6.3 Public Transport

6.3.1 Bus Transport

1. Improvement of Existing Bus-stop

(a) Type of existing bus-stop

There are many routes with more than 250 stops in George Town and 184 stops in Province Wellesley. These bus-stops may be classified into four (4) different types.

Type A, A'

These are actually bus-stops on sections of pedestrian ways located on both sides of the road. There are no special facilities at these bus-stops except for a small indicating board identifying them. Also, there are no special bus-bays.

Type A bus-stops are those described above but having shelters. Type A' is the same except they do not have shelters.

Type B, B'

Type B and B' is the same as type A or A' except that in type B and B' spaces are provided for the buses to stop. Type B is provided with a shelter but type B' is not.

Type C, C'

Type C, C' is the most popular type of bus-stop. There is no pedestrian way and so the shoulder of the road is used for the buses to stop. In the Type C bus-stop, shelter is provided. Type C' is the same except that it has no shelter.

Type D, D'

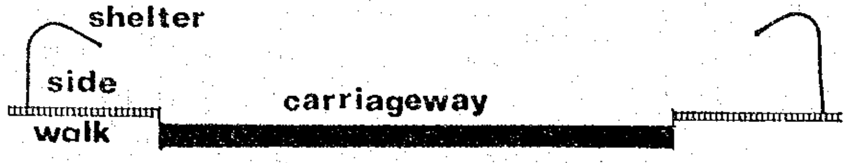
For this type, there is no pedestrian way but there is additional space provided for buses to stop. Just as for type C & C', the shoulder of the road is used for the buses to stop. Type D has shelter but type D' does not have shelter.

(b) Improvement plan of existing bus-stops

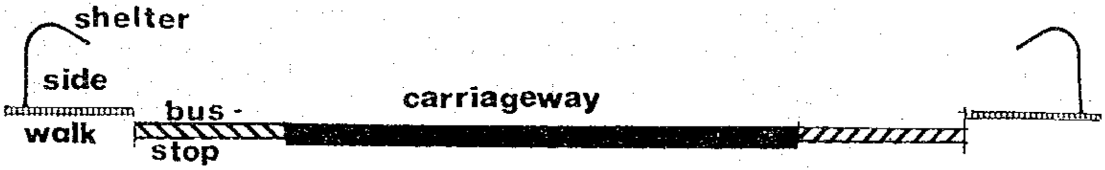
(i) Objectives of improvement

Fig.6.4 Conditions of Existing Bus Stops

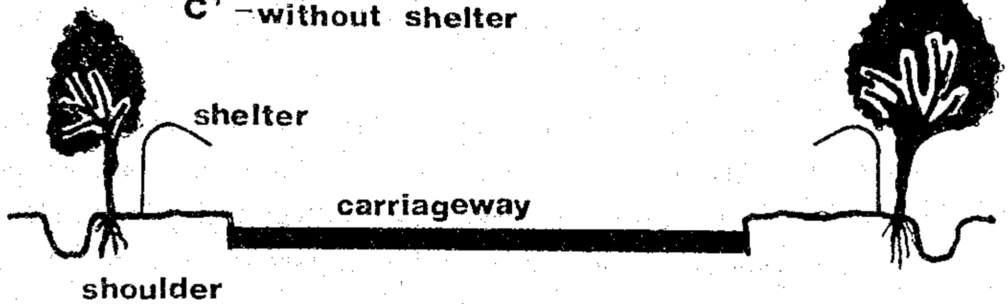
TYPE A -with shelter
A' -without shelter



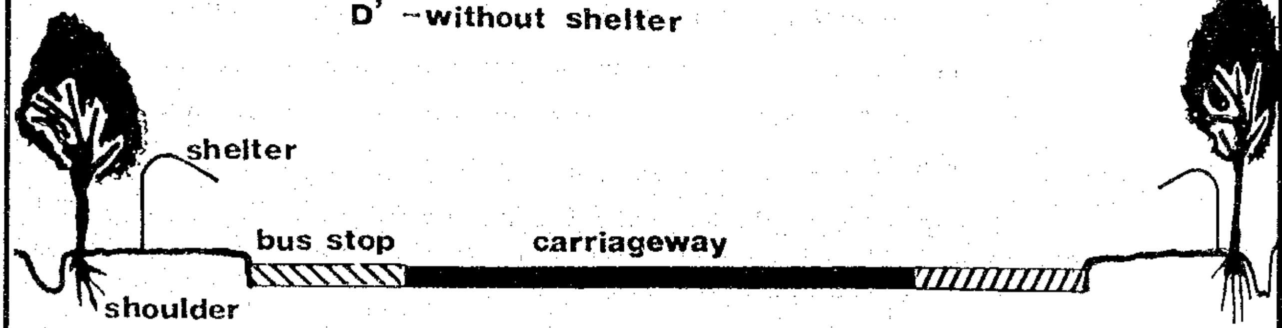
TYPE B -with shelter
B' -without shelter



TYPE C -with shelter
C' -without shelter



TYPE D -with shelter
D' -without shelter



The most important thing in the improvement of existing stops is the provision of additional space to bus-stop lanes. This is because almost all existing roads are two-lane highways or carriage-ways with a width of about 9.0 metres. As such, when a bus is at a stop, it obstructs the smooth flow of traffic and vehicles following behind have to wait until the bus starts moving again.

In such a situation, the traffic capacity is decreased and traffic congestion occurs. Therefore, the proposal to provide additional space to bus-stop lanes will improve the existing condition of traffic.

(ii) To improve existing conditions of bus-stops

The small indicating board which identifies a bus-stop is the only facility available and as such does not provide information on the time schedules of buses. The proposal to improve existing conditions of bus-stops will raise the quality of the bus service to users.

(iii) Items for improvement at bus-stops

Items for improvement are as follows:

(1) Provide additional bus-stop lanes.
(2) Provide pedestrian way.
(3) Provide shelters for waiting passengers.
(4) Provide information at bus-stops.
(5) Provide lighting facilities.
(6) Others.

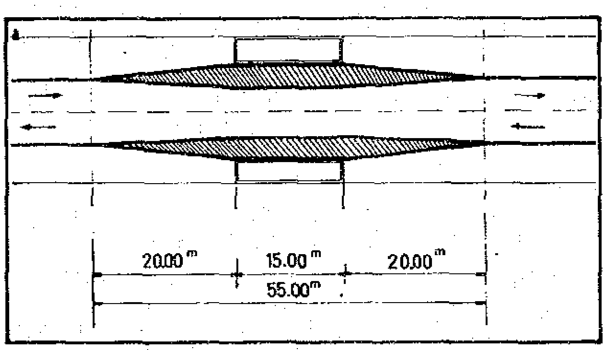


Fig. 6.5 SITE PLAN OF BUS-STOPS   Unit: in meters

(c) Cost estimates

Costs of improvement are shown in Tables 6.5 and 6.6.

Table 6.5 NUMBER OF BUS-STOPS ACCORDING TO TYPE AND COST OF IMPROVEMENT (PENANG ISLAND)

Name of Road	Number of existing Bus-stops by Type								Cost
	A	A'	B	B'	C	C'	D	D'	(M$1,000)
Clthrop Road						1			10.5
Green Lane			6	4		3			52.2
Jalan Scotland	4								35.3
Western Road			2	5	3				45.1
Jalan Residency						2			21.0
Jalan Gottlieb						2			21.0
Jalan Bagan Jermal		1				2			30.9
Waterfall Road						5			52.3
Lorong Batu Lanchang					6				56.0
Jalan Ayer Itam	2	1	15	3		1			70.8
Kampong Baru						1			10.5
Jalan Padang						4			41.9
Boundary Road						6			62.9
Jalan Kampong						7			73.3
Hill Railway Road					4	2			58.3
Jalan Balik Pulau						1			10.5
Jalan Batu Lanchang					6	3			87.5
Jalan Jelutong	7		2	1	1	8			160.9
Jalan Perak	2	1			8	2			116.9
Jalan Free School			1	2		1			17.7
Jalan Caunter Hall					5	5			99.1
Jalan Macalister					12	6			175.0
Jalan Kelawai			8						13.0
Lorong Maktab						2			21.0
Jalan Burma						17			178.0
Jalan Anson						4			41.9
Jalan Dato Keramat	6	2							72.8
Jalan Pantai						5			52.3
Jalan Sungai Pinang						5			52.3
Transfer Road					1				9.4
Argyll Road					1				9.4
Brick Kiln Road	4								35.3
Penang Road		3							29.8
Leboh Sandilands						1			10.5
Leboh McNair						2			20.9
Leboh Carnavon						2			20.9
Jalan Kg. Kolam						2			20.9
Leboh Chulia		4		2					45.3
Leboh Pitt						2			20.9
Leboh Light	1	1		1		1			31.9
Pengkalan Weld		1			1	2	3		64.6
Gat Leboh Chulia						1			10.5
Gat Leboh China						1			10.5
Pesara King Edward									10.5
Total	26	14	34	18	48	110	3	0	2,092.2

Table 6.6 Province Wellesley

Name of Road	Number of existing Bus-stops by Type								Cost (M$1,000)
	A	A'	B	B'	C	C'	D	D'	
Jalan Bagan Luar (Jalan Kuala Bekah)						10	11	12	304.6
Jalan Sungai Tembus					1	3			40.7
Jalan Pasir Begu						7			73.2
Jalan Kampung Kuala						6		1	72.0
Jalan Permatang Tiga Ringgit							1	3	35.8
Jalan Sungai Dua						10			104.6
Jalan Lahar Yoi						10			104.6
Jalan Seberang To'Doi						3			31.4
Jalan Tasek Gelugor						7		1	82.4
Jalan Kampong Selamat					1	11			124.4
Jalan Bagan Tuan Kechil-Permatang Pauh					1	1	4	1	61.5
Jalan Permatang Pauh - Nibong Tebal	1	10	2			18	1	6	363.4
Jalan Bagam Dalam - Simpang Ampat						10	6		153.2
Jalan Simpang Ampat - Bukit Mertajam						7		1	82.4
Jalan Bukit Mertajam - Macang Bubok						17			177.8
Total	1	10	2		3	120	23	25	1,812.0

2. Exclusive Bus Lane and Cost Estimates

(a) Route of Exclusive Bus Lanes

The following are recommended to be exclusive bus lanes.

1) GREEN LANE L = 3,100m
2) JALAN AYER ITAM L = 4,000m
3) JALAN DATO KERAMAT L = 1,400m
4) BRIDGE STREET L = 1,000m
5) BRICK KILN ROAD L = 900m
6) JALAN JELUTONG L = 3,500m
7) FEDERAL ROUTE 1 L = 8,500m
8) JALAN PERMATANG RAWA L = 3,500m

Total .... L =25,900m

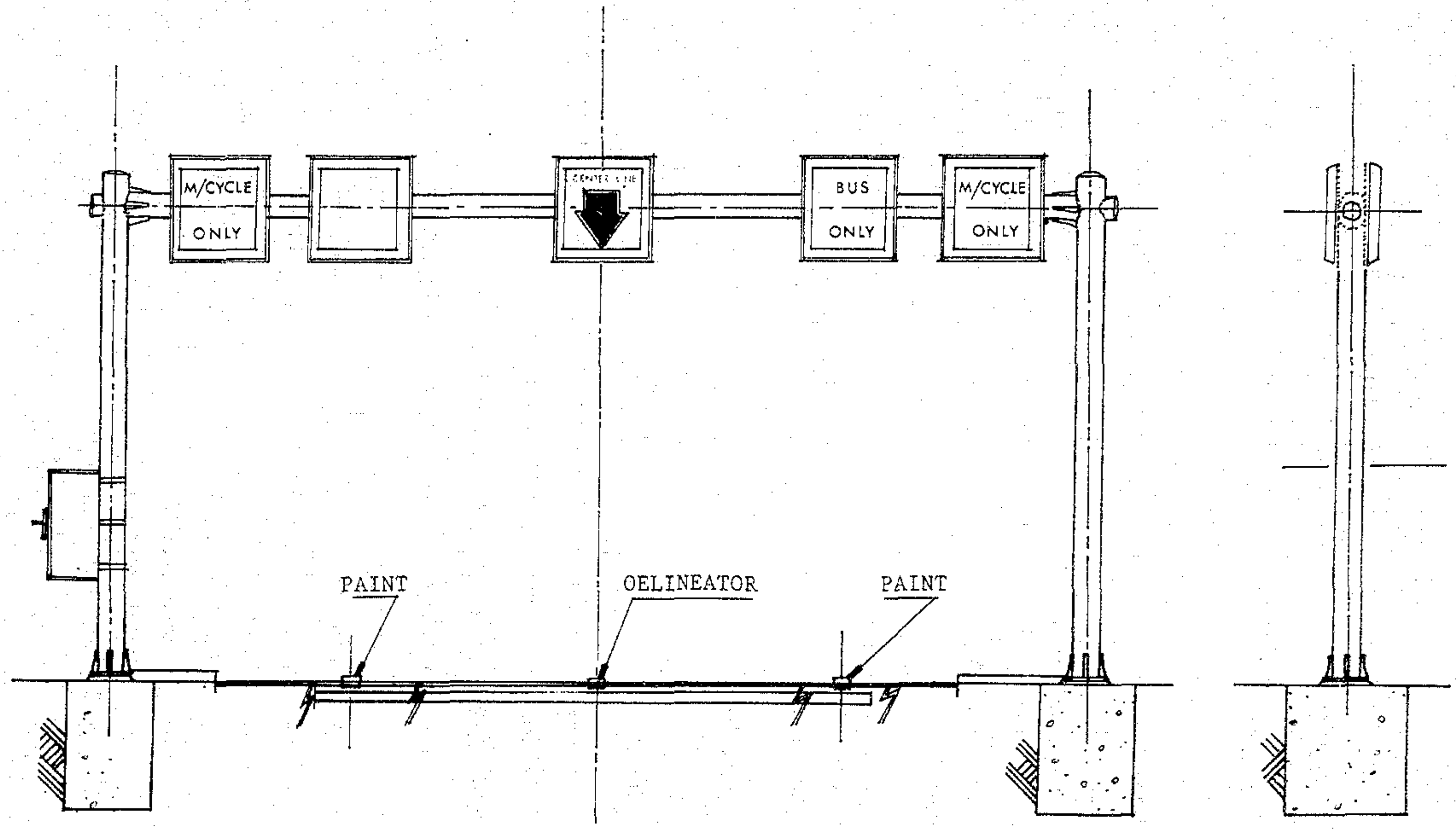


Fig.6.6 Sign-Board

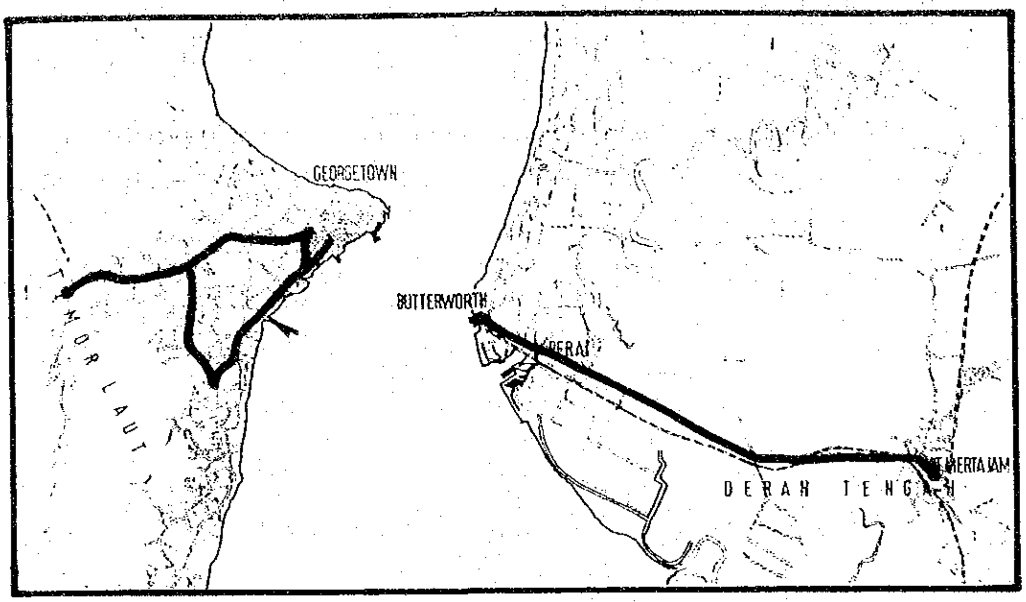


Fig. 6.7 LOCATION OF EXCLUSIVE BUS LANES

(b) Preparation for Exclusive Bus Lanes

Exclusive Bus Lanes are prepared as follows:

1) Sign-boards (shown in Fig. 6.6)
Sign-boards should be set up as a guide to the location of the exclusive bus lanes.

2) Lane Marks
In addition, signs should be installed, to indicate the existence of exclusive lanes so that they can be noticed easily.

(c) Cost Estimates

Sign-boards should be:

1) set up at intervals of every 1,000 metres.

2) installed at exclusive bus lanes indicating 'Bus' at intervals of every 500 metres.

Table 6.7 CONSTRUCTION COST

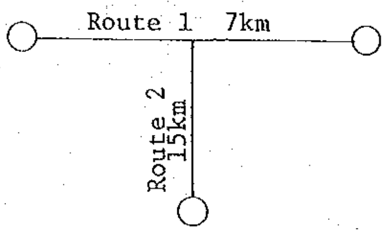
Description	Unit	Number	Unit Cost	Cost ($'000)
Sign-boards	Vol.	26	2,000	57
Marking	km.	25.9	1,000	29
Total				86

6.3.2 New Transportation System

1. General

The approximate construction cost and the relationship between the number of passengers and operation cost per trip is discussed below.

1) Length of Routes



2) Items for premise of estimation

i. Average length between stations = 1.0km

ii. Schedule speed = 25km/h

iii. Operation interval during peak hour = 5 minutes for each route.

3) Number of trains required

i. Required time for one way journey in each route

Route 1 $\frac{19}{25}$ x 60 min. = 45.6 min.

Route 2 $\frac{7}{25}$ x 60 min. = 16.8 min.

ii. Required number of trains

Route 1 $\frac{45.6}{5}$ x 2 ways = 18 trains or 19 trains (including reserve)

Route 2 $\frac{16.8}{5}$ x 2 ways = 6 trains or 7 trains (including reserve)

2. Approximate Construction Cost (KM$ = M$1,000)

This amount includes both fixed and variable cost. Variable cost is related to the number of trains.

1) Train

Tracks, electrical equipment, buildings, factories for repair and maintenance, excluding land cost.

200KM$/car x 22 = 4,400KM$ .... (1)

2) Power station

Capacity of power station.

