Table 5.14 PROJECT COST ESTIMATE

(in thousand M$ at 1980 prices)

Route	No. of Lanes	Access to N.C.R	Construction Cost			Land Acquisition & Compensation	D.D Service			Total			
			F.C	L.C	Tax		F.C	L.C	Tax	F.C	L.C	Tax	Total
Plan 1	4-lane	Partial	39,941	44,278	4,732	51,564	3,028	5,063	448	42,969	100,905	5,180	149,054
		Full	40,051	44,422	4,745	51,564	3,037	5,078	450	43,088	101,064	5,195	149,347
	2-lane	Partial	30,386	30,245	2,978	24,946	2,180	3,645	323	32,566	58,836	3,301	94,703
		Full	30,496	30,389	2,991	24,946	2,189	3,660	324	32,685	58,995	3,315	94,995
Plan 2	4-lane	Partial	43,657	48,046	5,089	43,626	3,297	5,513	488	46,954	97,185	5,577	149,716
		Full	43,767	48,190	5,102	43,626	3,306	5,528	489	47,073	97,334	5,591	150,008
	2-lane	Partial	29,663	35,285	3,429	31,224	2,335	3,905	346	31,998	70,414	3,775	106,187
		Full	29,773	35,429	3,442	31,224	2,344	3,920	347	32,117	70,573	3,789	106,479

Partial : Partial Access to North Coastal Road

Full : Full Access to North Coastal Road

5.7 Annual Maintenance Cost

Data from "The Malaysia Highway Maintenance Study" (1974, JKR), "Memorandum for A Case for the Revision for GRANT-IN-AID FOR MAINTENANCE TO MUNICIPALITIES IN WEST MALAYSIA" and other related references are used in the estimation of the annual maintenance cost of the Outer Ring Road in this study. The cross-section of the Outer Ring Road is somewhat different from the above mentioned road and so there are some alterations in the items of maintenance cost that need to be considered.

The following items must be taken into account in the estimation of the annual maintenance costs.

a. Resurfacing the roads

The resurfacing of roads including the carriageway and shoulder is to be carried out once every 10 years. The unit cost of resurfacing per square meter of carriageway and shoulder with 4-cm thick Premixed Asphalt Macadam is estimated at five dollars.

b. Roadside trees

This item for maintenance of roadside trees consists of trimming the branches, ensuring the supply of water, protection of the trees and others with the unit cost estimated at one thousand dollars per kilometer.

c. Drainage

The life time period of the drainage system is assumed to be 20 years with 5% of it having to be renewed or repaired every year of which the unit cost of changing drainage is estimated at fifty dollars per kilometer.

d. Kerbs

The lifetime period of kerbs is assumed to be 20 years with 5% of kerbs having to be renewed or repaired every year of which the unit cost of changing kerbs is estimated at fifteen dollars per kilometer.

e. Road marking and Street Lighting

The maintenance of the above includes road line painting,

kerb repainting, repainting of traffic code signs and others of which the unit cost is estimated at one thousand dollars per kilometer.

f. Traffic signal

This maintenance of traffic signals includes repairing the signals and renewing them if necessary. The life time period of signals is 20 years and the cost of the equipment for repairing or renewing signals is $25,000 therefore the unit cost is estimated to be $1,250 per year.

g. Slope protection

To unkeep and protect slopes, grass cutting and planting of cutting and embankment slopes is necessary. The slope width being 20 meters (total of both sides) will requir one cutting a month at M$ 0.05 per square meter.

h. Central reservation

Maintenance necessitates cutting of grass and trees with central reservation width being 3 meters requiring one cutting a month at M$ 0.05 per square meter.

i. Guard rails

In the maintenance of guard rails, it is necessary to change and repair the guard rails with 5% of guard rails having to be renewed or repaired every year of which the cost is estimated to be fifty dollars per kilometer.

j. Scupper pipes and kerb outlet channels

Scupper pipes and kerb outlet channels need to be cleared regularly with unit cost estimated to be eight hundred dollars per kilometer.

k. Bridges and other structures

The condition of bridges and other structures need to be investigated regularly and repaired if found faulty with the unit cost estimated at one thousand dollars per kilometer. The maintenance costs are shown in Tables 5.15 and 5.16.

Table 5.15 ANNUAL MAINTENANCE COST (per kilometer)

	Unit	($) Unit Cost	Quantity	Cost (M$) Economic	Tax (5%)	Total
Resurfacing of road	M^2	5	950 1,900	4,750 9,500	237 475	4,987 9,975
Roadside trees	KM	1,000	1 1	1,000 1,000	50 50	1,000 1,050
Drainage	M	50	100 100	5,000 5,000	250 250	5,250 5,250
Kerb	M	15	100 100	1,500 1,500	75 75	1,575 1,575
Marking and Street Lighting	KM	1,000	1 1	1,000 1,000	50 50	1,050 1,050
Traffic Signals	KM	1,250	1 1	1,250 1,250	63 63	1,313 1,313
Slope Protection	KM^2	0.05	20,000 20,000	1,000 1,000	50 50	1,050 1,050
Central Reservation	M	0.05	0 1,000	0 50	0 3	0 53
Guard Rail	KM	50	50 50	2,500 2,500	125 125	2,625 2,625
Pipe and Kerb Outlet	KM	800	1 1	800 800	40 40	840 840
Bridges and other Structures	KM	1,000	1 1	1,000 1,000	50 50	1,050 1,050
Sub-Total				19,800 24,600	990 1,231	20,790 25,831
15% Administrative and Technical Staff				2,970 3,690	148 185	3,118 3,875
Total				22,770 28,290	1,138 1,416	23,908 29,706

Note : The upper row is 2-lane
The lower row is 4-lane

Table 5.16 MAINTENANCE COST OF EACH SEGMENT

Unit : M$ a year

Segment	Length (Km)	4-lane			2-lane		
		Economic	Tax	Total	Economic	Tax	Total
Segment 1	0.700	19,803	991	20,794	15,939	796	16,735
Segment 2	2.000	56,580	2,832	59,412	45,540	2,276	47,816
Segment 3	5.900	166,911	8,354	175,265	134,343	6,714	141,057
Segment 4	2.100	59,409	2,974	62,383	47,817	2,390	50,207
Segment 5	4.300	121,647	6,089	127,736	97,911	4,893	102,804
Segment 6	1.150	32,533	1,628	34,161	26,185	1,309	27,494
Segment 7	1.120	31,685	1,586	33,201	25,502	1,274	26,776
Segment 8	1.600	45,264	2,266	47,530	36,432	1,821	38,253
Segment 9	4.400	124,476	6,230	130,706	100,188	5,007	105,195
Segment 10	2.000	56,580	2,832	59,412	45,540	2,276	47,816

6. ECONOMIC EVALUATION

6.1 General

6.1.1 Procedure

The procedure for a preliminary economic evaluation of the Project Roads comprises the following:

a. Choice of indicators for economic analysis

b. Preparation of alternative plans

c. Economic cost estimate

d. Unit traffic cost analysis

e. Benefit estimate

f. Economic analysis

g. Sensitivity analysis

h. Project appraisal

6.1.2 Choice of Indicators for Economic Evaluation

There are three types of economic indicators used in the project appraisal, for the standard procedure of the Economic Planning Unit and also of the international financers, of which are:

a. Internal Rate of Return (IRR)

There are two kinds of internal rate of return, financial and economic. Since the financial rate of return is used only for private investment, the economic rate of return is used for this project. The IRR shows the discount rate which gives the break even point between the present value of benefit and that of cost as given by the following formula.

$$B(R) - C(R) = 0$$

$$B(R) = \sum_{i=1}^{n} \frac{bi}{(1+R)^i}$$

$$C(R) = \sum_{i=0}^{n-1} \frac{Ci}{(1+R)^i}$$

R : Internal Rate of Return

Ci : Cost in the year (i)

bi : Benefit in the year (i)

n : Project life in years

In order that the project be economically feasible, the IRR should be more than the opportunity cost of capital in Malaysia, generally 12 percent.

b. Net Present Value (PV)

The NPV will indicate the difference between the discounted cost and benefits using the rate of opportunity cost of capital. A positive NPV means the project is economically feasible.

c. Benefit-Cost (B/C) ratio

The B/C ratio is the ratio obtained by dividing the present value of benefit by that of cost.

$$\text{Benefit-Cost Ratio} = \frac{B}{C}$$

where

$$B = \sum_{i=1}^{n} \frac{bi}{(1+r)^i}$$

$$C = \sum_{i=0}^{n-1} \frac{Ci}{(1+r)^i}$$

bi : Benefit in the year (i)

Ci : Cost in the year (i)

r : Discount rate

n : Project life in years

Among the three economic indicators, the IRR is mainly used to establish the investment timing and the best conbination of the different alternative plans in this study.

6.2 Alternatives

(1) General

The alternatives discussed in the engineering and traffic

studies are evaluated economically with the following items:

a. Route

b. Access to the North Coastal Road

c. Typical Cross-Section

d. Stage Construction by Road Section and Segment

However, the stage acquisition of ROW as an alternative is not included in the economic alalysis because of the difficulty for acquisition of additional land after completion of the Project Road.

(2) Route Alignment

The alternative routes of the Outer Ring Road are discussed in the engineering study with the result that two (2) alternative routes are selected of which are shown in Fig. 6.1.

a. Plan 1 : The route passes through Jalan Gottlieb

b. Plan 2 : The route passes through Gurney Drive extension and skirts Mt. Olivia.

(3) Access to the North Coastal Road

An additional interchange is required at the North Coastal Road and the Project Road.
The types of access are as follows.

1) F : Full Access Interchange

2) P : Parrtial Access Interchange

3) N : No Additional Interchange

(4) Design of Typical Cross-Section

Preliminary engineering studies indicate the following typical cross-sections:

a. Two (2) - Lane road (2-L)

b. Four (4) - Lane road (4-L)

Based on the results of the traffic projection, the six (6)-lane road is not included in the economic analysis.

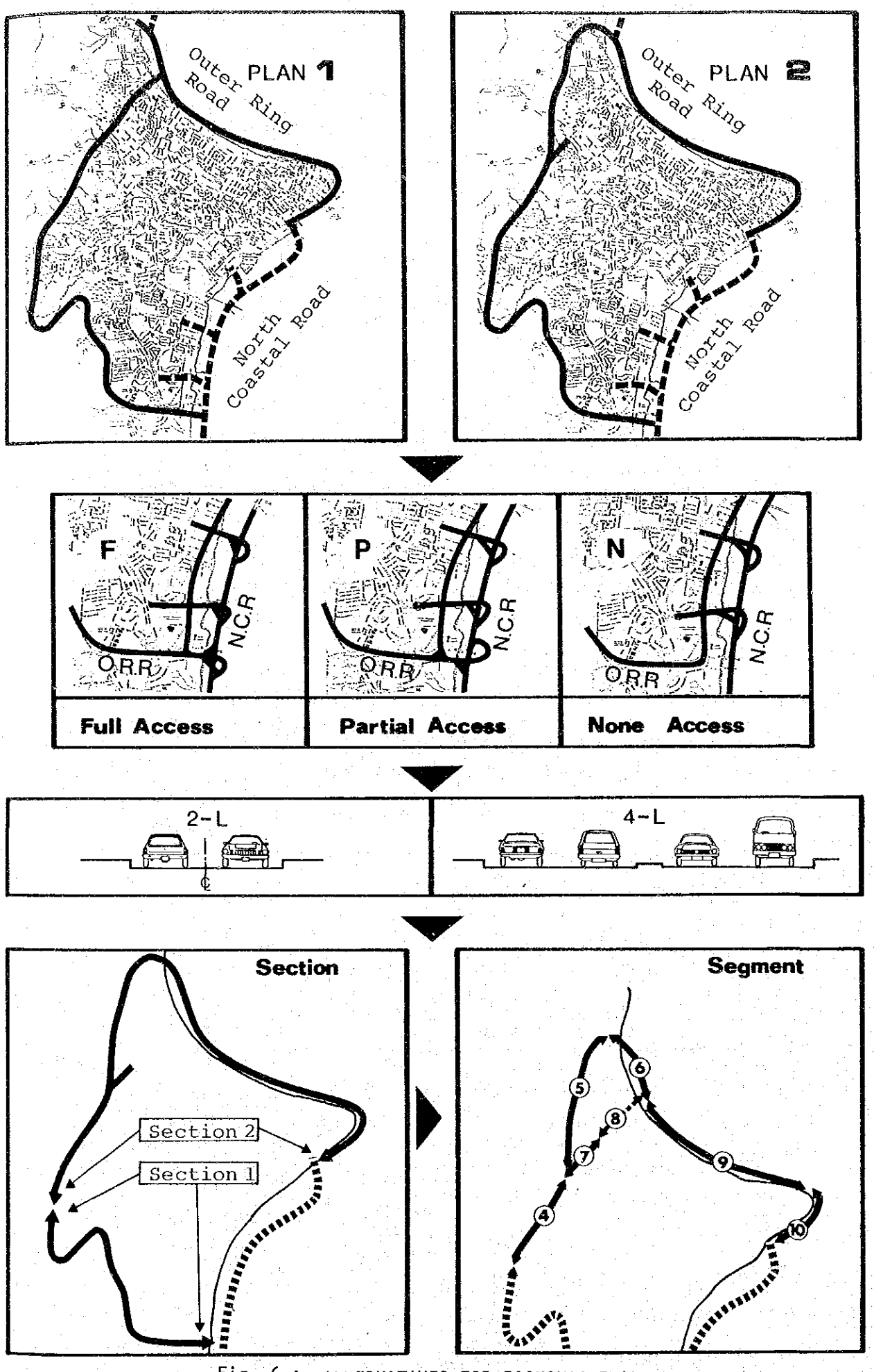


Fig. 6.1 ALTERNATIVES FOR ECONOMIC EVALUATION

(5) Stage Construction by Road Section and Segment

In the economic evaluation, the following alternatives of stage construction are adopted.

a. By Section

Section 1 : Southern Section of the Outer Ring Road
Section 2 : Northern Section of the Outer Ring Road

b. by Segment

Segments 4 and 7 : Ayer Itam to Western Road
Segments 5 and 6 : Encircling Mount Erskine Road
Segment 9 : Gurney Drive Extension

(The sections and segments above are the same as used in the traffic projection and cost estimate).

All the segments of Section 1 are evaluated at the same time because each segment by itself without the completion of all the other segments cannot serve traffic.

(6) Combination of Alternatives

The following combination of the above-mentioned alternatives are evaluated by economic analysis.

Table 6.1 COMBINATION OF ALTERNATIVES

Route	Access Type	Cross-Section	Stage Construction	
			Section	Segment
Plan 1	Full	4-lane	All	All
Plan 2	Full	2-lane	All	All
			Section 1	All
			Section 2	All 4 & 7 5 & 6 9
		4-lane	All	All
			Section 1	All
			Section 2	All 4 & 7 5 & 6 9
	Partial	4-lane	All	All
	None	4-lane	All	All

Combination of route, access type and cross-section are expressed in such abbreviations as;

Plan	Route	Access Type	Cross-section
Plan 1-F, 4-L	Plan 1	Full	4-Lane
Plan 2-F, 4-L	Plan 2	Full	4-Lane
Plan 2-P, 2-L	Plan 2	Partial	2-Lane
Plan 2-N, 2-L	Plan 2	None	2-Lane

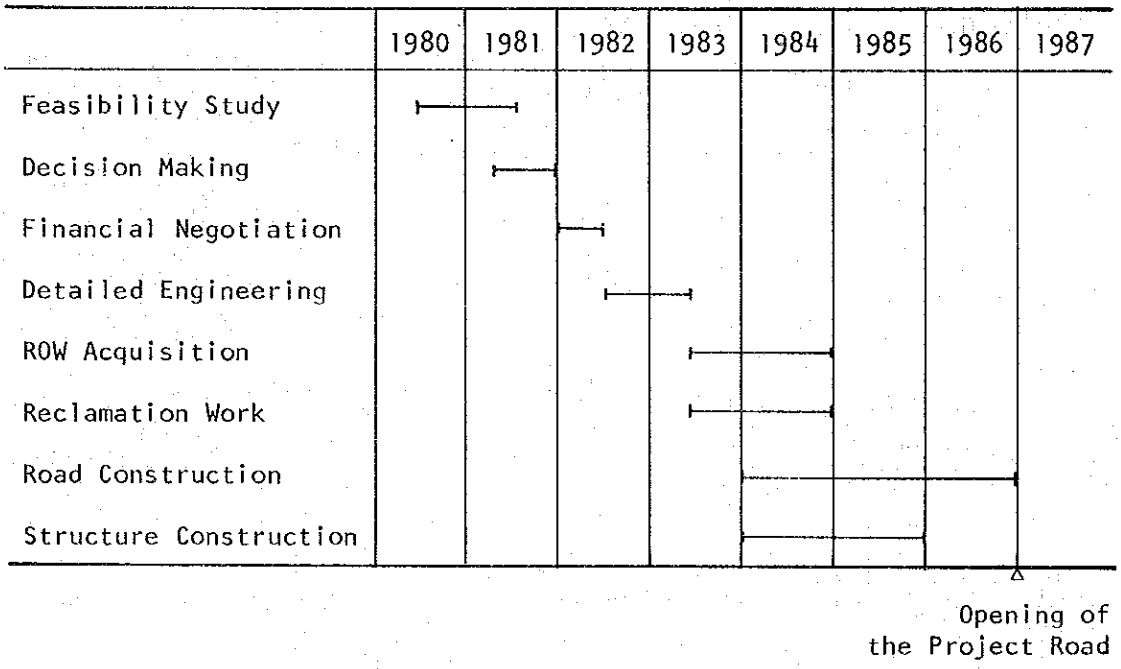
6.3 Economic Cost Estimate

6.3.1 Construction Schedule

For the purpose of reaching the best investment plan, a preliminary construction schedule including negotiation, detailed engineering and actual construction work is assumed and is described below.

