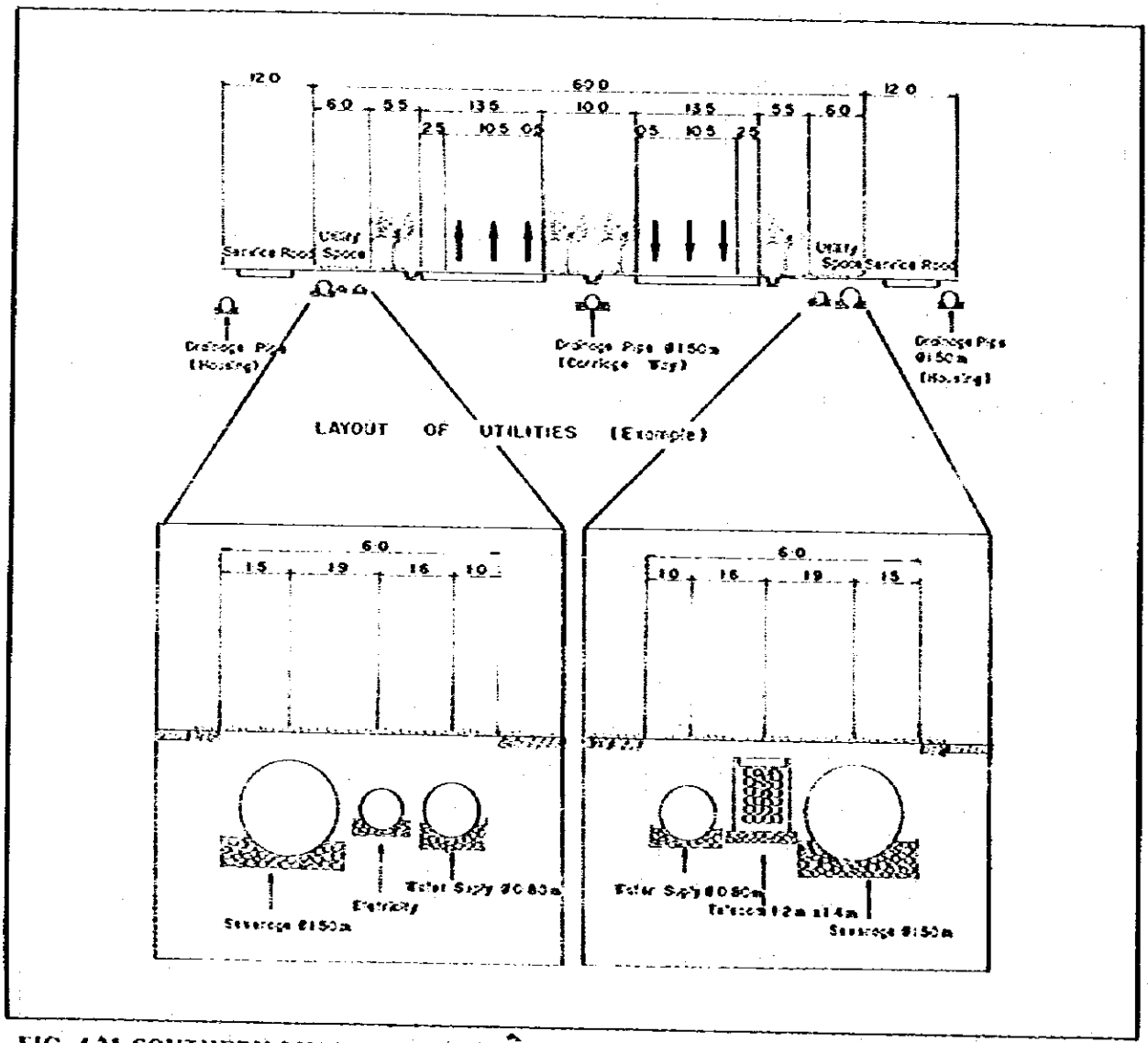


FIG. 4-21 SOUTHERN LINK CROSS-SECTION UTILITY PLAN FOR NEW DEVELOPMENT AREA

TABLE 4-13 UTILITY REQUIREMENTS

Utility Type	Quantity	Size
Sewerage Pipe	2	ϕ 1.50 m
Water Supply	2	ϕ 0.80 m
Telecom	1	Box 1.2 m x 1.4 m
Electricity	1	ϕ 0.60 m
Drainage		
a) Carriageway	1	ϕ 1.50 m
b) Abutting Property	2	ϕ 1.50 m

Revetment

In general, the type of revetment can be classified into three kinds, namely, sloping face, vertical face and composite types. The choice of revetment to be constructed depends on the:

1) Hydrological Condition.
2) Topography and soil conditions of the ground foundation.
3) Construction materials, period and cost.