75kw/car x 24 = 1,800kw
1,800kw x 2KM$/kw = 3,600KM$ .... (2)

3) Third rail

800KM$/km, one-way x (15km + 7km) x 2-ways
= 35,200 .... (3)

4) Signal equipment

800KM$/km, one-way x (15km + 7km) x 2-ways
= 35,200 .... (4)

5) Telecommunication equipment

200KM$/km, one-way x (15km + 7km) x 2-ways
= 8,800 .... (5)

6) Train car

500KM$/car x 26 = 13,000 .... (6)
(ATS, excluding ATO)

Total

(3), (4), (5) = 79,200KM$
(1), (2), (6) = 21,000 x N = Number of cars/train

Tracks and Stations 154,400KM$

Gross total (233,600 + 21,000 x N)KM$

Double Tracks/km (10,600 + 950 x N)KM$

3. Relationship between the number of passengers and investment cost (total construction cost).

1) Transporting capacity per day.

i. Fixed capacity per car = 60 persons.

ii. Peak ratio of 1 hour to a car = 12%

iii. Number of trains per hour = 12

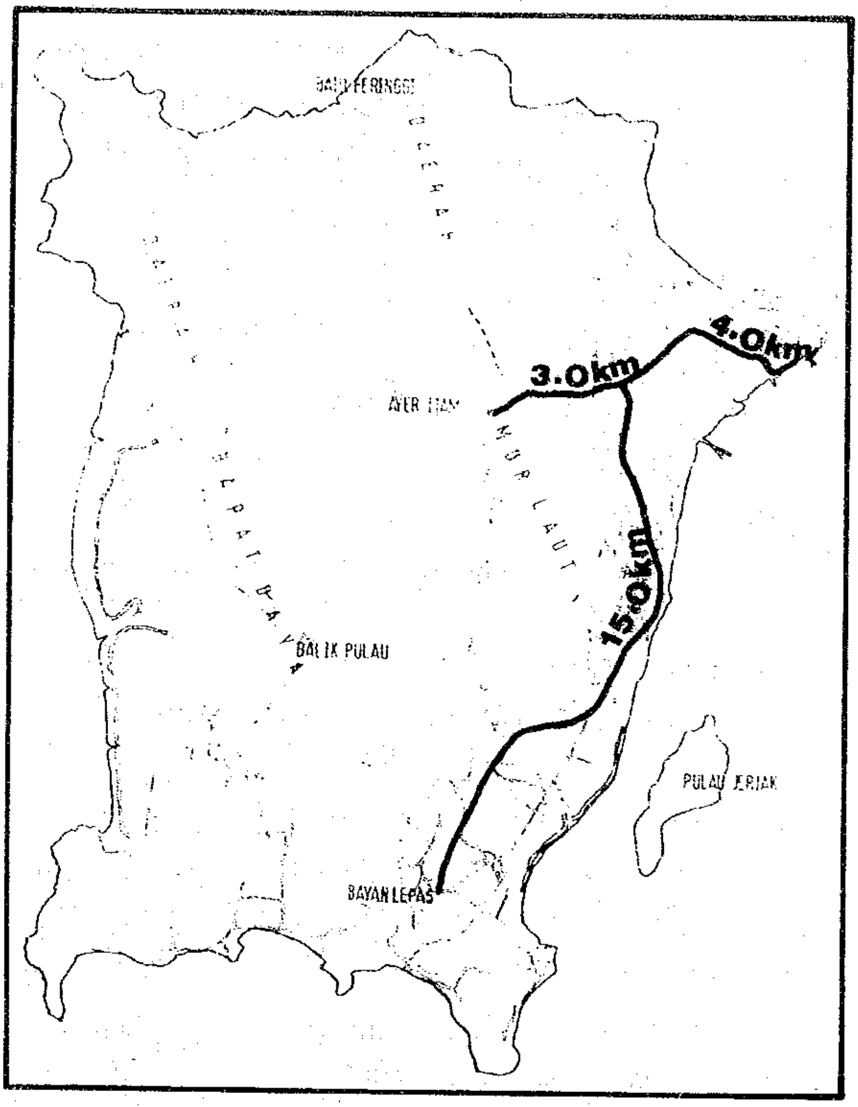


Fig. 6.8 LOCATION OF NEW TRANSPORT SYSTEM

2) The transporting capacity per day of a number of cars per train is M.

60persons x 12trains x 2ways x 2routes x N

= 2,800 x N persons/bothways 2-routes/hour

$2,880 \times N \times \frac{100}{12} = 24,000 \times N$ persons/day

3) Relationship between construction cost & transporting capacity.

Table 6.8 CONSTRUCTION COST AND TRANSPORTING CAPACITY

No. of cars/train	Capacity/hour, 2-ways, 2-routes	Capacity/day, 2-ways, 2-routes	Total construction cost KM$
N = 1	2,800 persons	24,000 persons	253,000
2	5,600 "	48,000 "	275,600
4	11,200 "	96,000 "	317,600
6	16,800 "	144,000 "	359,600
8	22,400 "	192,000 "	401,600

4. Rough Estimate of Running and Other Costs

1) Number of persons required for operating the following.

Station

2 persons per station x 31 stations x 2.5 shifts
= 155 persons

Drivers and Conductors

2 persons per train x 24 trains x 3.5 shifts
(excluding stand-bys) = 168 persons

Maintenance

* Truck. 0.6 person/one-way, km x 22km x 2 ways = 27

* Electricity. 0.7 person/one-way, km x 22km x 2 ways = 31

* Car. 0.5 person/car x (26 x N) car = 13 x N

For other operations, it will be 10% of the above total = 38 + 1 x N.

Total (419 + 11 x N) persons.

2) Personnel cost

M$600/month x 12 month x (419 + 14 x N) = 42,011 + 67.2 x N KM$/year.

3) Maintenance cost

* Tracks
M$20,000/double tracks/year x 22km = 440KM$

* Electricity
M$40,000/double tracks/year x 22km = 880

* Cars
12,000 KM$/car/year x 26 x N = 312 x N

Total = 1,320 + 312 x N

4) Power cost

* Total running distance

6 trains/hour x 22km x 2 way x $\frac{100}{12}$ x N = (2,200 x N)km/day

* Electricity consumption

0.12 KWH/ton. km x 12 ton/car x 2,200 x N

= (3,170 x N)KWH/day

* Power Cost

(3,170 x N)KWH x 365days x M$0.1/KWH = (116 x N)KM$/year

5) Transporting cost (for tickets and others)

1 cent/passenger x (24,000 x N)passengers/day x 365

= 87.6 x N KM$/year

6) Other costs

20 percent of above total cost

Personnel	2,011 + 67.2	x N KM$/year
Maintenance	1,320 + 312.0	x N KM$/year
Power	116.0	x N KM$/year
Transporting	87.6	x N KM$/year
	3,331 + 583	x N KM$/year
Other costs	666 + 117	x N KM$/year
Total	3,992 + 700 x N	

7) Rate of depreciation

Assuming that the rate of depreciation per year is 4 percent of total construction cost.

(273,600 + 21,000 x N)KM$ x 0.033 = (7,700 + 690 x N)KM$/year

8) Interest rate

Assuming that all construction costs are borrowed at an interest rate of 4 percent per annum.

(233,600 + 20,000 x N) x 0.04 = (9,344 + 840 x N)KM$/year

9) Total annual expenditure

Running cost	3,997 + 700 x N KM$/year
Depreciation	7,700 + 690 x N KM$/year
Interest	9,344 + 840 x N KM$/year
	21,041 + 2,230 x N KM$/year

Table 6.9 NUMBER OF PASSENGERS AND FARE PER TRIP

No. of cars/ train	Daily capacity (Persons)	Capacity per year ('000 persons)	Total construction cost KM$	Total annual expenditure KM$	Fare per trip $	Fare per trip, excluding depreciation & interest
N=1	11,000	4,015	253,600	24,698 (6,194)	6.15	1.54
2	22,000	8,030	273,600	26,820 (6,856)	3.34	0.85
4	44,000	16,060	313,600	31,064 (8,180)	1.93	0.51
6	66,000	24,090	353,600	35,308 (8,504)	1.46	0.39
8	88,000	32,120	393,600	39,552 (10,828)	1.23	0.34
10	110,000	40,100	433,600	43,796 (12,152)	1.09	0.30

( ): Running cost only
(excluding depreciation and interest)

Table 6.10 COST OF TRACKS AND STATIONS (per 22.0km)

Description	Class	Unit	Quantity	Unit Cost	Cost (M$'000)
1. Station	terminal	vol.	4	1,148,000	4,592
Station	minor terminal	vol.	19	574,000	10,906
2. Steel		Ton.	26,540	2,000	73,080
3. Concrete		M^3	6,160	150	924
4. Pillar		Ton.	3,762	2,000	7,524
5. Excavation	common	M^3	73,500	5	367
Sub-total					97,393
Per Kilometre					3,985
6. Land Acquisition	commercial	M^2	70,000	600	42,000
	other	M^2	150,000	100	15,000
Sub-Total					57,000
Total					154,39

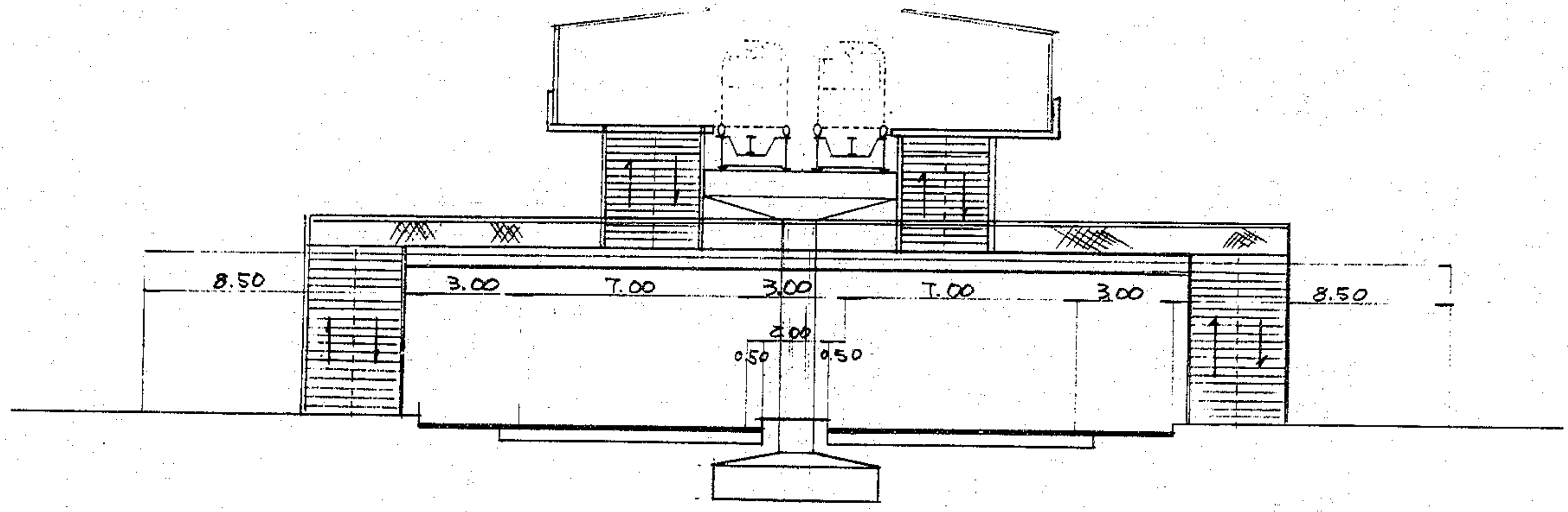


Fig. 6.9 Cross-Section of Station (Unit: in meter)

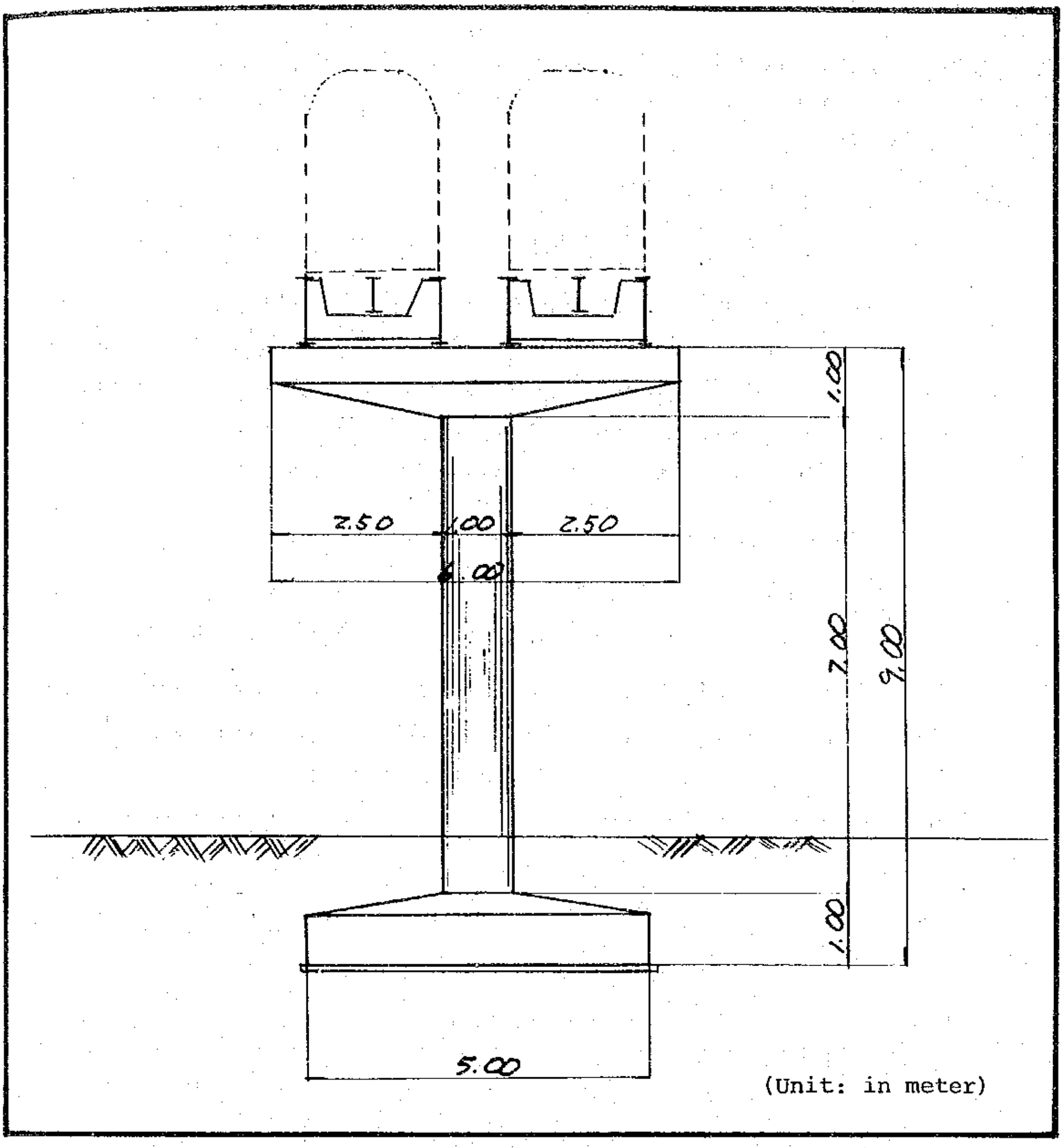


Fig.6.10 General Cross-Section of Guideway

6.4 Traffic Operation and Management

6.4.1 Sidewalks

1. Aspects of Sidewalk Plan

(a) Avoidance of cutting trees in the construction of sidewalks

Roadside trees contribute to a pleasant environment in towns and cities. In a situation where there is not enough space for the construction of a sufficiently wide sidewalk due to the presence of roadside trees, a narrow sidewalk can be constructed and thus roadside trees can be preserved.

(b) Relation of sidewalks to existing roads

Sidewalks are different in urban areas and in the suburbs as they are in the C.B.D. and in other built up areas.

As a general rule, sidewalks should be established in district and local distributors in urban areas as well as district distributors in the suburbs.

District		district distributors	local distributors
Urban area	C.B.D	*	*
	Other built-up area	*	*
Suburbs		*	-
Rural		-	-

* with sidewalks
\- without sidewalks

(c) Forms of sidewalk

Sidewalks must be distinquished from carriage-ways in that they are for the use of pedestrians while carriage-ways are for vehicles.

There are various ways of differentiating sidewalks and carriage-ways but the form of a particular sidewalk is derived from the existing road cross-section, traffic conditions and the use of the roads. In addition, safety of pedestrians, existing road conditions and costs have to be taken into consideration in deciding the type of sidewalk.

Sidewalks and carriage-ways are divided by kerb-stones. In urban areas, roads are narrow and as such the covered part of drains beside the roads are used as sidewalks.

(d) Avoidance of building removal in the construction of side-walks

Not only are roads in the urban areas narrow but there are also built-up areas along both sides of them and thus there is insufficient space wide enough for sidewalks. In this situation, there is no need to remove the buildings, instead, the width of sidewalks must be decreased.

(e) To provide sidewalks of adequate width

Demand for sidewalks vary according to adjacent land use patterns and road conditions. In the commercial areas especially, sufficient space for pedestrians is required not only from the point of view of safety but also from the need to provide amenities for urban living. Therefore parking control should be considered if there is insufficient space for sidewalks.

2. Types of Sidewalk

As mentioned above, sidewalks are constructed along limited arterial streets and circulating roadways. These may be divided into eight (8) different cross-sections (See Fig. 6.12) and the sidewalk for each cross-section is recommended by taking into consideration these different cross-sections of the roads.

1) Type A

This is suitable for narrow circulating roadways in the C.B.D. The width of the right of way is about 12.0m and drains run along both sides of the road. Thus, sidewalks with widths of 1.5m can be constructed along side the drains allowing enough space for two (2) persons walking side by side.

The mount-up of the sidewalk should be about 15cm high which is enough to ensure that no hindrance is caused to either pedestrians or vehicles.

2) Type B

The width of the right of way is about 15.0m, the carriageway 6.0m wide, the road shoulder 2.5m wide and the sidewalk 2.0m wide. This type cannot be constructed along a dual carriage-way in which instance, the side-walks should be built over the drain. The road shoulder is used by motor-cycles and by cars when they need to stop for a short time.

3) Type C

Type C is the most popular type for and around the C.B.D. This type of sidewalk is the same as Type A and Type B. A sidewalk width of 2.5m is established on a road of a 20m width. The cross-section of this road is not completely a dual carriage-way as the inner lane is used for vehicles while the outer lane is used for motor-cycles, bicycles, trishaws and for vehicles which need to stop for a short time.

4) Type D

Type D is the same as Type C except that this road is for one-way traffic. Each of the four (4) lanes of this carriage-way is about 3.5m wide. The inner lanes are used by heavier vehicles while the outer lanes are used by lighter vehicles and for temporary stopping.

5) Type E

This type of sidewalk is applicable to road cross-sections in urban areas other than in the C.B.D. In the case where the carriage-way is very narrow, sidewalks cannot be constructed alongside the carriage-way. However, they can be set up if there is space beside the roadside trees. Presently, such space has grass growing and sidewalks constructed here should be of concrete block.

6) Type F

The cross-section of the road for Type F is the same as that for Type E but here, the existing shoulder is already mounted up.

Wherever space allows, sidewalks may be constructed either on the left or right side of roadside trees and should be of concrete block construction.

7) Type G

The cross-section of the road for Type G is the same as that for Type E but in this case, the sidewalk is constructed of concrete block. This sidewalk is not mounted-up but a kerb is set up between the sidewalk and carriageway. The kerb should be 25cm. high and serves to 'protect' pedestrians from traffic and vice versa.

8) Type H

This type of sidewalk is recommended for dual carriageways. Since there are large drains on both sides of the road, the cover of these drains may be used as sidewalks.

Each of these sidewalks is shown in Fig. 6.11 and 6.12.

3. Sidewalk Network

According to the discussion of the sidewalk plan just prior, a sidewalk network was prepared. As a general rule, sidewalks are established along both sides of district distributors and local distributors thus giving rise to a continuous system of sidewalks. Existing roadside conditions were also surveyed.

Sidewalks in relation to names of roads, width of roads, traffic flow, parking conditions, types of improvement and length of improvement are shown in Tables 6.11 and 6.12.

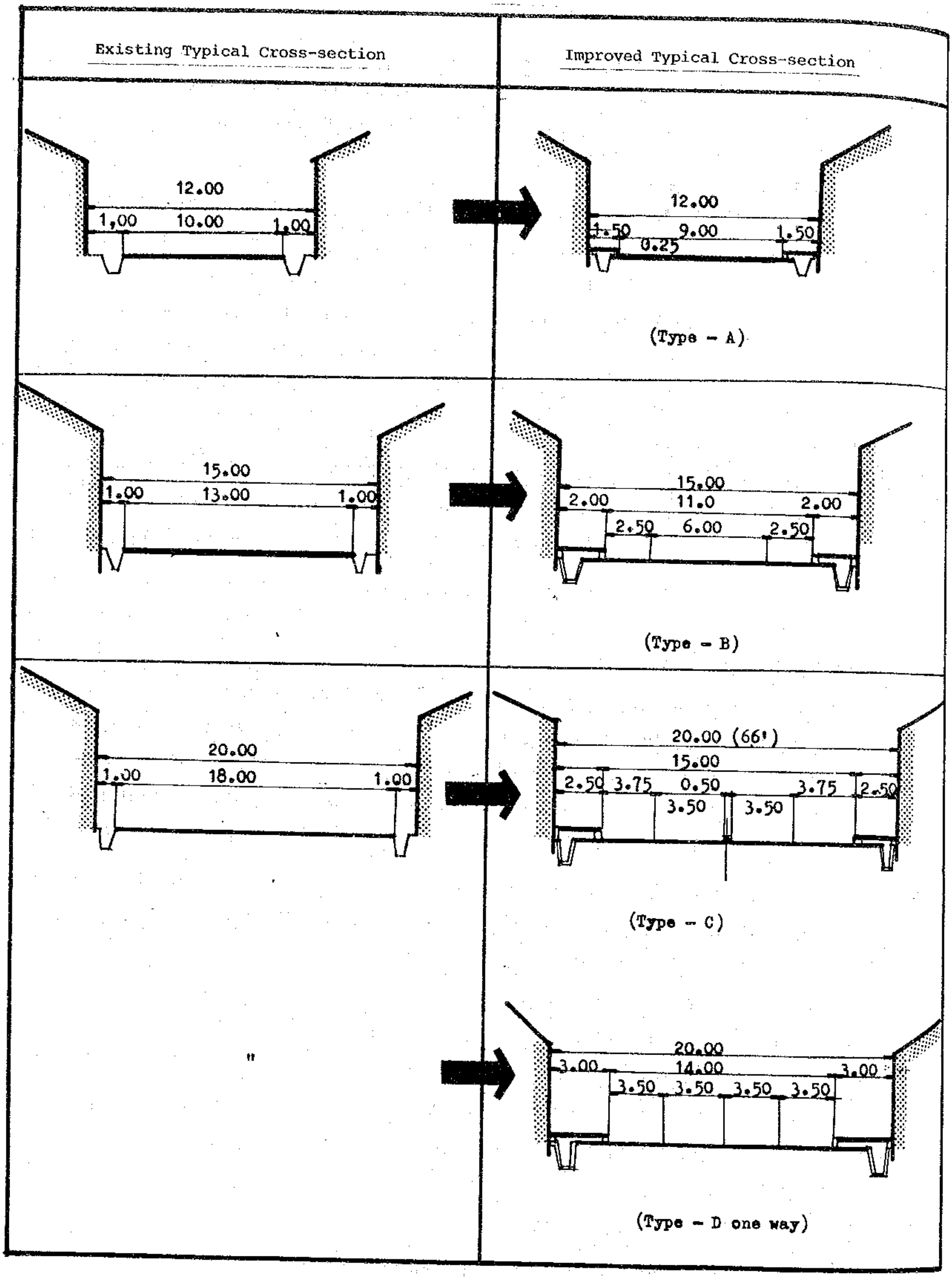


Fig. 6.11 TYPES OF SIDEWALK RECOMMENDED
(in C.B.D.)