April 1980 - March 1981	Feasibility Study
April 1981 - Dec. 1981	Decision Making
Jan. 1982 - June 1982	Financial Negotiation
July 1982 - June 1983	Detailed Engineering
July 1983 - Dec. 1984	ROW Acquisition
July 1983 - June 1985	Reclamation Work
Jan. 1984 - Dec. 1986	Road Construction
Jan. 1984 - Dec. 1985	Structure Construction

Fig. 6.2 CONSTRUCTION SCHEDULE



6.3.2 Economic Construction Cost

The construction cost estimates were described in detail in Chapter 5. The construction cost consist of land acquisition and compensation, reclamation, and construction of roadway and structure. The cost of reclamation, roadway and structure are sub-divided into

foreign and local component cost and taxes while the land acquisition and compensation cost are purely local component cost.

For the evaluation of the project, the cost and benefits are expressed in economic values and the economic cost are estimated from the financial cost less taxes.
The results of the economic cost estimates are shown in Table 6.2.

6.3.3 Stream of Economic Cost

Taking into consideration construction activities, the implementation period of the Project Road will take about 4 years. The distribution of the different cost per year is assumed as follows:

Year	Detailed Engineering (%)	Economic Cost Stream			
		Reclamation Work (%)	Road Construction (%)	Structure Construction (%)	Land Acquisition (%)
1982	50				
1983	50	25			50
1984		50			50
1985		26	30	50	
1986			30	50	
1987			40		

6.3.4 Maintenance Cost

The detailed estimate of the maintenance cost up to the economic life of the Project is described in Chapter 5.

6.4 Traffic Cost Study

6.4.1 General

The traffic cost used for the Phase II Study, follows that for the Phase I Study.

The traffic cost which excludes tax is basically divided into two: one is vehicle operating cost and the other is time cost. The vehicle operating cost is further sub-divided into two (2): running cost and fixed cost. The method of the traffic cost estimates in the Study is basically similar to that used in the "Year Book of Transport Statistics, 1975".

The vehicle operating costs are estimated based on the following

Table 6.2 ECONOMIC COST BY ALTERNATIVES

(In thousand M$ at 1980 Prices)

Route	Access Total	Cross Section	Stage Construction		Economic Cost	Components (M$ '000)			
			Section	Segment		Road & Structure	Reclamation	Land Acquisition	Detailed Engineering & Supervision
Plan 1	Full	4-Lane	All	All	137,791	64,204	14,485	51,564	7,538
Plan 2	Full	2-Lane	All	All	102,673	49,130	16,072	31,224	6,247
			Section 1	All	42,995	22,184	0	18,685	2,126
			Section 2	All	59,678	26,946	16,072	12,539	4,121
				4 & 7	17,078	9,872	0	6,261	945
				5 & 6	22,662	12,274	2,677	6,278	1,433
				9	19,938	4,800	13,395	0	1,743
		4-Lane	All	All	144,393	74,795	17,162	43,626	8,810
			Section 1	All	59,839	32,317	0	24,426	3,096
			Section 2	All	84,554	42,478	17,162	19,200	5,714
				4 & 7	26,046	14,511	0	10,144	1,391
				5 & 6	31,821	18,098	2,677	9,056	1,990
				9 & 10	26,687	9,869	14,485	0	2,333
	Partial	4-Lane	All	All	144,114	74,541	17,162	43,626	8,785
	None	4-Lane	All	All	141,483	72,843	17,162	42,856	8,622

vehicle types:

M/Cycle
Passenger Car
Mini-Bus
Stage-Bus
Pick-Up
Medium Truck
Heavy Truck

6.4.2 Vehicle Operating Cost

1. Running Cost.

(1) Fuel cost

The fuel cost is calculated based on fuel consumption per kilometer, the running speed and fuel price per litre.

(2) Oil cost

The coil cost is calculated on the basis of oil consumption per kilometer and oil price.

Note: . Planning and Research Division, Ministry of Communications, K.L.

. Highway Planning and Public Transport Unit, *Ministry of Works and Public Utilities*, K.L.

(3) Tyre cost

The tyre cost is calculated based on the tyre life span, annual running kilometer and set prices of tyres.

(4) Maintenance and repair cost

The maintenance and repair costs are divided into those of labour and spare parts cost. The labour cost is calculated by using the total labour hour for each type of vehicle while the cost of spare parts is estimated on the basis of vehicle cost in percentage.

(5) Depreciation cost

The distance determined depreciation cost is estimated by setting up the percentage of depreciation to the total

depreciation cost as shown in Table 6.3 which also indicates the salvage value.

Table 6.3 DEPRECIATION AND SALVAGE VALUE

	Percentage of Depreciation (%)	Salvage Value (% of Vehicle Cost)
M/Cycle	30	15
Private Car	30	20
Taxi	85	15
Bus	70	15
Light-Van	60	15
Medium Truck	70	15
Heavy Truck	70	15

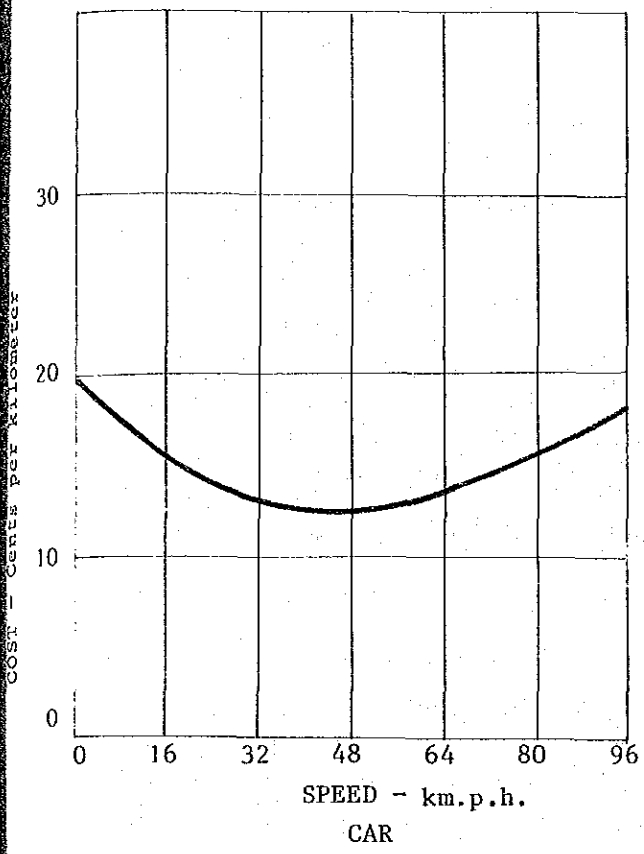
Source: Year Book of Transport Statistics 1975

(6) Running cost

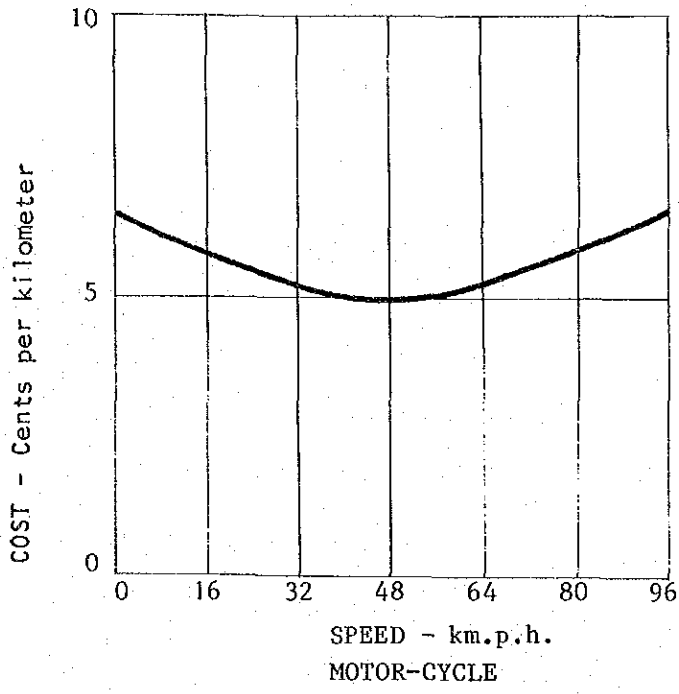
The basic running cost per kilometer is calcualted to sum up all elements mentioned above as shown in Table 6.4

Factors affecting running cost are vehicle speed and surface characteristics of the roads. However, as the surface condition of roads in Penang Island is good only vehicle speed is taken into account. Running cost by vehicle speed is shown in Fig. 6.4.

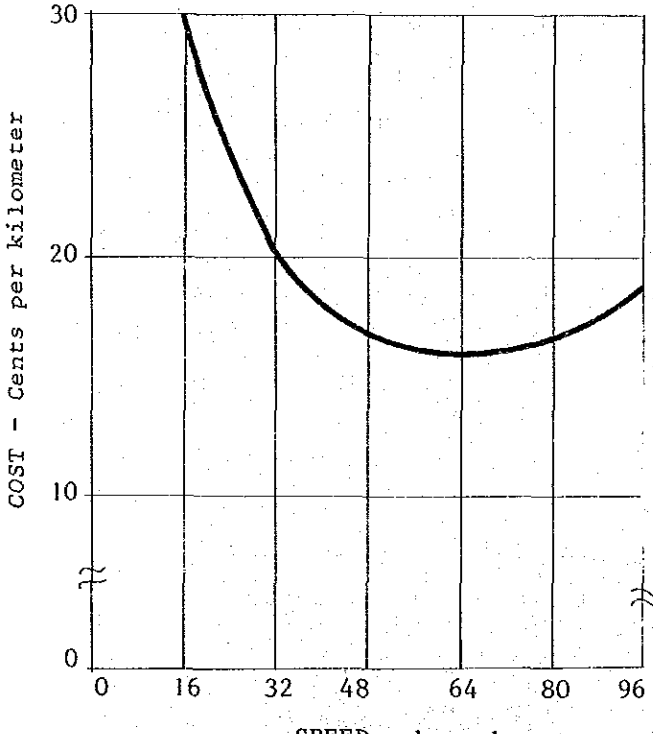
(Unit : Cents per km)



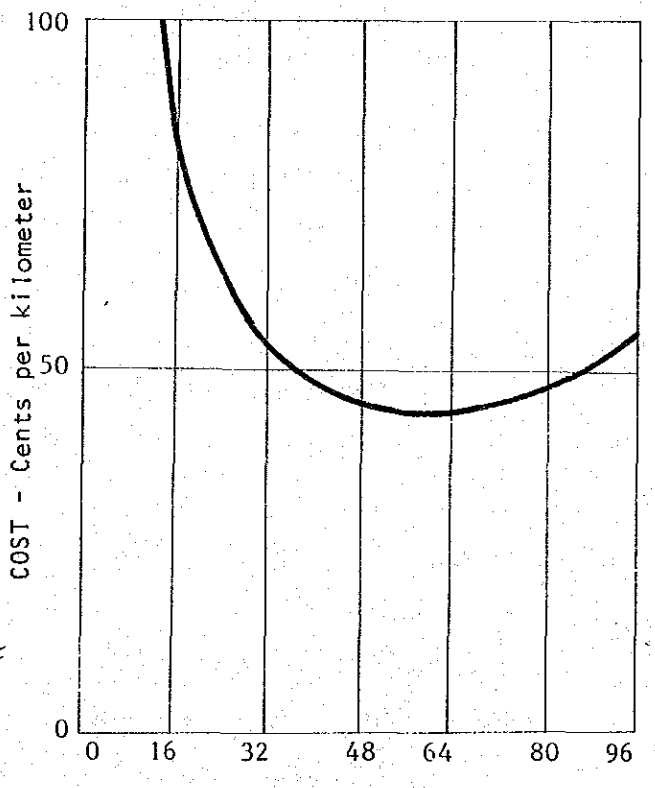
CAR



MOTOR-CYCLE



LIGHT TRUCK



HEAVY TRUCK

Fig. 6.3 RUNNING COST BY SPEED AND BY VEHICLE TYPE

Table 6.4 RUNNING COST

(Unit: cents per km at 1980 Prices)

	M/Cycle	Car	Taxi	Bus	Light Truck	Medium Truck	Heavy Truck
Running Cost	4.93	13.33	10.81	24.33	16.43	33.76	44.87
Fuel	2.56	6.75	4.05	7.15	6.84	9.45	12.80
Oil	0.27	0.93	1.14	1.30	1.12	1.30	1.98
Tyres	0.22	0.84	1.11	6.00	1.78	6.75	10.00
Maintenance	1.22	3.15	2.48	5.11	4.06	11.23	14.00
Depreciation	0.66	1.66	2.03	4.77	2.63	5.03	6.09

Note : Excluding tax

2. Fixed Cost.

(1) Crew cost

The crew cost is calculated separately for bus and truck drivers, bus conductors and cargo loading and unloading labourers for heavy trucks.

(2) Time-related depreciation

The time-related depreciation is given by subtracting the distance determined depreciation from total depreciation. Then the depreciation cost per hour is calculated by estimating vehicle life and annual running hours.

(3) Interest

Since the opportunity cost of capital was estimated at twelve percent (12%) annually, the interest cost in commercial vehicles are, therefore, calculated by using the same interest rate.

(4) Overhead cost

As a substitute for accident cost, insurance cost and overhead cost are included as a part of the fixed cost.

(5) Total fixed cost

After the determination of the various cost items above, the fixed cost per operational hour is estimated for each type of vehicle and is shown in Table 6.5.

Table 6.5 FIXED COST

(Unit : M$ per hour at 1980 Prices)

	M/C	Car	Taxi	Bus	Light-Van	Medium Truck	Heavy Truck
Fixed Cost	0.32	1.20	2.64	5.88	0.73	3.72	5.95
Crew	-	0.23	1.57	3.92	0.43	2.43	2.81
Depreciation	0.18	0.43	0.12	0.61	0.17	0.30	0.36
Interest	0.14	0.54	0.37	1.64	0.42	0.99	1.20
Overhead	-	-	0.58	2.23	0.43	1.60	1.58
Sub-total	0.32	1.20	2.64	8.40	1.45	5.32	5.95
Fleet substitutability factor	1.0	1.0	1.0	0.7	0.5	0.7	1.0

Note : Excluding tax

6.4.3 Time Cost

Time cost is calculated according to the family income approach method with the following assumptions:

1. Travellers will be willing to pay in order to save travel time
2. The traveller's value of travel time is a function of his personal income
3. The traveller's value of travel time is a function of his travel purpose

Time cost of each type of vehicle is calculated by the following formula.

$$Cj = Nj \cdot Ij \times \sum_{i} Ti \cdot Pi$$

where :

Cj : Time Cost of vehicle "j"
Nj : Average occupancy of vehicle "j"
Ij : Hourly income of passenger of vehicle "j"
Ti : Composition Ratio of Trip Purpose "i"
Pi : Time value factor of Trip Purpose "i"

Then each item of the formula is determined as follows.

1. Average Occupancy (Nj)

Passenger Car	:	1.65 Passengers/car
Motor-Cycle	:	1.30 Passengers/car
Bus	:	35 Passengers/car

2. Hourly Income (Ij)

The hourly income is calculated by annual income of families and annual working hours by non-vehicle owners, motor-cycle owners and motor-car owners.

Non-Vehicle Owner	1.30 M$/hour
Motor-Cycle Owner	2.17 M$/hour
Motor-Car Owner	4.87 M$/hour

3. Time value by Trip Purpose

The time value factor by each trip purpose is determined based on the aforementioned assumption and tabulated with the compostion ratio of each trip purpose to the total trip as shown below.

Trip Purpose (i)	Time Value Factor (Pi)	Composition Ratio (Ti)	
		for Owner	for none Owner
Business	100% of hourly income	25%	21%
To and from work	50% of hourly income	42%	59%
Private	No value	33%	20%
Total		100%	100%

Therefore : $\sum_i P_i \cdot T_i$ = 46% (for Vehicle Owner)

= 50.5% (for None Vehicle Owner)

Accordingly the time cost of each vehicle type is given as follows.

