Table 12.3 Evaluation of traffic safety (PYE)

SECTION	ROUTE-I (Airbase)		ROUTE-II (Green Belt)		ROUTE-III (Defu Avenue)	
PIE ~Paya Lebar IC	H. Alignment : △ Gradient: ◎ Pyschological Oppression: ◎ Succesive Diverging & Merging: ○ Weaving : ◎ Sight Distance: ◎					◎
Paya Lebar IC ~Tampines IC	H. Alignment : ○ Gradient : △ Pyschological Oppression : △ Succesive Diverging & Merging : ◎ Weaving : ◎ Sight Distance: △	△	H. Alignment : △ Gradient : ◎ Pyschological Oppression : ◎ Succesive Diverging & Merging : ○ Weaving : ○ Sight Distance: ○	○	H. Alignment : ○ Gradient : ◎ Pyschological Oppression : ◎ Succesive Diverging & Merging : ○ Weaving : ○ Sight Distance: ○	○+
Tampines IC~TPE IC	H. Alignment : ◎ Gradient : ◎ Pyschological Oppression : ◎ Succesive Diverging & Merging : ◎ Weaving : ◎ Sight Distance: ◎			◎	H. Alignment : ◎ Gradient : ◎ Pyschological Oppression : ◎ Succesive Diverging & Merging : ◎ Weaving : ◎ Sight Distance: ◎	◎
EVALUATION	△		○		○+	

Note; Marks indicate as ◎:favourable,○:acceptable,△:unfavourable,×:unacceptable

aggravation of traffic towards the local roads, the effective usage of the road space for the roadside residents, environmental impacts and an admissibility as city assets.

12.4.1 Local Traffic Alleviation and Serviceability

1) Local traffic alleviation

Expressways attract long distance traffic, diverting it from nearby roads. Expressway interchange on the other hand could cause concentration of traffic at the connecting points with ordinary roads. Fig. 12.7 shows the locations and sections where these phenomenon would occur.

(1) KLE

As the locations and access services in the tunnel and viaduct alternatives are the same, the effects of the local traffic alleviation and aggravation are the same. The main roads along KLE that will clearly increase in traffic load is Nicoll Highway towards the city. New traffic signals are needed on both Sims Av. and Geylang Rd.. Also, at the intersection between Nicoll Highway and Mountbatten Rd., the grade-separated ramps will possibly reduce the load.

(2) PYE

The traffic volume on arterial roads between Hougang New Town and proposed interchanges would increase.

For the case of Route-I, a total of four traffic signalized intersections would be added, two intersections with Paya Lebar Rd.; one with Tampines Rd.; and one with the planned Punggol Rd. While for the case of Route-II and III, a total of three signalized intersections would be added, one intersection with Paya Lebar Rd.; one with Tampines Rd.; and one with the planned Punggol IC. Whichever the route may be,

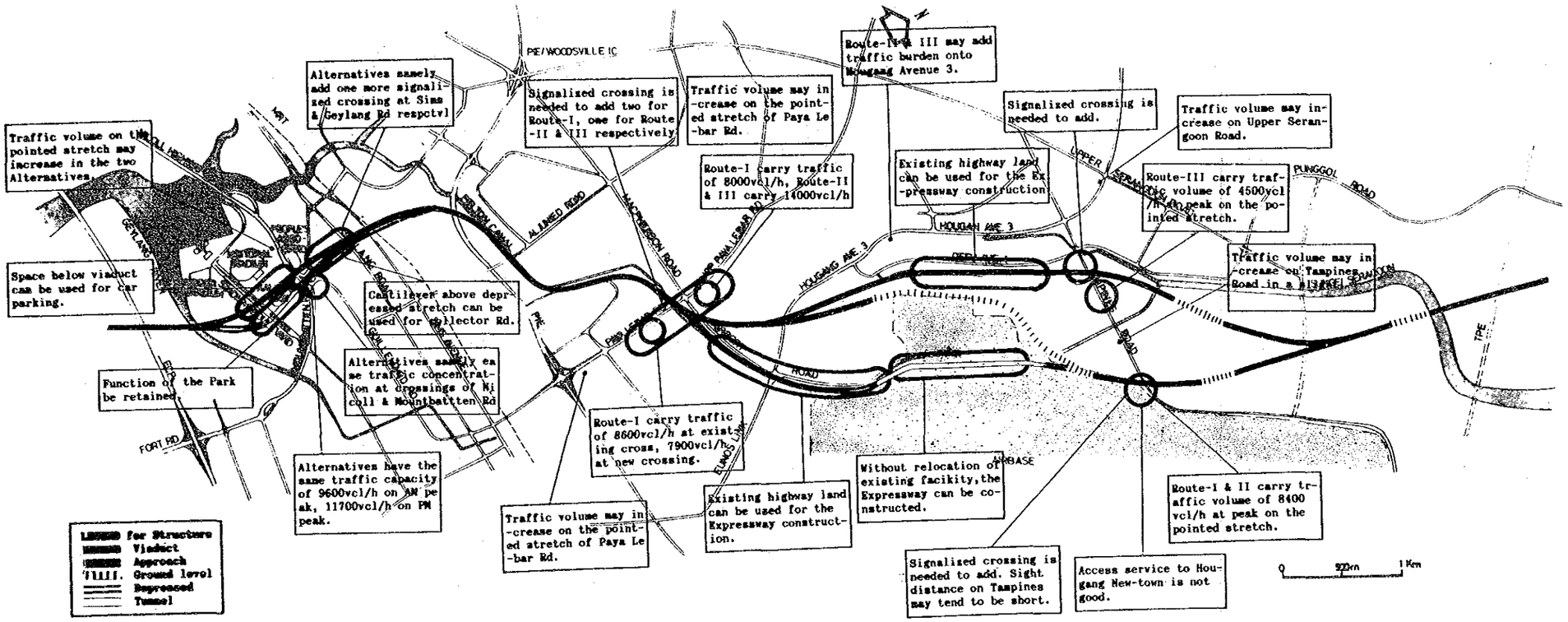


Fig. 12.7 Local traffic alleviation and local service

there will be new intersections at the Paya Lebar Road, only about 250m away from the existing large intersection. It would create a relatively big influence on the traffic flow.

2) Local traffic serviceability

This condition applies to the whole sections of the KLE (tunnel and viaduct) and part of section of the PYE.

(1) KLE

Between the tunnel and viaduct alternatives, the structures in the Kallang Park are different. For the case of tunnel, the space above it can be used freely and for the viaduct, the space below it can be used. The tunnel alternative continues in semi-covered depressed type from Nicoll Highway to Sims Avenue. Top of side walls are made with cantilever slab overhanging about 7m to create space for one 2 vehicle lane width. Meanwhile the viaduct alternative is planned in this section with a viaduct. For the case of viaduct, the piers for main throughway and ramps would become obstacles for the use of the space below expressway.

As for the tunnel alternative from the MRT to KLE/PYE/PIE IC, the tunnel structure is to change to the viaduct structure. In the viaduct structure, because of the complicated ramp and piers, the space above and below expressway cannot be effectively used.

Table 12.4 shows the evaluation on the 2 alternatives for the KLE.

Table 12.4 Evaluation of local traffic serviceability (KLE)

SECTION	ROUTE-I (TUNNEL)		ROUTE-II (VIADUCT)	
ECP IC ~ Nicoll IC	Utilization of above or below of expressway : ◎ Alleviation or aggravation of local traffic : O Accessibility to interchange : O Close signalised intersection : O	O +	Utilization of above or below of expressway : O Alleviation or aggravation of local traffic : O Accessibility to interchange : O Close signalised intersection : O	O
Nicoll IC ~ PIE IC	Utilization of above or below of expressway : O Alleviation or aggravation of local traffic : O Accessibility to interchange : O Close signalised intersection : O	O	Utilization of above or below of expressway : △ Alleviation or aggravation of local traffic : O Accessibility to interchange : O Close signalised intersection : O	O –
EVALUATION	O+		O	

Note; Marks indicate as ◎:favourable, O:acceptable, △:unfavourable, ×:unacceptable

(2) PYE

In the case of Route-I, the Air Base can be used as it is now, and the proposed expressway would also not affect the present traffic condition. Since no additional land is necessary for construction of new 6 lane

expressway, it is evaluated high in terms of effective land use. The section on the Airport Rd. would use slightly more space but it has a good point that the present 4 lanes road space is used as a 10 lane space.

Since the Route-II passes at ground level at the north of SBS bus depot, the space above and below the expressway would not used effectively. There is however no problem because the need to use roadside area by residents is very limited.

In the case of Route-III, the expressway construction does not take land but uses the existing road space effectively. Within a 55m road space, a land of 4 lane at ground level presently, a new 6 lane would be added. The usage of the land has been increased up to 2.5 times. In the median strip, there is a space of 9m width, which is only suitable for plantation or a U turn space.

The evaluation on the 3 alternatives for PYE are conducted as shown in Table 12.5.

Table 12.5 Evaluation of local traffic serviceability (PYE)

SECTION	ROUTE-I (Airbase)		ROUTE-II (Green Belt)		ROUTE-III (Defu Avenue)	
PIE ~ Paya Lebar IC	Utilization of above or below of expressway : ◎ Alleviation or aggravation of local traffic : ○ Accessibility to interchange : ○ Close signalized intersection : ◎					○ +
Paya Lebar IC ~Tampines IC	Utilization of above or below of expressway : ◎ Alleviation or aggravation of local traffic : △ Accessibility to interchange : △ Close signalised intersection: △	○ −	Utilization of above or below of expressway : △ Alleviation or aggravation of local traffic : ○ Accessibility to interchange : ○ Close signalised intersection: ○	○	Utilization of above or below of expressway : ○ Alleviation or aggravation of local traffic : ◎ Accessibility to interchange : ○ Close signalised intersection: ○	○ +
Tampines IC~TPE IC	Utilization of above or below of expressway: △ Alleviation or aggravation of local traffic: ◎ Accessibility to interchange : ○ Close signalized intersection : ◎			○ +	Utilization of above or below of expressway : △ Alleviation or aggravation of local traffic : ◎ Accessibility to interchange : ◎ Close signalised intersection: ◎	◎
EVALUATION	△		○		○+	

Note; Marks indicate as ◎:favourable,○:acceptable,△:unfavourable,×:unacceptable

12.4.2 Environmental Impact

The construction of expressway brings two aspects of negative effects on the roadside area; which are effects brought by the expressway itself

and the traffic on the expressway. Among them the problems that occur frequently in the city are noise, vibration, exhaust fumes, brightness hazard, electric wave hazard, scenery, community division, intrusion of privacy and others. In Singapore expressways basically have buffer zones, therefore presently there would not be much of environmental problems along the expressway. But in the future it may become a society problem.

Noise, vibration, exhaust fumes and intrusion of privacy are mainly picked up as evaluated items considering the public concern, the structure of proposed road, land usage, etc.

The influence on the facility along the road are determined by the sensitivity of the receiving area and the grade of impact. Therefore, generally based on each country's own environment standard, different values are set taking into account the land use. Presently, in Singapore the environmental standards are not set yet. This study shall summaries the environmental impact investigation in a comparatively subjective manner. Table 12.6 shows the influence characteristics.

1) KLE

Fig. 12.8 shows the environmental influence of the 2 alternatives for the KLE and summarized result is in Table 12.7.

Table 12.7 Evaluation of local environmental impact (KLE)

SECTION	ROUTE-I (TUNNEL)		ROUTE-II (VIADUCT)	
ECP IC ~ Nicoll IC	Noise : △ Vibration : ◎ Air Pollution: △ Privacy : ◎ Sunnhine : ◎ Community Separation: ◎	◎	Noise : ○ Vibration : ○ Air Pollution: ○ Privacy : ◎ Sunnhine : ○ Community Separation: △	○
Nicoll IC ~ PIE IC	Noise : △ Vibration : △ Air Pollution: △ Privacy : △ Sunnhine : △ Community Separation: △	△	Noise : × Vibration : △ Air Pollution: △ Privacy : × Sunnhine : △ Community Separation: ×	×
EVALUATION	○		△	

Note; Marks indicate as ◎:favourable,○:acceptable,△:unfavourable,×:unacceptable

2) PYE

Fig. 12.8 shows the environmental influence on the 3 alternatives for PYE and the summary is in Table 12.8.