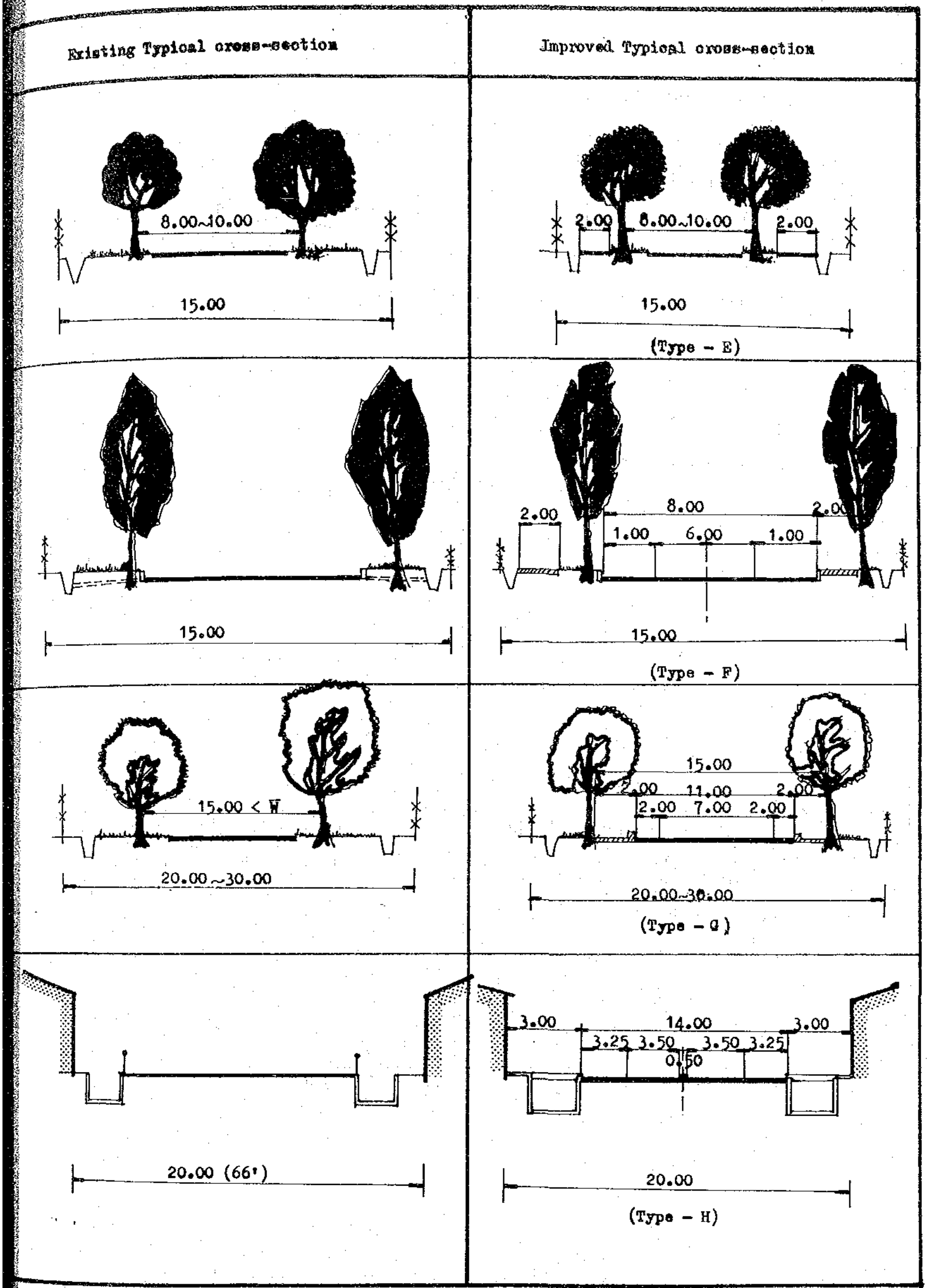


Fig. 6.12 TYPES OF SIDEWALK RECOMMENDED
(Other Urban Areas)

4. Construction Cost Estimates

Construction cost was estimated according to each type of improvement (A to H) per kilometre.

The length of each sidewalk was measured and cost was calculated by multiplying this length by the cost per kilometre.

Construction costs are shown in Table 6.11.

Table 6.11 UNIT CONSTRUCTION COST OF EACH TYPE OF IMPROVEMENT

Type	Unit (km)	Unit Construction Cost ($)	Remarks
A	1	15,000	
B	1	20,400	
C	1	24,600	
D	1	28,800	
E	1	15,500	
F	1	15,500	
G	1	23,000	
H	1	36,000	

Note: Construction cost for one (1) side of the road only.

Table 6.12 COST OF SIDEWALK IMPROVEMENT

Type	Length of Improvement (km)				Cost (M$'000)			
	Island	B.W	B.M	Total	Island	B.W	B.M	Total
A	1.1	4.3	5.7	11.1	16.5	64.5	166.5	247.5
B	1.5	6.9	-	8.4	30.6	140.7	-	171.3
C	17.15	23.4	-	40.55	421.9	575.6	-	997.5
D	6.3	-	-	6.3	181.4	-	-	181.4
E	1.6	-	-	1.6	24.8	-	-	24.8
F	-	-	-	-	-	-	-	-
G	35.1	-	0.8	35.9	809.3	-	18.4	825.7
H	1.6	-	-	1.6	57.6	-	-	57.6
Total	64.35	34.60	6.5	104.45	1,540.1	780.8	184.9	2,505.8

Note: Island: Penang Island
B.W : Butterworth
B.M : Bukit Mertajam

Table 6.13 TYPE OF IMPROVEMENTS (Penang Island)

Name of Road	Width of Road (ft)	Traffic Flow	Parking Conditions	Type of Improvement	Length of Improvement(m)	Remarks
Pengkalan Weld	74	two ways	no	C	400	one side
Pengkalan Weld	74	two ways	no	C	1,200	both sides
Leboh Victoria	40	two ways	ok	A	550	both sides
Leboh Pantai	66	one way	no	D	700	both sides
Bridge Street	66	one way	no	D	1,000	both sides
Leboh McNair	66	one way	ok	D	1,000	both sides
Brick Kiln Road	66	one way	no	D	900	one side
Leboh Chulia	66	two ways	no	C	1,300	both sides
Leboh Chulia	66	two ways	no	C	400	one side
Gat Leboh Chulia	66	two ways	no	C	200	one side
Penang Road	66	two ways	no	C	500	both sides
Penang Road	66	two ways	no	C	300	one side
Muntri Street	50	two ways	ok	B	750	both sides
Leboh Chulia	66	two ways	no	C	550	both sides
Leboh Chulia	66	two ways	no	C	650	one side
Jalan Prangin	66	two ways	no	C	900	one side
Leboh Prangin	66	two ways	no	–	400	Improvement of road
Jalan Dato Keramat	100	two ways	no	C	1,050	both sides
Jalan Macalister	66	two ways	no	G	3,100	both sides
Jalan Northam	100	two ways	no	G	900	both sides
Jalan Northam	100	two ways	no	G	700	one side
Jalan Burma	74	two ways	no	G	1,550	both sides
Jalan Burma	74	two ways	no	H	1,350	one side
Jalan Argyll	66	two ways	no	C	950	both sides
Jalan Pangkor	74	two ways	no	C	600	both sides
Leboh Raya Peel	74	two ways	no	C	450	both sides
Jalan Anson	74	two ways	no	C	650	both sides
Jalan Sg. Pinang	74	two ways	no	–	1,250	Improvement of road
Jalan Patani	66	two ways	ok	G	500	both sides
Jalan Jelutong	66	two ways	no	G	2,300	one side
Jalan Ayer Itam	100	two ways	no	G	2,000	both sides
Jalan Ayer Itam	100	two ways	no	C	300	one side
Jalan Trengganu	74	two ways	ok	G	450	both sides
Jalan Trengganu	74	two ways	ok	G	450	both sides
Jalan Perak	100	two ways	no	G	900	both sides
Jalan Free School	74	two ways	ok	G	1,350	one side
Transfer Road	66	two ways	ok	G	400	both sides
Transfer Road	66	two ways	ok	G	300	one side
Jalan Cantonment	100	two ways	ok	G	450	both sides
Jalan Lim Lean Teng	66	two ways	ok	G	600	both sides
Jalan Caunter Hall	66	two ways	ok	G	900	both sides
Jalan Batu Lanchang	66	two ways	ok	G	1,200	both sides
Jalan Hamilton	66	two ways	ok	G	1,000	one side
Jalan Van Praagh	66	two ways	ok	G	1,100	both sides
Lorong Perak	50	two ways	ok	E	800	both sides
Barrack Road	66	two ways	ok	G	800	both sides
Total (in Penang Island)					40,050	

Table 6.14 TYPE OF IMPROVEMENTS (Butterworth)

Name of Road	Width of Road (ft)	Traffic Flow	Parking Conditions	Type of Improvement	Length of Improvement(m)	Remarks
Jalan Pantai	50	one way	ok	–	–	Improvement of road
Jalan Bagan Luar	66	two ways	no	C	1,900	both sides
Jalan Kampong Gajah	50	two ways	no	B	3,450	both sides
New Chain Ferry Road	74	two ways	no	C	1,000	one side
New Chain Ferry Road	74	two ways	no	C	3,100	both sides
Jalan Sungei Nyior	40	two ways	no	A	700	one side
Jalan Heng Choon Thiam	66	two ways	no	C	800	both sides
Jalan Siram	40	two ways	no	A	1,100	both sides
Jalan Telaga Ayer	40	two ways	no	A	700	both sides
Jalan Permatang Pauh	66	two ways	no	C	1,500	both sides
Jalan Kampong Paya	66	one way	ok	C	600	both sides
Jalan Raja Uda	66	two ways	no	C	3,300	both sides
Total					18,150	both sides

Table 6.15 TYPE OF IMPROVEMENTS (Bukit Mertajam)

Name of Road	Width of Road (ft)	Traffic Flow	Parking Conditions	Type of Improvement	Length of Improvement(m)	Remarks
Jalan Stowell	33			–	–	Improvement of road
Jalan Besar	40	one way	no	A	1,050	both sides
Jalan Aston	40	one way	no	A	550	both sides
Jalan Arumugam Pillai	40	two ways	no	A	1,250	both sides
Jalan Muthupalaniappa	66	two ways	ok	G	400	both sides
Total					3,250	both sides

6.4.2 Intersections

1. Policy for Intersection Improvement Plan

(a) Construction of intersections in stages

The plan for the improvement of intersections may be divided into two (2) different stages of construction. The first stage is an immediate action stage, i.e., to embark on the improvement of intersections at the present moment and to continue into the second stage when the Penang Bridge and the North Coastal Road are constructed. The improvement of intersections should be made in conjunction with these projects until their completion. However, stage one is interlinked closely with stage two and careful considerations must be given when making immediate intersection improvements. For example, there is an urgent need to improve the intersection between Penang Road and Magazine Road but there must be some awareness of the commuter plan, the North Coastal Road plan and other related plans of the future. Therefore, it is exceedingly important to make a thorough examination of the Highway Improvement Plan before embarking on any improvements.

(b) Roundabout intersections and signalized intersections

It is observed that roundabout intersections have sufficient right of way and the traffic volume at these intersections is small.

On the other hand, signalized intersections are narrow, especially in the C.B.D. and the traffic volume is large.

Accordingly, it is desirable to convert roundabout intersections in George Town, Butterworth and Bukit Mertajam into signalized intersections because the right of way of these intersections are very narrow.

The traffic capacity of roundabout intersections and signalized intersections will be mentioned later.

(c) To avoid the removal of trees in the improvement of intersections

Roadside trees contribute greatly to a pleasant environment in towns and cities. In a situation where there is insufficient space to widen an intersection due to the presence of roadside trees, it is better to decrease the width of one lane from 3.5 meters to 2.75 meters and thus preserve the roadside trees.

(d) Signalized intersections

a. It is necessary to provide an additional lane in improved signalized intersections. This additional lane will make it possible for the traffic volume to increase by 200 to 300 P.C.U/hr. Thus traffic flow can be dealt with at intersections and there will be less traffic accidents.

b. Additional lanes should be of sufficient width and length to enable vehicles to come to a half with ease. The width of the lane should be 3.0 meters and its length should be 20 to 30 meters. This allows an accomodation of 5 to 6 vehicles to stop at one time.

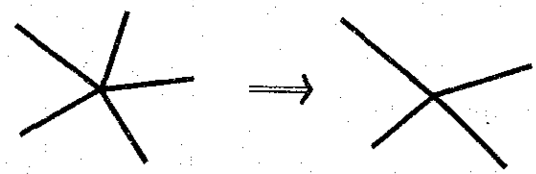
(e) In order to construct simple intersections

Intersections are points where roads cross each other and where the direction of traffic flow changes.

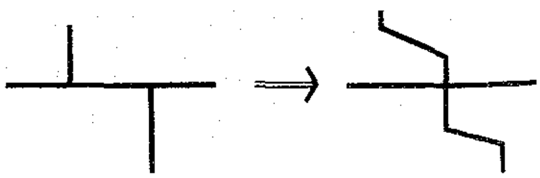
As a general rule, the following should be observed in establishing intersections.

a. Avoid five (5) legged intersections.
b. Roads should cross at 90 degrees.
c. Avoid having two (2) intersections close to each other.

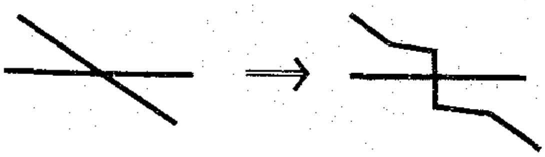
a



c



b



(f) Grade separation intersection

Grade separation intersection can be established on condition that the following factors exist.

a. The capacity at intersections of four (4) lane carriageways is about 3,000 vehicles (shown in the capacity of intersection). Thus, wherever there are intersections where the traffic volume is more than 3,000 vehicles, they should be converted into grade separation intersections.

b. The construction of grade separation intersection requires a large area for its frontage road. Thus, the possibility of acquiring the necessary space should be considered.

Besides the policy mentioned above, the team recommends that a detailed survey for traffic movement and phenomenon should be carried out continuously for a long period since there is no Malaysian standard based on actual conditions for traffic engineering.

The improvement scheme of intersections described here-in-after is, therefore, based on the standard of Japan and the U.K., and is suggested to be examined if the detailed study is to be performed.

2. Calculation of Traffic Capacity

(a) Signalized Intersection Traffic Capacity

The capacity of signalized intersection is calculated from the formula given below.

$$Cp = 1800 \times L \times R \times T$$
$$CD_1 = Cp \times 0.8 \times G_1/C$$
$$CD_2 = Cp \times 0.8 \times G_2/C$$

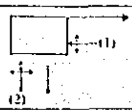
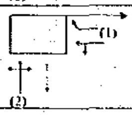
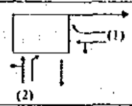
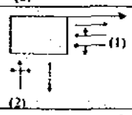
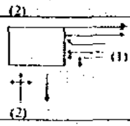
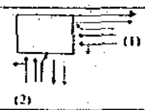
1800 is the basic traffic capacity of an intersection.
Cp is the possible traffic capacity (V/G/L)
L is the left turning vehicle adjustment factor.
R is the right turning vehicle adjustment factor.
T is the truck adjustment factor.
L and R are shown below.

Percentage of Turning Vehicles	Left turning vehicle(L)		Right turning vehicle(R)	
	One lane	More than two lanes	One lane	More than two lanes
0	1.000	1.000	1.000	1.000
5	0.915	0.975	0.885	0.955
10	0.835	0.950	0.770	0.910
15	0.790	0.930	0.690	0.865
20	0.750	0.905	0.655	0.820
25	0.730	0.880	0.635	0.795
30 over	0.710	0.855	0.615	0.775

T is shown below

Percentage of Truck(%) (T)	Adjustment factor (T)
0	1.000
5	0.960
10	0.925
15	0.885
20	0.850

Table 6.16 RESULTS FROM THE CALCULATIONS

Case	Capacity P.C.U./hr. (1)	(2)	Total	Remarks
1	404	323	727	
2	672	323	995	
3	672	672	1344	
4	1270	266	1536	
5	1583	266	1849	 two phase
	1438	213	1651	" three phase
6	1583	1583	3166	

(b) Roundabout traffic capacity

Practical capacities of weaving sections may be calculated from the formula given below:

$$Qp = \frac{86w(1 + e/w)\ (1 - p/3)}{1 + W/L}$$

where Qp is the practical capacity of the weaving section in pcu's per hour.

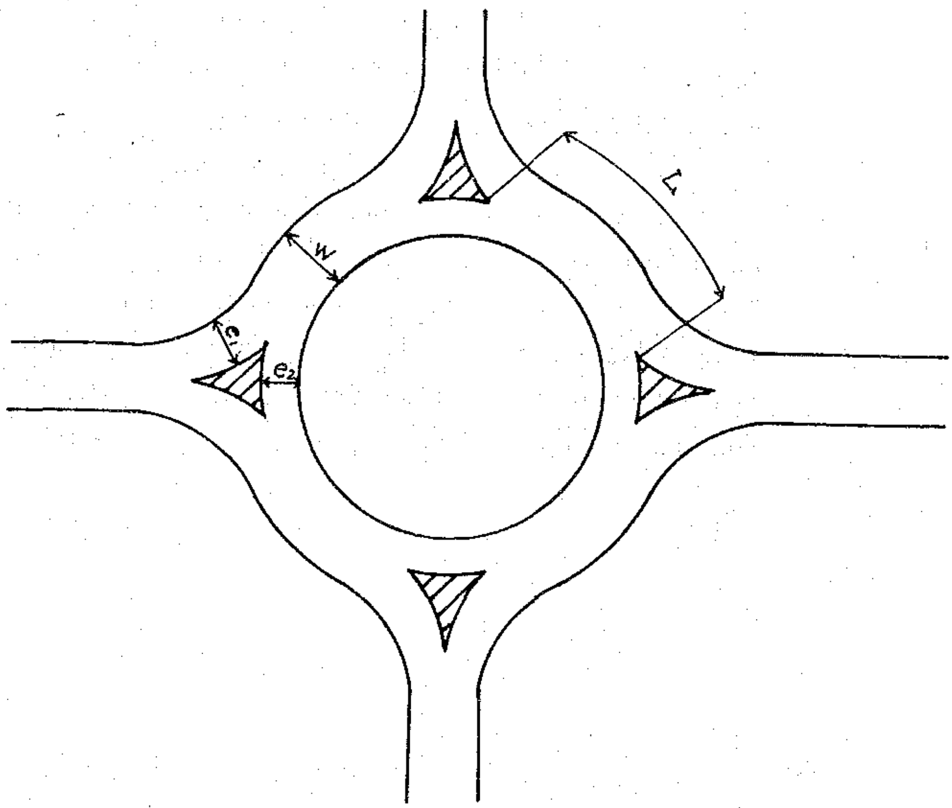
- w is the width of the weaving section in feet (within a range of 20 ft. to 60 ft.),
- e is the average width in feet of the two carriageways e_1 and e_2 entering the weaving section (e/w range 0.4 to 1.0),
- L is the length of the weaving section in feet (range 60 ft. to 300 ft. and w/1 range 0.12 to 0.4),
- p is the proportion of weaving traffic, i.e., the ratio of the sum of the weaving streams to the total traffic on the weaving section (range 0.4 to 1.0).