		M$/hr (1980 Price)
Passenger Car	:	3.7
Motor-Cycle	:	1.3
Bus	:	23.0

6.5 Benefit Estimates

6.5.1 Benefits Accounted

The direct benefits of the construction of the Project Road can be defined as the difference in the traffic cost between the case where the project is implemented and the case of where it is not with classification into three categories:

1. Vehicles which currently use the unimproved project roads (nomral traffic)
2. Vehicles which will be diverted to the project roads (diverted traffic)
3. Vehicles not diverted to the project roads (non-diverted traffic)

Normal traffic is that which will always use the Project Road with or without improvement and will experience benefits in terms of savings in running cost and travel time.

The diverted traffic relates to that which will be diverted to the project roads upon its completion with this diverted traffic experiencing savings in running cost and travel time compared to its previous longer and congested route.

In the case of the Outer Ring Road, most of it consists of newly constructed roads where only diverted traffic will run.

Non-diverted traffic will benefits in traffic cost terms due to decongestion of existing roads.

Besides these three kinds of benefits, there is also the generated benefits from generated traffic although this traffic was not taken into account in this study because it is anticipated to be negligible.

The benefit from the Project Road is therefore derived from normal, diverted and non-diverted traffic in the following way.

a. Reduction in travel time (Time Benefit)

b. Savings in vehicle operating cost (Running Benefit)

   - savings in running cost
   - savings in fixed cost

Indirect benefits like a boost to the tourist industry, the opportunity for starting new development etc. are intangible and therefore are not included in the benefit estimate.

6.5.2 Benefit Calculation Method

Each type of benefit is calculated using the following formulae.

a. Time benefits

$$TB = \sum_{ij} \left\{ P_{ij} \ (t_{ij}^{WO} - t_{ij}^{W}) \ V \right\}$$

where :

TB : time benefit

P_{ij} : passenger using the project road between zones i and j

t_{ij}^{WO} : travel time between zones i and j in the case where the project is not implemented

t_{ij}^{W} : travel time between zones i and j in the case where the project is implemented

V : time value

b. Savings in running cost

$$RB = \sum_{ij} \left\{ T_{ij} \ (L_{ij}^{WO} \cdot RC_{ij}^{WO} - L_{ij}^{W} \cdot RC_{ij}^{W}) + (t_{ij}^{WO} - t_{ij}^{W}) \times FC_{ij} \right\}$$

where :

RB : savings in running cost

T_{ij} : traffic volumes between zones i and j using the project road

L_{ij} : travel distance between zones i and j

RC_{ij} : running cost between zones i and j

FC_{ij} : fixed cost between zones i and j

c. Benefit Calculations

Using the network assignment model, the benefits of each alternative plan are calculated as follows.

Table 6.6 BENEFITS OF ALTERNATIVE PLANS

(In thousand dollars at 1980 Prices)

	Benefits in year		Remarks 1)
	1985	2000	
Plan 1-F, 4-L	19,601	62,561	2001
Plan 2-F, 4-L	21,718	69,606	2001
Plan 2-F, 2-L	17,374	55,079	1993
Plan 2-P, 4-L	20,914	69,459	2001
Plan 2-N, 4-L	20,112	66,795	2001
Plan 2F, 4-L			
Section 1	3,942	10,220	2011
Section 2	17,776	59,386	2000
Segments 4 & 7	9,378	31,182	1997
Segments 5 & 6	2,449	7,943	2011
Segments 9 & 10	5,949	20,261	2000
Plan 2F, 2-L			
Section 1	3,942	10,220	2009
Section 2	13,432	44,859	1992
Segments 4 & 7	7,616	25,117	1990
Segments 5 & 6	1,653	5,847	2000
Segment 9	4,163	13,895	1990

Note : 1) Year that the traffic demand on the Project Road exceeds its capacity.

The yearly benefits are calculated based on the following assumptions.

(a) The yearly benefits are estimated using the annual growth rate of benefits of years 1985 and 2000.

(b) The yearly benefits are constant after the traffic demand on the Project Road exceeds its capacity.

6.6 Economic Analysis

6.6.1 Evaluation for Alternative Routes

The results of the economic analysis of the alternative routes are summarized in Table 6.7 where the economic indicators show that both plans are feasible although, Plan 2 is economically more feasible than Plan 1.

Table 6.7 ECONOMIC INDICATORS BY PLAN

Route Alternatives	Discounted Benefits ($ '000)	Discounted Cost ($ '000)	B/C Ratio	Net Present Value ($ '000)	Internal Rate of Return (%)
Plan 1-F, 4-L	157,519	88,309	1.78	69,210	18.2
Plan 2-F, 4-L	175,019	92,021	1.90	82,998	19.1

Notes : a. Discount Rate : 12%
b. Project Lige : 25 years

6.6.2 Evaluation for Alternative Cross-Section

The economic analysis of the alternative cross-section plans is shown in Table 6.8. Both plans are economically feasible. However, the 4-lane road plan is more feasible than the 2-lane road plan as the former has a higher B/C ratio, NPV as well as the I.R.R.

Table 6.8 ECONOMIC INDICATORS BY NUMBER OF LANES

	Discounted Benefits ($ '000)	Discounted Cost ($ '000)	B/C Ratio	Net Present Value ($ '000)	Internal Rate of Return (%)
Plan 2-F, 4-L (4-lane road)	175,019	92,021	1.90	82,998	19.1
Plan 2-F, 2-L (2-lane road)	111,087	65,811	1.69	45,276	18.5

Notes : a. Discount rate : 12%
b. Project Life : 25 years

6.6.3 Evaluation for Access to North Coastal Road

Alternative access plans to the North Coastal Road are evaluated from an economic viewpoint for the purpose of determining whether these plans will be viable.

The result of economic analysis of access plans is shown in Table 6.9. From this table, it is found that Plan 2-F which has a full service interchange has higher feasibility compared with the other plans from the economic point of view.

Table 6.9 ECONOMIC INDICATORS BY ACCESS PLAN

	Discounted Benefit ($ '000)	Discounted Cost ($ '000)	B/C Ratio	Net Present Value ($ '000)	Internal Rate of Return (%)
Plan 2-F, 4-L (Full Service)	175,019	92,021	1.90	82,998	19.1
Plan 2-P, 4-L (Partial Service)	172,624	91,863	1.88	80,761	18.9
Plan 2-N, 4-L (No Service)	166,002	90,230	1.84	75,772	18.6

Notes : a. Discount rate : 12%
b. Project life : 25 years

6.6.4 Evaluation by Section

Plan 2, which passes through Mount Erskine (route K), is considered the most viable route. However, combined alternative plans by road section and cross-section plans are evaluated.

The results of the economic analysis of Section 1 and 2 with the four (4)-lane and two (2)-lane road plans are shown in Table 6.10.

Table 6.10 ECONOMIC INDICATORS BY SECTION AND CROSS-SECTION

	Discounted Benefit ($ '000)	Discounted Cost ($ 000)	B/C Ratio	Net Present Value ($ '000)	Internal Rate of Return (%)
Section 1,					
Plan 2-F, 4-lane	30,772	37,987	0.81	- 7,215	10.1
Plan 2-F, 2-lane	29,892	27,391	1.09	2,501	12.8
Section 2,					
Plan 2-F, 4-lane	143,460	54,030	2.65	89,430	23.8
Plan 2-F, 2-lane	81,216	38,421	2.11	42,795	22.7

Notes : a. Discount Rate : 12%
b. Project Life : 25 years

From this table, the following observations can be made.

a. In section 1, the two (2)-lane road plan is feasible with an IRR of 12.8%. However, the four (4)-lane road plan is not economically feasible as its economic indicators are lower than the opportunity rate of capital. If the investment timing of the four (4)-lane plan is deferred year by year, this plan could be feasible however, concerning this point, analysis will be done later.

b. In section 2, both the two (2)-lane and four (4)-lane road plans are economically feasible. However, the four (4)-lane plan has an advantage over the two (2)-lane plan.

Fig. 6.4 shows the relationship between the opening year of the 4-lane road of section 1 of the Project Road and the IRR. According to this figure, the four (4)-lane road plan of this section will be feasible if this plan is implemented after the year 1991.

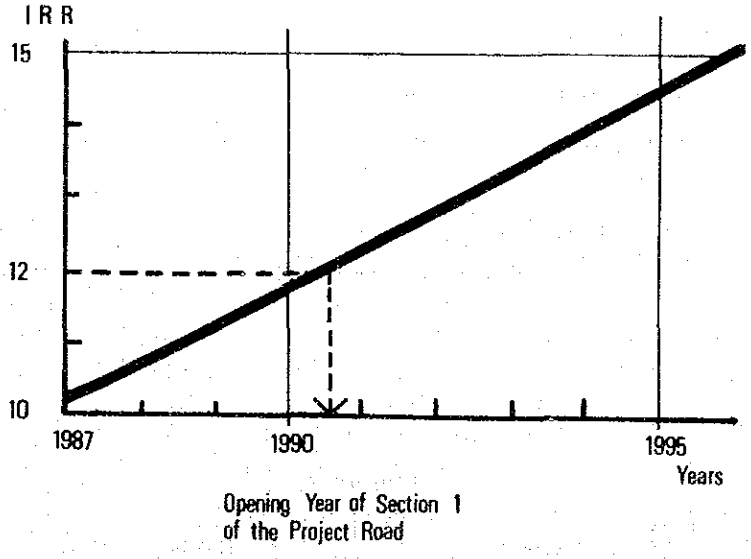


Fig. 6.4 RELATIONSHIP BETWEEN IRR AND OPENING YEAR OF SECTION 1

6.6.5 Priority of Road Segments

The purpose of this analysis is to clarify the priority ranking of the road segments in the Project Road although it is made only for

section 2 of the Project Road due to the comparatively low economic indicators of section 1. The results of the analysis indicates the segments 4 and 7 (from Ayer Itam Road to Jalan Gottlieb) have first priority covers segments 9 and 10 while the last being segments 5 and 6.

Table 6.11 ECONOMIC INDICATORS BY ROAD SEGMENTS

Segment	Discounted Benefit ($ '000)	Discounted Cost ($ '000)	B/C Ratio	Net Present Value ($ '000)	Internal Rate of Return (%)
Seg. 9					
2-lane road	22,512	13,078	1.72	9,434	18.8
Seg. 9 and 10					
4-lane road	46,806	17,150	2.73	29,656	23.7
Seg. 4 and 7					
4-lane road	75,589	16,670	4.53	58,919	32.6
2-lane road	42,793	10,904	3.92	31,889	27.8
Seg. 5 and 6					
4-lane road	21,065	20,212	1.04	853	12.5
2-lane road	15,911	14,440	1.10	1,471	12.9

Notes : 1. Project life : 25 years
2. Discount rate : 12%

6.7 Sensitivity Analysis

The sensitivity analysis of the Project Road is made by postulating a change in the following conditions:

1. Increase in the Project Cost
2. Decrease in the Project Benefit
3. Increase in the Project Cost and a decrease in the Project Benefit
4. Change in Construction Cost Stream
5. Shortening of Project Life
6. Change in growth rate of motorcar and motor-cycle traffic

The detailed examination is presented below:

(1) Construction cost

The factors which influence the construction cost are as follows:

a. Quantity

b. Unit cost of material

c. Unit cost of equipment

d. Efficiency of equipment

e. Efficiency of labour

An increase of 20% in the project cost accrues changes in the above factors while occurring no change in the project benefits the results of which are shown in Table 6.14. Even when the project cost is increased by 20%, plans 1-F, 2-F and 2-P are still feasible.

(2) Project benefit

Even if the project benefit is reduced by 20% while the project cost remains unchanged, all plans are still feasible as shown in Table 6.14.

Taking this a step further even when the project cost is increased by 20% and at the same time the benefit decreased by 20%, the 3 plans are found to be still feasible.

(3) Construction Cost stream

A study is made to effect a change in the yearly stream of the construction cost where a larger initial cost is required compared to the original case while the construction period is kept constant as shown below:

Table 6.12 YEARLY STREAM OF CONSTRUCTION COST

(In Percentage)

Year	Land Acquisition	Reclamation Work	Roadway Construction	Structure Construction
1983	50%	50%		
1984	50	50	50%	50%
1985			30	50
1986			20	

As is clear from Table 6.14, even when the yearly stream is changed, all plans are still feasible.

(4) Project life

A study is made of the case where the project life is cut by 5 years from 25 years to 20 years but even with this change, all plans are still feasible.

(5) Change in the Growth Rate of M/Car and M/Cycle Traffic

In the traffic projection of case 'A', the motorcar trips in the study area are expected to grow at an average annual growth rate of 4.6 percent between 1979 and the year 2000. On the other hand, the motor-cycle trip in the area is expected to decrease slightly from 137.1 thousand in 1979 to 126.4 thousand in 2000.

In the sensitivity analysis, case 'B' is examined where growth of the motor-cycle trip in the Study Area follows past trends while the motorcar tip is slightly less than the original projection.

Table 6.13 TRAFFIC PROJECTION FOR SENSITIVITY ANALYSIS (CASE B)

	1979	1985	2000
Motorcar			
Study Area	277.1	333.8	585.4
External Area	4.7	7.0	22.9
Penang Island	281.8	340.8	608.3
	(100)	(121)	(216)
Motor-Cycle			
Study Area	135.9	164.9	263.7
External Area	1.2	1.5	2.4
Penang Island	137.1	166.4	266.1
	(100)	(121)	(194)

Even if the motor-cycle trip is expected to increase from the original projection and the motorcar trip decreases, the project is still feasible as indicated in Table 6.14.

Table 6.14 RESULTS OF SENSITIVITY ANALYSIS

Plan / Conditions	Plan 1-F (Full Service)			Plan 2-F (Full Service)			Plan 2-P (Partial Service)		
	B/C Ratio	NPV ($ '000)	IRR (%)	B/C Ratio	NPV ($ '000)	IRR (%)	B/C Ratio	NPV ($ '000)	IRR (%)
1. Original Results	1.78	69,210	18.2	1.90	82,998	19.1	1.88	80,761	18.9
2. 20% Cost Increase	1.49	52,034	16.1	1.59	65,163	16.9	1.57	62,957	16.7
3. 20% Benefit Decrease	1.49	42,955	16.1	1.59	53,828	16.9	1.57	51,992	16.7
4. 20% Cost Increase and 20% Benefit Decrease	1.24	25,779	14.2	1.33	35,993	14.9	1.32	34,188	14.7
5. Change in Cost Stream	1.73	66,441	17.7	1.84	80,086	18.5	1.82	77,857	18.3
6. Project Year 20 Years	1.64	56,529	17.7	1.75	68,891	18.6	1.73	66,651	18.4
7. Change in Growth Rate of M/cycle and M/car Traffic	-	-	-	1.66	60,341	17.3	1.54	49,412	16.5

6.8 Conclusions of Project Appraisal

Through the economic evaluation in addition to the engineering and environmental studies, the Outer Ring Road is clarified to be feasible with the following recommendations.

6.8.1 Route

Plan 2 which passes through the outskirts of Mt. Olivia is recommended due to its superior economic indicators as well as its lower adverse effect on the existing environment along the route as compared with Plan 1.

6.8.2 Access to the North Coastal Road

The result of economic evaluation indicates that the full access to the North Coastal Road is more feasible than the partial access. From the engineering aspect, however, the partial access is more acceptable due to the technical difficulty involved in the full interchange which cannot yield the adequate weaving length desirable to meet the service level of traffic on the North Coastal Road.

Through discussion with the Government of Malaysia, the partial access was finally chosen as a recommended plan.

* Note : This matters were also discussed at Bridge Committee.

6.8.3 Cross Section

From the whole stretch of the Outer Ring Road, a four-lane road should be constructed. However the right of way may differ in each area as discussed in Chapter 4. For example, off Gurney Drive, at least 20 meters of buffer zone to the existing properties and 10 meters of promenade to the sea are recommended for improved landscaping of the area as well as for recreational activities for citizens and tourists.

6.8.4 Priority in Project

Section 2 (northern section of the Outer Ring Road) should be given a higher priority for implementation. Especially segments 4, 7, 9 and 10. These segments are most necessary for implementation first as a relief measure for Jallan Ayer Itam, Jallan Buruma and Jallan Northam from an anticipated over flow of traffic in about 1985 and also, these segments have shown very high economic indicators.

However, section 1 is recommended to be opened in about 1991 after the opening of section 2.

In addition to the Outer Ring Road, the extension of Weld Quay is also very important for dispersing the traffic from the North Coastal Road which would result in the better functioning of the Outer Ring Road.