Among the evaluated items, most important one is noise problem; therefore an recommendation for countermeasures is described below.
There are several locations where noise level would be beyond 65 dB(A). Those are the area as follows, and noise shelter or noise barrier must be studied in detailed design stage.

Table 12.6 Expressway structure and environmental impact

	Viaduct Structure	Ground Level Expressway	Depressed . Trough Structure	Tunnel
Cross Section				
Noise	*Effective of noise reduction to middle or low rise building. *Countermeasure to residence above carriageway level is difficult. *Noise from under viaduct may generate low-frequency band sound to harm health. *Countermeasure by sound-proof wall & shelter. *When underpassed by street ,noise eflected under viaduct bottom be added.	*Radially dispersing to semisphere from carriageway, not advantageous. *Attenuation by ground friction can be expected at rapid decrease where residence locate apart from expressway at some distance. *Countermeasure by dyke, soundproof wall, shelter, etc are considered.	*Multi-reflection to wall surfaces in U-shape radiate into air up to high rise residence neighboring to the expressway. *Transversially radiation can be rapidly attenuated. *Countermeasure by sound absorbing treated wall, sound proof wall & dyke are applicable.	*No noise on tunnel stretch *Concentrated sound discharge from portal & grow large noise. *Noise from portal can gain longitudinally directional power. *Countermeasure by sound-absorbing treating on inner surface, dyke on outside tunnel portal & sound shutter-ing wall.
Vibration	*Piled foundation has no problem because bearing strata as vibration origin is deep. *Joint at girder end often give problem.	*Tendency to generate vibration at the most probability. Especially problematic on soft ground area. *Especially roadway roughness is influential.	*Although problematic when shallow depressed, generally less problem because massive concrete trough absorb shock embedded in soil ground to damp further.	*No problem because massive concrete box absorb shock embedded peripherally in soil ground to damp further
Gas Exhaust	*Many cases exhausting origin position at level higher than 10m where wind effect on better condition for dispersion. *Gas exhaust concentrate at above viaduct sidewall. Residence nearby is impaired.	*The most difficult to disperse because wind velocity go down disturbed by buildings. *Generally the nearer to expressway the thicker density of gas exhaustion.	*One way directional trough where exhausted gas flow to downstream even if open to air may let gas out in very high density at locations.	*No exhaustion on tunnel stretch except for portal or ventilation shaft discharging concentratedly where residence nearby located rise problem.
Intrusion of Privacy	*Elevation of two tier viaduct correspond to 2 or 3 storey, three tier to 5 or 6 storey. The case viaduct come near residence suspect of privacy intrusion.	*Running vehicles at ground level expressway have nothing to do with privacy intrusion.	*Since the elevation of running vehicle is underground no way to intrude privacy.	*Since the elevation of running vehicle is underground no way to intrude privacy.

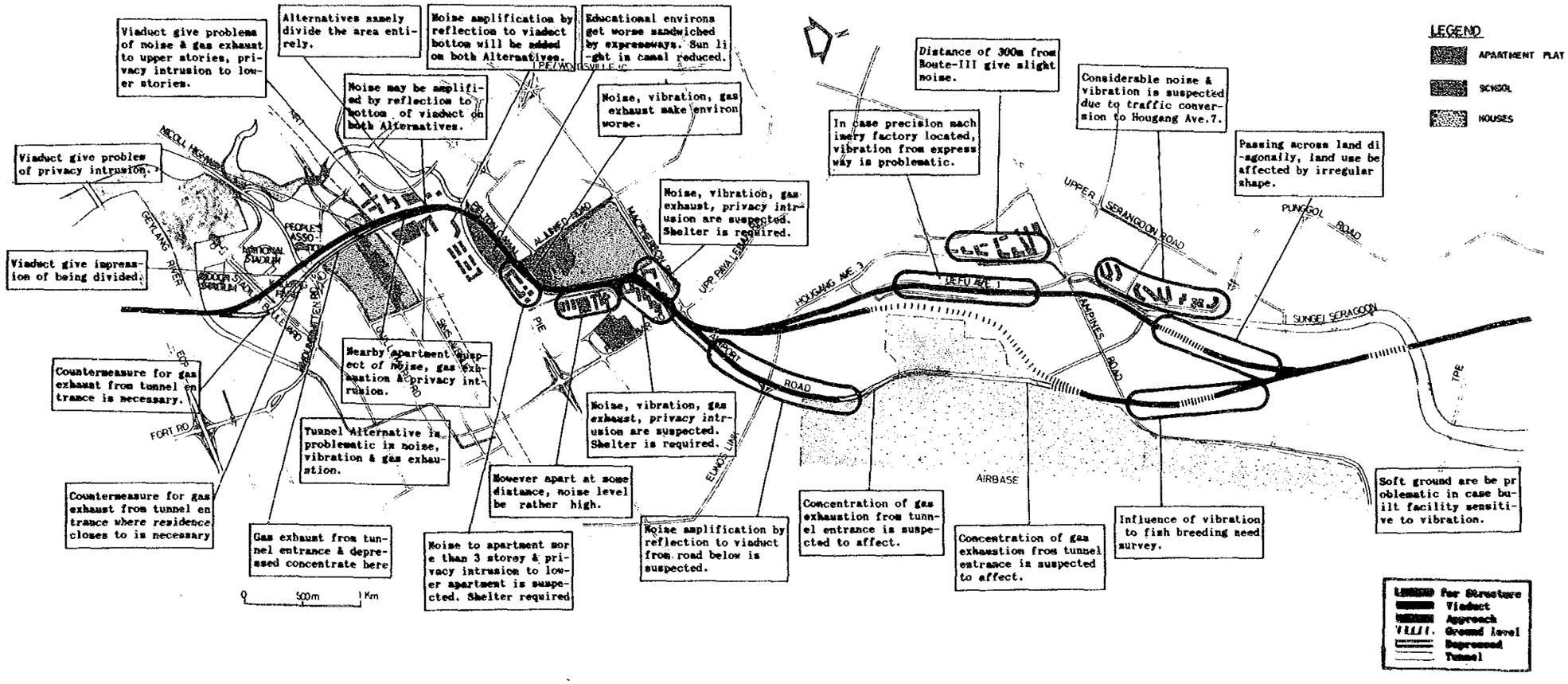


Fig. 12.8 Environmental impact to locations

THE FEASIBILITY STUDY OF SELECTED EXPRESSWAYS IN SINGAPORE

- section between the MRT and PIE on the KLE
- medium rise apartments zone and near schools along the PYE

Table 12.8 Evaluation of local environmental impact (PYE)

SECTION	ROUTE-I (Airbase)		ROUTE-II (Green Belt)		ROUTE-III (Defu Avenue)	
PIE ~Paya Lebar IC	Noise : △ Privacy : △		Vibration : ◎ Sunshine : △		Air Pollution : △ Community : ○	○ –
Paya Lebar IC ~Tampines IC	Noise : △ Vibration : ○ Air Pollution: △ Privacy : ○ Sunnhine : ○ Community : ◎	○ –	Noise : ○ Vibration : ◎ Air Pollution: ○ Privacy : ○ Sunnhine : ◎ Community : ◎	◎	Noise : △ Vibration : ○ Air Pollution: ○ Privacy : ○ Sunnhine : ○ Community : ○	○
Tampines IC~TPE IC	Noise : ◎ Vibration : △ Air Pollution: ◎ Privacy : ◎ Sunnhine : ◎ Community : ○			◎	Noise : △ Vibration : △ Air Pollution: △ Privacy : ◎ Sunnhine : ◎ Community : △	○ –
EVALUATION	○		○+		○–	

Note; Marks indicate as ◎:favourable,○:acceptable,△:unfavourable,×:unacceptable

12.4.3 Admissibility as City Assets

The urban morphology in Singapore is advanced in its integration. The city is arranged as a whole alike a house where urban facilities are allocated their own function and assets value like furniture in a house. All of the urban facilities such as houses, buildings, bridges, plantings, and canals in Singapore are in accordance with a certain common style or an inherent style of legacy in th sense of function, appearance and ecology. In the city area, any structures newly constructed shall accord with the common style. The structures against the style would be neither accepted as assets nor qualified. Outside the city, a new style can be established.

a. Function

As observed at the Keppel Viaduct, the viaduct structure partitions the areas of a different type and actuates the function, appearance and ecology of the area, where the two different businesses in function, i.e, container yard for shipping business and block of commercial offices are partitioned by the viaduct.

b. Appearance

As another effect of viaduct on the Keppel Road, the viaduct plays a shutter to the shipping yard which appears an ugly complex of harboring facilities. In the case of Benjamin Sheares Bridge, people can not see it at the distance closer than 1km except from Marina Center. Close view of the bridge is invisible by the shutter. Long view only sends a silhouette floating in the horizon. In suburban area, the structural esthetics is admitted so as to imply the area to people who visit there.

c. Ecology

This aspect is a viewpoint which handles circumstance based on the human ethology and psychological response. Psychological unpleasantness seems to take place below viaduct from where man might be watched and done harm. Neighborhood living room might be exposed through windows to the sight of drivers traveling on the viaduct. In the case of depressed highway, neighborhood and pedestrian can look down with the effect to ease the feeling.

The common style which would retain the value of city assets is summarized as follows;

- Facilities and buildings shall be so arranged in the manner as to unify the same kind of function and be so used as suiting in the area. Viaduct shall meet the requirement of the style in appearance and ecology. Bridges and viaducts are admissible when they passed across the natural obstructions.

- Viaduct structure shall be shuttered by green belt in principle. Where the space for green belt is short, the structure surface should be concealed with turfs. Viaduct which located far from view point longer than 1km need not be shuttered. Viaduct structure requires aesthetic design into appearance in accordance to the area function. In suburban area, symbolic esthetics or artistic design is necessary so as to imply the local individuality.

- Intrusion of privacy through windows is regarded problematic. Viaduct highway shall be apart from residences by sufficient distance. When highway is planned in such homogeneous places as low rise city area or wide green field, it is preferred to a ground level highway or depressed highway.

The common style summarized above is at times prior to the traffic function of the expressways. The reason is because the high speed transportation by mobiles is not always placed with the first priority. In the city where the integration of urban morphology has advanced, facilities against the style can be rejected to be admitted into city. On the viewpoint confronting the expressway function, the Alternatives have been examined at passing locations. Evaluation result is summarized in Fig. 12.9 and Table 12.9.

As the result of evaluation, Kallang Expressway is preferred to the Route-I so called Tunnel scheme and Paya Lebar Expressway to the Route-I including tunnel under Air Base and Route-II passing by the Air Base in the sense of high admissibility as city assets.