The practical capacity derived from this formula is 80 percent of the maximum capacity found from experiments on isolated weaving sections. This provides a margin of safety to meet the effects of wet weather, possible intersection between weaving section, variations in flow during the hour of the day and possible interference from pedestrians crossing the road. The ranges quoted may not be absolute but are those covered by tests; the formula is valid within these ranges provided there are no standing vehicles on the approaches to the roundabout and that the site of the roundabout is level, with approach gradients not exceeding 1 in 25.

Table 6.17 CAPACITY OF EACH CASE

L (ft.)	W (ft.)	e (ft.)	P	Q (P.C.U./hr)	Q x 80% (P.C.U./hr)
30	20	10	0.75	1,159	927
"	25	10	"	1,233	986
"	30	15	"	1,451	1,161
"	35	15	"	1,486	1,189
50	20	10	0.75	1,382	1,106
"	25	10	"	1,505	1,204
"	30	15	"	1,814	1,451
"	35	15	"	1,897	1,518
70	20	10	0.75	1,500	1,200
"	25	10	"	1,613	1,290
"	30	15	"	2,030	1,624
"	35	15	"	2,150	1,720
100	20	10	0.75	1,613	1,290
"	25	10	"	1,806	1,445
"	20	15	"	2,233	1,786
"	35	15	"	2,389	1,911
150	20	10	0.75	1,712	1,370
"	25	10	"	1,929	1,543
"	30	15	"	2,419	1,935
"	35	15	"	2,622	2,098

Source: "Roads in Urban Areas" Ministry of Transport, Scottish Development Department, The Welsh Office.



3. Improvement Scheme of Intersections

(a) Intersections to be improved

According to the improvement policy mentioned earlier and to the traffic flow estimated, forty (40) intersections have been selected for improvements. These intersections are considered important and are expected to be improved in the short-run.

Table 6.18 LIST OF INTERSECTIONS

No.	Name of Streets	Remarks
1.	Jalan Tanjung Tokong, Jalan Kelawai, Jalan Bagan Jermal.	At-Grade
2.	Jalan Bagan Jermal, Jalan Gottlieb, Mount Erskine Road, Jalan Burma.	"
3.	Jalan Gottlieb, Waterfall Road, Jalan Western.	"
4.	Jalan Kelawai, Jalan Northam, Jalan Pangkor, Jalan Gurney.	"
5.	Jalan Western, Jalan Macalister.	"
6.	Penang Road, Burma Road, Prangin Road.	At-Grade
7.	Penang Road, Magazine Road, Macalister Road.	"
8.	Prangin Road, Maxwell Road, Carnavon Street, Prangin Ghat, Gladstone Road.	"
9.	Weld Quay, Prangin Ghat.	Grade Sep.
10.	Jalan Dato Keramat, Perak Road.	At-Grade
11.	Jalan Air Itam, Jalan Trengganu.	"
12.	Jalan Free School, Jalan Perak.	"
13.	Lorong Perak, Jalan Jelutong.	"
14.	Jalan Jelutong, Jalan Perak, Jalan Batu Lancang.	"
15.	Green Lane, Jalan Free School.	"
16.	Green Lane, Jalan Hamilton, Lorong Batu Lancang.	"
17.	Green Lane, Jalan Batu Lancang.	"
18.	Jalan Air Itam, Ayer Puteh Road.	"
19.	New Coastal Road intersection.	Grade Sep.
20.	Jelutong Road, Sg. Pinang Road, Proposed Coastal Road.	At-Grade
21.	Proposed Coastal Road.	Grade Sep.
22.	Jalan Gelugor, Jalan Jelutong, Proposed Coastal Road, Jalan Jelutong.	Grade Sep.
23.	Jalan Gelugor, Green Lane, Proposed Coastal Road.	"

Table 6.18 LIST OF INTERSECTIONS (Cont'd)

No.	Name of Streets	Remarks
24.	Outer Ring Road - 2 Proposed Roads to Lorong Batu Lancang and Jalan Relau.	At-Grade
25.	Gelugor Road Outer Ring Road - 2	"
26.	Relau Road Proposed Road to Ayer Itam.	"
27.	Relau Road. Proposed Road to Outer Ring Road - 2	"
28.	Sungai Nibung Road, Relau Road.	Grade Sep.
29.	Jalan Tengah Proposed Road to Lorong Batu Lancang.	"
30.	Jalan Bagan Ajam, Jalan Dragon Tempe, Jalan Paku Lima, Jalan Sungai Dua.	At-Grade
31.	Jalan Sungai Dua, Jalan Raja Uda.	"
32.	Jalan Bagan Luar, Jalan Kampung Gajah, Jalan Jeti Lama, Jalan Telaga Ayer.	"
33.	Jalan Telaga Ayer, Jalan Permatang Pauh, Jalan Siram, Jalan Raja Ua.	At-Grade
34.	Jalan Bagan Luar, Jalan Pantai, Jalan Heng Choon Thiam	"
35.	Jalan Pantai, Pier Road, Mitchell Road, New Ferry Road, Bagan Luar Road, Bagan Dalam Road.	"
36.	Jalan Bagan Dalam, Jalan Assumption.	At-Grade
37.	Coastal Road - 3, Chain Ferry Road, Prai Road, Jalan Baharu.	"
38.	Federal Route - 1 Federal Route - 2 Jalan Baharu	Grade-Separated
39.	Jalan Arrumugam Pillai, Jalan Besar Jalan Tanah Liat.	At-Grade
40.	Jalan Permatang Pasir, Jalan Tanah Liat, Proposed East - West Highway.	"
41.	Jalan Permatang Pauh, Jalan Permatang Pasir, Federal Route - 1.	"
42.	Alor Star - Changkat Jering Highway and Sungai Dua Road	Grade-Separated
43.	Siram Road, Heng Choon Thiam Road	At-Grade
44.	Chain Ferry, Sungai Nyior Road	"

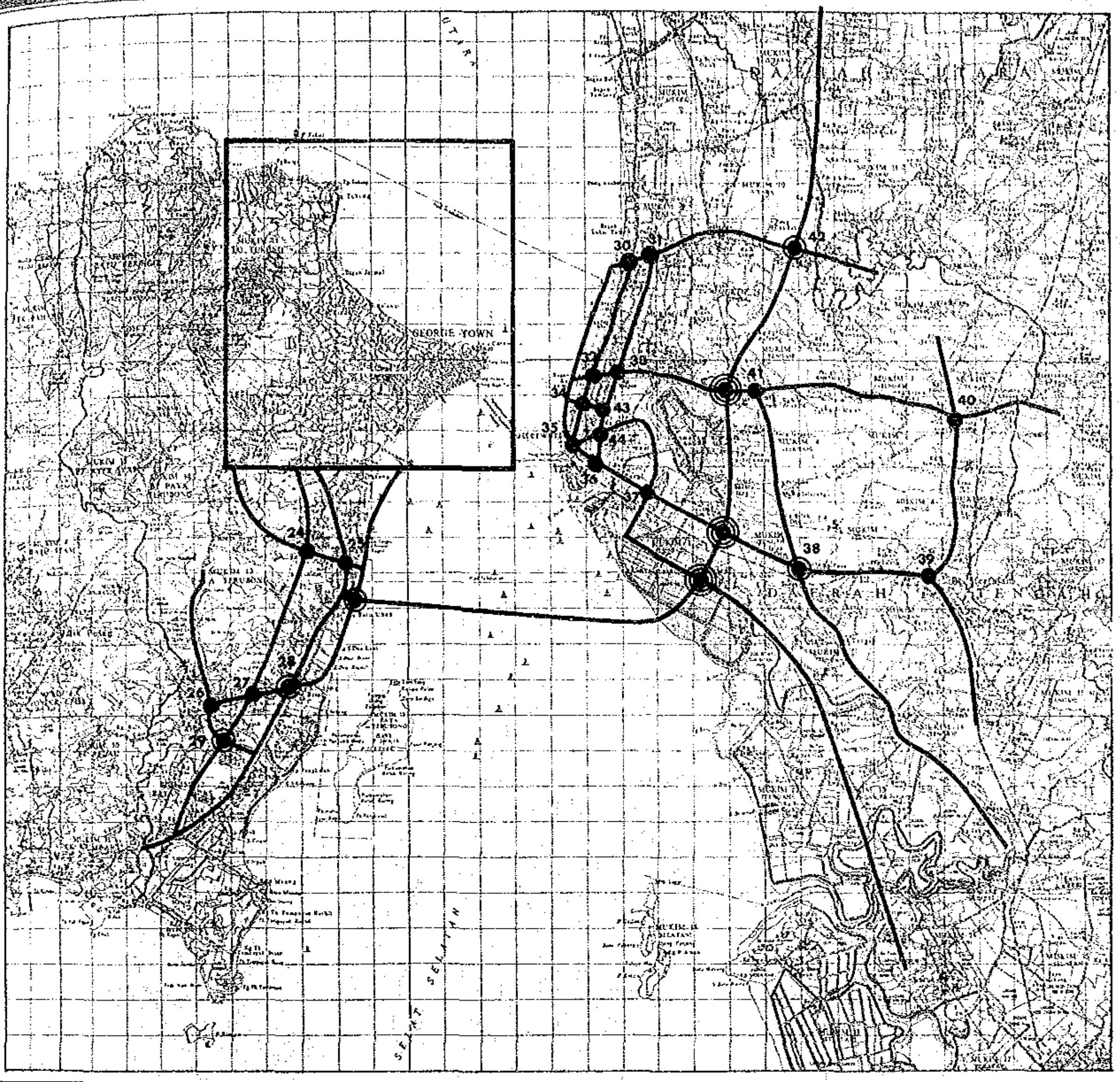


Fig.6.13 Location of Intersection

NORTH

● Intersection

PENANG URBAN TRANSPORT STUDY

URBAN TRANSPORT STUDY IN GREATER METROPOLITAN AREAS OF GEORGETOWN, BUTTERWORTH AND BUKIT MERTAJAM

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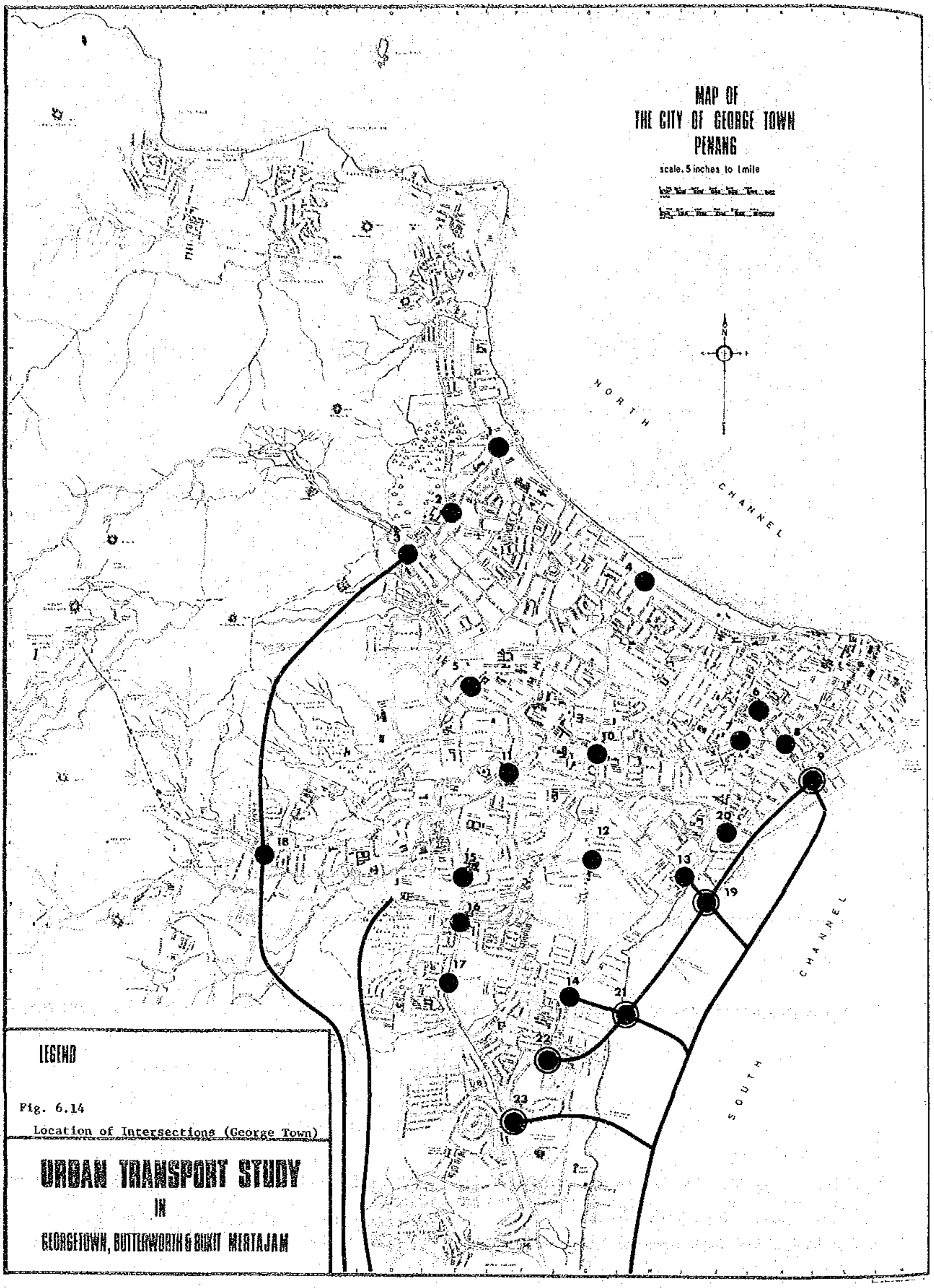


Fig. 6.14
Location of Intersections (George Town)

(b) Improvement scheme and cost

The intersections are classified into eighteen (18) types. Seven (7) of them are general, common types of intersections i.e., type A to type F. Other types are specific according to their sites and road conditions. (see chapter 9.4.2)

Improvement Costs of intersections total $65,606,000 and grade separation amounts to 95 percent of the total cost.

Table 6.19 COST OF INTERSECTION IMPROVEMENT

	Number	Cost of Detailed Engineering and Supervision	Construction Cost	Total Project Costs M$'000
At-Grade Intersection	35	213	2,661	2,874
Penang Island	22	142	1,774	1,916
Province Wellesley	13	71	887	958
Grade-Separated Intersection	9	4,641	58,011	62,652
Penang Island	7	3,609	45,117	48,726
Province Wellesley	2	1,032	12,894	13,926
Total	44	4,854	60,672	65,606

6.4.3 Signals

1. Cost of Improving Existing Signals

The method of improvement is described in the 'Interim Report Part-C'. The location of existing signal intersections is shown in Fig. 6.15. There are twenty one (21) signal intersections in both Penang Island and Province Wellesley.

The unit cost per signal intersection is as follows:

1)	Removal of the existing signal	= $ 5,000
2)	Marking	= $ 3,000
3)	Construction of new signal	= $40,000
4)	Others	= $10,000
	Total	= $58,000

Therefore, total improvement cost for all the twenty one (21) intersections is \$58,000 x 21 = \$1,218,000.

2. Cost of Introducing New Signals

The critical intersections selected in the study will be installed with signals which can be controlled by a traffic control center.

The unit cost of construction is estimated to be about \$100,000.

\$100,000 x 25 intersections	= \$2,500,000
\$53,000 x 10 intersections	= \$530,000
Total	= \$3,030,000

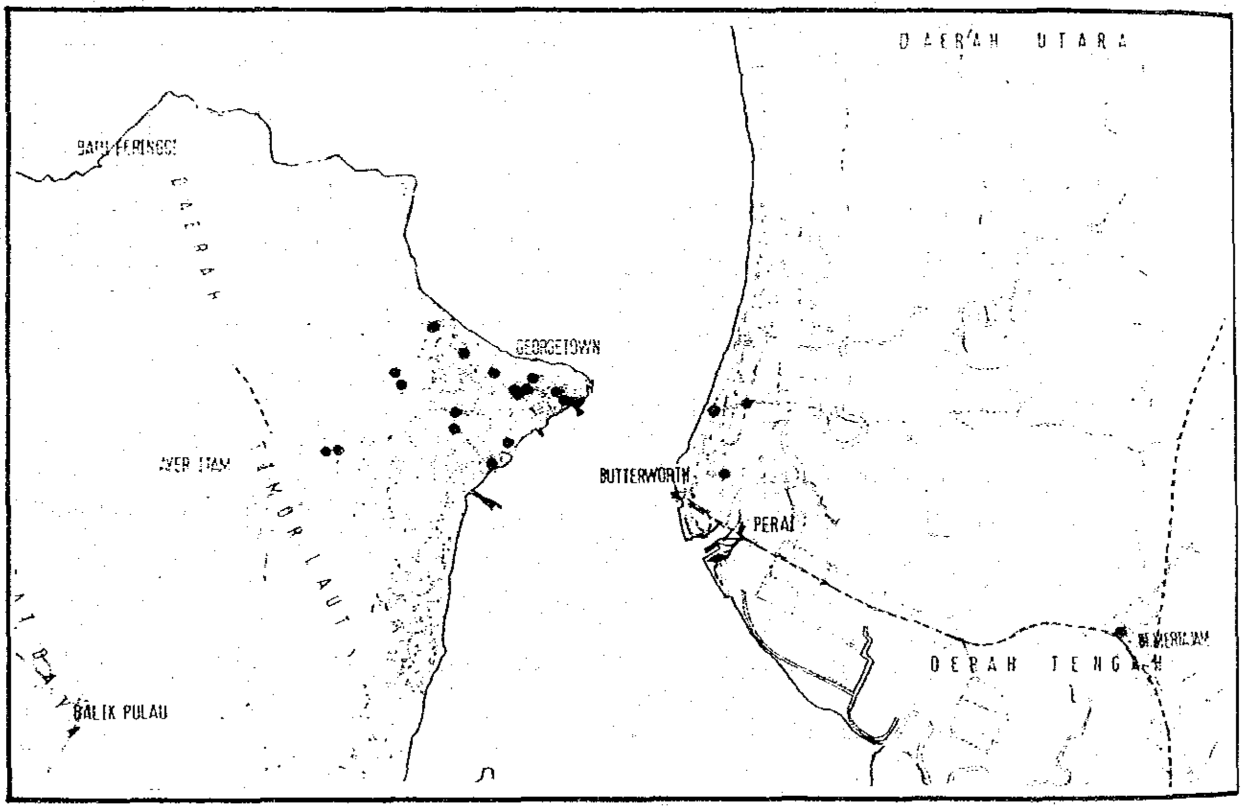


Fig. 6.15 Location of Existing Traffic Signals

6.4.4 Delineation

1. Demarcation of Traffic Flow

The center lines of existing roads are merely painted lines and therefore are not visible to drivers in the dark. This is unsafe and can cause traffic accidents. As a measure to reduce traffic accidents, necessary improvements to existing center lines are required.

1) Roads to be improved.