7. IMPELMENTATION PROGRAM

7.1 General

The main purpose of this chapter is to establish the implementation program for the construction of the Project Road taking into account the available financial resources of the Malaysian Government, investment requirements of Highway Projects and investment timing of the Project Road. The implementation program will be established according to the following procedure:

1. Comparative analysis between highway funds and investment requirements of highway projects.
2. Financial cost estimates.
3. Preparation of implementation schedule.
4. Annual investment requirements.

Through discussions with the Government of Malaysia, the implementation program for Plan 2-P was prepared, calling for a 4-lane road with a partial interchange to the North Coastal Road of and detailed description is presentend below.

7.2 Comperative Analysis between Highway Funds and Investment Requirements

7.2.1 Forecast of Highway Funds

The comparative analysis between highway funds and investment requirements of the proposed projects was already made in the implementation program of the Phase I Study. The Phase II Study, therefore, follows basically the analysis which is made in the Phase I Study.

In order to estimate the future highway funds, the past data is examined. Table 7.1 shows the past trend of expenditures during 1972 to 1978, showing that the growth rate of road expenditure was 14 percent per annum during 1972. The road expenditure is further subdivided into that of Federal Road expenditure and of State Road expenditure as shown in Table 7.2.

Table 7.1 ROAD EXPENDITURE (1972 - 1975)

(Million dollars at current prices)

Year	Road Expenditure	Federal Road Expenditure	State Road Expenditure
1972	167.4	59.5	107.9
1973	203.9	94.3	109.6
1974	280.1	131.2	148.9
1975	325.9	173.6	152.3
1976*	370.8	-	-
1977*	424.0	-	-
1978*	414.0	-	-

Source : Highway Planning Unit

* Estimated provisionally by HPU.

The amount of road expenditure is largely dependent upon the national revenue which is proportionate to the G.D.P. Therefore, in this forecast, it is assumed that the road expenditure will grow in proportion to the G.D.P. As a result, the road expenditure is expected to increase from $445.9 million in 1978 to $711.5 million in 1985 and to $2,149.7 million in the year 2000. The allocation of road expenditure to the Study Area is assumed at 2 percent, 4 percent, 6 percent and 8 percent to total road expenditure. The results are shown in Table 7.2 and 7.3.

Table 7.2 FORECAST OF BUDGET (1981 - 2000)

(Million dollars at 1979 prices)

Year	Road Expenditure	Federal Road Expenditure	State Road Expenditure
1979	445.9	252.0	193.9
1985	711.5	602.0	309.5
2000	2,149.7	1,214.6	935.1

Table 7.3 FORECAST OF BUDGET ALLOCATED TO THE STUDY AREA

(Million dollars at 1979 prices)

Year	Road Expenditure	Allocation to Study Area			
		2%	4%	6%	8%
1981	521.1	10.4	20.8	31.3	42.7
1985	711.5	14.2	28.5	42.7	56.9
1990	1,028.6	20.6	41.1	61.7	82.7
2000	2,149.7	43.0	86.0	129.0	174.0

7.2.2 Investment Requirements for Highway Projects in Penang

The investment requirements for the highway projects including the Project Road were established in the Master Plan Study. According to this program 23 projects for Penang Island and 20 projects for Province Wellesley amounting to M$608 million were proposed.

The investment requirements of highway projects for the next five years from 1981 to 1985 will be about M$200 million and those for the following five years from 1986 to 1990 will be about M$219 million.

Table 7.4 INVESTMENT REQUIREMENTS BY PHASE
(In thousand M$ at 1979 prices)

	Phase 1 (1981-1985)	Phase 2 (1986-1990)	Phase 3 (1991-2000)	Total
Highway Projects	199,525	218,712	189,714	607,951
Intersection Improvements	38,741	19,755	7,030	65,526
Others	7,718	679	172	8,569
Total	245,984	239,146	196,916	682,046

Notes : 1) The construction cost includes the detailed engineering and construction supervision.

2) The cost of the ORR project is included in Phase 1 and 2.

7.2.3 Comparison between Funds and Expenditure

If an average of about 3% of the total Budget of Malaysia during 1981 to the year 2000 is allocated to the Study Area of the Phase I Study, it seems possible to complete all the projects propsed in the Phase I Study. However, it is necessary to implement some projects in a later phase.

Table 7.5 COMPARISON BETWEEN FUNDS AND EXPENDITURE

(In million M$ at 1979 prices)

	Investment Requirements	Highway Funds
Phase 1 1981 - 1985	246.0	91.7
Phase 2 1986 - 1990	239.1	133.7
Phase 3 1991 - 2000	196.9	472.8
Total	682.0	698.2

7.3 Implementation Schedule

To establish the implementation program of the Project, the results of the project evaluation and the available financial resource allocated for the Project Road should be taken into account. The results of the comparative analysis between highway funds and investment requirements of the proposed projects show that a large amount of funds is expected to be required for the 10 years (1981-1990). Considering those conditions, the Project Road should be implemented in stages and over a longer period than the period from 1983 to 1986 which was employed in the economic analysis.

On the other hand, the results of the project evaluation show the following:

1. Staging of the acquisition for right of way and construction with a 2-lane road to be constructed initially but further widening with an additional 2-lane is not included in the schedule due to the difficulties anticipated in implementation.

2. Staging of the construction of road section and segment should be incorporated into the stage construction plan taking into account the priority section and the segment discussed in the previous section.

   Considering the results of the above mentioned, the following stage construction plan is recommended:

   Phase 1 : Northern Section (Section 2) of the Project Road (Jalan Ayer Itam-ORR intersection to Jalan Prangin-Weld Quay intersection)

Stage 1 : Segments 4 and 7
(Jalan Ayer Itam-ORR intersection to Jalan Gottlieb-ORR intersection)

Stage 2 : Segments 9 and 10
(Jalan Bagan Jermal - Gurney Drive intersection to Jalan Prangin-Weld Quay Road intersection)

Stage 3 : Segments 5 and 6
(Jalan Gottlieb - ORR intersection to Jalan Bagan Jermal-Gurney Drive intersection via Mount Erskine Road - ORR intersection)

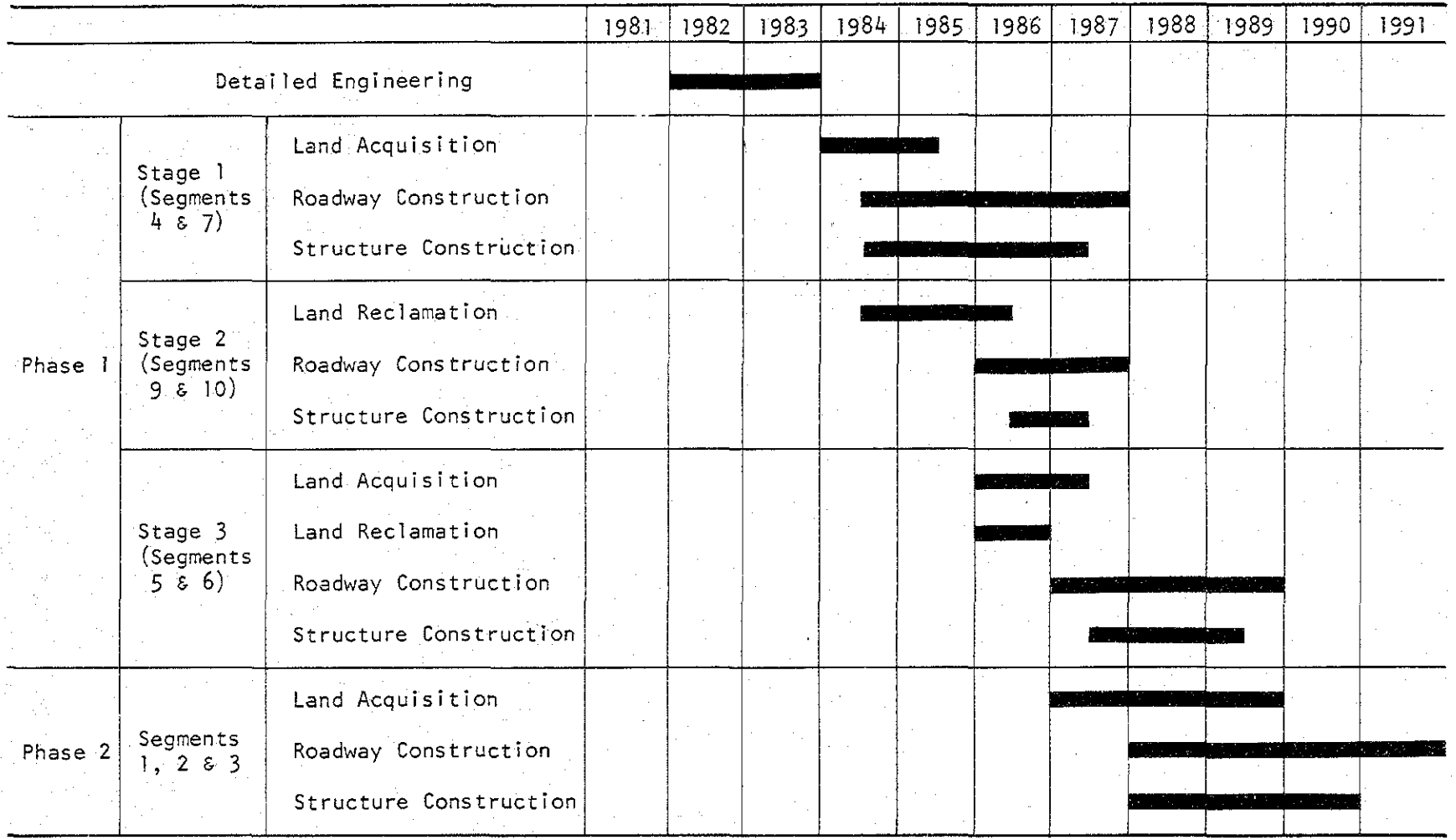
Phase 2 : Southern Section (Section 1) of the Project Road (Jalan Ayer Itam - ORR intersection to NCR - ORR intersection)

Following the stage construction plan, the implementation schedule for two phases and three stages, as shown in Fig. 7.1, is recommended.

7.4 Investment Requirements

The annual investment requirements of the Project Road are set based on the implementation schedule. The amount of annual investment required consists of land acquisition and compensation and construction of raodway and structures.

Fig. 7.1 RECOMMENDED IMPLEMENTATION SCHEDULE



The yearly investment requirements are presented in 1980 prices and broken down into foreign and local currency. The investment requirements of the Project Road by phase and stage are shown in Table 7.6. The annual investment requirements of the Project Road are shown in Table 7.7 to Table 7.12.

Table 7.6 SUMMARY OF FINANCIAL COST

(In thousand M$ at 1980 Prices)

	Foreign	Local	Total
Detailed Engineering and Construction Supervision	3,297	6,001	9,298
Phase 1			
Land Acquisition	-	19,200	19,200
Construction	28,786	34,365	63,151
Sub-Total	28,786	53,565	82,351
Stage 1			
Land Acquisition	-	10,144	10,144
Construction	7,705	7,584	15,289
Sub-Total	7,705	17,728	25,433
Stage 2			
Land Acquisition	-	0	0
Construction	10,953	15,043	25,996
Sub-Total	10,953	15,043	25,996
Stage 3			
Land Acquisition	-	9,056	9,056
Construction	10,128	11,738	21,866
Sub-Total	10,128	20,794	30,922
Phase 2			
Land Acquisition	-	24,426	24,426
Construction	14,871	18,770	33,641
Sub-Total	14,871	43,196	58,067
Total Land Acquisition	-	43,626	43,626
Construction	43,657	53,135	96,792
Total	43,657	96,761	140,418
Grand Total	46,954	102,762	149,716

Note : Tax is included in the 'Local' portion.

Table 7.7 ANNUAL INVESTMENT REQUIREMENTS FOR PHASE 1 AND PHASE 2

(In thousand M$ at 1980 Prices)

	Land Acquisition (Local)	Road Construction			Total		
		Foreign	Local	Total	Foreign	Local	Total
1982	-	603	1,170	1,773	603	1,170	1,773
1983	-	604	1,170	1,774	604	1,170	1,774
1984	6,763	3,070	3,521	6,591	3,070	10,284	13,354
1985	3,381	6,140	7,043	13,182	6,140	10,424	16,564
1986	6,037	7,832	9,956	17,788	7,832	23,825	31,657
1987	11,161	6,747	8,502	15,249	6,747	19,663	26,410
1988	8,142	8,260	9,495	17,755	8,260	25,897	34,157
1989	8,142	7,158	8,628	15,786	7,158	16,770	23,928
1990	-	4,356	5,370	9,726	4,356	5,370	9,726
1991	-	2,184	4,281	6,465	2,184	4,281	6,465
Total	43,626	46,954	59,136	106,090	46,954	102,762	149,716

Note : The construction cost includes the detailed engineering and construction supervision.

Table 7.8 ANNUAL INVESTMENT REQUIREMENT FOR PHASE 1

(In thousand M$ at 1980 Prices)

	Land Acquisition (Local)	Road Construction			Total		
		Foreign	Local	Total	Foreign	Local	Total
1984	6,763	2,898	3,324	6,222	2,898	10,087	12,985
1985	3,381	5,796	6,648	12,444	5,796	10,029	15,825
1986	6,037	7,393	9,398	16,791	7,393	15,435	22,828
1987	3,019	6,369	8,026	14,395	6,369	11,045	17,414
1988	-	3,685	3,894	7,579	3,685	3,894	7,579
1989	-	2,645	3,075	5,720	2,645	3,075	5,720
Total	19,200	28,786	34,365	63,151	28,786	53,565	82,351

Note : Exclude detail engineering and construction supervision.

Table 7.9 ANNUAL INVESTMENT REQUIREMENTS FOR STAGE 1, PHASE 1

(In thousand M$ at 1980 Prices)

	Land Acquisition (Local)	Road Construction			Total		
		Foreign	Local	Total	Foreign	Local	Total
1984	6,763	1,220	1,169	2,389	1,220	7,932	9,152
1985	3,381	2,440	2,337	4,777	2,440	5,718	8,158
1986	-	2,440	2,337	4,777	2,440	2,337	4,777
1987	-	1,605	1,741	3,346	1,605	1,741	3,346
Total	10,144	7,705	7,584	15,289	7,705	17,728	25,433

Note : Exclude detail engineering and construction supervision.

Table 7.10 ANNUAL INVESTMENT REQUIREMENTS FOR STAGE 2, PHASE 1

(In thousand M$ at 1980 Prices)

	Land Acquisition (Local)	Road Construction			Total		
		Foreign	Local	Total	Foreign	Local	Total
1984	-	1,678	2,155	3,833	1,678	2,155	3,833
1985	-	3,356	4,311	7,667	3,356	4,311	7,667
1986	-	3,799	5,366	9,165	3,799	5,366	9,165
1987	-	2,120	3,211	5,331	2,120	3,211	5,331
Total	-	10,953	15,043	25,996	10,953	15,043	25,996

Note : Exclude detail engineering and construction supervision.

Table 7.11 ANNUAL INVESTMENT REQUIREMENTS FOR STAGE 3, PHASE 1

(In thousand M$ at 1980 Prices)

	Land Acquisition (Local)	Road Construction			Total		
		Foreign	Local	Total	Foreign	Local	Total
1986	6,037	1,154	1,695	2,849	1,154	7,732	8,886
1987	3,019	2,644	3,074	5,718	2,644	6,093	8,737
1988	-	3,685	3,894	7,579	3,685	3,894	7,579
1989	-	2,645	3,075	5,720	2,645	3,075	5,720
Total	9,056	10,128	11,738	21,866	10,128	20,794	30,922

Note : Exclude detail engineering and construction supervision.