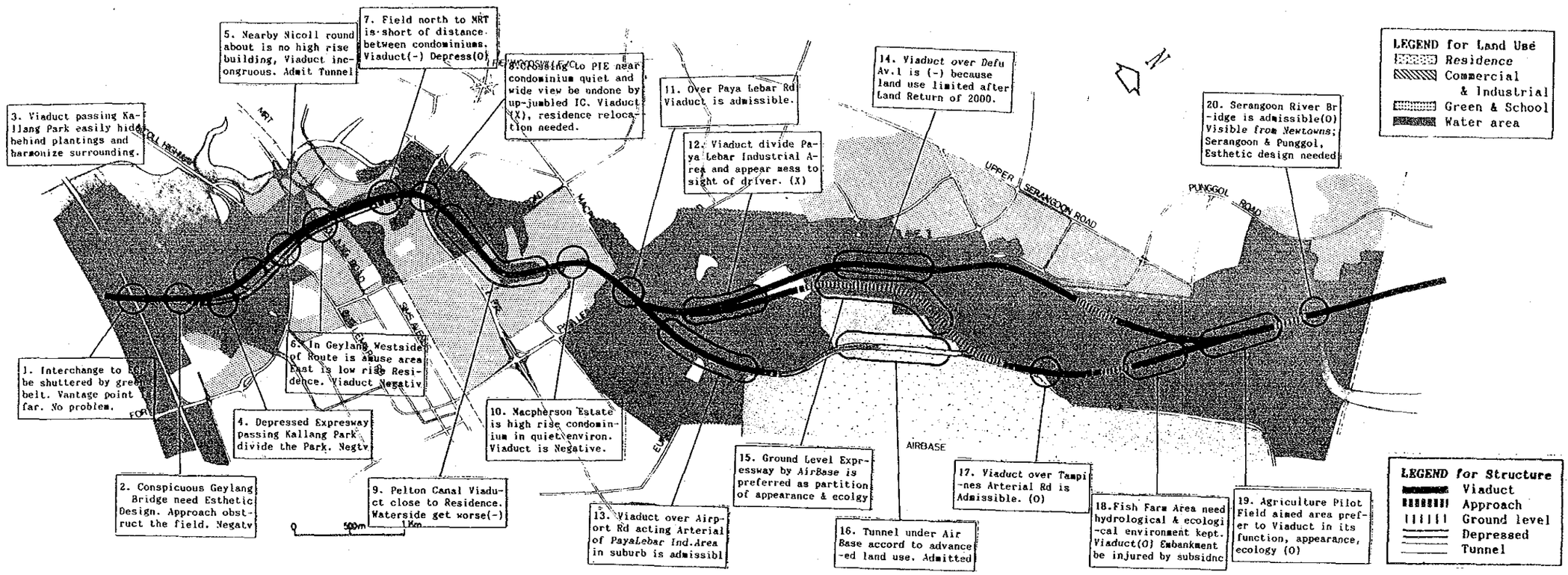


Fig. 12.9 Admissibility into city assets

Table 12.9 Admissibility as city assets at locations

KLE	Locations	Route-I	Route-II	Route-III	Comment
Kallang EXP	ECP & EC.Park	Viaduct ○	Viaduct ○		
	Geylang River	Bridge -	Bridge -		Esthetics Required
	Kallang Park	Tunnel -	Viaduct ○		
	Nicoll & Mount-batten Cross	Tunnel ○	Viaduct -		Access Service required
	Geylang Area	Depress ○	Viaduct -		Supply Collector
	MRT & BoonKeng Pri.schl.Field	Depress Atgrade ○	Viaduct -		Interchange Ramps Up-jumbling
----	Crossing PIE	Viaduct ×	Viaduct ×	Viaduct ×	ibid
Paya Lebar EXP	Pelton Canal	Viaduct -	Viaduct -	Viaduct -	Environmnt Problem
	Macpherson Est	Viaduct ×	Viaduct ×	Viaduct ×	Environ&View Worse
	PayaLebar Industrial Estate	Viaduct ○	Viaduct -	Viaduct -	Suit to Airport Rd Divide Area Worse
	Defu & AirBase	Tunnel ○	Depress ○	Viaduct ○	
	Cross Tampines	Viaduct ○	Viaduct ○	Viaduct -	- near Residence
	Agriculture	Viaduct ○	Viaduct ○	Viaduct ○	Lower The Better
	SerangoonRiver	Viaduct ○	Viaduct ○	Viaduct ○	Esthetic Required
Evaluation	KLE	Acceptabl	Problemtc		Problem at PIE
	PYE	Acceptabl	Acceptabl	Problemtc	Problem at Macphs.

Note: $:Favorable ○ :Acceptable - :Problematic × :Not Acceptable

12.5 Evaluation of Alternatives

12.5.1 KLE

The Alternatives for KLE were evaluated as shown in Table 12.10.

Table 12.10 Evaluation of alternatives

Evaluation Item	Route-I	Route-II
Construction & Maintenance	Problem	Favorable
Economy	Favorable	Favorable
Traffic safety	Problem	Favorable
Local traffic service	Favorable	Favorable
Local environmental impact	Favorable	Problem
Admissible as city assets	Favorable	Problem
Total evaluation	**Favorable**	**Favorable**

There were deficiencies on both Alternatives. Route-I with tunnel inherits a high possibility of traffic accident on the tunnel stretch because of unfavorable horizontal and vertical alignment as well as interchange traffic. Route-II with viaduct all through the way did not comply with the admissibility as city assets.

In order to settle the comparison into single solution, the balancing the weight of evaluation items was necessary by reviewing the technological development in future, managerial care by policy making, time duration of problematic phenomena and the relationship with citizen in Singapore as described below. Concerned people of interest on each Item was also considered.

- Item to which advanced technology can meet the alleviation of impact can be less emphasized. The least in case present state of art can meet denotes (D). The case where more development would be required denotes (C). The case where impossible to meet in a definite future denotes (B). The impossible case denotes (A).

- Item to which managerial care by a certain policy making can meet an improvement when the trouble come about can be less emphasized. The degree and denotation are the same as Item at a.

- Item of which problematic phenomena continues for a certain duration can be balanced by its time laps. The shorter duration is less emphasized.

- The relationship of Item with citizen is proportional to the emphasis.

The result of balancing weight among Items is summarized in Table 12.11.

Table 12.11 Weight of evaluation item

Evaluation Item	Concerned people of interest	Techno -logy evolve	Manage -rial care	Time laps troubl	Relati -on to citizen	Ord -er
Const. & Maint.	Government	B	D	D	D	6
Economy	Nation	B	D	B	D	5
Traffic safety	User	C	C	B	A	3
Local traffic service	User, Resid.	C	C	B	B	4
Environmnt impact	Residents	C	C	B	A	2
City assets	Nation	B	B	B	A	1

Table 12.11 will lead to the conclusion that the admissibility as city assets could not be coped with technological and political measures and would have a strong connection with the citizen. Although the items for traffic safety and environmental impact equally comes to the second rank, environmental impact should be emphasized more than traffic safety because concerned people are on the side of victims.

The admissibility as city assets can not be made up for by any means of replacement but in the scale of the whole. On the other hand, traffic safety involves such a flexibility as to be cared by the technological and political measures based on the concurrent advancement of the age.

Reevaluating the alternatives by Items to the first and second emphasis, tunnel alternative was superior to the viaduct one. However, the deficiency at third Item on traffic safety could not be allowed to remain later in Singapore. Tunnel alternative could be recommended on the condition that the following measures should be incorporated on the implementing stage of the project.

- Strengthening of tunnel lightings.
  Brighter lighting is known to reduce traffic accidents. Lighting installation arrangement shall be carefully studied.

- Readjustment of accesses at interchange.
  Weaving at interchange is generally a serious cause of accidents. Reduction of access services should be studied in this regard.

- Reconsidering of the regulation speed on the KLE.
  Although the KLE and PYE had been designed for 80km/hour, the Study Team recommends to reduce the regulation speed to 60 km/h in respect of traffic safety.

12.5.2 PYE

The alternatives for PYE were evaluated and the Route-II was recommended by a remarkable difference among them as shown in Table 12.12.

Table 12.12 Evaluation of alternatives

Evaluation Item	Route-I	Route-II	Route-III
Construction & Maintenance	Problem	Favorable	Problem
Economy	Problem	Favorable	Favorable
Traffic safety	Problem	Favorable	Favorable
Local traffic service	Problem	Favorable	Favorable
Local environmental impact	Problem	Favorable	Favorable
Admissibility as city asset	Favorable	Favorable	Problem
Total evaluation	Problem	**Favorable**	Acceptabl

12.6 Recommendations

Suitable alternatives were selected for each of KLE and PYE after confirming feasibilities in aspects of technical, economical and socio-science which included evaluation on social acceptance as city assets.

The conclusion came a hard way due to many restrictions imposed particularly on land use in this small country.

The followings are the Study Team's recommendation for the PWD to consider in future upon accepting some result of this Study.

a. Rezoning of land use at the crossing of KLE, PYE and PIE.

The expressway stretch crossing to the PIE would be in the complicated configuration of viaduct because of difficult locations. The environ of structures, with present land use of mostly housings, would be affected much in negative way. It is therefore recommended to change the land use, if possible, to something other than housings. (Fig. 12.10)

b. Specifying of the highway grade.

Short distance of interchange interval and insufficient weaving length will cause a deceleration friction at every interchange and a decrease of traffic safety. This unfavorable phenomena will be amplified by the merging from frontage roads and separated outer lanes, resulting to hindrance to the rapid traffic function all through the way. This situation can be improved by reorganizing the fundamental concept on the highway classification. A highway should be graded into classifications correspondent to its function or role. In other word, the highway function should be definitely specified and this specification would materialize the effective development of highway network.

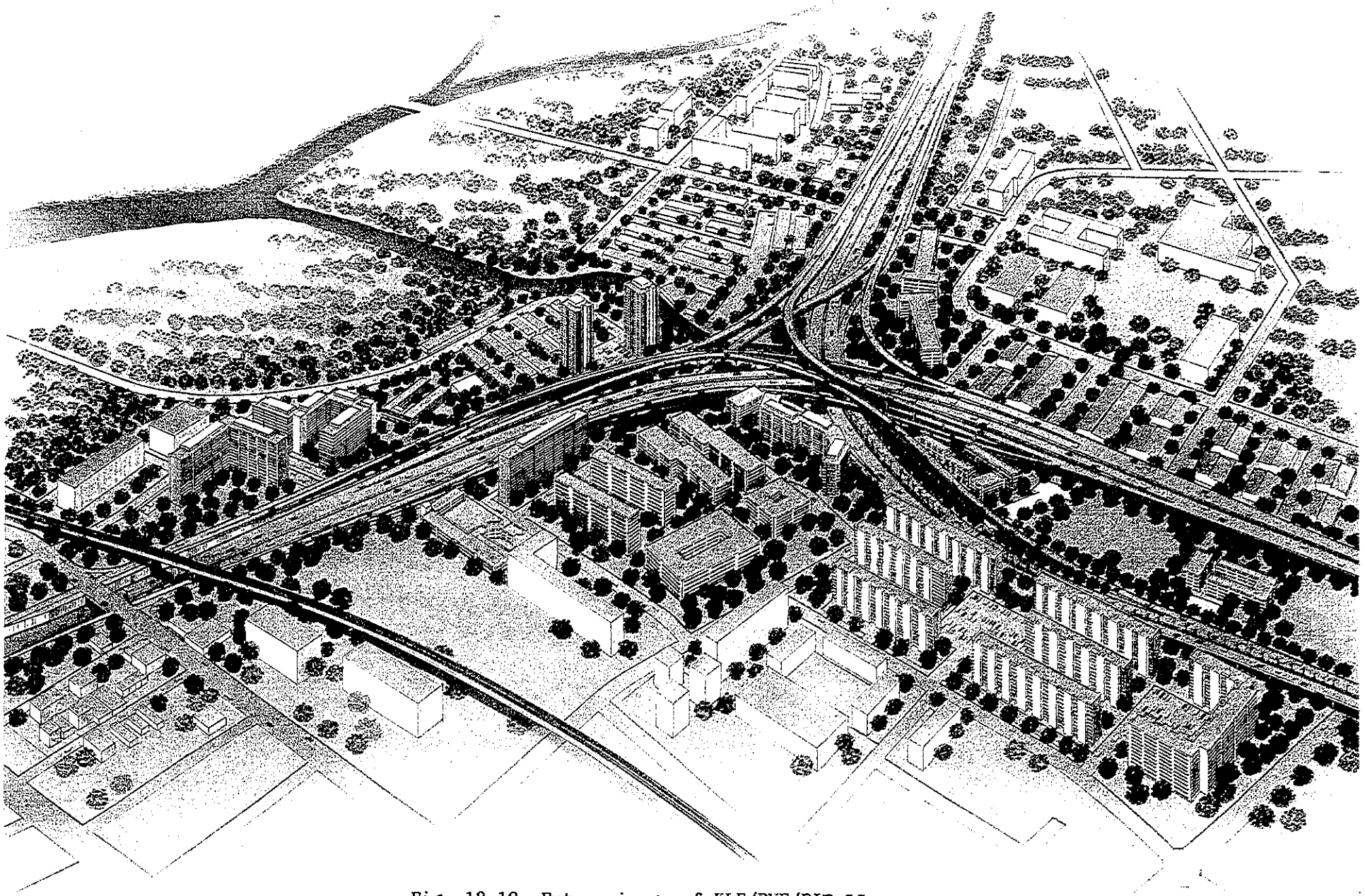


Fig. 12.10 Future image of KLE/PYE/PIE IC

CHAPTER 13

IMPLEMENTATION SCHEDULE

CHAPTER 13 IMPLEMENTATION SCHEDULE

PWD's plan for each expressway completion or starting date is as follows. The work implementation schedule is forecasted as the completion year, but also due to the other considerations like the size of project and other expressway (Central Expressway, Tampines Expressway, Seleter Expressway, Kranji Expressway) are to be taken into account.