Roads that need improvements are as follows:

1.	JALAN NORTHAM	L = 1,500m
2.	JALAN KELAWAI	L = 2,000m
3.	JALAN TANJONG TOKONG	L = 2,300m
4.	JALAN TANJONG BUNGAH	L = 3,000m
5.	LEBOH LIGHT	L = 600m
6.	PENGKALAN WELD	L = 1,400m
7.	PENANG ROAD	L = 300m
8.	LEBOH CHULIA	L = 1,100m
9.	JALAN ANSON	L = 2,000m
10.	JALAN BURMA	L = 3,700m
11.	JALAN MACALISTER	L = 1,400m
12.	JALAN DATO KERAMAT	L = 1,300m
13.	JALAN AYER ITAM	L = 3,100m
14.	JALAN BAGAN JERMAL	L = 800m
15.	JALAN GOTTLIEB	L = 600m
16.	WESTERN ROAD	L = 2,500m
17.	JALAN CANTONMENT	L = 1,800m
18.	JALAN SCOTLAND	L = 1,300m
19.	JALAN PANGKOR	L = 600m
20.	JALAN PERAK	L = 3,600m
21.	JALAN GELUGOR	L = 1,300m
22.	JALAN SUNGEI PINANG	L = 1,300m
23.	JALAN BATU LANCANG	L = 1,100m
24.	JALAN BAGAN LUAR	L = 1,800m
25.	JALAN KAMPONG GAJAH	L = 1,000m
26.	JALAN BAGAN AJAM	L = 5,500m
27.	JALAN PERMATANG PAUH	L = 3,400m

28.	JALAN CHAIN FERRY	L = 4,400m
29.	JALAN MUTHUPALANTIAPPA	L = 3,000m
30.	JALAN ARUMUGAM PILLAI	L = 1,200m
31.	JALAN SUNGAI RAMBAI	L = 2,500m
32.	JALAN RUKIT MERTAJAM	L = 7,300m
33.	JALAN CHIKU	L = 400m
34.	JALAN MUTHUPALANIAPPA	L = 700m
35.	JALAN ARUMUGAM PILLAI	L = 1,400m
36.	JALAN STOWELL	L = 1,200m
37.	JALAN BESAR	L = 1,200m
38.	JALAN BAGAN LUAR	L = 1,600m
39.	JALAN KAMPONG GAJAL	L = 1,600m
40.	JALAN BAGAN JERMAL	L = 700m
41.	JALAN TELAGA AYER	L = 900m
42.	JALAN PERMATANG PAUH	L = 900m
43.	JALAN KAMPUNG PAYA	L = 500m
44.	JALAN HENG CHOER THIAN	L = 400m
45.	JALAN ASSUMPTION	L = 1,200m
46.	JALAN BAGAN DALAM	L = 700m
47.	JALAN CHAIN FERRY	L = 3,000m
48.	JALAN RAJA UDA	L = 1,900m
49.	JALAN SIRAM	L = 900m
50.	JALAN SUNGAI NYIUR	L = 900m
	TOTAL	87,600m

2. Preparation

A. To prepare delineators as center lines.

The center line divides the traffic flow into two (2) different directions. The center line must be prepared clearly so that it can be seen at night. Therefore, it is recommended that delineators be used as center lines. A detailed scheme of delineators is shown in Fig. 6.16.

B. To demarcate car lanes from motor-cycle lanes and other vehicle lanes.

The traffic flow on existing roads is mixed, comprising of cars, motor-cycles, bicycles, pedestrians, etc.

The traffic flow must be organized by having separate lanes for the different types of vehicles. For this purpose, there must be demarcation lines which are prepared by painting.

Existing center lines with a width of 10cm are prepared by painting but actually this width is too narrow and should be widened.

3. Construction Cost Estimates

Construction cost includes the installation of delineators and lane markings. As mentioned earlier, the detailed scheme of delineators is shown in Fig. 6.16. Demarcation marking is made between car lanes, motor-cycle lanes and others. The width of these markings should be 15cm. Delineators can be established by excavating the center of the existing carriage-way.

Table 6.20 CONSTRUCTION COST OF DELINEATORS

Description	Unit	Length (KM)	Unit Cost (M$)	Cost (M$'000)
Delineator	KM	87.6	11,322	992
Painting	KM	87.6	2,160	189
Sub-total				1,181
Engineering Services				94
Total				1,275

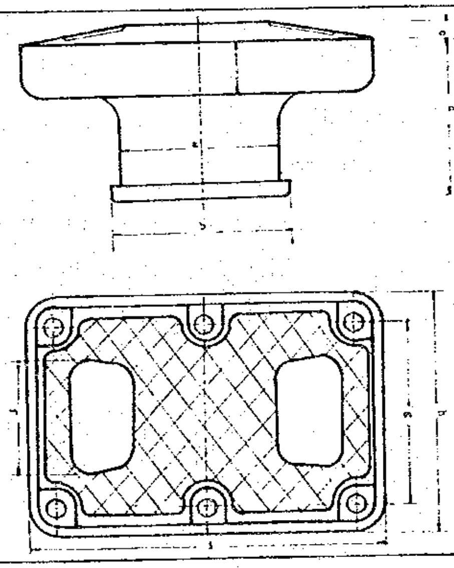


Fig. 6.16
Scheme of Delineators

6.5 Parking

6.5.1 Parking Capacity

It is recommended that the parking capacity in the C.B.D. of George Town should be as follows:

Table 6.21 PARKING CAPACITY IN THE C.B.D

Parking	1979	1985	2000
On-street	14,130	11,500	10,000
Off-street	3,490	6,500	11,000
Total	17,620	18,000	21,000

In the year 2000, the majority of parking spaces will be supplied by off-street parking. This means that about 7,500 units of parking space should be developed between 1979 and the year 2000.

6.5.2 Multi-storey car-park

In order to maximize land utilization in the C.B.D., the multi-storey car park is recommended even though it has higher parking fees compared to the usual ground level car-parks which owe their lower parking fees to the low cost of land (less than $78 per square foot).

Average capacity of multi-storey car-park is calculated as follows:

$$C = \pi r^2 \times d$$

c : parking capacity

r : maximum walking distnnce
: 200 m

d : density of parking demand

$$d = \frac{11000 \text{ lots}}{550 \text{ ha}} = 20 \text{ lots / ha.}$$

As such, the ideal parking capacity from the point of view of driver convenience is less than 250 units of parking lot and when the present plot ratio is limited to 400 percent in the C.B.D., 4-storey car-parks will be prevalent.

6.5.3 Cost Estimate

(1) Unit Cost

According to the following estimation, the unit cost of multi-storey car-parks is about $18,200 per lot.

Construction Cost

(4-storey car-park)

$13,500 per lot

Land Acquisition Cost

$C = P \times S \times 1/4 = \$4,640$

C : Land acquisition cost

P : Price oflland assumed to be $50 / ft^2

S : Unit Space : 371 ft^2/ lot

From the above calculations, unit cost is $18,200 per car.

(2) Total Cost

Construction cost of multi-storey car-parks depend upon its share in the total supply of off-street parking. However, due to the inavailability of data to help forecast the future share of multi-storey car-parks, cost estimate is done by assuming that all new off-street parking will be supplied by 4-storey car-parks.

The total cost is estimated as follows:

Table 6.22 COST OF PARKING SPACE

	1985	2000	Total
New parking lots	3,010	3,500	6,510
Cost	54,782	63,700	118,482

unit : $'000

6.6 Preliminary Plan for Transport Terminal Complex

6.6.1 Background

It is a well know fact that Penang has developed into a major growth centre in the north of Peninsular Malaysis, and is expected to keep its steady growth into the future as the second largest city in Malaysia. The East-West Highway, Pan-Asian Highway and the other national highway projects will strongly support the future urban growth of Penang State. The Penang Bridge and coastal road projects will have positive impacts on the modernization of the urban structure in Penang Island and George Town. Industrial development in Prai will take the initiative in the rapid urban development in Province Wellesley.

Traffic and transport planning will be an essential factor in the control of future development patterns of urban growth in Penang. The planning of future transportation systems will consist of three (3) major aspects:

1. Planning of traffic network system.
2. Planning of public transportation system.
3. Planning of traffic management.

The concept for the transport terminal project which will be discussed in this chapter is derived from one of the needs for the planning of the future mass transportation system. It is an important strategy to improve the present bus transport system in line with the mass transport policies for the future of Penang.

The transport terminal plan is expected to satisfy the following needs which were discussed in the chapter on the bus transport system in this report.

1. To achieve a higher concentration of route network in order to provide easier accessibility to bus transport for passengers.
2. To achieve an efficient bus service in order to increase the convenience and reliability of the system.
3. To achieve a more efficient connecting system at the main traffic nodes in an effort to increase the mobility of bus users.

In this project, four (4) bus terminals are proposed for the study area; two (2) of them for Penang Island and two (2) for Butterworth while also including new developments and improvements on the upgrading of existing facilities.

The terminal proposed for the centre of George Town is highly complex in terms of its concept and functional requirements. George Town already has a considerably high density of bus route network besides having an improvement plan for the future for the network around the Komtar development area. As such, the plan for the terminal complex needs to take the following factors into careful consideration.

1. It is necessary to plan the terminal complex in conjunction with the development concept and functions of the Prangin - Maxwell Road bus station.

2. The plan for the terminal should be designed in order to improve the traffic movement in George Town so that it can support the proposed bus transport system.

3. It should be carefully planned so that a good link between the ferry station and the terminal is achieved in terms of the needs of passengers.

4. The terminal should be able to help control the effects of future in-coming and out-going traffic that will be generated by the construction of the dispersal road.

5. The terminal should be planned to meet the new traffic demands on national and international levels in line with future tourist development.

6.6.2 <u>Location of the Transport Terminal</u>

1. <u>Entrance of the North Coastal Road (Dispersal Road)</u>

   The future of George Town will be very much affected by strong impacts form the Penang Bridge Plan, the Penang Traffic Dispersal Plan as well as other development projects. According to the implementation of these projects, the traffic conditions in Penang, particularly in George Town, will be almost completely changed. To control these impacts, it is desirable that adequate traffic control is available in order to maintain a smooth traffic flow rather than allow the direct dispersal of the traffic into built-up areas.

The portions of the intersections at the end of the North Coastal Road which have limited access to the C.B.D. can be effective in the control of in-coming and out-going regional traffic by means of planning traffic control facilities such as a passenger terminal, a bus terminal, and a car-park linked to the ferry terminal.

2. Reclamation Area

Reclamation of land of a width of about 500 meters is planned along the North Coastal Road. The reclaimed land is generally considered to have many economic advantages and suffers from less constrains in physical planning, design and construction of traffic facilities.

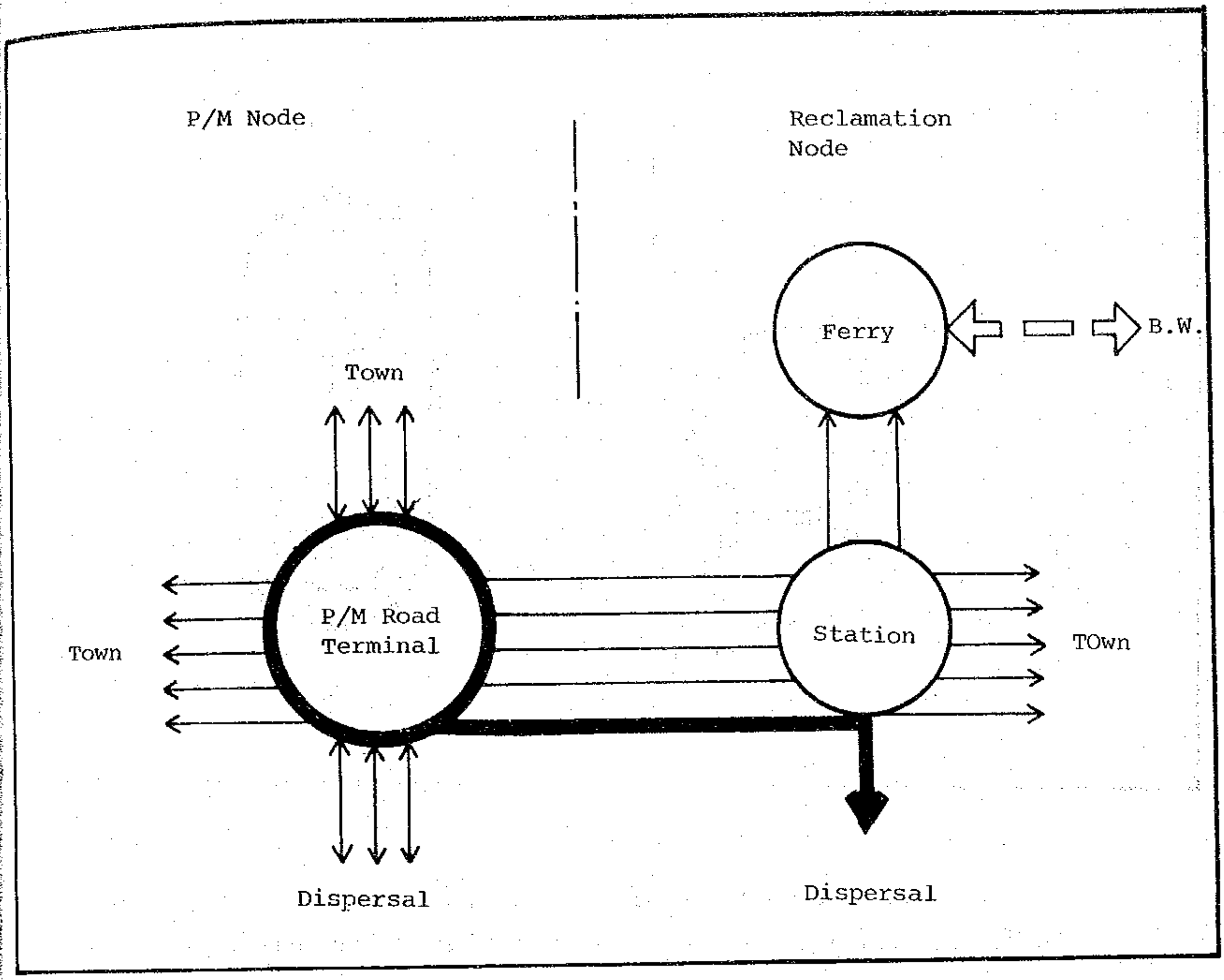
Generally speaking, development in reclamation areas has no problems in the implemental stages of projects such as purchase and compensation to former land owners.

Especially in the case of George Town the reclaimed land is located very close to the C.B.D. and thus strategic development in the reclamation area will have extensive effects on the re-arrangement of land use in the built-up area.

6.6.3 Functional Relationship of the Traffic Nodes

As mentioned earlier, the traffic terminal complex cannot be planned without considering its relationship with the Prangin Road-Maxwell Road (P/M) station. This means that both these traffic nodes, the terminal at the reclamation area and the p/M station, should be recognised to be conceptually composed of an integrated centre of a mass transportation system in George Town and thus the expected functions of the centre will be effectively shared by both of them.

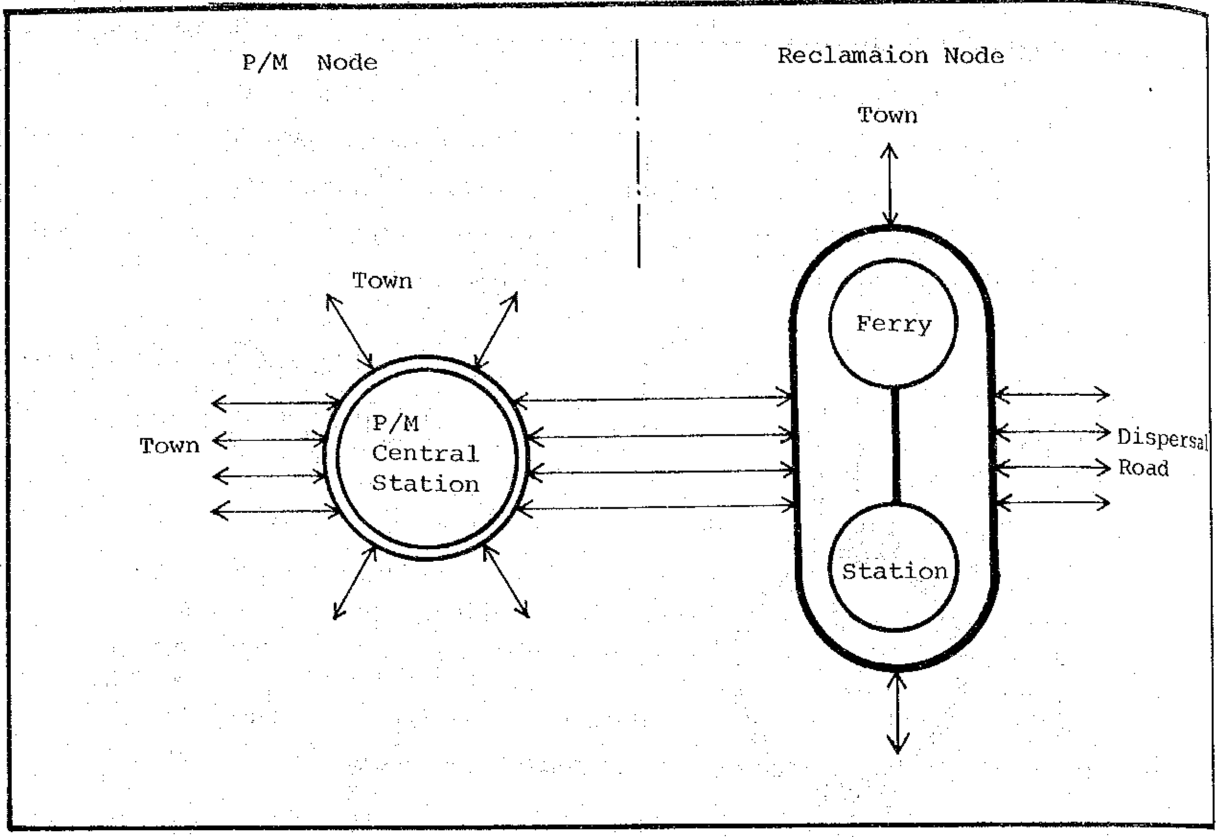
1. Pattern A



In this situation, the P/M station can carry out the major functions required. The P/M station is expected to become the main origin and destination of the bus transport system for the town in Penang Island and Province Wellesley. The Transport Terminal planned in the reclamation area will be like a minor distributor station for ferry users and a sort of stop-over station for the bus services from the towns and dispersal road to the P/M station.

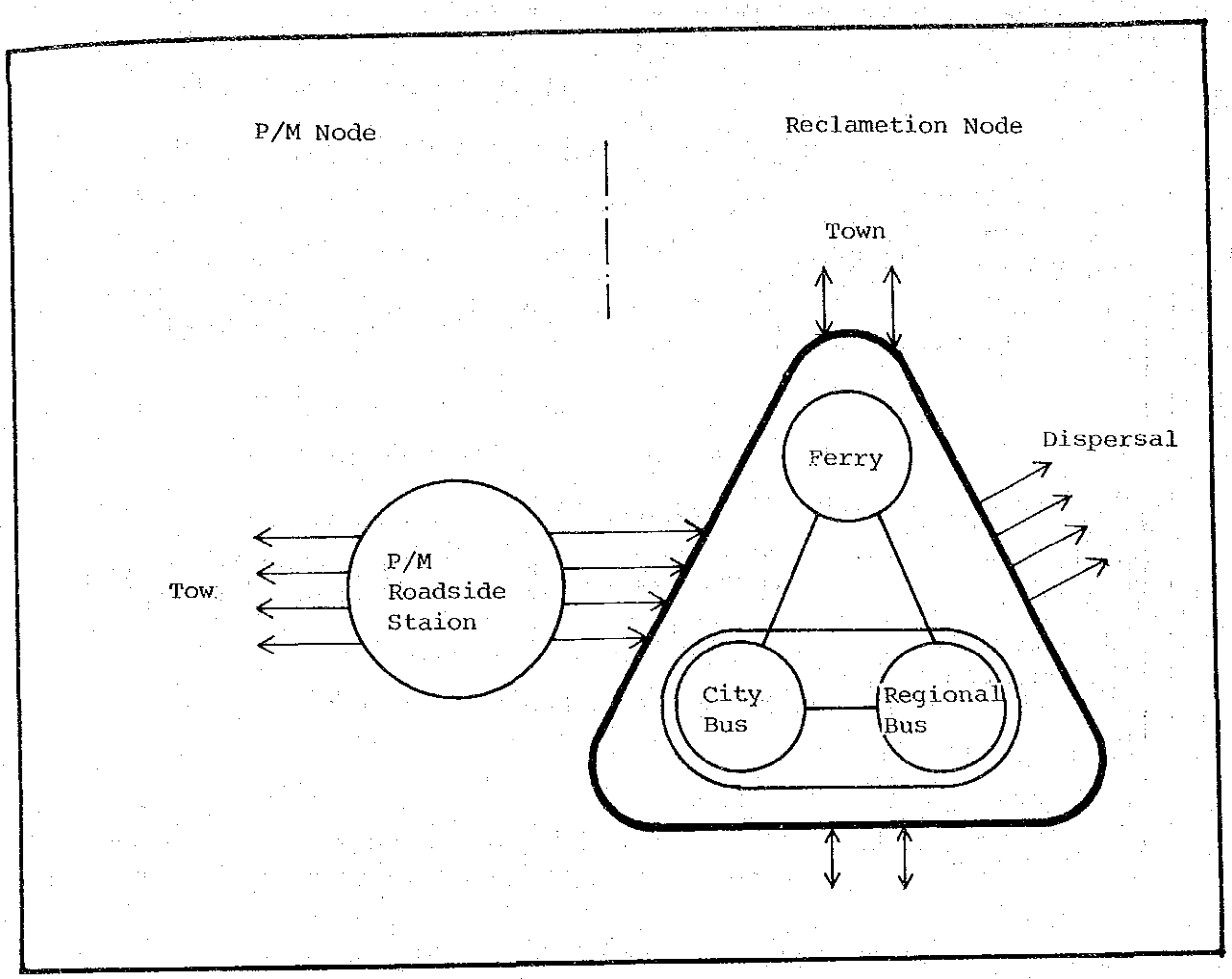
This plan follows very closely the functional elements of the present structure. When traffic demand increases to more than what has been assumed, an extension of the P/M station will have to be planned. When the situation becomes difficult, it will be necessary to expand the distrubutor station in the reclamation area: this will mean a changing of our development policy from alternative A to Alternative B.