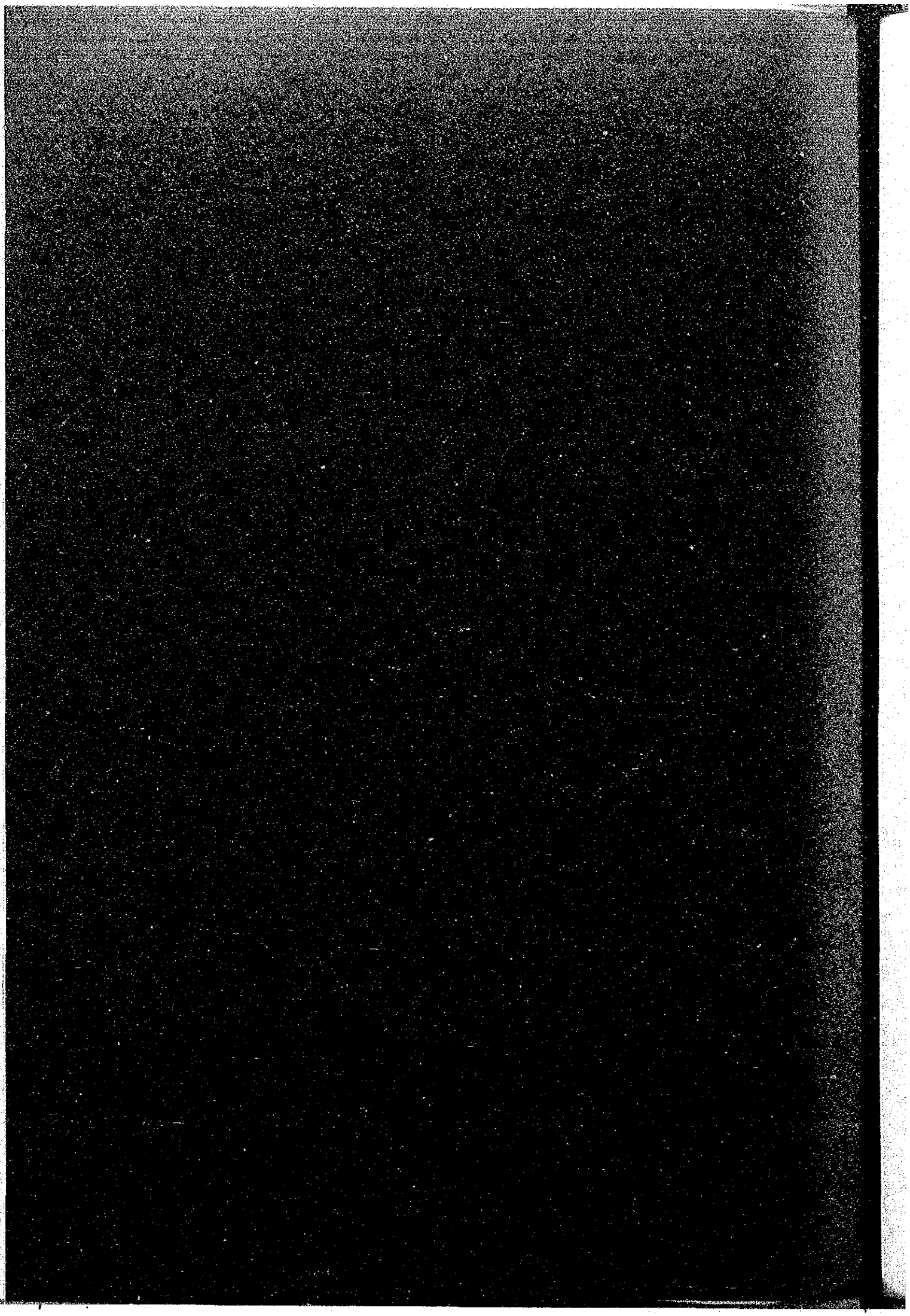
Table 7.12 ANNUAL INVESTMENT REQUIREMENT FOR PHASE 2

(In thousand M$ at 1980 Prices)

	Land Acquisition (Local)	Road Costruction			Total		
		Foreign	Local	Total	Foreign	Local	Total
1987	8,142	-	-	-	-	8,142	8,142
1988	8,142	4,112	5,069	9,181	4,112	13,211	17,323
1989	8,142	4,112	5,069	9,181	4,112	13,211	17,323
1990	-	4,112	5,069	9,181	4,112	5,069	9,181
1991	-	2,535	3,563	6,098	2,535	3,563	6,098
Total	24,426	14,871	18,770	33,641	14,871	43,196	58,067

Note : Exclude detail engineering and construction supervision.

APPENDICES



1. 0-D Tables

O-D TABLE IN YEAR 2000

(Unit : p.c.u.)

	CENTER	INNER			OUTER				OTHERS			MAINLAND		TOTAL
	1	2	3	4	5	6	7	8	9	10	11	12	13	
1	84118	19572	23482	30592	26600	32239	16588	22760	20866	10729	50186	4163	13033	354928
2		2582	3232	3557	6384	4836	2435	2858	3950	1516	6806	518	1731	59977
3			3065	7309	4622	9217	3766	4954	3968	2118	9412	669	2170	77984
4				5903	5217	10949	4507	8548	4951	3001	14745	1014	3139	103432
5					8257	8954	6813	5896	12333	3268	13595	1027	3366	106332
6						9348	9700	11390	7264	4311	17668	1160	3802	130838
7							7283	6969	5371	3629	11744	819	2581	82205
8								8261	5559	4368	24970	1247	4040	111820
9									11720	3517	15734	1416	4795	101444
10										2955	18147	1180	4048	62787
11											76123	4387	14193	277710
12														17600
13														56898
TOTAL														881785

O-D TABLE IN 1985

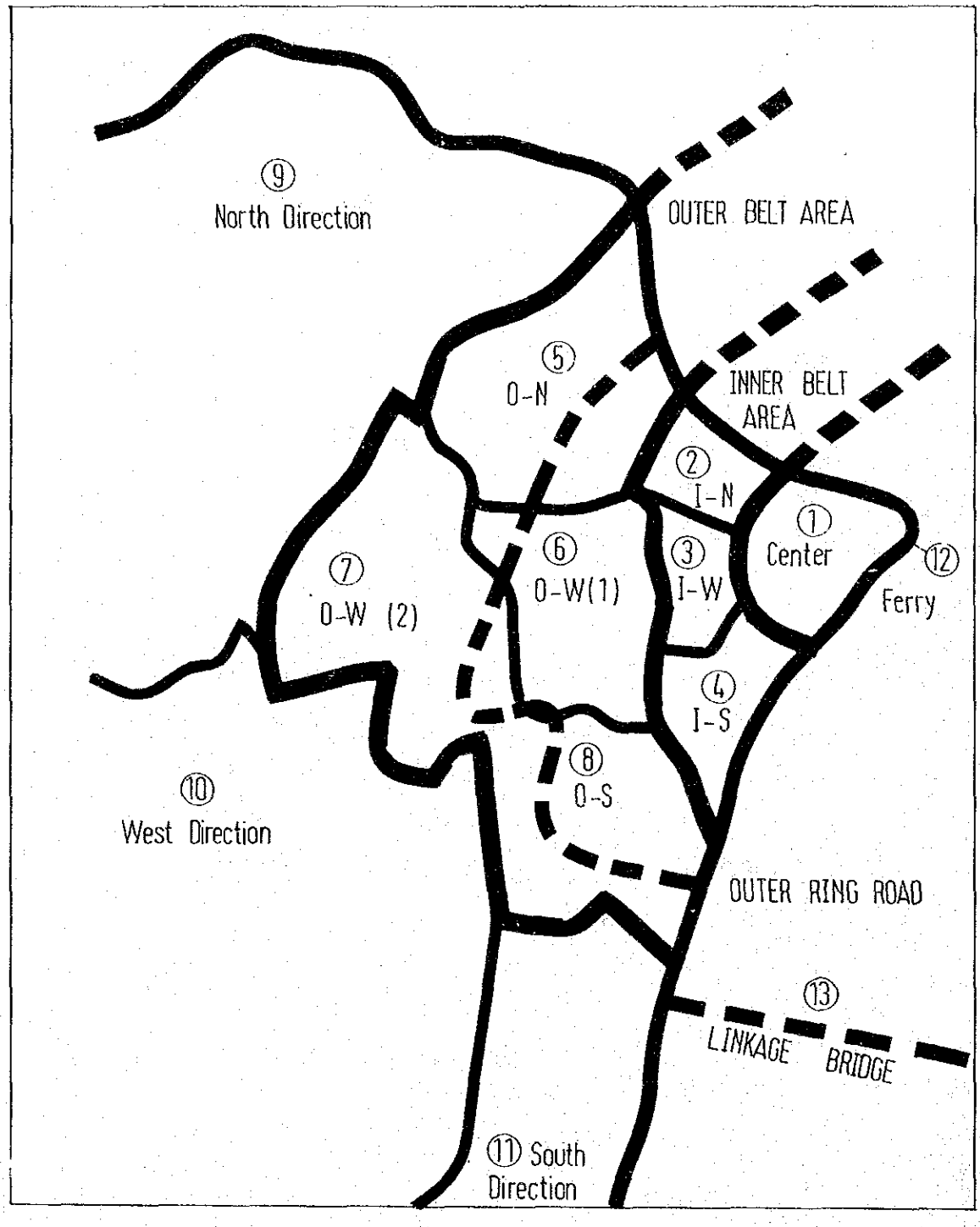
(Unit : p.c.u.)

	CENTER	INNER			OUTER				OTHERS			MAINLAND		TOTAL
	1	2	3	4	5	6	7	8	9	10	11	12	13	
1	71075	11486	22161	22739	22087	22838	11458	16769	10743	4227	24714	1940	7207	249444
2		1094	2134	1835	4121	2295	1110	1396	1411	416	2207	144	659	30308
3			3488	6643	4381	7837	2840	4194	2270	966	5134	327	1346	63721
4				4641	3931	7815	2713	6704	2277	1154	6920	441	1583	69396
5					7800	6543	5195	4116	6510	1316	6377	420	1844	74641
6						6468	5556	7611	3157	1511	7454	416	1804	81305
7							5632	3600	2307	1160	4413	306	1114	47404
8								5776	2382	1553	11873	505	1938	68417
9									4979	909	4609	357	1619	43530
10										888	4822	240	1089	20251
11											29448	1316	4810	114097
12														6412
13														25013
TOTAL														517614

O-D TABLE IN 1979

(Unit : p.c.u.)

	CENTER	INNER			OUTER				OTHERS			MAINLAND		TOTAL
	1	2	3	4	5	6	7	8	9	10	11	12	13	
1	61704	10024	22932	22231	24614	21339	13589	16410	11242	2319	14987	8200		229791
2		1202	1888	1150	3717	1950	1109	1167	854	112	544	545		24262
3			4361	6725	5365	7871	2539	4611	1941	325	3428	1294		63280
4				4871	3588	7878	2428	6669	1969	487	5704	1386		65086
5					7749	6385	2837	2960	5478	408	2214	1375		66690
6						5777	5317	6840	1849	611	4319	1901		72237
7							4309	3086	898	575	2014	486		39187
8								4591	1833	784	7696	1412		58059
9									4724	349	2347	963		34447
10										344	2096	251		8661
11											13081	1483		59913
12														19296
13														
TOTAL														426811



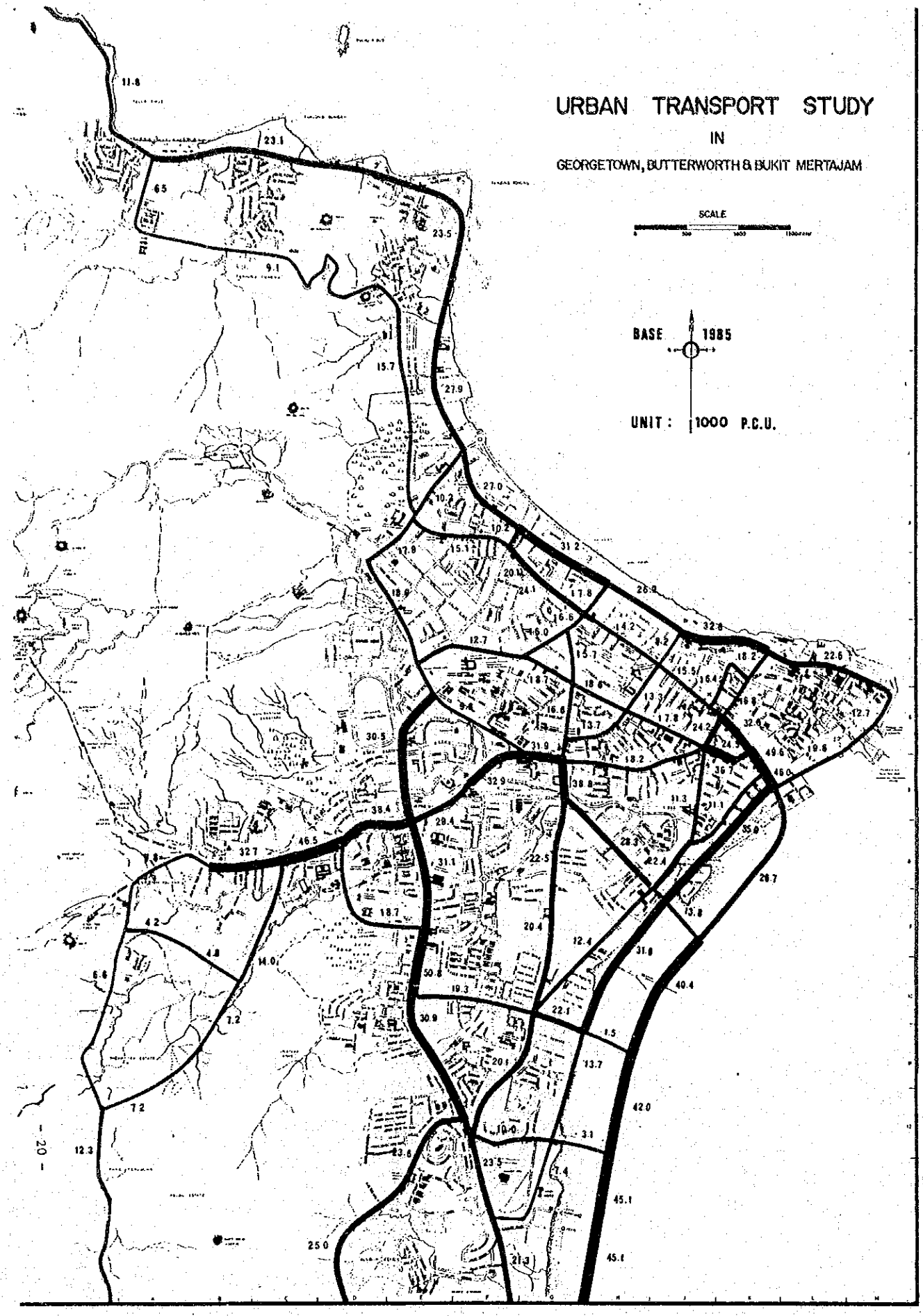
O-D tables presented here correspond to the zones illustrated in the above figure.

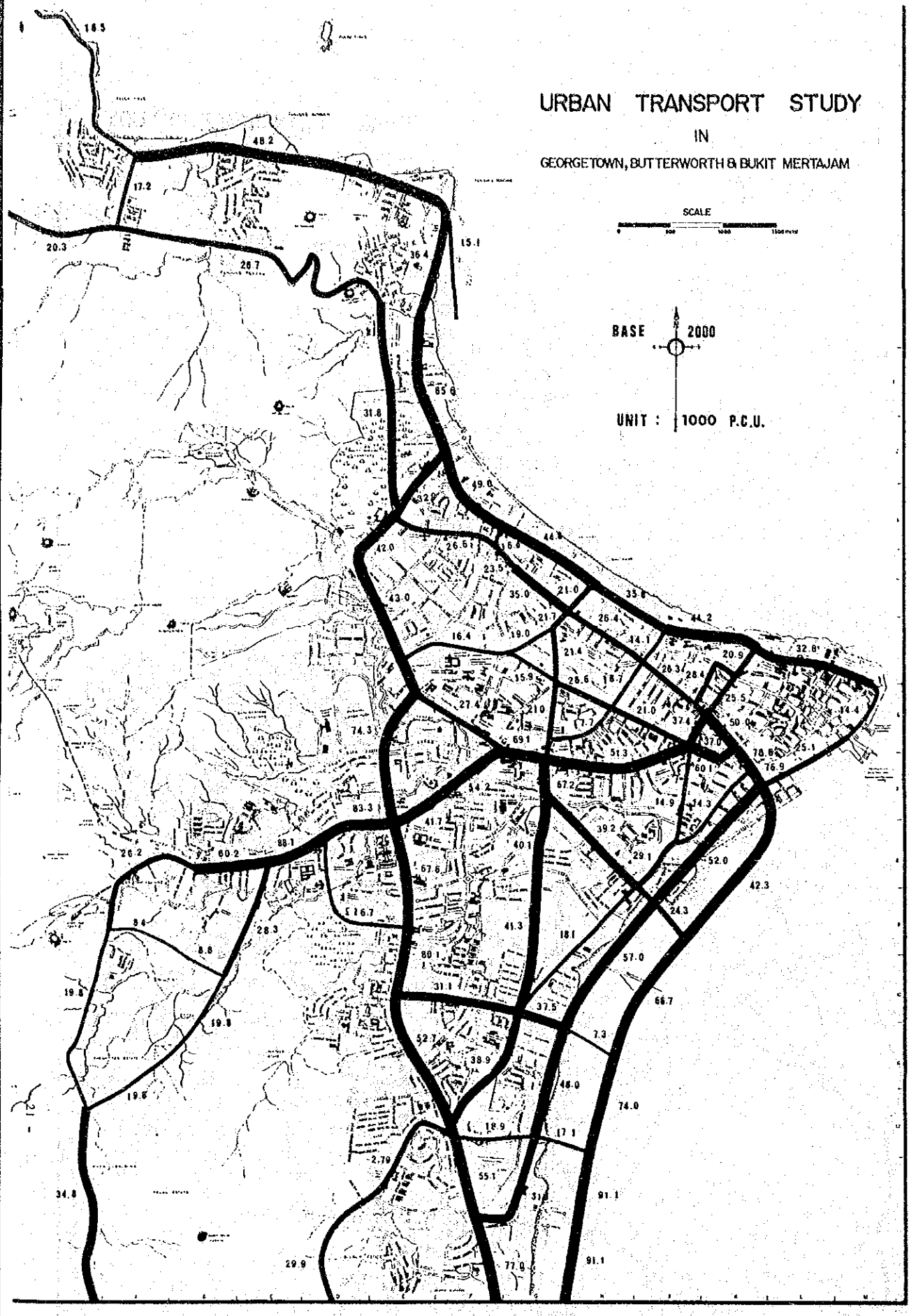
II. Traffic Assignment on the Road Network