- PIE	PIE/Woodsville Road IC - PIE/CTE IC	1994 completion
	PIE/CTE IC West - PIE/BKE IC	1995 completion
- KLE	KLE/ECP IC - KLE/PIE IC	1995 start
- PYE	PYE/PIE IC - PYE/TPE IC	2010 completion

As the results of the study for each expressway, and taking into account completion year, work size and work contents, each expressway is divided into several stages.

There is a need for topographic survey, soil analysis, detailed designs and land acquisition before the implementation.

13.1 Project Cost

The construction cost according to the 1990 units has been calculated. The results are shown Table 13.1.

Table 13.1 Estimated project cost

Cost in million S$

Designation	PIE	KLE	PYE
Construction Cost	84.4	276.4	358.1
Land Acquisition And Compensation Cost	0.0	33.2	17.3
Contingencies	8.4	31.0	37.5
Total	92.8	340.6	412.9

13.2 Stage Construction

In the construction of expressway, various investments are needed. One method for effective use of these investments is stage construction. Tragic needs, land development are combined to have common usage, in order to make investment effectively used. The budget for a complete expressway construction and other expressway implementation period is to be considered, so that stage construction can be done. Each expressway stage construction can be as follows:

13.2.1 PIE

Between Woodsville IC to PIE/CTE IC the construction will start in 1991 and aims to complete by 1994. From the traffic demand, between PIE/CTE

IC to Thomson IC needs to be first. Also in this sector, there are many structures therefore the period will be longer. The priority would be at the top. The next priority is between Thomson IC to Adam IC. This section shall be done by stage construction. And lastly between Adam IC to PIE/BKE IC. It is a 3-stage construction (refer to Fig 13.1).

13.2.2 KLE

The extension of KLE is short. But the tunnel section that includes underground interchange, ECP interchange, PIE interchange inclusive of the viaduct section, and Geylang River Bridge are all built up structures, therefore the implementation would take a long time. Each interchange is a critical pass, it is therefore difficult to have difference in the implementation for stage construction. From the point of view of the work size, work cost and work content it is ideal to have 3 work lots(refer to Fig.13.2).

13.2.3 PYE

PYE is to be constructed together with the 4 new towns along it to study the traffic demand of the roads along it. As the new town that is not planned yet, it is very difficult to plan the PYE schedule. It may be divided into 3 stages targeted to be completed by 2010.

- PYE/PIE - PIE/Hougang Ave IC
- PYE/Tampines IC - PYE/TPE IC
- PYE/Hougang Ave IC North - PYE/Tampines Road IC South

Because of the size between the PYE/PIE IC to PYE/HOugang Ave IC, the construction can be divided into 2 construction lots.

13.3 Implementation Schedule

Each expressway implementation schedule takes account of stage construction as shown in Table 13.2. The important factors on the number of days needed is as follows:

13.3.1 PIE

1) Detailed engineering design

First stage design is 18 months and 2nd and 3rd stage needs 12 months each. In the case of society economics, city region development indications, traffic volume needs to be forecasted. When there are changes in the feasibility study condition, more days is needed for the detailed design.

2) Tender process

After the detailed designs are completed, tender process will start. It is estimated to take 6 months, before the tender call, the interested party needs to examine the situation.

3) Land acquisition & compensation

To acquire the land for the route and the compensation, if there are no

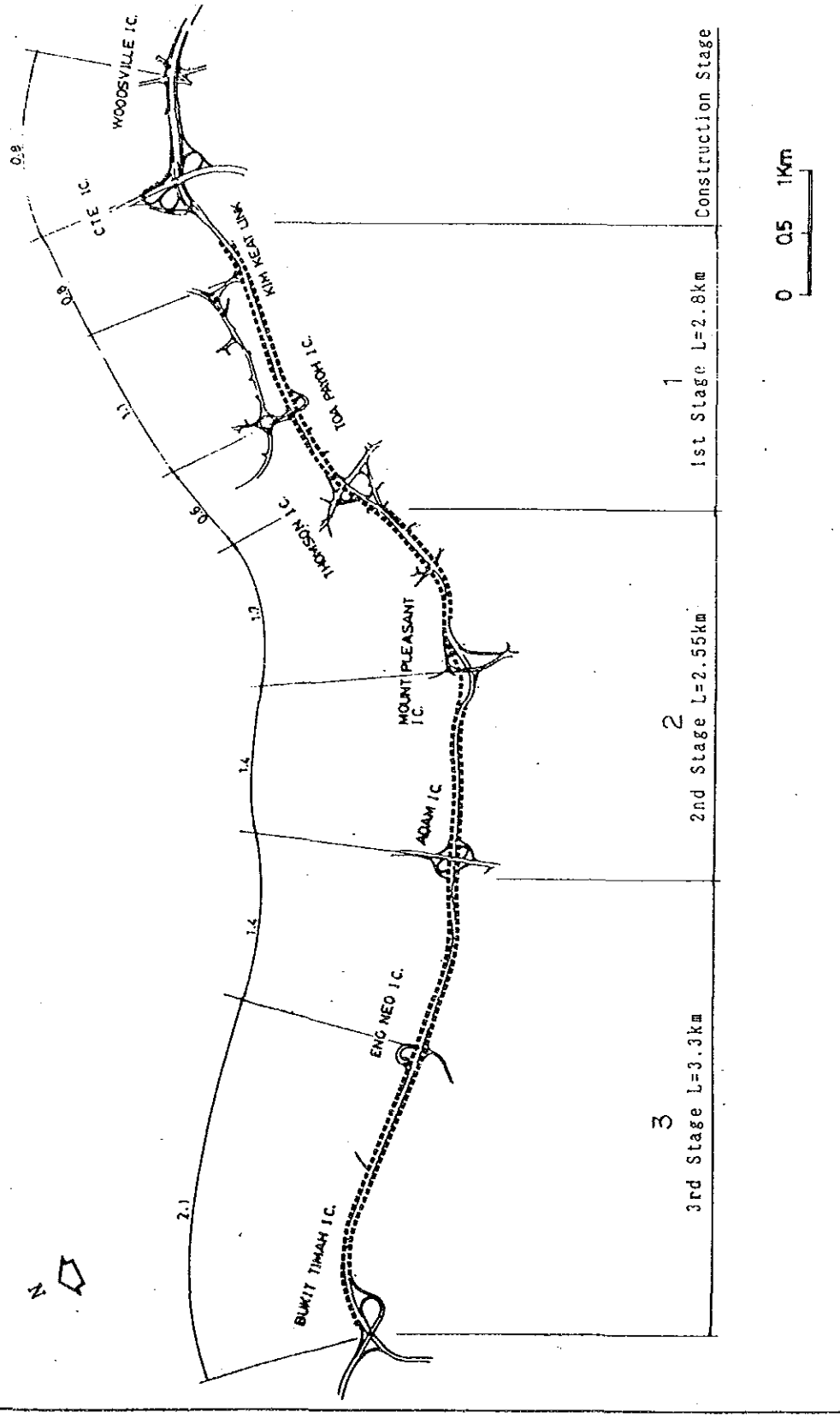
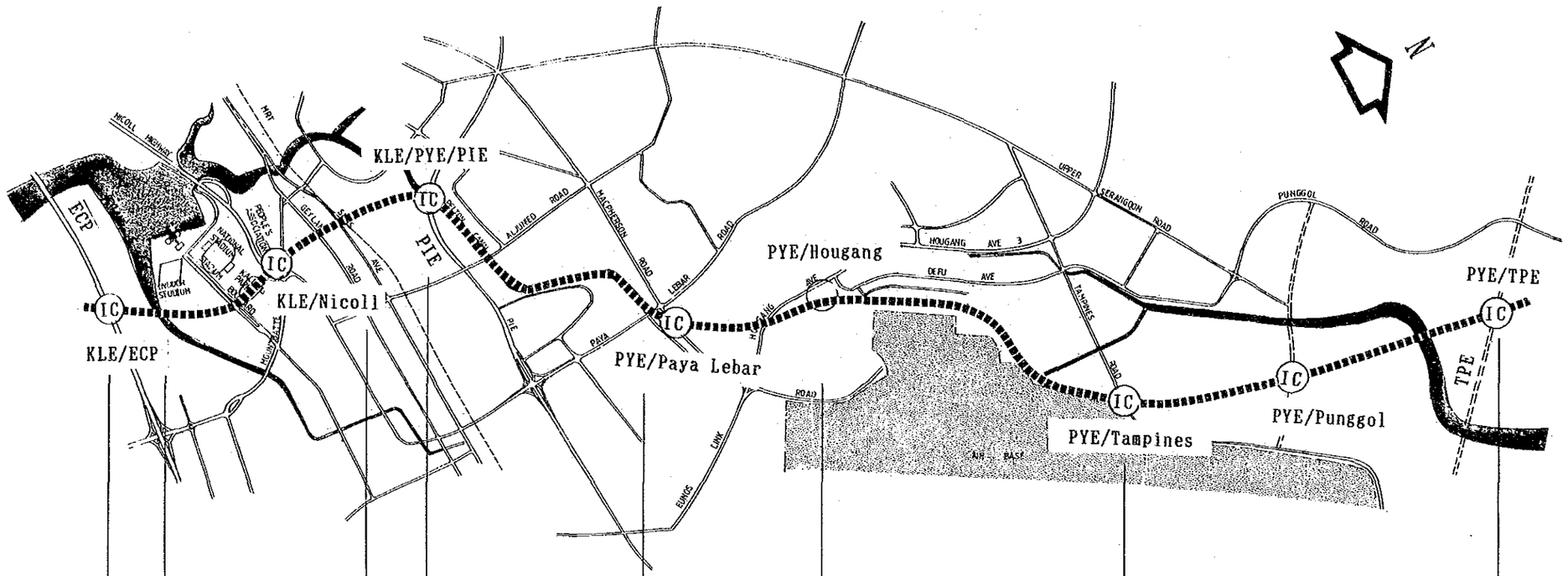