2. Pattern B



In this functional structure, it is planned that the P/M node is the central stop-over station but it is no more the origin and destination station, instead the transport terminal in the reclamation site becomes the origin and destination of the public transport system as a whole. The ferry along with the bus station will be linked and integrated to form a traffic terminal where passengers can take any form of transport, viz. ferry, long distance bus, city bus, taxi, trishaw or own private car. The site can provide enough space for a waiting concorce, bus bays, taxi and trishaw pools and car-parks.

3. Pattern C



The functional potential of the reclamation node in Pattern C, can be maximized to give three (3) functional cores; ferry station, local city bus and also, regional and national bus station. Some local lines may have their origin and destination station here without by-passing the P/M node. It may also be possible to integrate the three functions to provide a terminal for the new public transport system. The P/M node, will, in this case, be considered as a minor station and be relieved of the heavy function from the concentration of bus lines.

6.6.4 Facility Planning

Based on an analysis of the function of traffic nodes, three (3) alternative development plans for a transport complex in the reclamation area was formulated in accordance with the different development stages.

The comparative relationship between the three alternatives is illustrated in the conceptual diagram shown below.

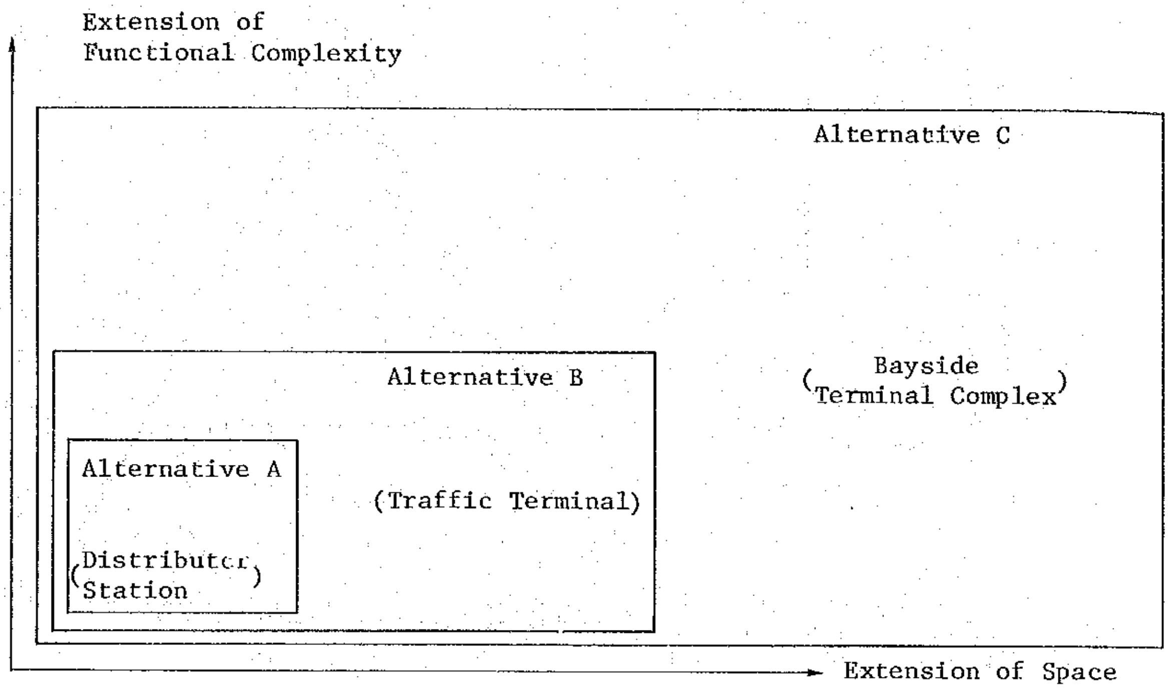


Fig. 6.17 <u>THREE ALTERNATIVE CONCEPTS</u>

(A) <u>ALTERNATIVE A : Plan for distributor station</u>

When we try to minimize the scale of new development in the preliminary stage, the plan for a passenger station should still unquestionably remain as a required facility in order that future traffic problems in the central area can be reduced.

The main facilities can be planned as follows:

1. Bus terminals on the regional and inter-regional level.

2. Taxi Terminals.
3. Car-Parks.
4. Approach network to the station.
5. Other minor facilities.

(B) <u>ALTERNATIVE B : Plan for traffic terminal</u>

When we can expect to have a more encouraging policy in the development of this area, there is a possibility that the area will have a multi-functional terminal which will be in line with the urban traffic projects and the urban renewal projects.

The main facilities will comprise:

1. But terminals on the regional and inter-regional levels.
2. Taxi Terminals.
3. Car-Parks.
4. Approach network to the stataion.
   (These are the same as in alternative A)
5. Shops for passengers.
6. Passenger Concorce.
7. Land as compensation to the resettlers and land owners involved in the redevelopment projects in George Town.

(C) <u>ALTERNATIVE C : Plan for "Bayside Termianl Complex"</u>

This is the most exciting image in the future reclamation area. When we maximise the possibility of future demand and the spatial and locational potential, we can formulate the integrated comprehensive development plan which will contain the various tourist oriented facilities as follow:

1. The same facilities as "alternative B" but quality of each facility and catchment population will vary from local passengers to international tourists.

2. A promenade which will integrate the ferry terminal and the bus terminal.

3. Tourist commercial and recreational complex (mainly out-door type) including international hotels.

4. International as well as local trading centres.

The development policy of this plan is to integrate local and international land transport networks with the sea transport network at the reclaimed land.

6.6.5 Cost Estimate of Transport Complex

(a) ALTERNATIVE A

Rough cost estimate of alternative A has the maximum development cost while alternative C has the minimum development cost. This gives a better understanding of the scale of the development project.

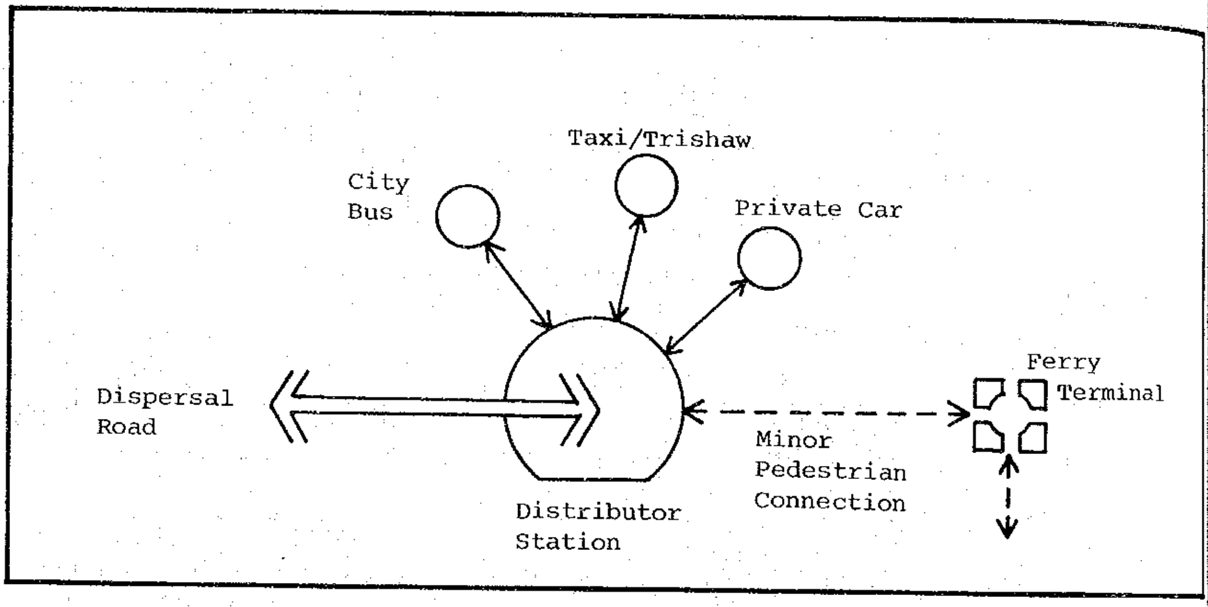


Table 6.23 FACILITIES AND SPACE REQUIREMENTS OF ALTERNATIVE - A

FACILITIES	CAPACITY	ACREAGE (M2)
1. Bus Station	15 Berths*	4,500
2. Bus Garage	15 Vehs.	1,050
3. Taxi Station	50 Vehs.	1,050
4. Car Park	200 Vehs.	6,000
5. Approach Road	–	2,000
6. Station Building	–	750
7. Pedestrian Concorce	–	1,000
8. Buffer Zone	–	8,500
Total		25,800

* Local Line : 8 Berths
Regional Line : 7 Berths

Table 6.24 ROUGH ESTIMATE OF CONSTRUCTION COSTS

Facilities	Item	Acreage (M2)	Unit Cost (M$/M2)	Cost (M$)
1. Bus Station		4,500	250	159,600
	Bus-bay			
	Bus-bay shelter			
	Pavement			
	Lighting			
	Excavation & Drainage			
2. Bus Garage		1,050	250	262,500
3. Taxi Station		2,000	38	77,000
	Taxi-bay			
	Taxi-bay shelter			
	Pavement			
	Lighting			
	Excavation & Drainage			
4. Car Park		2,000	27	188,800
	Pavement			
	Lighting			
	Excavation & Drainage			
5. Approach Road		2,000	27	54,400
	Pavement			
	Lighting			
6. Station Building		750	500	375,000
7. Pedestrian Concorce		1,000	50	50,000
8. Buffer Zone		8,500	10	85,000
Grand Total				1,252,000

(b) ALTERNATIVE C

Fig. 6.18 The Functional Concept of Alternative - C

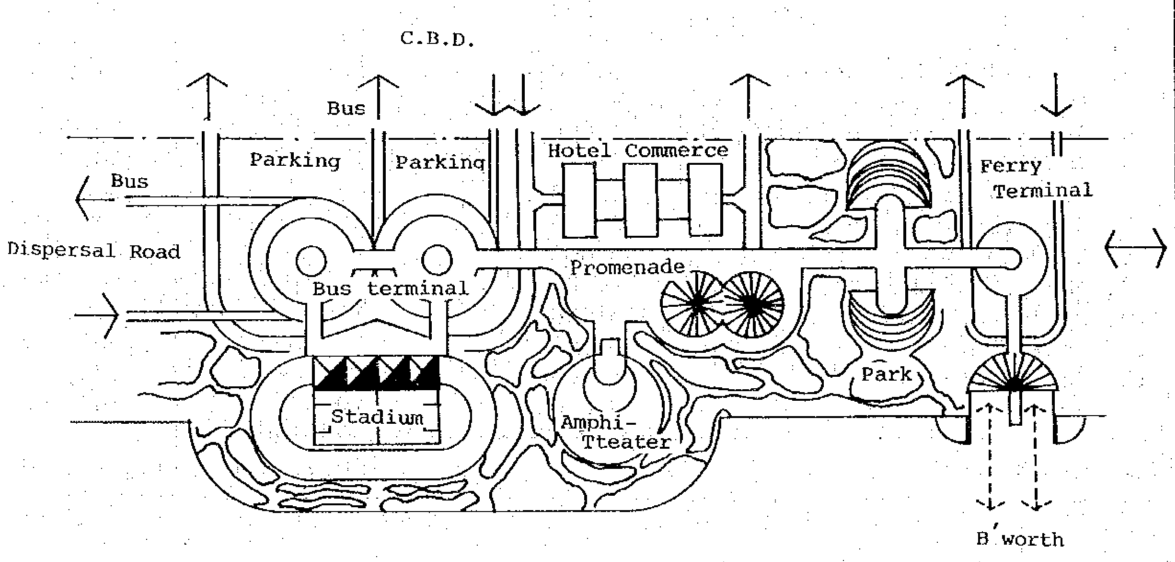


Table 6.25 FACILITIES AND SPACE REQUIREMENTS OF ALTERNATIVE C

Facilities	Capacity	Acreage (M2)	Facilities	Capacity	Acreage (M2)
1. Bus Station	30 Berths*	9,000	10 Stadium	15,000 persons	30,000
2. Bus Garage	30 Vehl.	2,100	11. Amphitheatre	5,000 persons	5,000
3. Taxi Station	100 Vehl.	4,000	12. Parks & Promenade	–	50,000
4. Car Park	500 Vehl.	15,000	13. Ferry Terminal		20,000
5. Pedestrian Concorce	–	3,000	14. Sea Museum		1,500
6. Station Building	–	1,000	15. Buffer Zone		30,000
7. Trade Center	1,000 persons	2,000			
8. Station Hoterl	100 Rooms	2,000			
10. Commerce Building	100 shops	2,000	Total		186,600

* Local Line : 18 Berths
Regional Line : 12 Berths

Table 6.26 ROUGH ESTIMATE OF CONSTRUCTION COSTS

Facilities	Acreage (M2)	Unit Cost (M$/M2)	Cost (M$)
1. Bus Terminal Building	24,100	385	9,918,500
Bus Station	9,000		
Bus Garage	2,100		
Taxi Stand	4,000		
1/2 Car Parks	7,500		
1/2 Pedestrian Concorce	1,500		
2. 1/2 Car Park	7,500	32	240,000
3. 1/2 Pedestrian Concorce (Outdoor)	1,500	50	75,000
4. Station Bldg.	1,000	500	500,000
5. Trade Centre	2,000	500	1,000,000
6. Station Hotel	2,000	650	1,300,000
7. Commercial Building	2,000	500	1,000,000
8. Stadium	30,000	–	3,000,000
9. Amphitheatre	5,000	–	500,000
10. Parks & Promenade	50,000	15	750,000
11. Ferry Terminal	20,000	–	1,000,000
12. Sea Museum	1,500	–	975,000
13. Buffer Zone	30,000	10	300,000
Grand Total		106.7	19,918,500

6.7 Transport Amusement Park Project

6.7.1 Introduction

The future of George Town will be very much affected by the strong impacts of the Penang Bridge Plan, the Penang Traffic Dispersal Plan as well as other development projects. With the implementation of these projects, the traffic condition in Penang will be almost completely changed. Thus, in order to help the public to adapt to this change, a Transport Park is being proposed.

6.7.2 Objectives

The objective of this proposal is to:

1. (1) Educate the public on traffic manners and regulations through exhibitions and film shows which will be held at the proposed hall.

   (2) Make the public aware of existing and future traffic problems i.e. through lectures and seminars regarding traffic matter.

   (3) Adapt the public - children, youngsters and adults - to the changing traffic system by introducing a Traffic Play Area.

6.7.3 Location of the Transport Park

The Reclamation Area in George Town is planned with a width of about 500 meters along the North Coastal Road. The reclaimed land is generally considered to have many economic advantages and suffers from less constraints in physical planning, design and construction of traffic facilities. The Transport Park will be located in this area near the proposed Transport Complex. The site is about 20,000 sq. meters i.e. 100 meters by 200 meters.

6.7.4 Brief Outline

The porposed miniature traffic play-area will consist of the following;

(1) Multi-purpose Hall:

This hall will serve as the centre of the Traffic Play-area. From time to time, film shows, seminars, lectures and exhibitions regarding traffic will be held here. The hall will be a three-storey building and will cater for both adults and youngsters.

The ground floor will be the main exhibition hall, lecture rooms and classes will be located on the first floow while the Conference Room and an Observation Room for the traffic Play Area will be located on the top floor.

(2) Main Office:

This office will be in charge of all happenings in this area i.e. from staging exhibitions to maintenance of the area. An information centre will also be located here to serve the public.

(3) Cafeteria:

As the area will be open to the public, a cafeteria will be set up to serve light drinks and food.

(4) Car Park:

There will be adequate provision for parking spaces of cars, bicycles and motor-cycles. The car park will be limited to the entrance area as a large part of the park will be traffic-free so as to allow people freedom of movement. Thus, entrance and exit of vehicles will not affect the public at large.

(5) Parks:

Parks will be one of the landscaped features of the miniature traffic play area. Adults and parents who come to watch the children at play can sit nearby on the benches provided or under the shade of the trees.

(6) Child's Play Area:

For those children who are waiting for their turn at the "cars" can safely play in the children's playground. There will be many kinds of play equipment e.g see-saws, ropes, slides etc. Parents too can sit in the park and enjoy the environment while keeping watch over their children.

(7) Open Spaces:

There will be adequate open spaces in the park and these will be mostly within the miniature play-area. It will be landscaped with trees and plants.

(8) Traffic Play-Area:

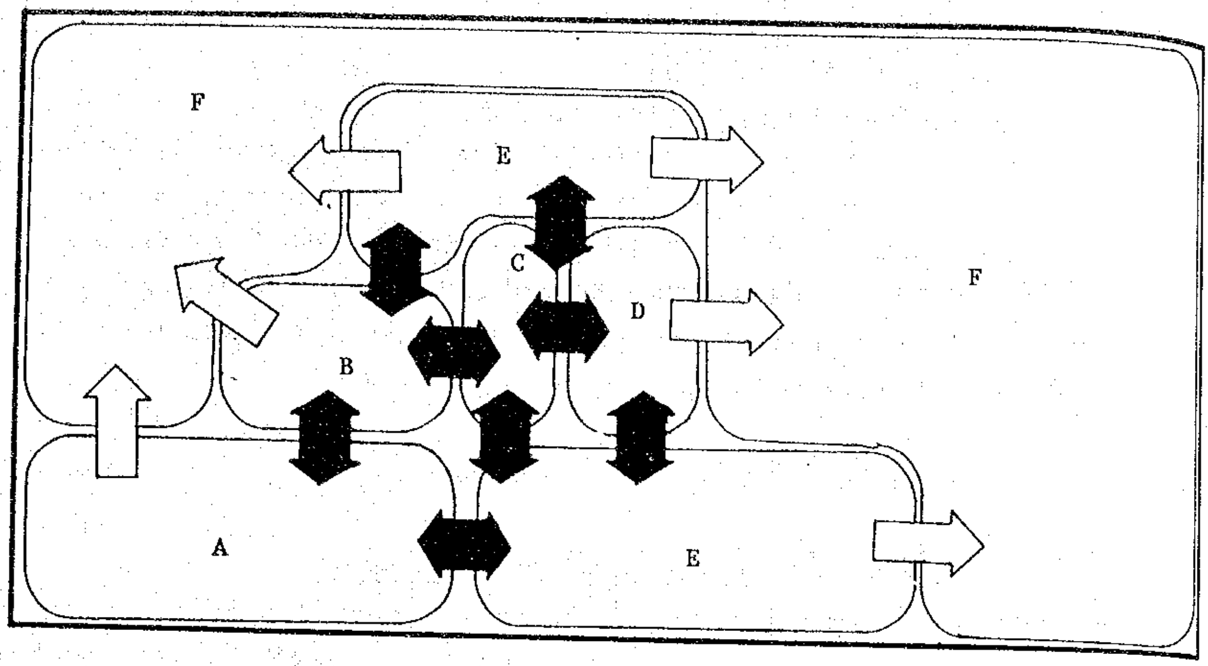
This is the main feature of the park. It is a miniature traffic system consisting of small-scale vehicles, a look-alike road system with traffic signals, parking bays and bus terminals. Children can hire the "cars" and drive in the area provided. There will be an interesting arrangement of the road system so as to enable the children to be really on the road.

The concept plan and the alternative plans will be presented.