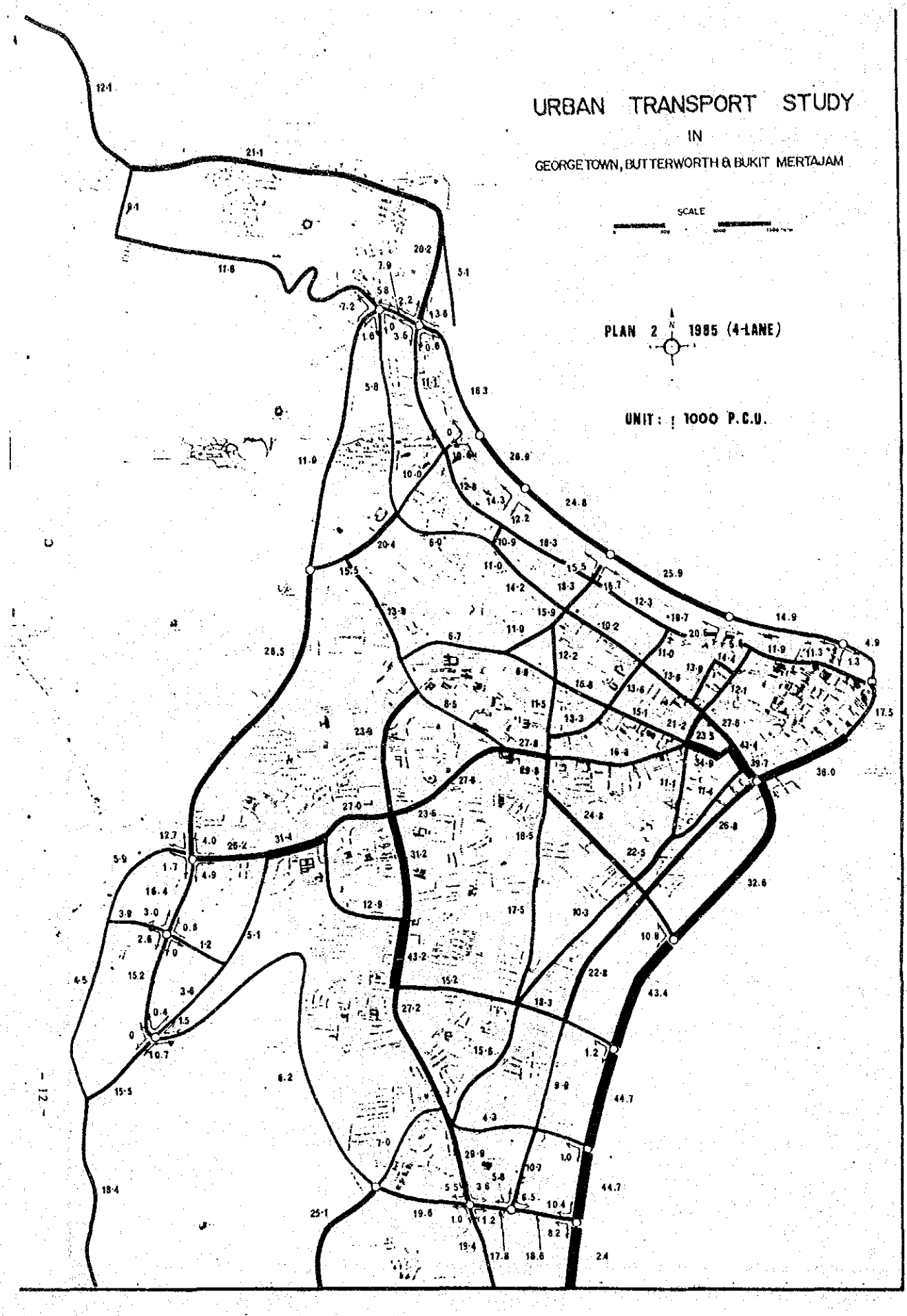
Base : The existing network with the North Coastal Road

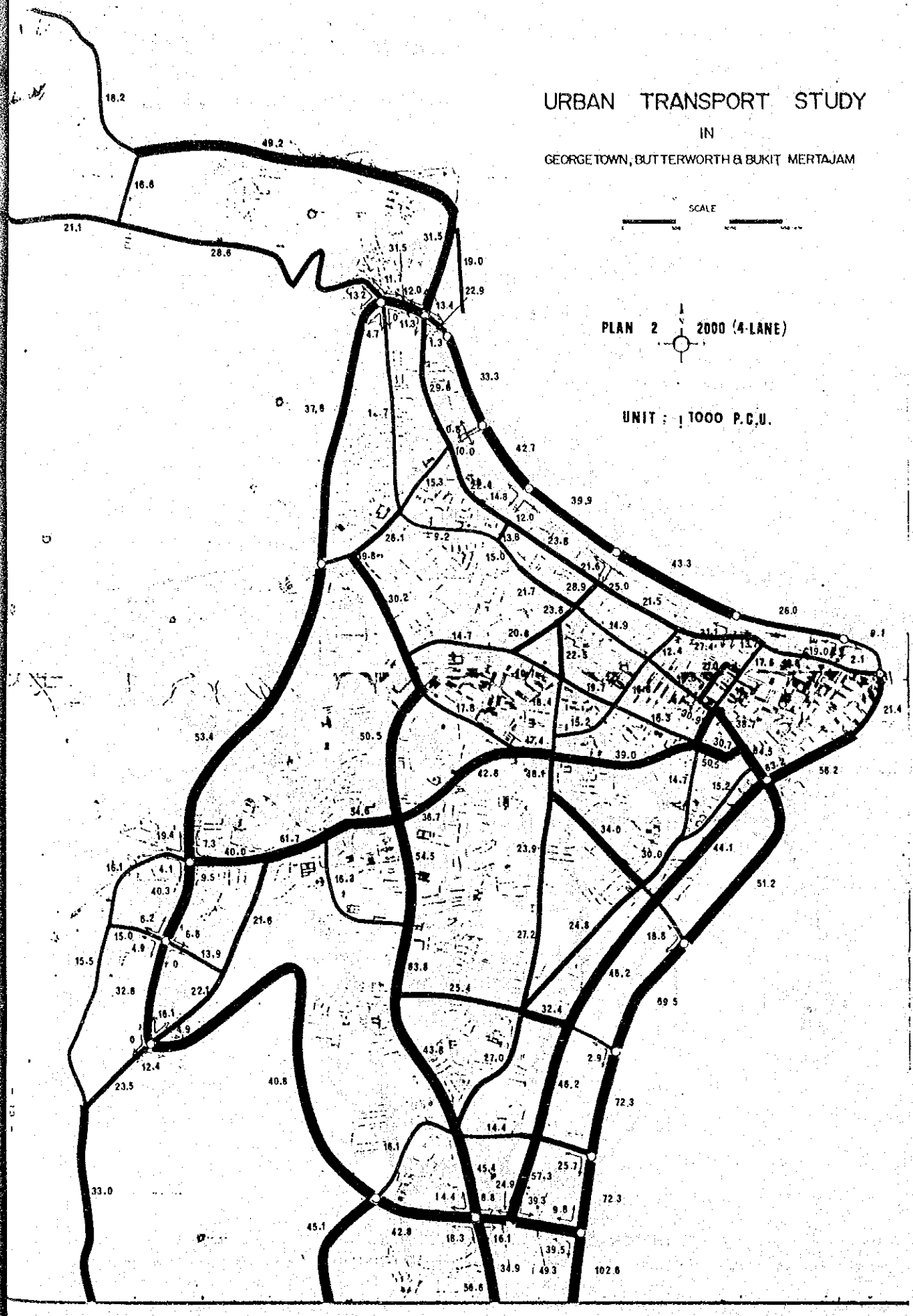
Plan 2 : Proposed Network with full access interchange to the North Coastal Road.

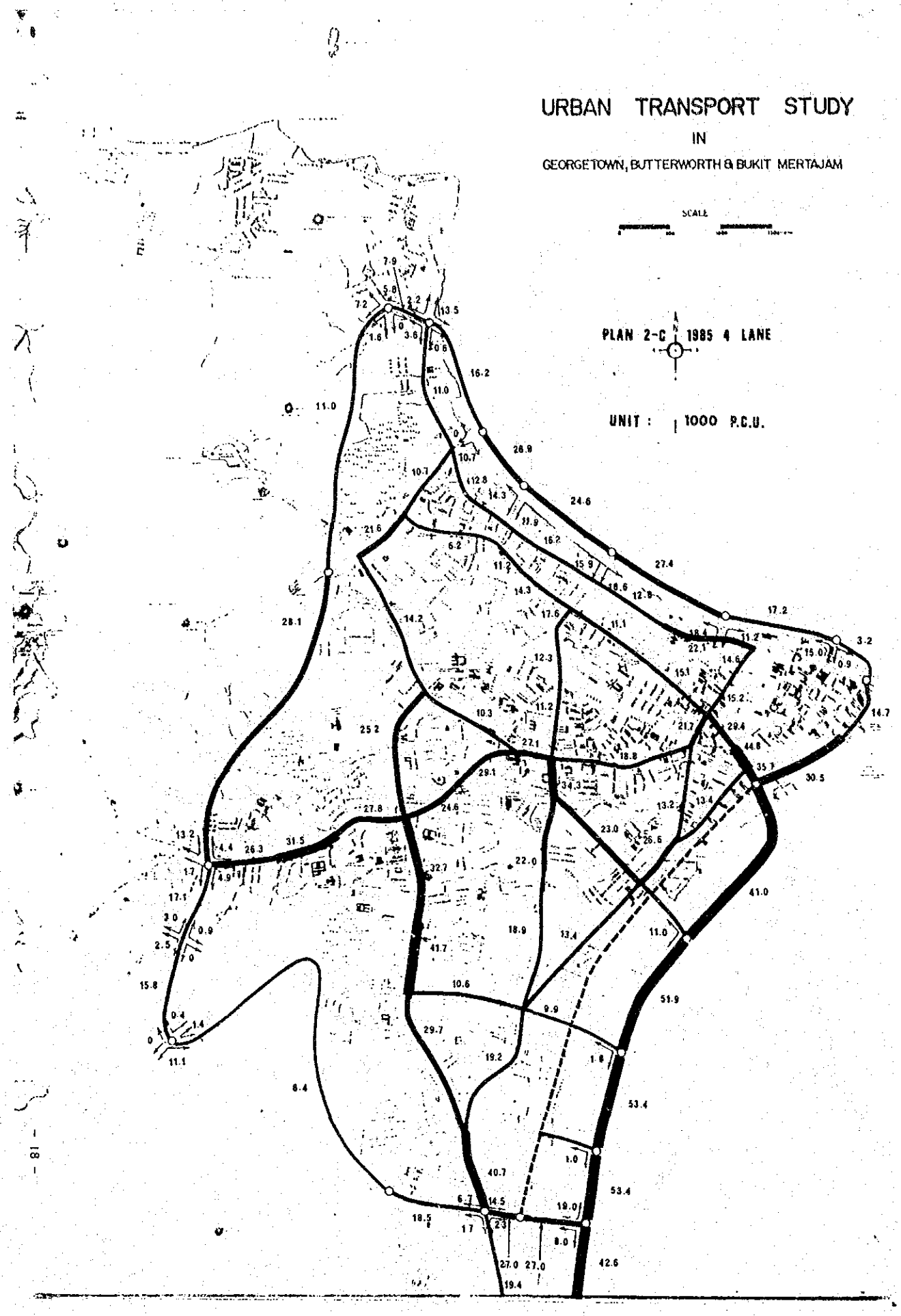
Pan 2-C : Same network as Plan 2 without the Weld Quay Extension.

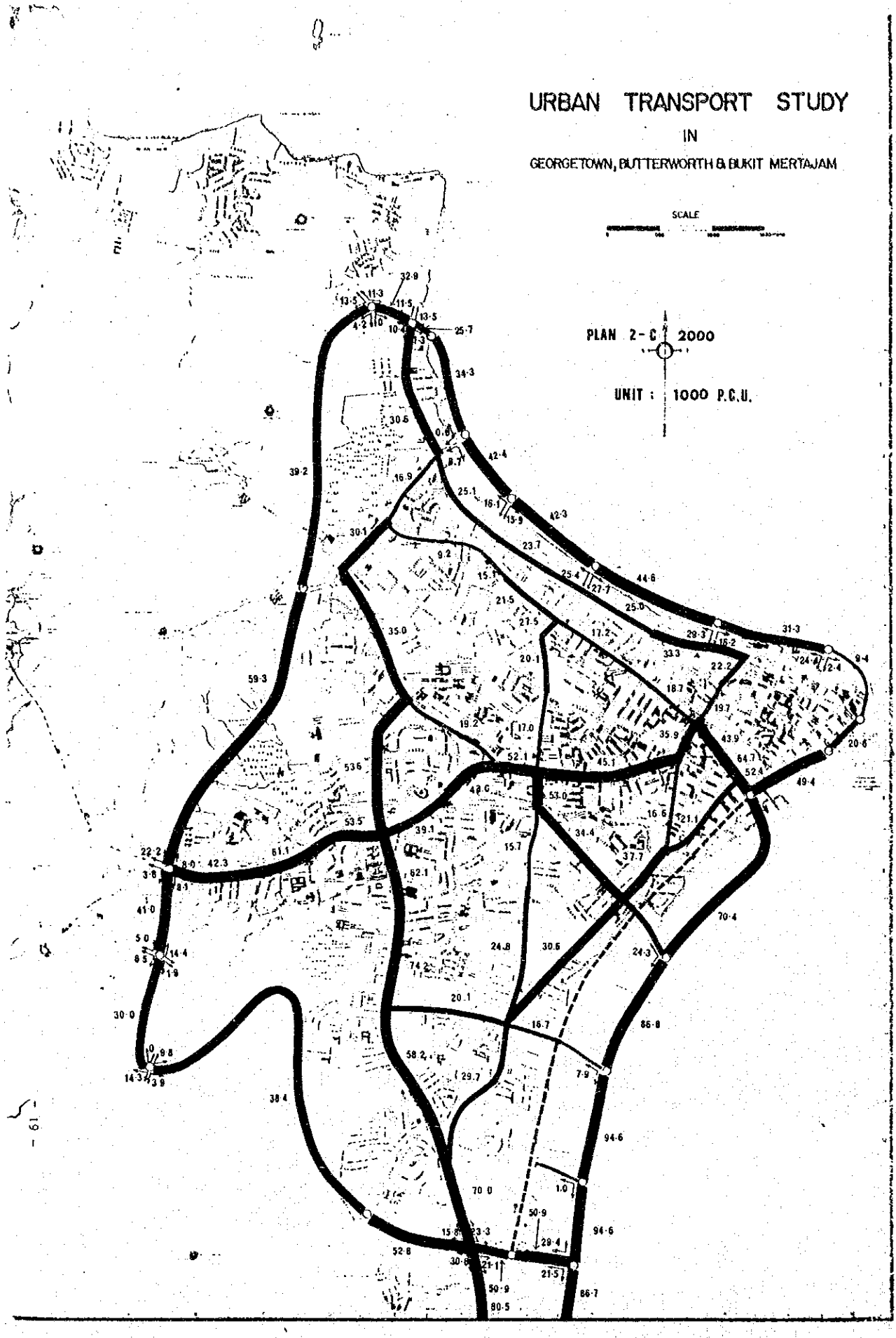

URBAN TRANSPORT STUDY
IN
GEORGETOWN, BUTTERWORTH & BUKIT MERTAJAM
SCALE
BASE 1985
UNIT : 1000 P.C.U.


URBAN TRANSPORT STUDY
IN
GEORGETOWN, BUTTERWORTH & BUKIT MERTAJAM
SCALE
BASE 2000
UNIT : 1000 P.C.U.


URBAN TRANSPORT STUDY
IN
GEORGETOWN, BUTTERWORTH & BUKIT MERTAJAM
SCALE
PLAN 2 1985 (4-LANE)
UNIT : 1000 P.C.U.


URBAN TRANSPORT STUDY
IN
GEORGETOWN, BUTTERWORTH & BUKIT MERTAJAM
SCALE
PLAN 2 2000 (4-LANE)
UNIT : 1000 P.C.U.