Fig. 13.1 Construction segment for PIE

THE FEASIBILITY STUDY OF SELECTED EXPRESSWAYS IN SINGAPORE

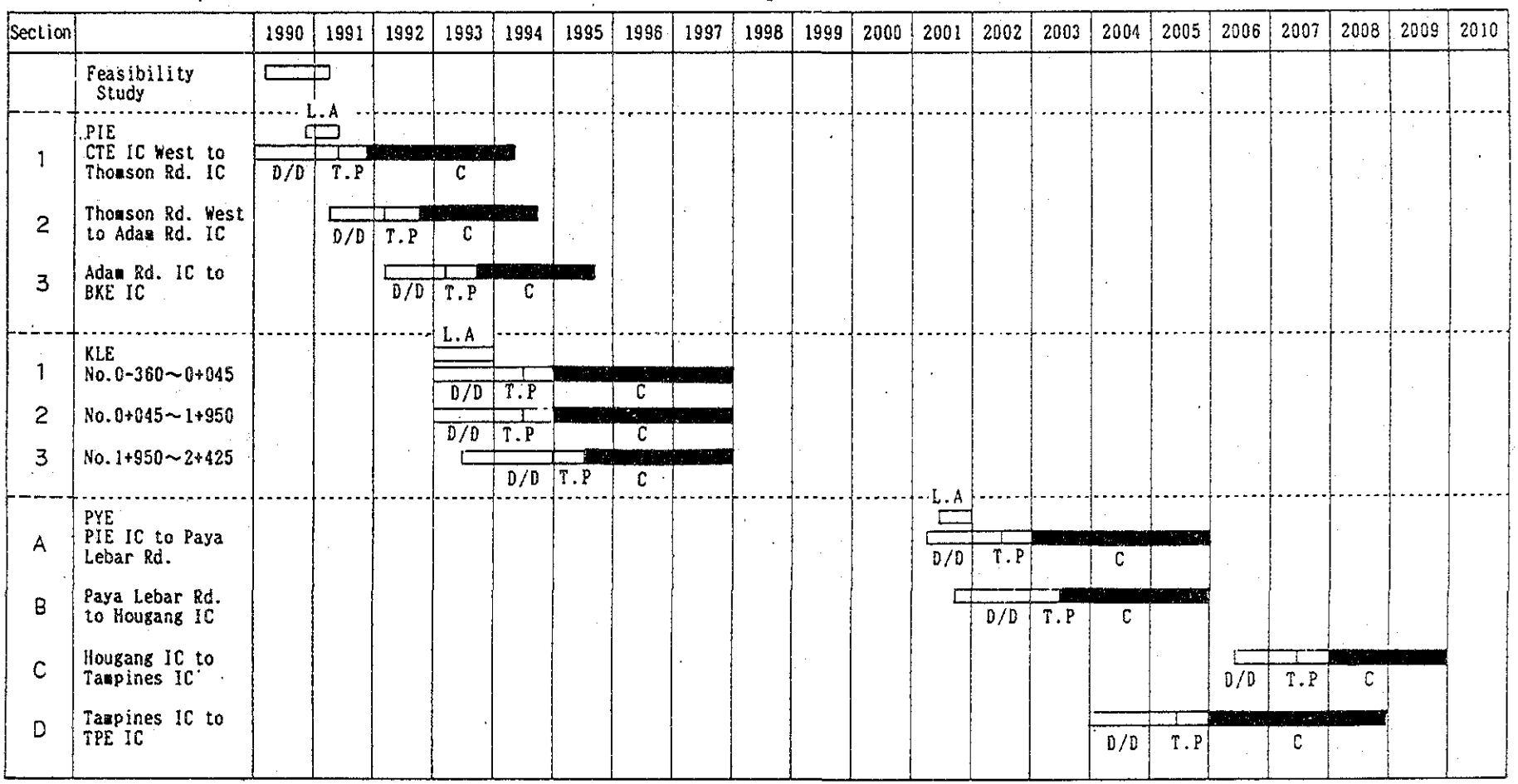


	1	2	3	A	B	C	D
Section Length	0.3Km	1.9Km	0.48Km	2.15Km	1.39Km		
Construction Stage	1st Stage 2.68Km			1st Stage 3.54Km		3rd Stage 3.08Km	2nd Stage 3.55Km
	Kallang Expressway			Paya Lebar Expressway			

0 0.5 1Km

Fig. 13.2 Construction segment for KLE & PYE

Table 13.2 Implementation schedule



F/S : Feasibity Study
D/D : Detailed Design
T.P : Tender Process
C : Construction
L.A : Land Acquisition and Compensation

problems it is estimated to take 6 months.

4) Construction

The 1st stage is predicted to be a relatively complicated work, construction during heavy traffic volume is estimated to take 30 months. In this sector there are many critical passes, and if there is one mistake, the whole structure would be affected, therefore there is a need to be careful not to delay the construction.

2nd and 3rd stage construction is simple, with no complications. It is estimated to take a total of 24 months.

13.3.2 KLE

1) Detailed engineering design

This expressway is estimated to come up with the detailed designs in 18 months as there are many complicating build up structures. As in the same with PIE if there are changes in the feasibility study conditions, then the number of days for the studies is to be estimated.

2) Tender process

Tender Process is estimated to take 6 months. There is a need for the interested party to inspect the situation.

3) Land acquisition & compensation

There are many private land to be acquired and compensated along this expressway. It is estimated to take 12 months.

4) Construction

As for this expressway, both tunnel and viaduct are built up structures. Each interchange structure is complicating, each interchange implementation is a critical pass. Section 1 & 2 is estimated to take 36 months, section 3 is estimated to take 30 months.

13.3.3 PYE

1) Detailed engineering design

The 1st implementation stage are all built up structures. But the type is the same and therefore the detail plan would not take so long. It is estimated to take 15 months. The 2nd stage is Serangoon River Bridge and interchange bridge with many built up structures, the detailed design is estimated to take 18 months. The 3rd stage is almost on the ground section, therefore it would not take so long and it is estimated to take 12 months.

2) Tender process

Each tender process stage is estimated to take 6 months.

3) Land acquisition & compensation

Along this expressway, there are a few private land problems, therefore it is estimated to take 6 months.

4) Construction

The first implementation stage is a 3.5km long viaduct. Furthermore it has to be built above the canal and the canal construction section is long. It is divided into 2 sections and estimated to take 36 months and 30 months respectively. The 2nd implementation stage is one work section of 3.5km extension inclusive of two interchange and Serangoon River bridge, it is estimated to take 36 months. The 3rd stage is a section almost all on the ground. Therefore it is not a difficult work and estimated to take 24 months.

APPENDIX

Contents of Appendix (MR: abbreviation for Main Report)

APPENDIX 5

Appendix 5.1 MR5.3: Correlation of Socio-Economic indices and Traffic Volumes

[Central/AM/Generation]

Model Formula	Zones	r	F-value	MER	%RMS
0.083*(Emp)+141.1	42	0.7749	60.1	231.7	49.2
0.081*(E-O)+271.3	42	0.7185	42.7	270.7	54.2
0.227*(E-R)+0.070*(E-O)+56.0	42	0.8016	35.1	227.6	46.6

Remarks

r : Correlation coefficient, value from -1 to 1; near 1 or -1 value indicates a strong linear relationship.

F-value : The correlation coefficient, number of samples and number of variables are the variables of this function. A high value has high persuasiveness.

MER : The Mean Error Ratio, this index shows accuracy within a narrow range, in small value indicates a high level ofaccuracy.

%RMS : This index shows the accuracy of the total with the proportion with the average, small value indicates a high degree of suitability.

Abbreviation of variables :

(Pop) : Population	(Enl) : Enrollment
(Emp) : Employment	(E-M) : Emp Manufacturing
(E-R) : Emp Retail Trade	(E-O) : Emp Others

[Central/PM/Generation]

Model Formula	Zones	r	F-value	MER	%RMS
0.198*(Emp)+216.6	44	0.7632	58.6	1458.8	54.3
0.778*(E-M)+579.0	4*	0.8384	4.7	89.7	32.1
0.191*(E-O)+528.2	44	0.7014	40.7	1672.4	60.0
0.586*(E-M)+0.199*(E-O)+413.3	44	0.7187	21.9	1591.7	58.5

*) Only four zones have industry. It is difficult to estimate for others since the value for others are all 0.

[Central/Off/Generation]

Model Formula	Zones	r	F-value	MER	%RMS
0.150*(Emp)+270.9	42	0.7760	60.5	205.9	49.5
0.142*(E-O)+528.4	42	0.6989	38.2	290.2	56.1
0.540*(E-R)+0.117*(E-O)+41.0	42	0.8332	44.3	142.1	43.4

[Central/AM/Attraction]

Model Formula	Zones	r	F-value	MER	%RMS
0.139*(Emp)+166.8	43	0.7835	65.2	2692.1	50.0
0.136*(E-O)+373.4	43	0.7309	47.0	3111.2	55.0
0.624*(E-M)+323.5	4*	0.8930	7.9	152.0	28.3
0.328*(E-R)+0.121*(E-O)+72.4	43	0.7956	34.5	2292.2	48.8

[Central/PM/Attraction]

Model Formula	Zones	r	F-value	MER	%RMS
0.141*(Emp)+212.5	44	0.7428	51.7	2792.0	55.5
0.135*(E-O)+447.4	44	0.6742	35.0	3214.4	61.2
0.470*(E-R)+0.113*(E-O)+18.1	44	0.7920	34.5	2076.2	50.8

[Central/Off/Attraction]

Model Formula	Zones	r	F-value	MER	%RMS
0.161*(Emp)+236.7	43	0.7562	54.8	1164.8	54.2
0.151*(E-O)+519.8	43	0.6737	34.1	1387.7	61.2
0.634*(E-R)+0.121*(E-O)-35.2	43	0.8319	44.9	770.1	45.9

[Non-Central/AM/Generation]

Model Formula	Zones	r	F-value	MER	%RMS
0.041*(Pop)+397.6	191	0.5983	105.4	215.5	65.9
0.159*(Enl)+573.2	154	0.4700	43.1	169.3	65.2
0.029.(Pop)+0.079*(Enl)+361.9	197	0.6216	61.1	199.6	64.9
0.039*(Pop)+0.329*(E-R)+308.8	199	0.6319	65.1	199.9	65.0

[Non-Central/PM/Generation]

Model Formula	Zones	r	F-value	MER	%RMS
0.152*(Emp)+328.6	272	0.7368	320.7	248.7	61.0
0.185*(E-O)+532.7	272	0.6356	183.0	324.7	69.7
0.391*(E-R)+0.160*(E-O)+478.6	272	0.6595	103.5	304.3	67.8

[Non-Central/Off/Generation]

Model Formula	Zones	r	F-value	MER	%RMS
0.021*(Pop)+463.1	191	0.4123	38.1	442.2	72.3
0.091*(Emp)+351.0	272	0.6022	153.6	321.1	68.8
0.113*(E-O)+470.4	272	0.5269	103.8	386.9	73.3
0.404*(E-R)+0.087*(E-O)+414.5	272	0.5820	68.9	350.4	70.1
0.108*(Enl)+0.092*(Emp)+134.5	273	0.7569	181.1	186.5	56.5

[Non-Central/AM/Attraction]

Model Formula	Zones	r	F-value	MER	%RMS
0.165*(Emp)+131.7	271	0.8379	633.9	305.3	56.0
0.158*(E-M)+0.176*(E-O)+164.1	271	0.8299	296.4	325.5	57.2

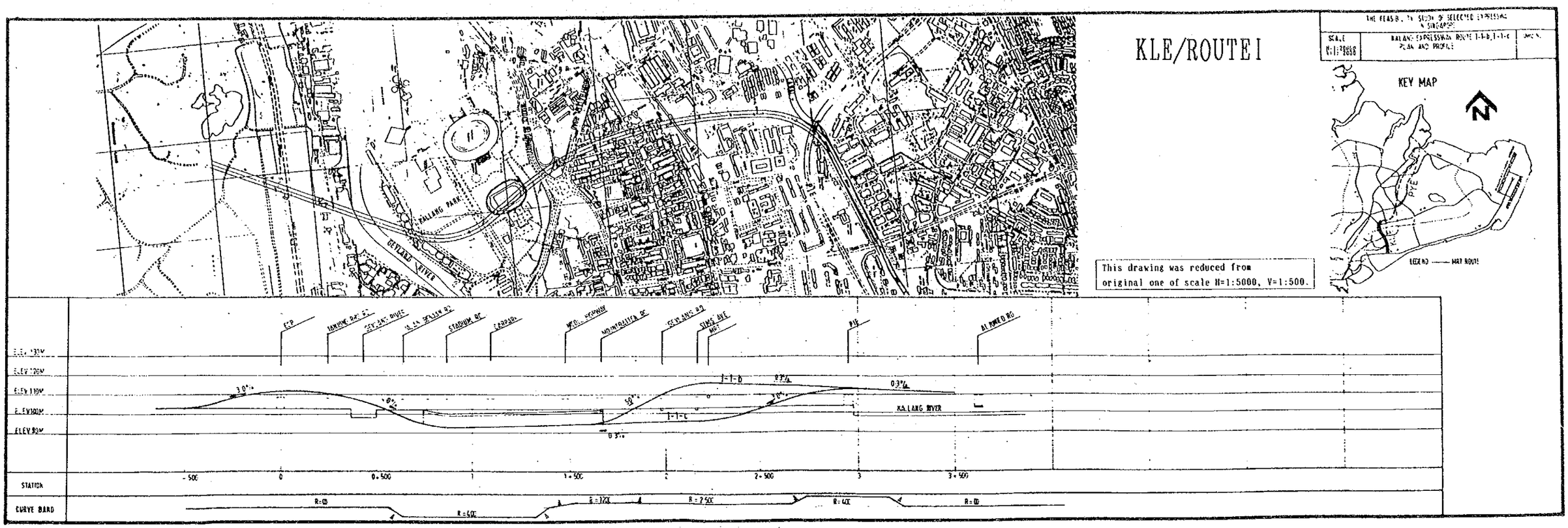
[Non-Central/PM/Attraction]