Table 6.27 AREA AND FLOOR SPACE ESTIMATION

	Floor Space (sq.m)	Area Space (sq.m)	Percentage of Area Space
1. Parking area	-	0.24	12.0
2. Multi-Purpose Hall:		0.12	0.6
a. Ground Floor:Exhibition Hall*	3,900		
b. 1st. Floor:Lecture Hall*	2,800		
1st. Floor:Classrooms (4)	1,800		
2nd. Floor:Conference Room*	2,800		
2nd. Floor:Observation Room	1,100		
3. Main Office	450	0.15	0.83
4. Information Centre	450	0.15	0.83
5. Store	450	0.15	0.83
6. Cafeteria	1,400	0.45	2.5
7. Park	-	0.39	18.0
8. Traffic Play Area	-	1.15	59.0
Total	14,350	2.8	

* circulation included.



LEGEND:

A : Parking area for cars, motor-cycles and bicycle.

B : Multipurpose Hall.

C : Main Office/Information Centre.

D : Cafeteria.

E : Park.

F : Traffic Play Area.

Link between components.

Fig. 6.19 THE CONCEPT PLAN OF TRAFFIC AMUSEMENT PARK

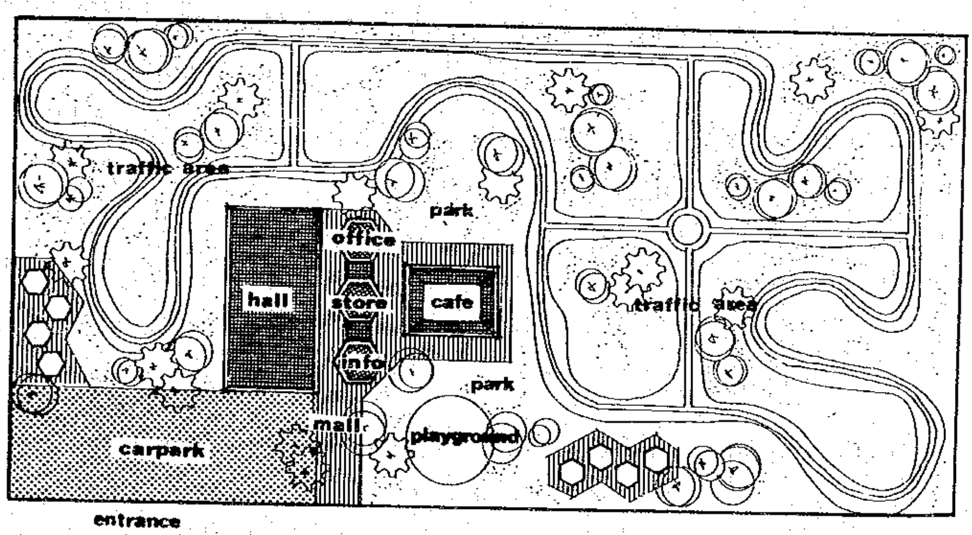


Fig. 6.20 SITE PLAN

6.7.5 Cost Estimate

Construction cost of the park is about M$7,640,300 according to the following estimation.

Table 6.28 CONSTRUCTION COST OF TRANSPORT PARK

Items	Quantity	Unit Cost	Cost ($)
Parking	2,400 m2	32 $/m2	76,800
Multi-Purpose Hall	11,600 m2	500 $/m2	5,800,000
Main Office	450 m2	400 $/m2	180,000
Information	450 m2	400 $/m2	180,000
Store	450 m2	400 $/m2	180,000
Cafeteria	1,400 m2	400 $/m2	560,000
Park	3,900 m2	15 $/m2	58,500
Traffic Play Area			
Pavement, etc.	5,000 m2	35 $/m2	175,000
Traffic facilities			300,000
Landscaping	6,500 m2	20 $/m2	130,000
Total			7,640,300

7. Evaluation of Long Term Transport Plans

EVALUATION OF LONG-TERM TRANSPORT PLANS

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7. EVALUATION OF LONG TERM TRANSPORT PLANS

7.1 Evaluation Overview

7.1.1 General

One of the principal objectives of this study is the formulation of a longer term plan to act as a framework for the envisaged changes. This chapter mentions an evaluation of the following long term transport plans:

1. The Master Plan of the road network.
2. Transport Strategies.
3. Identification of Priority Projects in the transport system.
4. The continued existence or termination of the present ferry system.
5. Introduction of a mini bus system.

7.1.2 Evaluation Procedure

1. Evaluation View Points

The evaluation basically proceeds by comparative analysis to determine where the net benefit of one alternative plan is greater than that of another.

In this study, the evaluation of the transport plans will be made from the following points of view;

* Economic Evaluation
* Financial Analysis

(1) Economic Evaluation

Here the team is basically concerned with a comparison between the costs of supplying the transport services in each plan and the benefits derived from these services. The benefits of each plan are then compared with the capital cost requirements to determine which plan can be expected to produce the better economic benefits. This comparison is described in a series of benefit/cost ratios which are useful in determining a general ranking among the various plans.

(2) Financial Analysis

There are two (2) types of financial analysis;

One is the estimation of the costs of supplying the transport services in each plan in view the national revenue, and the other covers the analysis of the cash flow of various transportation services. In this section, the latter type of analysis is adopted.

2. Indicators of Economic Analysis

The net benefit in any single year is benefit minus costs over the year which is multiplied by the annalised capital costs. This proportion of the capital cost is 12 percent which is the current discount rate defined by the Economic Planning Unit for use throughout Malaysia in all public sector investments.

The transport alternative plans producing a positive net benefit calculated on this basis can be taken as economically feasible. Since the single year rate of return is also calculated as the comparison between benefits and costs in the year, these plans are also considered worth implementing in economic terms if the single year rate of return of plans is over 12 percent.

7.1.3 Cases of Evaluations

Many alternatives are prepared from the combination of the road network and the strategies mentioned earlier, as shown in the following Table.

Table 7.1 TEST CASES OF ALTERNATIVE PLAN

Demand Control Plan / Road Network Plan	Plan A	Plan B	Plan C	Plan D
	Existing Situation	Parking Control Bus Exclusive Lane	New Transport System Parking Control Bus Exclusive Lane	Parking Control Car Pooling
(Present)	(1979)			
Base Case	1985 2000			
Plan 1 Under Planning	1985			
Plan 2 Proposed	1985			
Plan 3 Under Planning & Proposed	1985 2000	1985 2000		
Plan 4 Ultimate	2000	2000	2000	2000

Figures in the boxes show the projected years.

In addition, regarding the evaluation of the continued existence or termination of the present ferry system, the following cases are also computed.

1985	With and without the ferry system in case of Plan 3 - A
2000	With and without the ferry system in case of Plan 4 - B

7.2 Traffic Cost Estimates

7.2.1 General

There are various kinds of benefits that can be realized from transport improvements in urban areas. Among them, the savings in running costs and travel-time are the most important. These two (2) types of benefits have always been used as a means of justification from an economical point of view. Traffic costs can be defined as composite costs relating to running and travel-time costs. Regarding traffic costs, several studies were reviewed carefully.

Resulting from these, traffic cost estimates are fundamentally based on those in the Highway Planning Unit. However, all unit costs used in the study are tabulated on the basis of 1979 price levels.

7.2.2 Vehicle Operating Cost

Vehicle operating costs are composed mainly of running and fixed costs. Running costs are directly related to the use of vehicles and fixed costs are related to the ownership and are independent of the degree of vehicle usage.

Running costs are divided into the following:

a) Fuel Costs
b) Oil Costs
c) Tyre Costs
d) Maintenance and Repair Costs
e) Depreciation Costs

Fixed costs are divided into the following:

a) Depreciation Costs
b) Interests
c) Wages
d) Overheads

Detailed descriptions are as follows:

1. Running Cost

(1) Fuel Cost

The fuel cost is calculated based on fuel consumption per kilometer of paved road and running speed.

(2) Oil and Grease Cost

The oil and grease cost is computed on the basis of oil and grease consumption per kilometer.

(3) Tyre Cost

The tyre cost is also calculated based on the tyre lifetime and paved road and tyre set prices.

(4) Maintenance and Repair Costs

Maintenance and repair costs are divided into labour cost and spare parts. The labour cost is calculated by using the total labour hour for each type of vehicle during its lifetime and the cost of spare parts is estimated on the basis of percent of vehicle cost.

(5) Depreciation Cost

The depreciation cost is partly regarded as running costs due to physical wear and tear and to a degree as part of the fixed costs because of the decrease in value as a result of obsolescence and time wear. The salvage value is considered in this study.

(6) Total Running Cost

The total unit running cost per kilometer is the sum of all the aforementioned costs as shown in Table 7.2.

Running cost varies by travel speed on the roads. Therefore, the vehicle operating costs by travel speed is adopted for the computation of total vehicle cost. (See Fig. 7.1)

2. Fixed Cost

(1) Crew Cost

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

(2) Depreciation Cost

The fixed cost element is assumed to be the remainder of the depreciation value of the retailed price. The depreciation costs are determined on the basis of vehicle life and the annual running time.

(3) Interest of Capital

Since the interest cost of capital has been estimated at 12 percent annually, investments in vehicles are therefore accounted according to the same interest rate.

(4) Insurance and Overhead Costs

As a substitute for accident costs, insurance cost is included as part of the fixed costs.

After the determination of the various cost items above, the fixed cost per operational hour is established for each type of vehicle. The summary of fixed costs per vehicle hour is shown in Table 7.3.

7.2.3 Passenger Time Value

Time cost is calculated according to the family income approach method on the basis of the following assumptions:

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

The time value by each trip purpose is shown below based on the aforementioned assumptions:

1. Business Trip	100 percent of hourly income
2. Commuting to and from work	50 percent of hourly income
3. Travel to and from school	No value
4. Others	No value

The time value of each trip purpose was calculated on the basis of annual income of families and annual working hours by car-owner, motor-cycle-owner and non owners.

	Car Owner	M/cycle Owner	Non-Owner
To/from work	1.60	0.8	0.4
Business	3.20	1.6	0.8
Private	0	0	0
To/from school	0	0	0

The time value of cars by weighted composition of trip purpose and multiplied by vehicle occupancy is calculated below:

Cars	\$3.70 /hour
M/cycle	\$1.30 /hour
Buses	\$23.00/hour

Table 7.2 GENERAL CHARACTERISTICS OF ECONOMIC COST ESTIMATES 1979

	Private Vehicles M/cycle	Private Vehicles Car	Passenger Vehicles Taxi	Commercial Vehicles Bus	Lorry Light	Lorry Medium	Lorry Heavy
1. Average size	100 CC.	1,600 CC.	1,600 CC	44 Pass.	2 tons	9 tons	17 tons
2. Annual kilometerage (Kms)	11,300	19,300	96,500	104,600	24,100	48,200	48,200
3. Vehicle Costs (\$)	2,290	17,445	19,340	90,410	14,080	48,140	60,000
4. Net Costs of taxes less tyres (\$)	1,950	12,752	14,610	79,930	11,870	38,820	47,000
5. Average life (years)	7	10	5	10	10	10	10
6. Salvage value (\$)	290	2,550	3,653	11,990	1,780	5,820	7,050
7. Capital Recovery Factor (CRF) at 10%	0.2054	0.1628	0.2638	0.1628	0.1628	0.1628	0.1628
8. Sinking Fund Factor (SFF) at 10%	0.1054	0.0629	0.1593	0.0628	0.0628	0.0628	0.0628
9. Annual depreciation and interest (4x7) - (6x8)	370	1,916	3,272	12,260	1,820	6,044	7,902
(a) of which interest 9 - 9 (b)	130	896	1,081	5,198	811	2,718	3,516
(b) of depreciation $\frac{4-6}{5}$	240	1,020	2,191	7,062	1,009	3,326	4,386
10. Time related depreciation							
(a) Percentage (%)	70	70	15	30	40	30	30
(b) Annually (\$)	168	714	329	2,119	404	998	1,311
11. Kilometerage related depreciation							
(a) Annually (\$)	72	306	1,862	4,943	605	2,328	3,075
(b) Per kilometer (Cents)	0.64	1.59	1.94	4.75	2.52	4.81	6.38

Table 7.3 VEHICLE OPERATING COSTS
(In cents per Kilometer - 1979 prices)

	M/cycle	Car	Taxi	Bus	Light Truck	Medium Truck	Heavy Truck
Running Cost	3.56	10.73	8.54	20.74	12.21	26.37	35.32
Fuel	1.50	3.98	2.27	3.90	3.91	5.11	7.00
Oil	0.15	0.45	0.56	0.66	0.52	0.69	1.04
Tyres	0.16	0.77	1.03	5.55	1.31	5.91	8.87
Maintenance	1.11	3.94	2.74	6.06	3.94	9.84	12.03
Depreciation	0.64	1.59	1.94	4.57	2.52	4.81	6.38
Fixed Cost	0.30	1.13	2.56	5.78	1.33	3.42	5.62
Depreciation	0.17	0.41	0.11	0.58	0.24	0.28	0.35
Interest	0.13	0.51	0.36	1.56	0.33	0.76	1.16
Cre Wages		0.22	1.52	3.78	1.72	2.34	2.64
Overhead		-	0.57	2.34	0.36	1.51	1.47
Sub-Total	0.30	1.13	2.56	8.26	2.65	4.89	5.62
Fleet Substitutability	1.0	1.0	1.0	0.7	0.5	0.7	1.0

Note: Exchange Tax

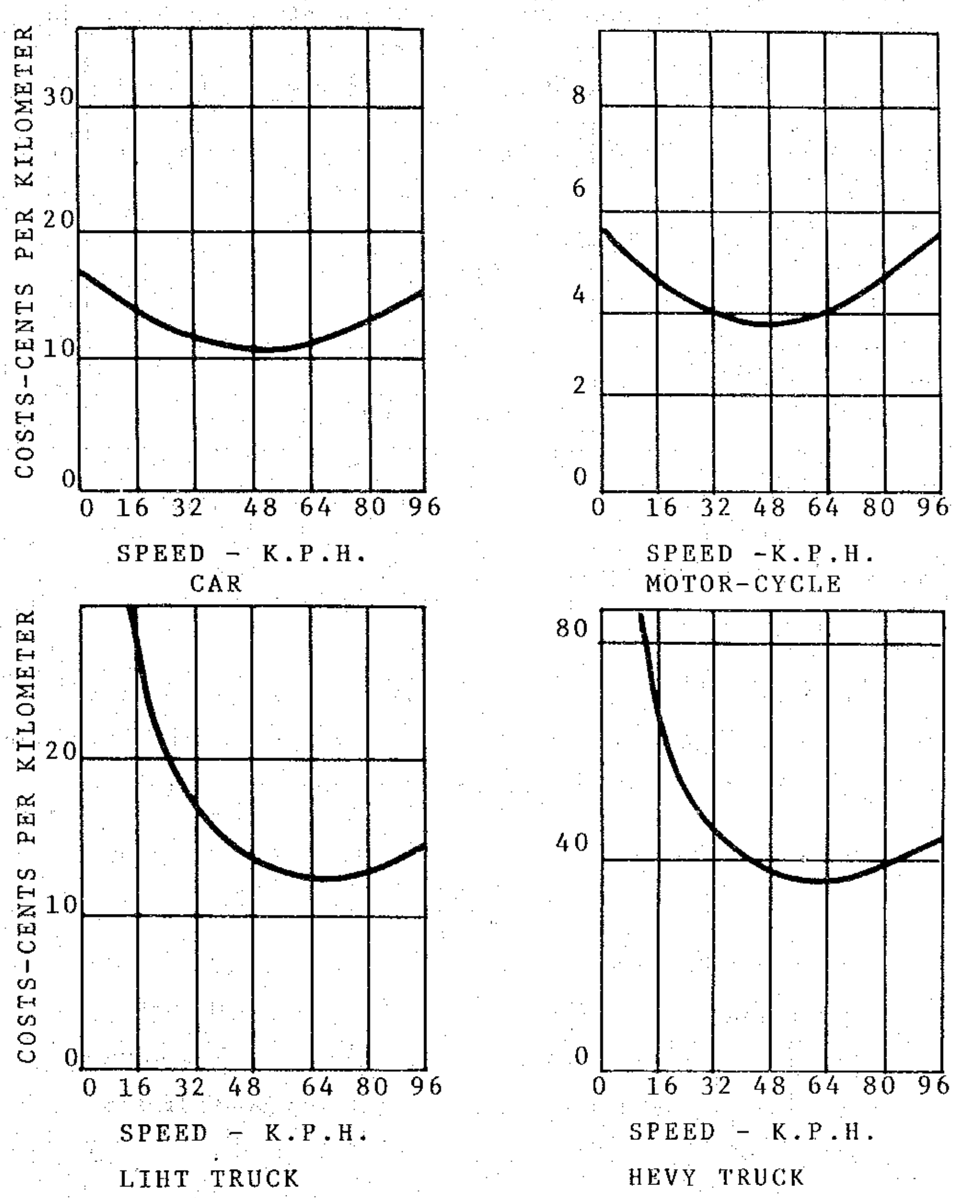

Fig. 7.1 Vehicle OPeration Costs and Speed

7.3 Cost Estimates of Alternative Plans

Table 7.4 summarizes the cost estimates of the alternative plans. Detailed cost estimates are described in the supplements, with estimates made on the basis of 1979 prices.

Table 7.4 COST ESTIMATES OF PALNS
(In thousand dollars at 1979 prices)

	Plans			
	4A	4B	4C	4D
Road Projects under Planning	96,000	96,000	96,000	96,000
New Proposed Road Projects 4-lane (2-lane)	213,424 (124,226)	213,424 (124,226)	213,424 (124,226)	213,424 (124,226)
Other Proposed Road Projects	304,310	304,310	304,310	304,310
Intersection Improvements	60,672	60,672	60,672	60,672
Exclusive Bus Lane		78	78	78
Construction of New Transport System			317,600	
Introduction of Car-Pool System				45,600
Total	674,406	674,484	992,084	720,084

7.4 Benefit Estimates of Alternative Plans

7.4.1 Procedure

On the basis of unit traffic cost and assigned traffic volume on each of the links on the roads, the benefits are estimated by using the network model. The network model is as follows:

a. Time benefits

$$TB = \sum_{ij} P_{ij} (t_{ij}^{A} - t_{ij}^{B}) V$$

where:

TB : time benefit

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

t^A_{ij} : travel time between zones i and j in case the alternative plan is implemented

t^B_{ij} : travel time between zones i and j in case that the project is not implemented

V : time value

b. Saving in running cost

$$RB = \sum_{ij}(RC^A_{ij} - RC^B_{ij}) + (t^A_{ij} - t^B_{ij})\ FC_{ij}$$

where :

RB : saving in running costs

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

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

7.4.2 Benefit Estimates

The result of benefit estimates are shown in Table 7.5 to 7.8.