URBAN TRANSPORT STUDY
IN
GEORGETOWN, BUTTERWORTH & BUKIT MERTAJAM
SCALE
PLAN 2-C 1985 4 LANE
UNIT : 1000 P.C.U.


URBAN TRANSPORT STUDY
IN
GEORGETOWN, BUTTERWORTH & BUKIT MERTAJAM
SCALE
PLAN 2-C 2000
UNIT : 1000 P.C.U.

III. Miscellaneous Alternatives

1. Alternative at Seashore Area

2. Alternative at Hilly Area

1. Alternative at Seashore

Considering the possibility that the area off the Gurney Drive will be reclaimed, the construction cost of a road running at 2000 ft from the seashore line is estimated for reference for future necessity.

1.1 Premise of Plan

The premises of the plan as follows:

1) The alignment of this road is from Tanjong Tokong to the front of M.P.P.P. as shown in Fig. 1.

2) The alignment is located in the sea 600 m (2000 feet) from the existing seashore line.

3) The typical cross-section of this road follows that of the Outer Ring Road as shown in Fig. 2.

4) The typical cross-section of the approach road which connects this road to the existing Gurney Drive and Jalan Northam is adopted to have a width of 74 feet which is planned by M.P.P.P. such as shown in Fig. 3.

5) The design speed is adopted to be 80 km per hour.

6) This plan does not include reclamation of the distance of sea between this road and the existing seashore line.

1.2 Construction Cost

The premises of construction cost estimates are as follows.

1) The construction cost consist of the road itself and the approach road.

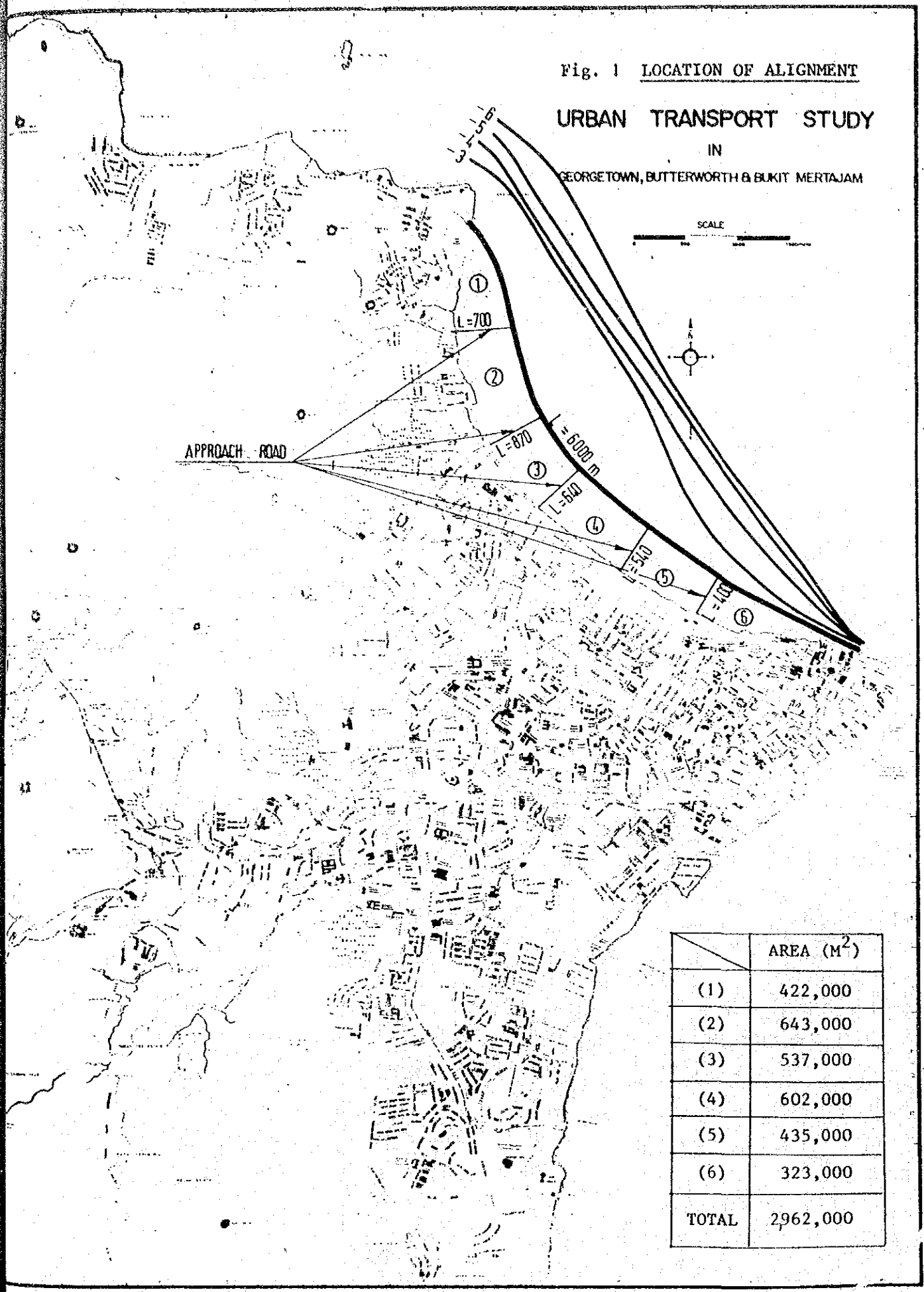
2) The construction cost is estimated in 1980 prices.

3) The same units cost as the Outer Ring Road project is adopted.

The total construction cost of the road alone is about M$54,500,000. The construction per kilometer of the road including the approach road, excluding approach road and the approach road itself are M$9,088,000, M$7,017,000 and M$3,945,000 respectively. The reclamation area is about 300 ha but the construction cost mentioned here excludes reclamation cost. In case of the Outer Ring Road, the construction cost for the same section is M$30,381,000.

The Construction Cost is shown in Table 1 and 2.

Fig. 1 LOCATION OF ALIGNMENT



	AREA (M^2)
(1)	422,000
(2)	643,000
(3)	537,000
(4)	602,000
(5)	435,000
(6)	323,000
TOTAL	2962,000

Fig. 2 CROSS SECTION OF RECLAMATION ROAD

S = 1 : 400

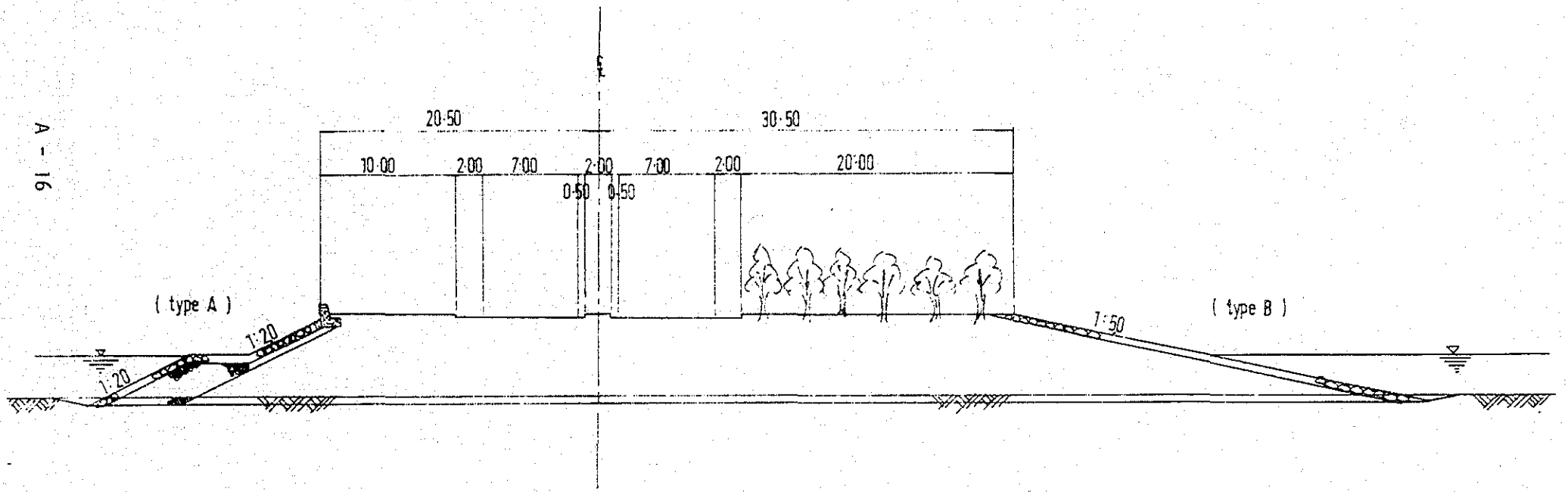


Fig. 3 CROSS SECTION OF APPROACH ROAD IN RECLAMATION ROAD

S = 1 : 400

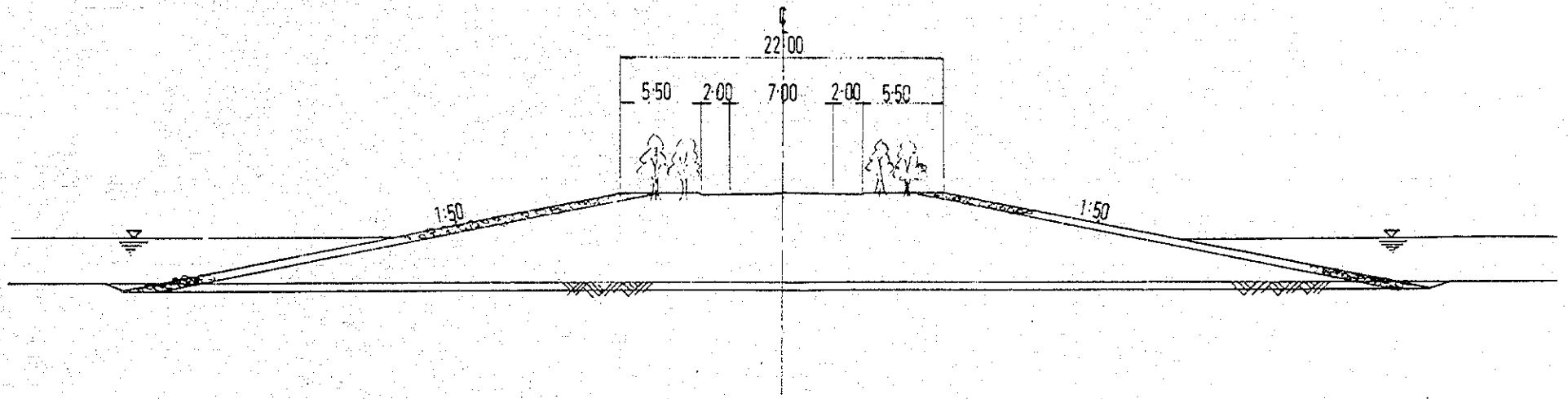


Fig. 4 GEOLOGICAL CROSS-SECTION
(BH-1 - BH-4)

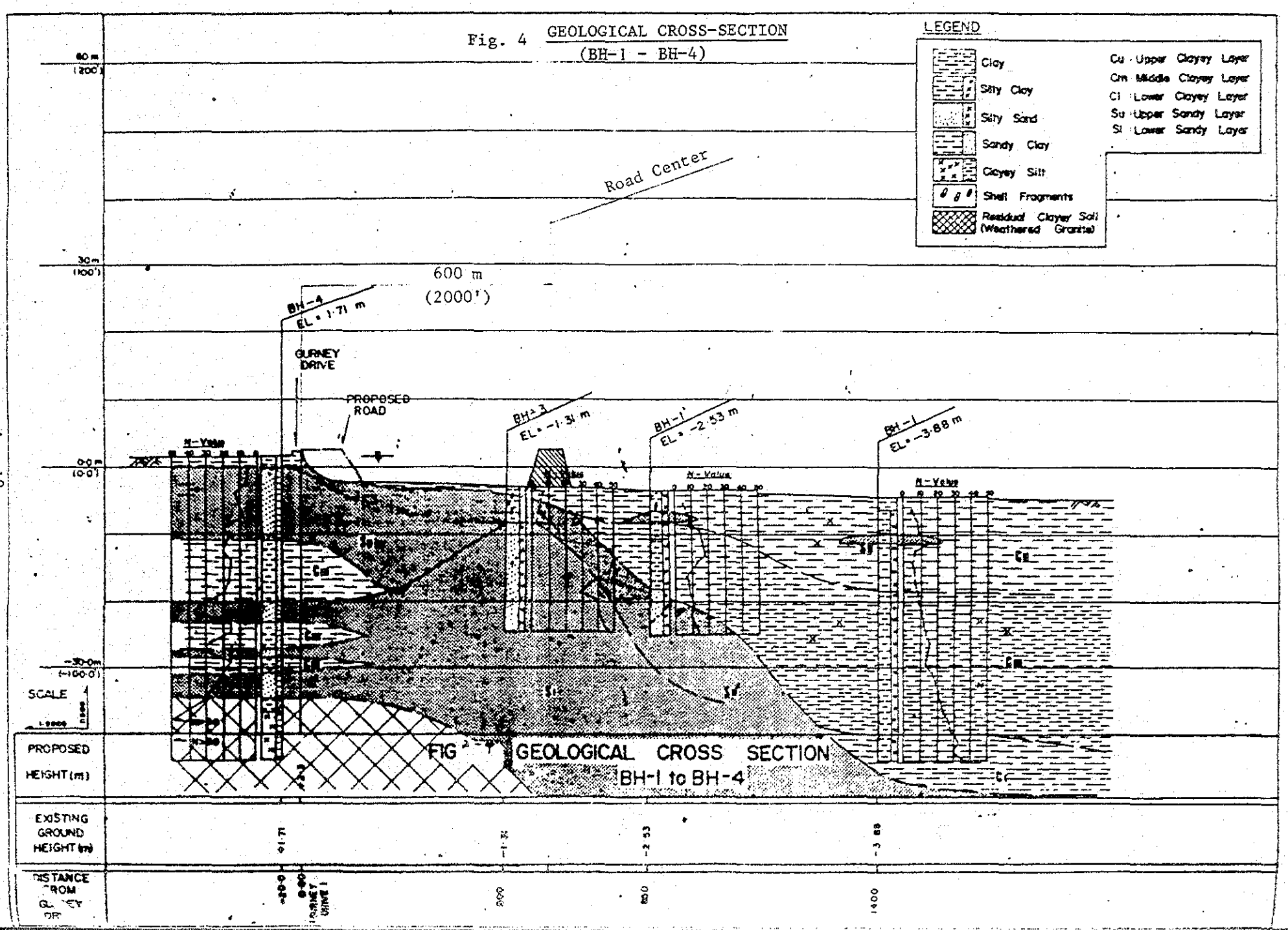


Table 1 CONSTRUCTION COST FOR RECLAMATION ROAD (year 2000)

Items		Class	Unit	Quantity	Unit Cost (M$)			Unit Cost (M$)			
					L.C	F.C	Tax	L.C	F.C	Tax	Total
Excavation			M^3	303,000	2.8	2.1	0.5	848,400	636,300	151,500	1,636,200
Embankment			"	2,730,000	1.9	2.5	0.2	5,187,000	6,825,000	546,000	12,558,000
Turfing		Open Space	M^2	120,000	5.0	0	0.3	600,000	0	36,000	636,000
Drainage	Roadside	0.5 x 1.0	M	12,000	101.3	48.5	6.1	1,215,600	582,000	73,200	1,870,800
	Pipe culvert	600	M	60	91.4	59.3	6.8	5,484	3,558	408	9,450
Wall Revetment		Type A	M	6,000	1284.5	747.1	158.8	7,707,000	4,482,600	952,800	13,142,400
		Type B	M	6,000	162.3	561.6	46.5	973,800	3,369,600	279,000	4,622,400
Pavement	Carriageway		M^2	96,000	11.6	15.9	1.3	1,113,600	1,526,400	124,800	2,764,800
	Shoulder		M^2	18,000	8.3	12.4	1.0	149,400	223,200	18,000	390,600
	Side Walk		"	60,000	8.4	6.1	0.8	504,000	366,000	48,000	918,000
Drainage	Box-culvert	5.0 x 5.0	M	612	1563.9	1374.3	162.7	957,107	841,072	99,572	1,897,751
								19,261,391	18,855,730	2,329,280	40,446,401

Table 2 CONSTRUCTION COST FOR RECLAMATION ROAD (year 2000)

Item		Class	Unit	Quantity	Unit Cost (M$)			Unit Cost (M$)			
					L.C	F.C	Tax	L.C	F.C	Tax	Total
Additional Facility	Kerb		M	12,000	12.6	5.7	0.9	151,200	68,400	18,800	238,400
	Central Reserved		"	6,000	25.2	10.4	1.8	153,000	62,400	18,800	234,200
	Guard Rail		"	12,000	10.3	34.5	4.4	123,600	414,000	52,800	590,400
	Lighting		"	6,000	9.0	11.0	1.0	54,000	66,000	6,000	126,000
	Lane-Marks		M	6,000	0.6	0.3	0.05	3,600	1,800	300	5,700
Intersection	At-grade		Vol	5	59,728.4	30534.8	2706.2	298,642	152,674	13,531	464,847
Approach	Road		M	3,150	1525.5	2206.7	213.1	4,805,325	6,951,105	671,265	12,427,695
Sub-total								5,589,367	7,716,379	781,496	14,087,242
Total								24,850,758	26,572,109	3,110,779	54,533,643

2. Alternative at Mountainous Area

The construction cost of the Outer Ring Road, including land acquisition cost and compensation, is about M$6,500,000 per kilometer. This is because there are many structures along the route site that have to be removed and also rock excavation will have to be done in the mountainous areas. In order that the construction cost be reduced the route should be located on as flat a terrain as possible.