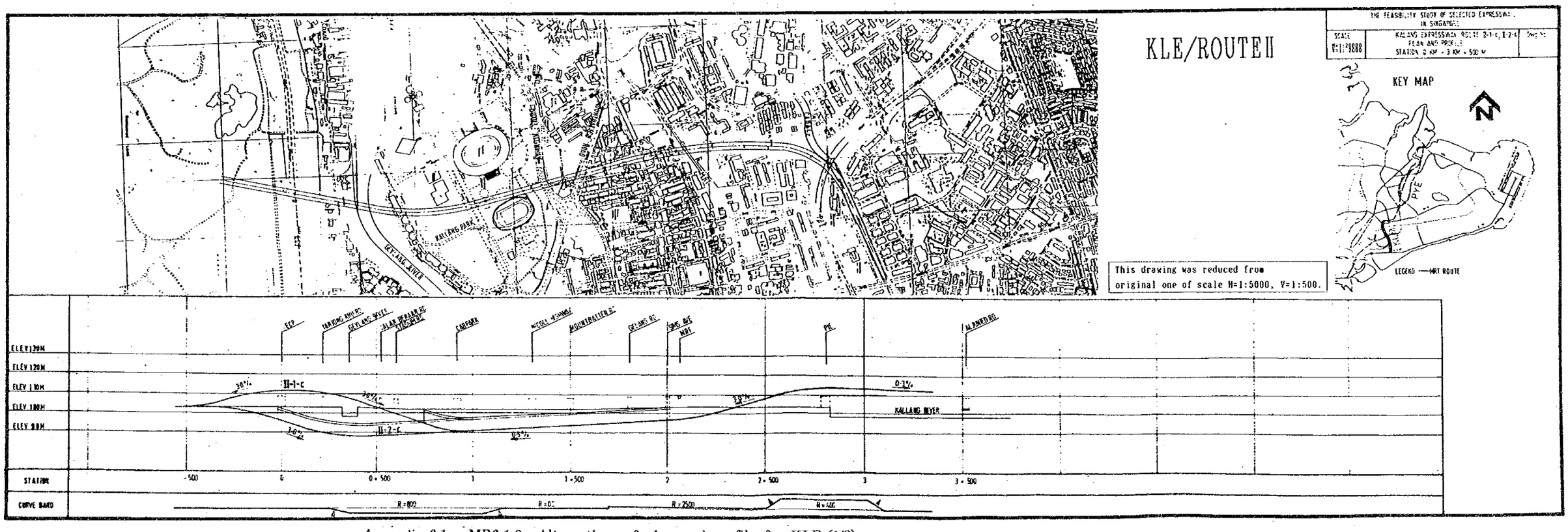
Model Formula	Zones	r	F-value	MER	%RMS
0.044*(Pop)+540.6	191	0.5624	87.4	240.7	65.7
0.803.(E-R)+0.074*(E-O)+596.6	272	0.5087	47.0	540.1	81.0
0.039*(Pop)+0.605*(E-R)+399.1	199	0.6228	62.1	220.2	62.9

[Non-Central/Off/Attraction]

Model Formula	Zones	r	F-value	MER	%RMS
0.091*(Emp)+332.9	272	0.6105	160.4	383.9	69.0
0.398.(E-R)+0.088*(E-O)+394.1	272	0.5946	73.5	420.7	70.1
0.106*(Enl)+0.091*(Emp)+120.5	273	0.7633	188.5	219.1	56.4

APPENDIX 6





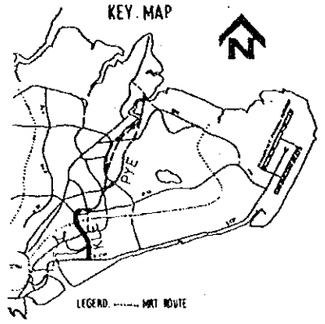
Appendix 6.1. MR6.1.2: Alternatives of plan and profile for KLE (1/2)

THE FEASIBILITY STUDY OF SELECTED EXPRESSWAYS IN SINGAPORE

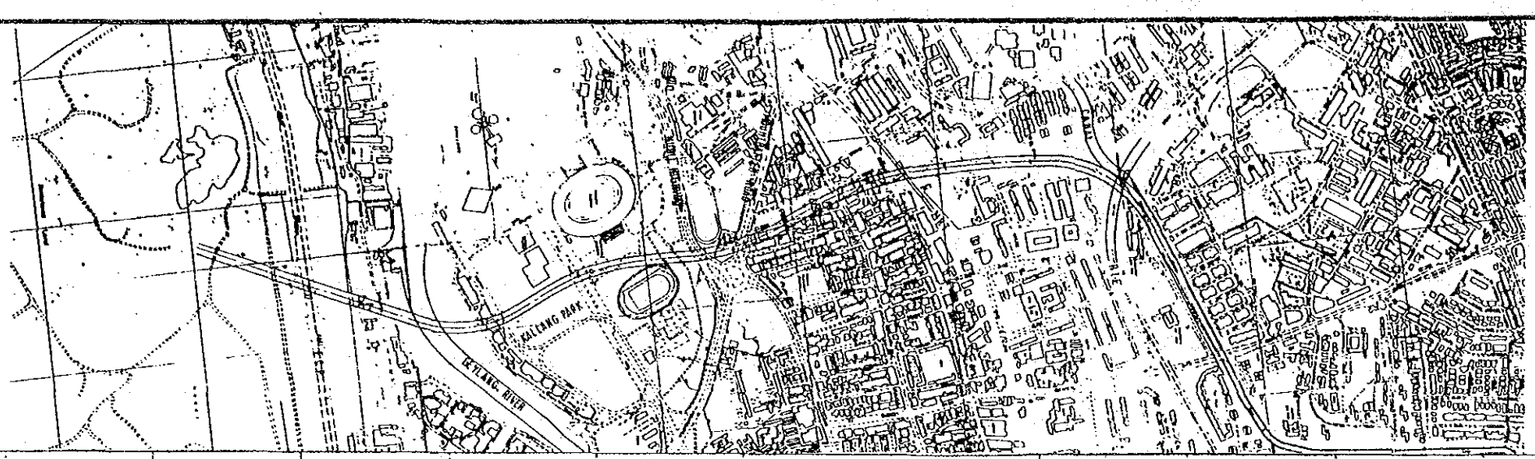
SCALE	KALLANG EXPRESSWAY ROUTE III-1-a	Dwg No.
H=1:5000 V=1:500	PLAN AND PROFILE STATION 0 KM - 3 KM + 500 M	

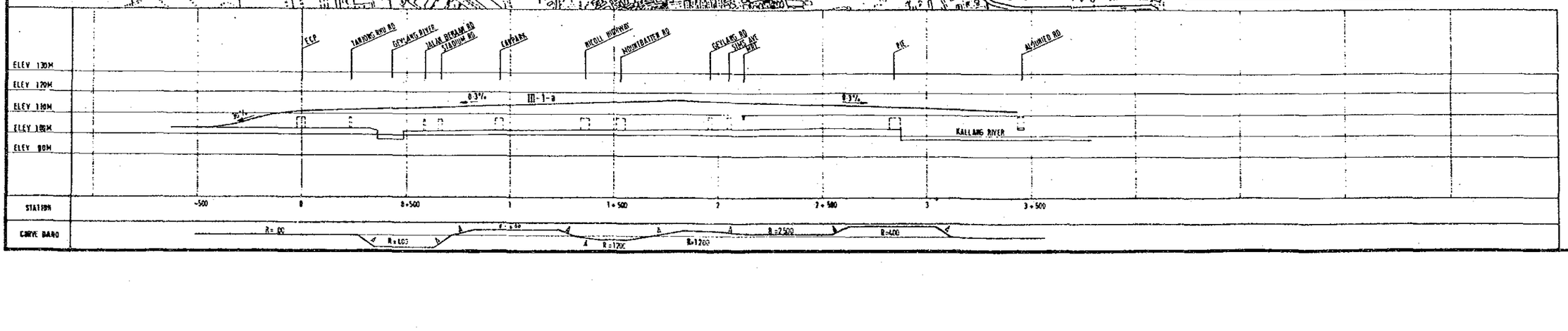
KLE/ROUTEIII

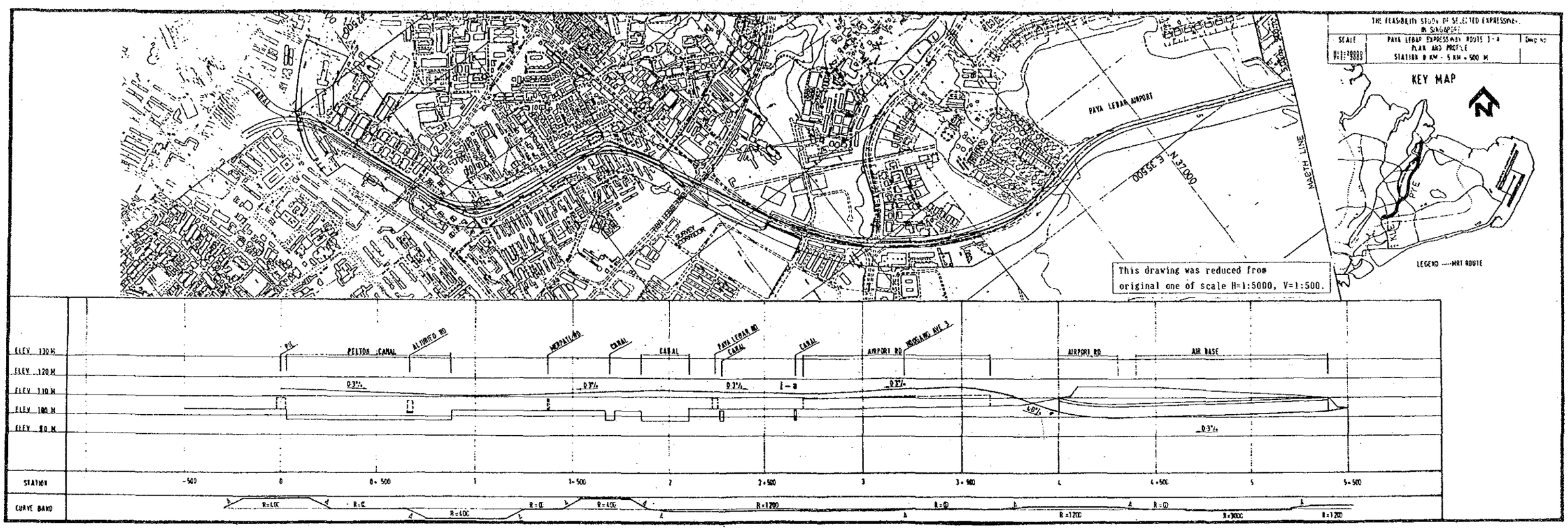
KEY MAP

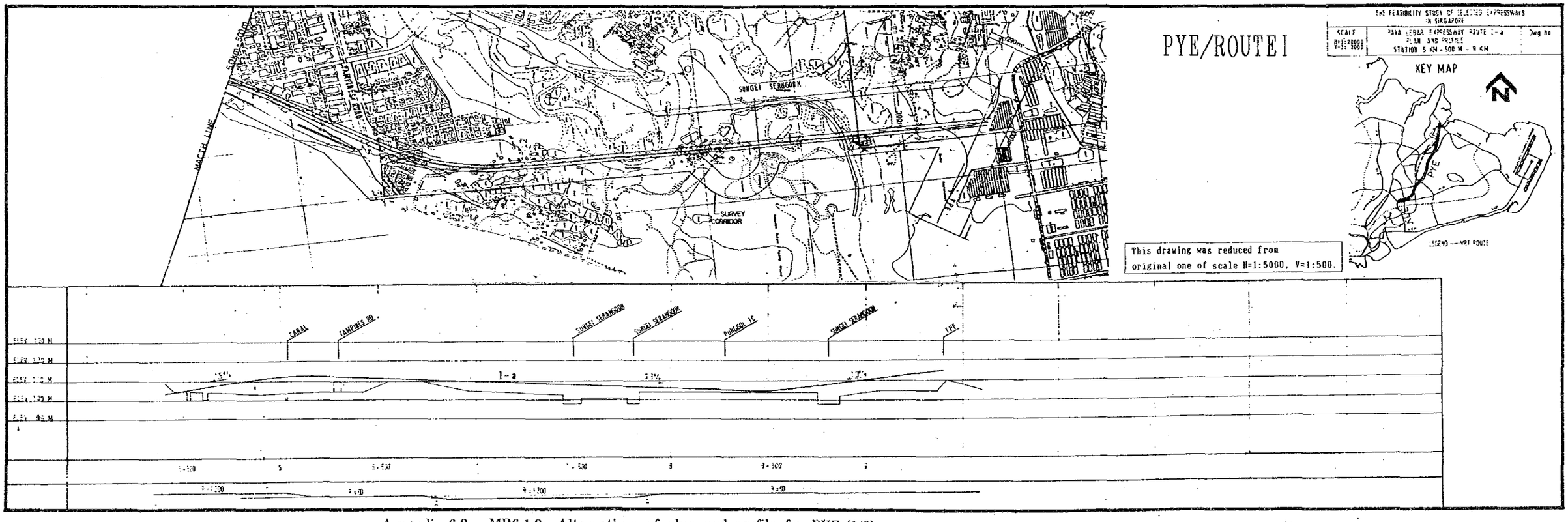


This drawing was reduced from original one of scale H=1:5000, V=1:500.