A stone pitching type slopped faced revetment is recommended as the most favourable type of structure for the swampy area along the Tebrau River (see Fig. 4-22).

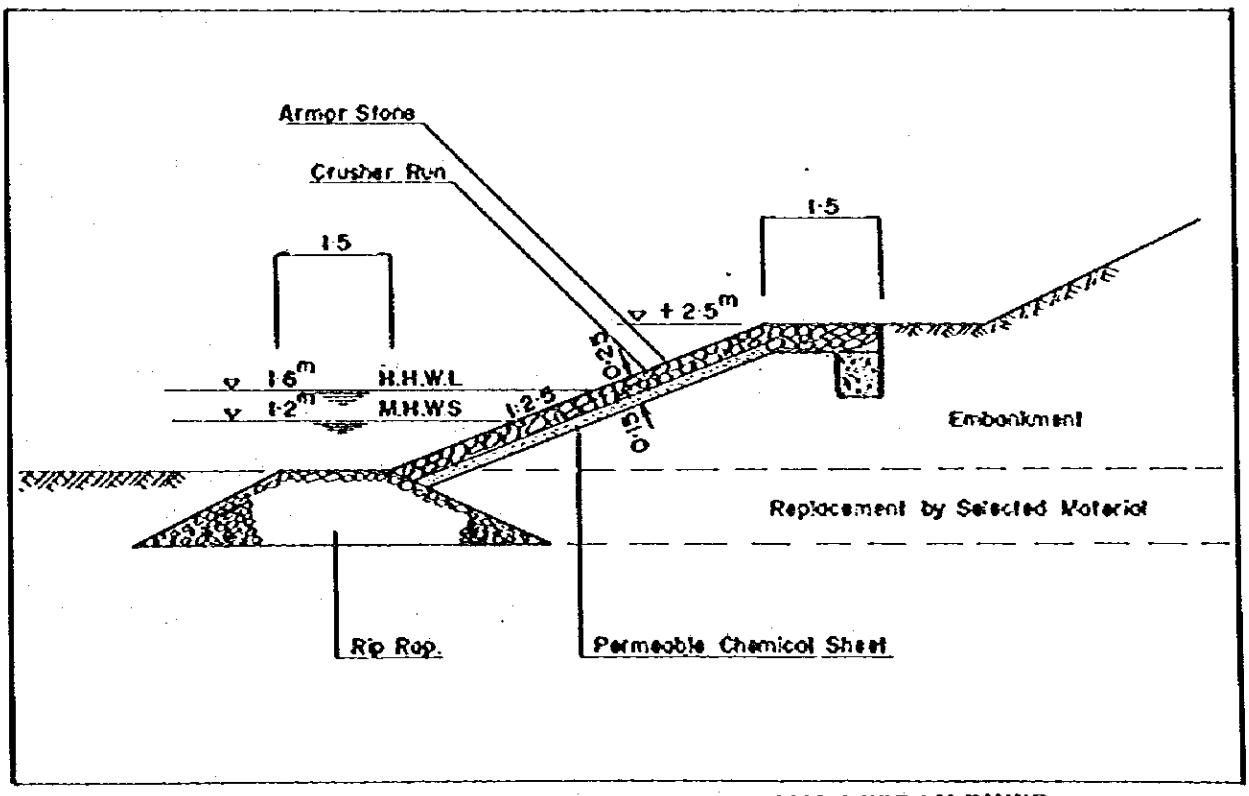


FIG. 4-22 RECOMMENDED REVETMENT ALONG TEBRAU RIVER