The possibility of a cheaper construction cost in the section from Jalan Ayer Itam to Waterfall Road whilst having some flat terrain, as in the other sections, does pass through residential areas and as such will obviously incur higher compensation cost than the proposed road.

However, it should be noted that the above-mentioned area avoided through the discussions at the technical committee due to the impossibility to acquire this land at the present moment.

Therefore, it will be necessary to review this alternative only if the present condition will change.

2.1 Location of Alternative Route

The basic factors that act as control points for the proposed route in this section are as follows:

a. To avoid passing through the Chinese cemetery located in the site of the proposed route.

b. To avoid passing through the golf course.

c. To avoid passing through the existing Jesselton residential area.

d. To avoid passing through the open space now being used as a public park.

The location of the alternative route is shown in Fig. 5 while the profile of the alternative route is shown in Fig. 6.

FIG. 5 LOCATION OF ALTERNATIVE ROUTE

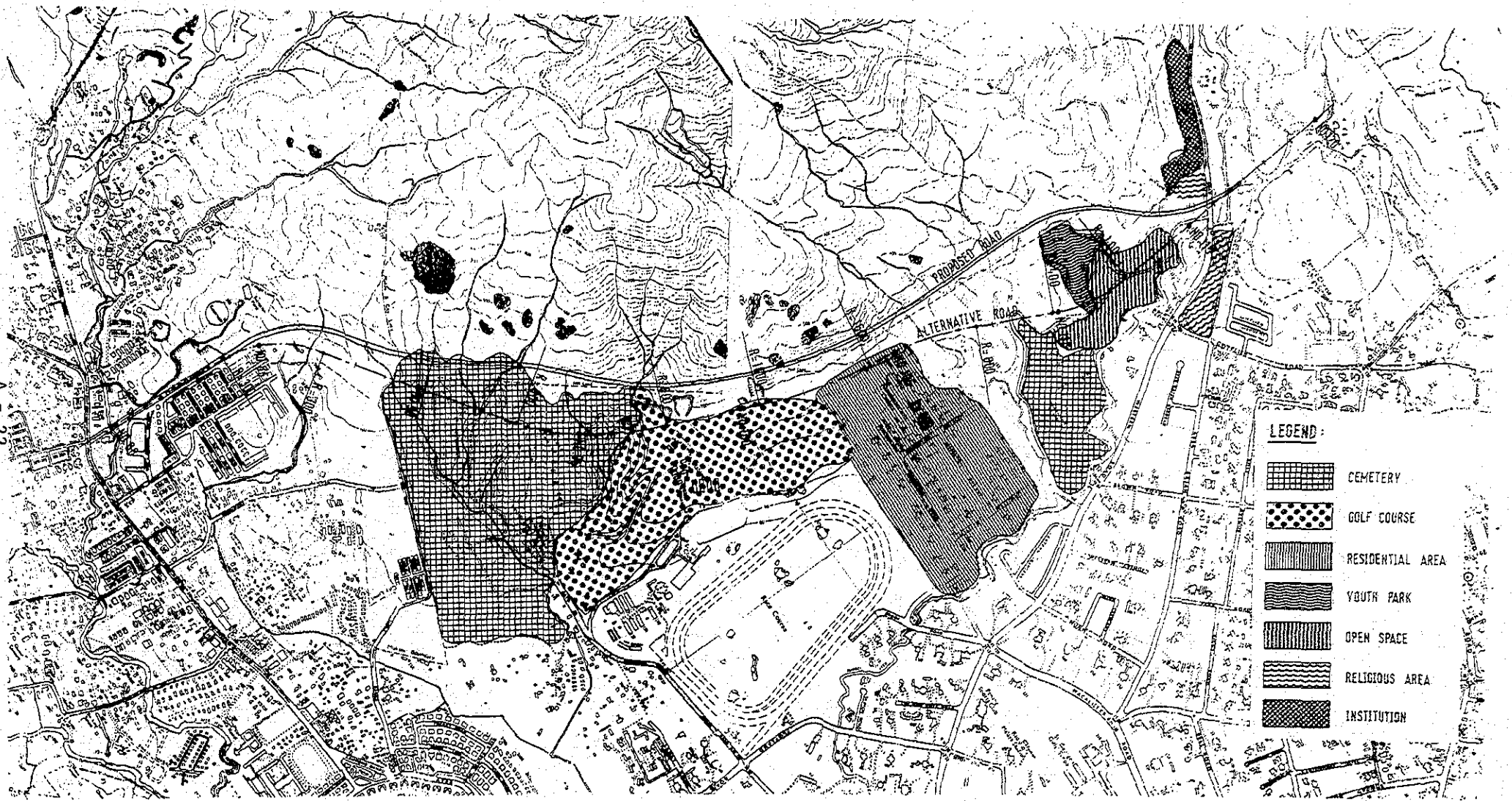
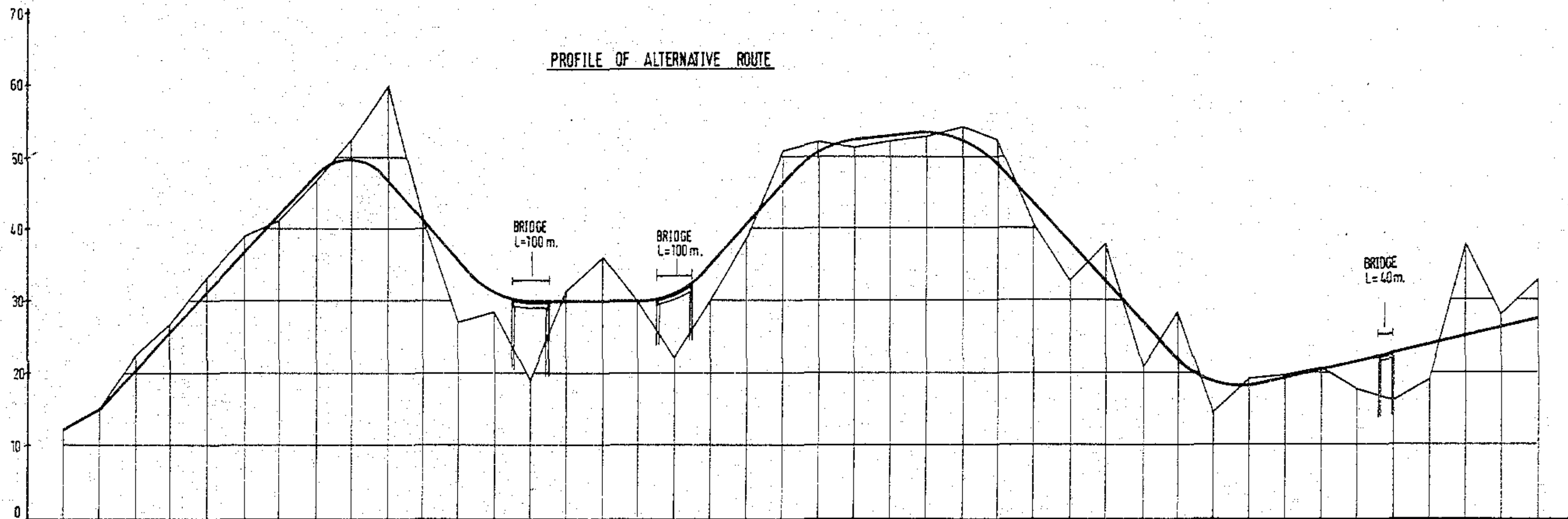


FIG. 6 PROFILE OF ALTERNATIVE ROUTE



GRADE: 12.00 | 15.00 | i = 5.428 %, L = 700 | 53.00 | i = 5.75 %, L = 400 | 30.0 | L = 500 | 30.0 | i = 5.5 %, L = 400 | 52.00 | i = 0.625 %, L = 400 | 54.50 | i = 5.214 %, L = 700 | 18.00 | i = 1.111 %, L = 900 | 28.00

STATION	79	80	81	82	83	84	85	86	87	88	89	90	91	92
PROPOSED HEIGHT	12.00	15.00	20.428	25.856	27.84	36.712	42.14	47.568	50.206	47.25	41.5	35.75	31.438	30.00
GROUND HEIGHT	12	15	22.5	27	33	39	41	46.5	52.5	60	37.5	27	28.5	18.9
ACCUMALATED DISTANCE	100	200	300	400	500	600	700	800	900	1,000	1,100	1,200	1,300	1,400

STATION	93	94	95	96	97	98	99	100	101	102	103	104	105	106
PROPOSED HEIGHT	30.00	30.00	30.00	31.375	35.5	41.00	46.5	50.55	52.625	53.25	53.875	52.660	49.286	44.072
GROUND HEIGHT	31.5	36	30	22.2	30	39	51	52.5	51.9	52.5	53.4	54	52.5	40.5
ACCUMALATED DISTANCE	1,500	1,600	1,700	1,800	1,900	2,000	2,100	2,200	2,300	2,400	2,500	2,600	2,700	2,800

STATION	107	108	109	110	111	112	113	114	115	116	117	118	119	120
PROPOSED HEIGHT	38.858	33.644	28.43	23.216	19.419	19.11	20.22	21.33	22.44	23.55	24.66	25.77	26.88	28.00
GROUND HEIGHT	33	38.1	21	28.5	15	19.5	20	21	18	16.5	19.5	38.1	28.5	33
ACCUMALATED DISTANCE	2,900	3,000	3,100	3,200	3,300	3,400	3,500	3,600	3,700	3,800	3,900	4,000	4,100	4,200

2.2 Comparison of the Construction Cost

The comparison of the construction cost between the proposed road and alternative road is shown in Table 3.

Table 3 COMPARISON OF CONSTRUCTION COST

(M$ 1,000)

Items	Proposed Route	Alternative Route
Construction Cost	25,645	10,180
Land Acquisition Cost	8,428	14,515
Compensation Cost	5,098	7,040
Total	39,171	31,735

Table 4 COMPONENTS OF CONSTRUCTION COST

(M$ '000)

Item	Sub-Item	Class	Unit	Quantity			Cost	
				Unit Cost	Proposed	Alt.	Proposed	Alt.
Site Clearance	Residential		M^2	3.15	0	36,000		113.4
	Field		"	0.43	0	94,000		40.4
	Mountain		"	0.58	150,100	-	87.1	-
Excavation	Soil		M^3	2.13	397,560	239,100	846.8	509.3
	Rock		"	17.0	292,350	0	4,969.9	0
Embankment	Soil		"	2.41	68,800	268,500	165.8	647.1
Slope	Grass		M^2	5.3	49,040	53,300	259.9	282.5
	Concrete		"	9.3	43,870	0	408.0	0
Turfing	Side Walk	Grass & Tree	M^2	6.2	0	12,700	0	78.7
	Open Space	Grass	"	5.3	0	0	0	0
Drainage	Roadside	0.5 x 1.0	M	155.9	0	1,900	0	296.2
		1.0 x 1.0	"	159.7	4,450	0	710.7	0
	Pipe Culvert	0 = 600	"	157.5	361	950	56.9	149.6
	Box Culvert	3.0 x 3.0	"	1,389.05	0	380	0	527.8
		5.0 x 5.0	"	3,100.9	0	0	0	0
	Demolishing	0.5 x 1.0	"	10.8	0	0	0	0
Wall	Concrete	H = 1.0	M		200	0	0	0
	Concrete	H = 5.0	"	1,075.8	300	100	322.7	107.5
	Mosonry	H = 5.0	"	202.5	0	100	0	20.3
	Revetment	Stone		1,905.2	0	0	0	0
	Demolishing		"		0	0	0	0
Pavement	Carriageway	Asphalt	M^2	28.8	62,400	60,800	1,797.1	1,751.0
	Shoulder	Asphalt	"	21.7	11,700	11,400	253.9	247.4
	Service Road	Asphalt	"	21.7	1,800	10,500	39.1	227.9
	Side Walk	Concrete Block	"	15.3	7,400	6,700	113.2	102.5
	Overlay	Asphalt	"	14.2	0	0	0	0
	Removing	Asphalt	"		0	0	0	0
Additional Facility	Kerb	Concrete	M	19.2	7,800	7,600	149.8	145.9
	Central Reserved	Concrete	"	37.4	3,900	3,800	145.9	142.1
	Guard Rail	Steel	"	49.2	3,900	3,800	191.9	187.0
	Lighting	Steel	"	21.0	0	0	0	0
	Lane-Marks	Paint	"	0.95	3,900	3,800	3.7	3.6
Inter-Section	At-grade		No.	92,969.4	1	1	93.0	93.0
	Grade Separation				0	0	0	0
	Interchange		Vol	1,555,785.4	0	0	0	0
Bridge	L = 50	Concrete	M^2		0	0	0	0
	L = 50	Concrete	"	1,000	15,030	4,320	15,030.0	4,320.0
Approach Road			M	934.5		200		186.9

Table 5 COMPARISON OF LAND ACQUISITION COST

(M$'000)

Station	Proposed Route	Alternative Route	Remarks
79 - 85	6,790	600 x 35 x 277 = 5,817	Residential
85 - 89		400 x 30 x 11 = 132	Mountainous
89 - 97		800 x 35 x 22 = 616	Cemetery
97 - 102		550 x 30 x 80 = 1,350	Gold Course
102 - 105	1,638	250 x 30 x 800 = 600	Residential
105 - 115	387*	1,000 x 30 x 80 = 2,400*	Open Space
115 - 117		200 x 30 x 110 = 600	Residential
Total	8,815	16,915 (14,515)	

* Government Land

Table 6 COMPARISON OF COMPENSATIONZ

(M$'000)

Station	Proposed Route	Alternative Route	Remarks
79 - 85	2,967	= 2,967	Residential
85 - 89	-	= 0	Mountainous
89 - 97	-	800 x 35 ÷ 30 x 500 = 466	Cemetery
97 - 102	-	= 500	Gold Course
102 - 105	-	20 x 41.6 + 153 = 985	Residential
105 - 115	-	= 0	Open Space
115 - 117	2,122	2,122 = 2,122	Residential
Total	5,089	7,040	

IV. List of Staff

Steering Committee, Government of Malaysia

1. Y.B. Tan Sri Ishak b. Haji Pateh Akhir - Chairman
   Economic Planning Unit, Prime Minister's Department.
2. Datuk Basha Bin Nordin - Chairman
   Economic Planning Unit, Prime Minister's Department.
3. Miss Leong So Seh - Secretary
   Economic Planning Unit, Prime Minister's Department.
4. Mr. Anuar Bin Khabar
   Economic Planning Unit, Prime Minister's Department.
5. Mr. Zaidan Bin Haji Othman
   Highway Planning and Public Transport Unit,
   Ministry of Works and Utilities.
6. Mr. T.S. Jayaratnam
   Highway Planning and Public Transport Unit,
   Ministry of Works and Utilities.
7. Mr. Ghazali Bujang
   Highway Planning and Public Transport Unit,
   Ministry of Works and Utilities.
8. Mr. Hiroshi Nakajima (Colombo Plan Expert)
   Highway Planning and Public Transport Unit,
   Ministry of Works and Utilities.
9. Mr. Yoon Shee Leng
   Public Works Department, Kuala Lumpur.
10. Mr. Liew Hon Yong
    Treasury (Contract Section)
11. Mr. Mohd Ali Bin Yusof
    Ministry of Public Enterprise.
12. Mr. Thor Keat Beng
    Ministry of Transport.
13. Mr. Mohd Yusof Bin Mat Judin
    Ministry of Transport.
14. Mr. Inder Singh Khosa
    Ministry of Works and Utilities.
15. Mr. Rosly Abdul Kadir
    Survey Department, Kuala Lumpur.
16. Mr. Ai Win Endin Win
    State Economic Planning Unit, Penang.
17. Datuk Koh Kek Ee
    Public Works Department, Penang.
18. Mr. Thomas Gan Eng Siew
    Municipal Council of Pulau Pinang.
19. Mr. Hua Keng Tong
    Municipal Council of Pulau Pinang.
20. Mr. Ong Chow Meng
    Municipal Council of Seberang Perai.