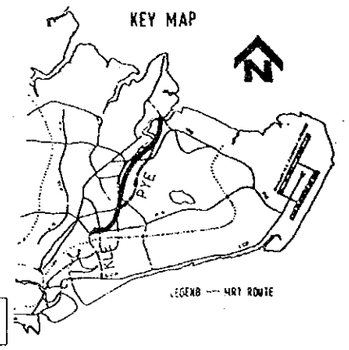


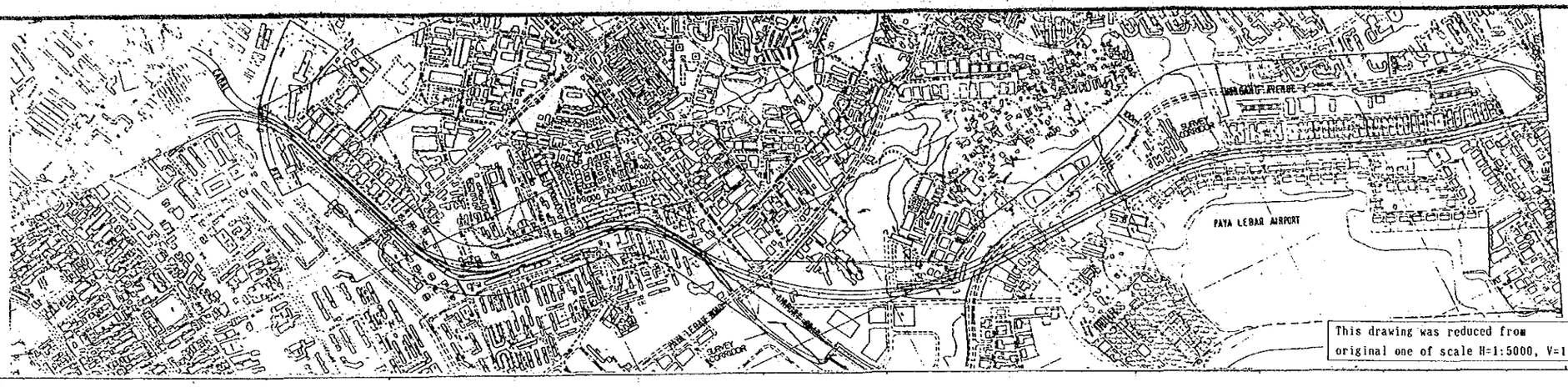
Appendix 6.2. MR6.1.2: Alternatives of plan and profile for PYE (1/3)

THE FEASIBILITY STUDY OF SELECTED EXPRESSWAYS IN SINGAPORE

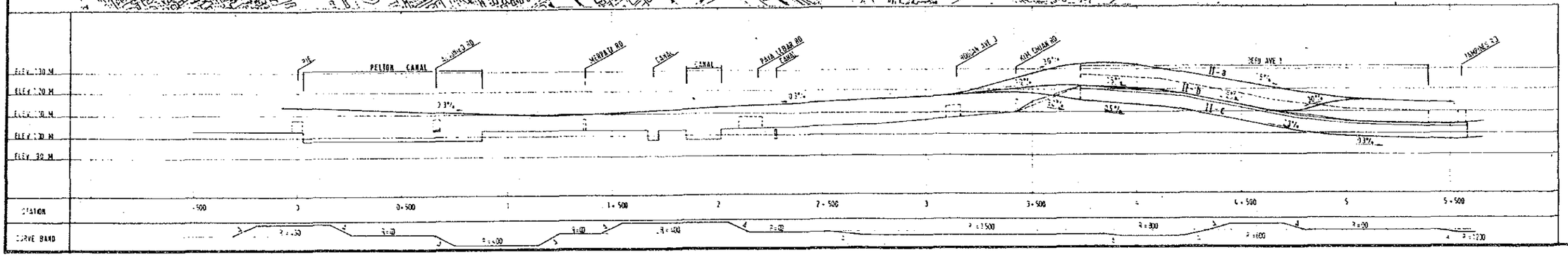
SCALE	PAYA LEBAR EXPRESSWAY ROUTE II-a,b,c PLAN AND PROFILE STATION 0 KM - 5 KM + 500 M	Dwg. No
H=1:20000 V=1: 2000		

KEY MAP





This drawing was reduced from original one of scale H=1:5000, V=1:500.

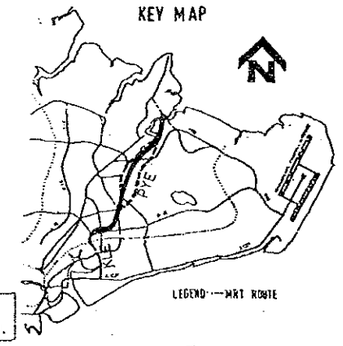


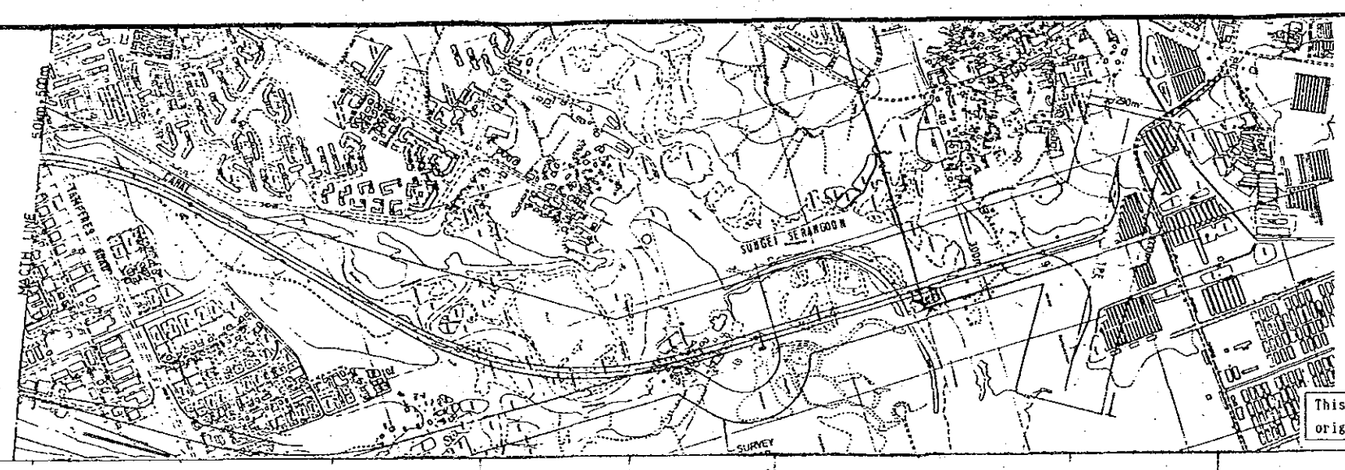
PYE/ROUTE II

THE FEASIBILITY STUDY OF SELECTED EXPRESSWAYS IN SINGAPORE

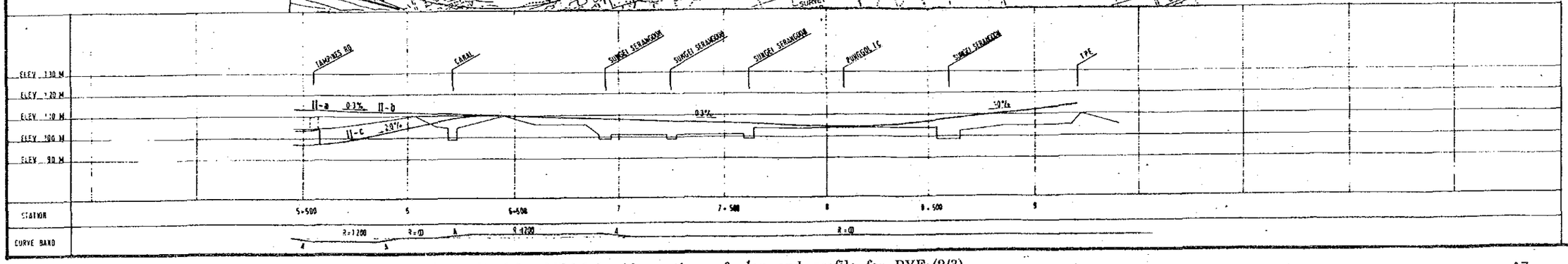
SCALE	PAYA LEBAR EXPRESSWAY ROUTE II-a,b,c PLAN AND PROFILE STATION 5 KM + 500 M - 9 KM + 500 M	Dwg. No
H=1:20000 V=1: 2000		