Table 7.5 ANNUAL BENEFITS OF ALTERNATIVE PLANS STUDY AREA, 1985
(In M$'000 at 1979 prices)

	Plan 3-A	Plan 3-B
Car Owners		
car operating cost saving	27,823	36,768
time saving	26,235	32,110
public transport fare	0	-1,912
gain/less due to diverted traffic	0	-2,319
Sub-total	54,058	64,647
Motor-cycle Owners		
motor-cycle operating cost saving	2,867	3,085
time saving	3,959	4,493
public transport fare	0	-581
gain/less due to diverted traffic	0	-251
Sub-total	6,826	6,746
Non Owners		
time saving (Total)	1,984	5,845
Bus Operators		
operating cost saving	0	585
fares	0	2,493
Sub-total		
Total Net Benefit	62,868	79,316

Table 7.6 ANNUAL BENEFITS OF ALTERNATIVE PLANS
STUDY AREA, 2000
(In M$'000 at 1979 prices)

	Plan 4 - A	Plan 4 - B	Plan 4 - C	Plan 4 - D
Car Owners				
* car operating cost saving	125,706	149,878	171,334	159,228
* time saving	163,816	180,345	187,714	195,505
* public transport fare	0	-4,629	-10,007	-4,629
* gain/less due to diverted traffic	0	-10,858	-5,539	-10,858
Sub-total	289,522	324,736	343,502	339,246
Motor-cycle Owners				
* motor-cycle operating cost saving	7,841	8,449	7,226	8,697
* time saving	9,868	9,597	11,023	10,179
* public transport fare	0	-651	-1,449	-651
* gain/less due to diverted traffic	0	-442	-337	-442
Sub-total	17,709	16,953	16,446	17,783
Non-owners				
* time saving	9,755	11,224	14,954	11,224
* public transport fare	-	-	-5,932	-
Sub-total	9,755	11,224	8,022	11,224
Bus Operators				
* operating cost saving	398	-57	2,468	-57
* fares	0	5,280	-1,856	5,280
Sub-total	398	5,223	612	5,223
NTS Operators				
* operating cost	-	-	-29,961	-
* public transport fare	-	-	32,504	-
Sub-total	-	-	2,543	-
Total Net Benefit	307,629	348,136	352,485	373,476

Table 7.7 ANNUAL BENEFITS DERIVED FROM PROJECT IMPLEMENTION
STUDY AREA, 1985
(In M$'000 at 1979 prices)

		Plan 1 - A	Plan 2 - A	Plan 3 - A
Cars 1)	Annual Time Cost Savings	11,008	16,622	27,823
	Annual Operating Cost Savings	12,780	14,272	26,235
	Savings on fixed costs	4,060	5,451	9,606
	Savings on running costs	8,720	8,821	16,629
	Sun-total	23,789	30,896	54,058
Motor-cycles	Annual Time Cost Savings	1,705	2,215	3,959
	Annual Operating Cost Savings	1,290	1,675	2,867
	Savings on fixed costs	394	512	915
	Savings on running costs	896	1,163	1,952
	Sub-total	2,995	3,890	6,826
	Total	26,784	34,786	60,884

Note: 1) includes taxis, lorries and buses

Table 7.8 BENEFITS DERIVED FROM PROJECT IMPLEMENTATION
STUDY AREA, 2000
(In M$'000 at 1979 prices)

		Plan 3 - A	Plan 4 - A
Cars 1)	Annual Time Cost Savings	86,314	163,816
	Annual Operating Cost Savings	65,107	125,706
	Savings on fixed costs	32,659	61,984
	Savings on running costs	32,448	63,722
	Sub-total	151,421	289,522
Motor-cycles	Annual Time Cost Savings	5,161	9,868
	Annual Operating Cost Savings	4,101	7,841
	Savings on fixed costs	1,191	2,277
	Savings on ru-ning costs	2,910	5,564
	Sub-total	9,262	17,709
Total		160,683	307,231

Note: 1) includes taxis, lorries and buses

Table 7.9 RESULTS OF TRAFFIC ASSIGNMENT OF CAR TRAFFIC BY PLANS
STUDY AREA, 1985

	Base	Plan 1-A	Plan 2-A	Plan 3-A	Plan 4-B
Daily Trips Assigned (1000 Trips)	471	471	471	471	462
Vehicle Kilometer (1000 Kms)	5,928	5,736	5,779	5,621	5,539
Vehicle Hours (1000 Hrs)	213	203	199	187	184
Average Trip Length (Kms/Trip)	12.6	12.2	12.3	11.9	12.0
Average Travel Time (Min./Trip)	27.1	25.8	25.4	23.8	23.9
Average Travel Speed (Kms/Hr)	27.9	28.4	29.1	30.0	30.1

Table 7.10 RESULTS OF TRAFFIC ASSIGNMENT OF M/CYCLES BY PLANS
STUDY AREA, 1985

	Base	Plan 1-A	Plan 2-A	Plan 3-A	Plan 3-B
Daily Trips Assigned (1000 Trips)	319	319	319	319	319
Vehicle Kilometers (1000 Kms)	2,904	2,876	2,874	2,870	2,864
Vehicle Hours (1000 Hrs)	145	141	140	135	134
Average Trip Length (Kms/Trip)	9.1	9.0	9.0	9.0	9.0
Average Travel Time (Min./Trip)	27.1	26.3	26.3	25.0	24.9
Average Travel Speed (Kms/Hr)	20.2	20.5	20.5	21.6	21.7

Table 7.11 RESULTS OF TRAFFIC ASSIGNMENT OF BUS BY PLANS STUDY AREA, 1985

	Base	Plan 1-A	Plan 2-A	Plan 3-A	Plan 3-B
Daily Passengers (1000 Pass)	171.9	171.9	171.9	171.9	189.7
Passenger Kilometers (1000 Kms)	1,942.7	1,942.7	1,942.7	1,942.7	2,077.1
Passenger Hours (1000 Hrs.)	137.0	127.8	127.4	123.0	125.0
Average Trip Length (Kms/Trip)	11.30	11.30	11.30	11.30	11.30
Average Travel Time (Hrs./Trip)	47.8	44.6	44.5	42.9	40.8
Average Travel Speed (Kms/Hr)	14.18	15.20	15.25	15.79	16.61
Fleet Kilometers (1000 Kms)	30,618	30,618	30,618	30,618	38,931

Table 7.12 RESULTS OF TRAFFIC ASSIGNMENTS OF CAR TRAFFIC BY PLANS STUDY AREA, 2000

	Base	Plan 3-A	Plan 4-A	Plan 4-B	Plan 4-C	Plan 4-D
Daily Trips Assigned (1000 Trips)	1,140	1,140	1,140	1,109	1,099	1,044
Vehicle Kilometers (1000 Kms)	16,243	16,172	16,075	15,741	15,610	15,252
Vehicle Hours (1000 Hrs.)	789	716	633	617	610	578
Average Trip Length (Kms/Trip)	14.2	14.3	14.1	14.2	14.2	14.6
Average Travel Time (Min./Trip)	41.4	38.0	33.3	33.4	33.3	33.3
Average Travel Speed (Kms/Hr)	20.6	22.6	25.4	25.5	25.6	25.8

Table 7.13 RESULTS OF TRAFFIC ASSIGNMENTS OF MOTOR CYCLE BY PLANS STUDY AREA, 2000

	Base	Plan 3-A	Plan 4-A	Plan 4-B	Plan 4-C	Plan 4-D
Daily Trips Assigned (1000 Trips)	334	334	334	329	323	329
Vehicle Kilometers (1000 Kms)	3,163	3,112	3,093	3,024	2,974	3,024
Vehicle Hours (1000 Hrs.)	157	144	133	134	130	132
Average Trip Length (Kms/Trip)	9.5	9.3	9.3	9.2	9.2	9.2
Average Travel Time (Min./Trip)	28.1	25.9	23.9	24.4	24.2	24.2
Average Travel Speed (Kms/Hr.)	20.2	21.6	23.2	22.6	22.8	22.9

Table 7.14 RESULTS OF TRAFFIC ASSIGNMENT OF BUS BY PLANS STUDY AREA, 2000

	Base	Plan 3-A	Plan 4-A	Plan 4-B	Plan 4-C	Plan 4-D
Daily Passengers (1000 Pass.)	208.0	208.0	208.0	259.2	186.7	259.2
Passenger Kilometers (1000 Kms)	2.489.7	2.489.7	2.489.7	2.934.0	2,338.4	2.934.0
Passenger Hours (1000 Hrs.)	209.4	190.9	169.8	204.2	158.8	204.2
Average Trip Length (Kms/Trip)	11.97	11.97	11.97	11.3	12.5	11.3
Average Travel Time (Hrs./Trip)	60.41	55.05	48.99	47.27	51.06	47.27
Average Travel Speed (Kms/Hr.)	11.89	12.85	13.66	14.37	14.71	14.37
Fleet Kil-meters (1000 Kms)	38,931	38,931	38,931	45,534	36,839	45,534

Table 7.15 ESTIMATED DAILY TRAFFIC CHARACTERISTICS OF VEHICLES STUDY AREA, 1985

	Without Project (Base)	PENANG ISLAND		PROVINCE WELLESLEY		BOTH AREAS
		Project 1	Project 2	Project 3	Project 4	On-going Projects
Daily Vehicle Hours 1000	178,190 -	174,870 0.981	176,640 0.991	176,960 0.993	173,080 0.971	169,845 0.953
Daily Vehicle Kms	4,761,300 -	4,768,100 1.001	4,784,200 1.005	4,755,850 0.999	4,717,540 0.991	4,692,100 0.985
Average Trip Length (Kms/Trip)	12.47 -	12.49 1.002	12.53 1.005	12.46 0.999	12.36 0.991	12.29 0.986
Average Travel Time (Mins./Trip)	28.01 -	27.49 0.981	27.77 0.991	27.82 0.993	27.21 0.971	26.70 0.953
Average Travel Speed (Kms./Hr.)	26.71 -	27.26 1.021	27.08 1.014	26.87 1.006	27.26 1.021	27.62 1.034

Notes: 1) includes lorry, passengers and commercial vehicles except motor-cycles.
2) comparison between base case and project case.

Table 7.16 ESTIMATED DAILY TRAFFIC CHARACTERISTIC OF MOTOR-CYCLE STUDY AREA, 1985

	Without Project (Base)	PENANG ISLAND		PROVINCE WELLESLEY	
		Project 1	Project 2	Project 3	Project 4
Daily Vehicle Hours	141,760	139,450	140,710	141,180	138,780
Daily Vehicle Kms	2,861,400	2,862,600	2,861,900	2,865,740	2,836,740
Average Trip Length (Kms/Trip)	9.13	9.13	9.13	9.14	9.05
Average Travel Time (Mins./Trip)	27.14	26.69	26.93	27.02	26.57
Average Travel Speed (Kms./Hr.)	20.18	20.52	20.34	20.29	20.44

7.5 Economical Evaluation

7.5.1 Ultimate Plan of Proposed Highway

The ultimate plan of the proposed highway (see Plan 4-A) is evaluated below with the result also shown.

		(M$'000)
Benefit in 2000	307,231	
Annualized Costs at 12%	80,929	
Capital Cost	674,406	
Net Benefit in 2000	226,302	
Rate of Return in 2000	45.6 %	
B/C Ratio in 2000	3.80	

Since the net benefit in the year 2000 is M$226 million, the rate of return and B/C ratio will be 45.6 percent and 3.80, respectively, the ultimate plan of the proposed highway network is economically feasible.

7.5.2 Proposed Transport Policy Measure

The team proposed alternative transport policy measures in the previous chapter. These transport policy measures are evaluated economically.

Table 7.17 shows the results of the economic analysis. In the year 1985, plan 3-B, which includes control of private car use and introduction of bus lanes, is economically more feasible than plan 3-A, which is without any control. The net benefits of plan 3-B is over 53 million, while that of plan 3-A is only 36 million.

Table 7.17 ECONOMIC INDICATORS IN PLAN 3-A AND 3-B IN 1985
(In M$'000 in 1979 prices)

	Plan 3-A	Plan 3-B
Benefits in 1985	62,868	79,316
Costs annualized at 12%	26,427	26,436
Capital Costs	220,222	220,300
Net Benefits in 1985	36,441	52,880
Rate of Return in 1985	28 5%	36.0%
R/C Ratio in 1985	2.38	3.00

For the year 2000, the team proposes an additional transport policy and public transport expansion measures.

These are:

Plan C : to introduce new transport system

Plan D : to control the private-car uses by car-pool system

According to the economic analysis, plan 4-D is the highest economic indicator among these alternative transport plans. The next best is plan 4-B.

Table 7.18 ECONOMIC INDICATORS IN PLANS 4-B, 4-C AND 4-D IN 2000
(In M$'000 in 1979 prices)

	Plan 4-B	Plan 4-C	Plan 4-D
Benefits in 2000	348,136	352,485	373,476
Costs annualized at 12%	80,938	119,041	86,410
Capital Costs in 2000	674,484	992,006	720,084
Rate of Return in 2000	51.6	35.5	51.9
B/C Ratio in 2000	4.30	2.96	5.32

7.5.3 High Priority Projects among Road Network

According to traffic volume assigned in both design years and the growth rate of traffic volume, it is necessary to improve or construct the following roads immediately.

1. Penang Island

* Project 1 Outer Ring Road (From CBD to Ayer Itam)
* Project 2 Outer Ring Road (From Ayer Itam to North Coastal Raod)
* Weld Quay Extension

* Widening of Green Lane
* Improvement of Jalan Prangin and Jalan Maxwell
* Construction of Bayan Lepas Road

2. Province Wellesley

* Project 3 West Coastal Road with Prai Bridge and Improvement of Jalan Permatang Pauh
* Seberang Jaya Road
* Project 4 Widening of Existing Federal Route 1
* Approach Roads

These high priority projects are evaluated economically.

From Table 7.6, the following observations can be made.

1. All the high priority projects are economically feasible except the four lane highway in Project 2.
2. From the view point of priority, project 4 (construction of the southern part of the West Coastal Raod with Prai Bridge and widening of the existing Federal Route 1) has the highest economic indicators among high priority projects.
   The projects with the second highest rating are the on-going ones such as the Weld Quay and Prai Barrage Approaches projects.
   The proposed projects have also high priority indicators in view of the net present worth in 1985.

Table 7.19 ECONOMIC INDICATORS OF HIGH PRIORITY PROJECT
(In M$'000 at 1979 prices)

		Benefits in 1985	Economic Cost	Cost Annualized at 12%	Net Benefit in 1985	B/C Ratio in 1985	First Year Rate of Return %
Proposed Projects	4 - lane	34,786	213,424	25,611	9,175	1.36	16.2
	2 - lane		124,226	14,907	19,879	1.75	28.0
Project 1	4 - lane	10,691	74,966	8,996	1,695	1.19	14.3
	2 - lane		41,176	4,941	5,750	1.86	25.9
Project 2	4 - lane	3,951	52,075	6,249	-2,298	0.63	7.6
	2 - lane		28,736	3,448	503	1.15	13.7
Project 3	4 - lane	3,272	21,846	2,622	650	1.25	14.9
	2 - lane		13,088	1,571	1,701	2.08	25.0
Project 4	4 - lane	15,535	64,537	7,744	7,791	2.01	24.1
	2 - lane		41,226	4,947	10,588	3.14	37.7
On-Going and On-Planning Projects		27,082	96,000	11,520	15,562	2.35	28.2

7.6 Financial Analysis

7.6.1 Bus Transport Operation

Table 7.19 summarizes the results of the financial analysis. According to the passenger projections, total passenger kilometers will be expanded from 532 million in 1979 to 765 million in plan A, and 815 million in plan B in 1985, and to 973 million in plan A, 1138 million in plans B and D, and 921 million in plan C in the year 2000. In proportion with the passenger kilometers, it is necessary to expand the bus fleet.

The income statement is based on two (2) fare levels:-

One is the 1979 fare level (3.9 cents per kilometer adult fare) and the other is a fare level 42 percent higher than the 1979 one. (5.5 cents per kilometer). Using two fare levels, the rate of return of capital investments is computed. The results are shown in Table 7.20.

If the existing fare level is maintained most of the bus companies are expected to be in debt; if the 5.5 cents per kilometer fare level is imposed, the capital rate of return is expected to be 10.1 percent.

7.6.2 Intoduction of New Transport System

Table 7.21 shows the results of the financial analysis for introduction of the new transport system. This capital investment is based on the guide way system.

In the income statement, the fare income is based on the 12 cents per kilometer adult fare. Compared with the present bus fare, the fare of the new transport system is about three times higher.

Based on this assumption, return on investment is calculated which is expected to be 1.4 percent. Considering this, it is financially not feasible. However, if the Government is prepared to provide the capital investments, it could be operational.

Table 7.20 ANNUAL INCOME STATEMENT OF BUS TRANSPORT (1985 and 2000)

	1985		2000			
	Plan A	Plan B	Plan A	Plan B	Plan C	Plan D
Passenger Kms (1000 Kms)	765,442	815,317	973,273	1,138,362	920,968	1,138,362
Number of Buses	446	496	593	693	560	693
Fleet Kms (1000 Kms)	30,618	32,931	38,931	45,534	36,839	45,534
Cumulative Capital Investment (M$'000)	41,940	44,640	53,370	62,370	50,400	62,370
Existing Fare Level						
Revenue (M$'000)	30,728	32,730	39,071	45,699	36,971	45,699
Fare	29,546	32,471	37,568	43,941	35,549	43,941
Others	1,182	1,259	1,503	1,758	1,422	1,758
Expenditure (M$'000)	36,095	38,443	45,898	53,671	43,296	53,671
Operating Expenses	26,095	27,720	33,090	38,702	31,200	38,702
Depriciation	6,710	7,142	8,539	9,979	8,064	9,979
Interest	3,350	3,571	4,269	4,990	4,032	4,990
Net Operating Income (M$'000)	-5,367	-5,703	-6,827	-7,972	-6,325	-7,972
Fare 5.5 cents						
Revenue1 (M$'000)	43,783	46,636	54,631	65,114	52,679	65,114
Fare	42,099	44,842	53,530	65,114	50,653	62,610
Others	1,684	1,794	2,101	2,504	2,026	2,504
Expenditure (M$'000)	36,095	38,433	45,898	53,671	43,296	53,671
Net Operating Income (M$'000)	7,688	8,203	9,733	11,443	9,383	11,443
Income Tax	3,459	3,691	4,780	5,149	4,222	5,149
Net Income (M$'000)	4,229	4,512	5,353	6,294	5,161	6,294
Rate of Return	10.1%	10.1%	10.1%	10.1%	10.2%	10.1%

Table 7.21 FINANCIAL SUMMARY OF NEW TRANSPORT SYSTEM

	(1,000 M$)
Capital Investment	317,600
Construction including Property	233,600
Rolling Stock	84,000
Income Statement	
Operating Revenue	34,504
Passenger	32,879
Others	1,625
Operating Expense	29,901
Operations	6,797
Depreciation	10,400
Interest	12,704
Net Operating Income	4,603
Net Income-Percent Return on Investment	1.4%

7.6.3 Continued Existence of Ferry System

Table 7.22 summarizes the results of the financial analysis for the ferry system. A detailed analysis is given in the supplements.

Table 7.22 STATEMENT OF FERRY REVENUES AND EXPENDITURES IN 1985 BEFORE OPERATION OF THE BRIDGE

Item	Amount (1000 M$)
Revenue	29,036
Expenditure	20,300
Operating Income	8,736
Tax	4,805
Net Income	3,931
Percent of Revenue	13.5%

According to the above figures, the ferry system is expected to have a large amount of profits before operation of the bridge. However, after operation of the Penang Bridge, the traffic demand will decrease as follows;

	1985	
	Before Operating	After Operating
M/cycles	14,400	6,500
Bicycles	2,150	2,150
Cars	12,170	1,400
Trucks	2,430	280
Passengers	66,080	46,230

Considering the decreased traffic demands, the following major assumptions are made;

1. In the expenditure, the depreciation cost will be nearly zero due to selling of the surplus ferries.
2. In proportion with the reduced number of ferries, the crew and personnel related to the ferry will be reduce.

As a result, the following operating expenditures in 1985 will be needed.

	(M$'000)
Operating Cost	7,501
Wage	3,014
Fuel & Oil	1,409
Maintenance	2,004
Others	1,074
Depreciation	0
Interest	750
Total	8,251

On the other hand, the operating revenue of the ferry system is 7,410 thousand dollars in 1985. Therefore, the balance between the operating revenue and expenditure is as follows:-

	(thousand dollars)
Expenditure in 1985	8,251
Revenue	7,410
Net Income	841

However, the revenue, even after operation of the Penang Bridge, is expected to increase at 5 percent per annum so that towards the end of 1988 a small profit can be expected.

7.7 Introduction of Mini-Bus System

The Government has already decided to introduce the mini-bus system in Penang. On the basis of this premise, the function of the mini-bus is analyzed from economical and operation view points in this study.

1. Economical View Points

The stage and mini-bus cost and productivity have already been studied in Kuala Lumpur. The study expresses the productivities of both bus systems as follows:

Mearure	Indicator	mini-bus performance (stage = 100)
(i) Full cost	cost per seat mile	65 to 75
(ii) Capital economy	seat miles per dollar initial cost over vehicle life	50
(iii) Labour productivity	(i) seats miles per employee per year	60 to 65
	(ii) wage oost per seat mile	70
(iv) Wage rates	average earnings	115 - 120
(v) Fuel economy	fuel & oil cost per seat mile	65

The Kuala Lumpur experience concludes that the mini-bus is a significantly more costly form of public transport, in terms of resources and productivity.

2. Impact on Road Traffic

The projected daily public transport demands are 2,234,000 passenger - kilometers in plan B in 1985. On the basis of these demands, the impact on the road traffic is examined below.

	Stage Bus	Mini-Bus
Passenger Demands (1000' passenger-kms)	2,234	
Occupancy	25	12
Daily Fleet Kilometers in 1985 (1000 kms)	89.3	186.2
Rate of P.C.U	3.0	2.0
P.C.U Kilometers	267.9	372.4

Mini-buses will increase the vehicle kilometers by as much as 40 percent in order to cater for the projected demand. This increase in vehicle kilometers will, on the whole, not effect road traffic much. However, in some specific area, for example in the C.B.D., it will increase the traffic volume significantly.