KEY MAP

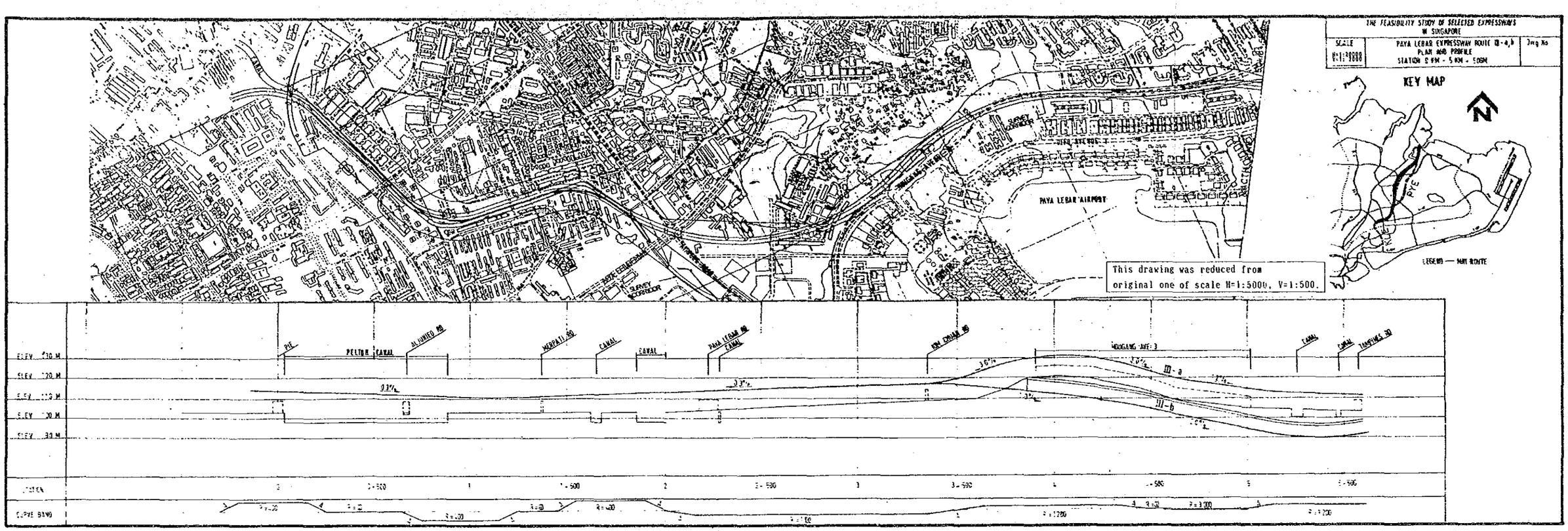


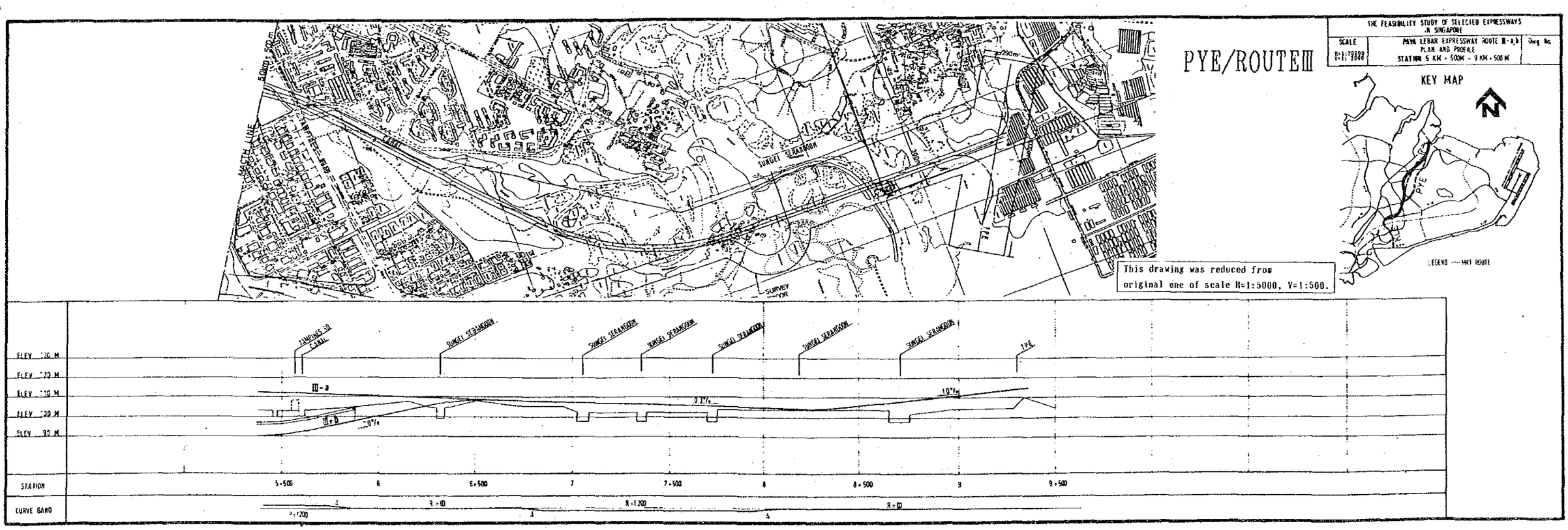


This drawing was reduced from original one of scale H=1:5000, V=1:500.



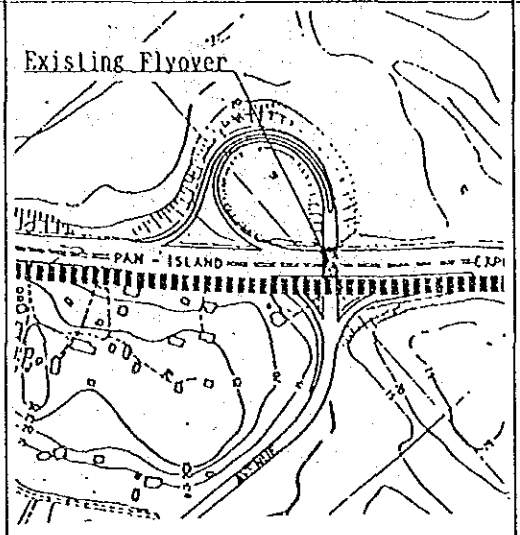
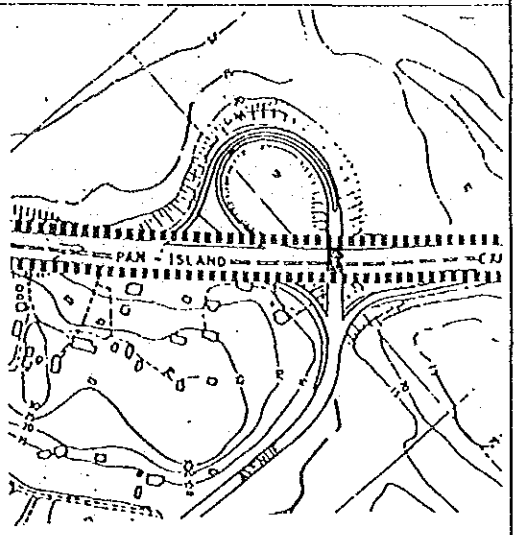
Appendix 6.2. MR6.1.2: Alternatives of plan and profile for PYE (2/3)





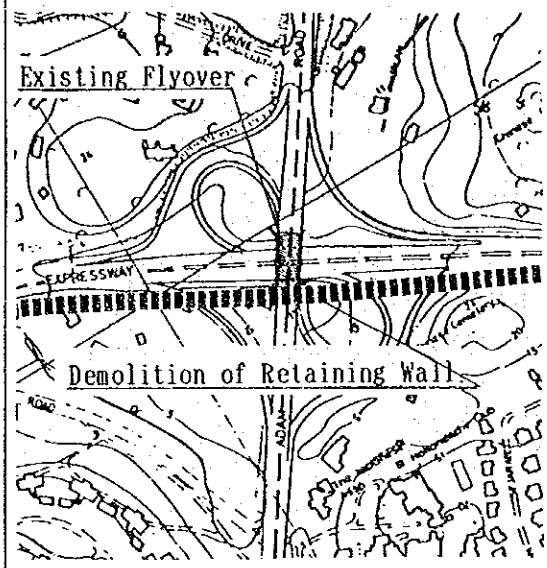
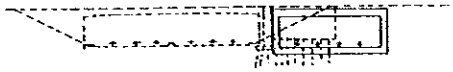
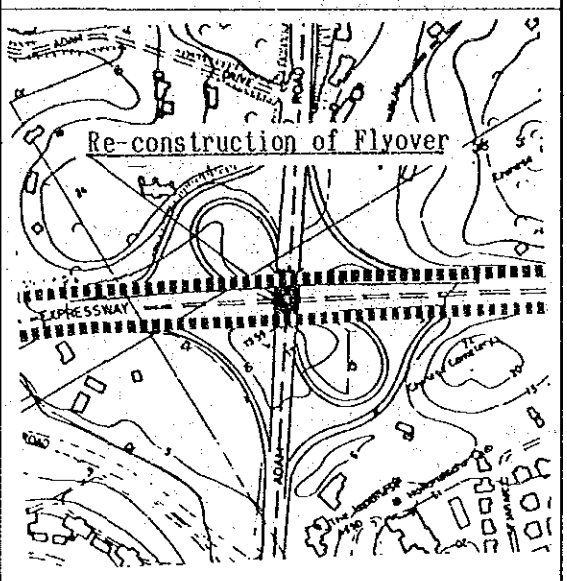
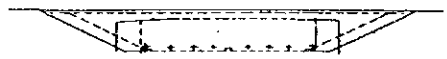
Appendix 6.2. MR6.1.2: Alternatives of plan and profile for PYE (3/3)

Appendix 6.3 MR6.3.6: Selection of feasible alternation
Eng Neo Flyover

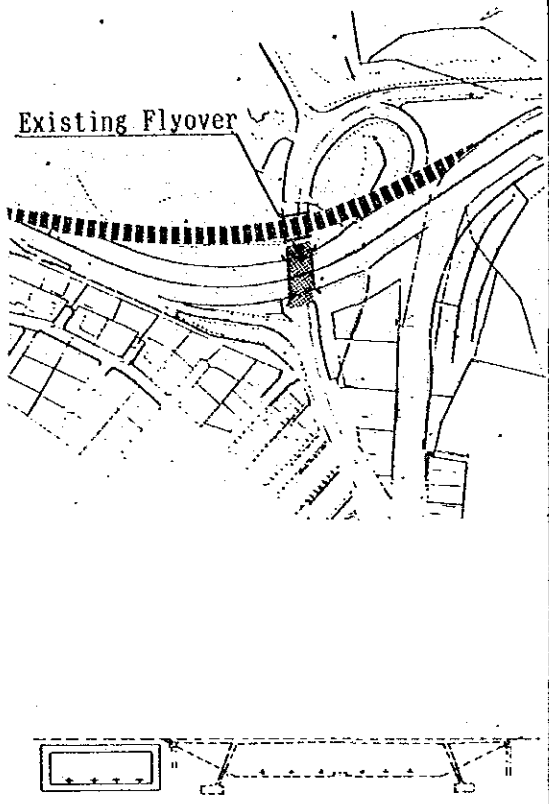
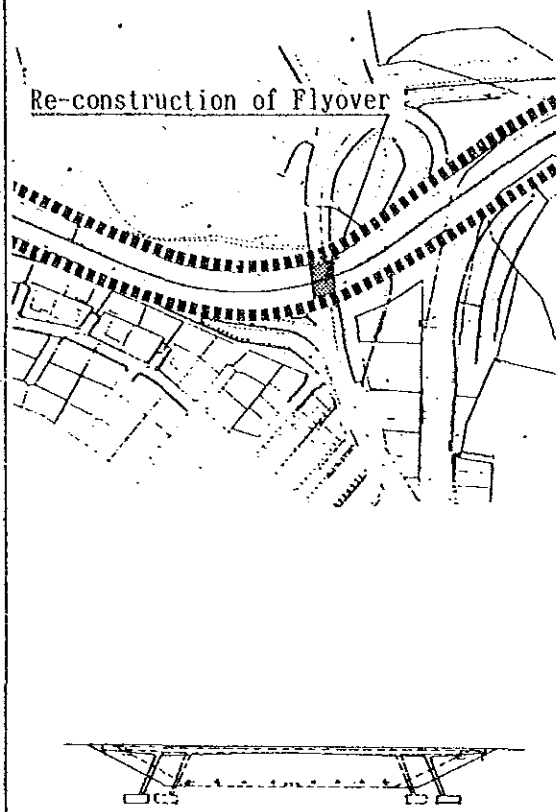
	Additional 4 lanes at only one side of the existing expressway	Widening of 1 lane at both sides of the existing expressway
Sketch		
Traffic Management	-Keeping 6 lanes for the expressway will be possible. -Keeping the existing cross road condition will be possible. -The expressway will not have a good horizontal alignment when re-aligned.	-Keeping 6 lanes for the expressway may be possible. -Keeping the existing cross road condition will be possible. ○
Construction	-Construction will be easy and will not affect the existing bridge. -No influence on cross road. ○	-Joining of the existing and the new superstructure will be needed. -Construction may not be easy. -No influence on cross road.

Note: ○; better than the other
△; having the same condition
×; construction is very difficult

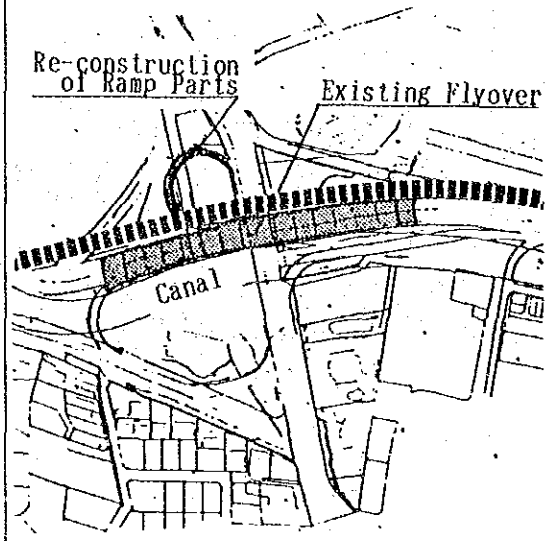
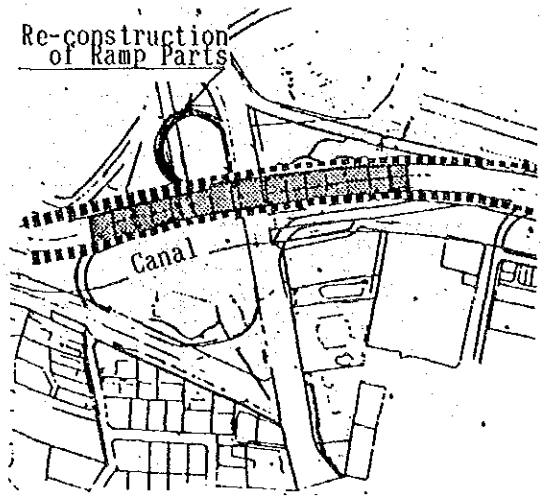
Adam Flyover

	Additional 4 lanes at only one side of the existing expressway	Widening of 1 lane at both sides of the existing expressway
Sketch	 	 
Traffic Management	-Keeping 6 lanes for the expressway will be possible. -Cross road will either be managed by keeping half of the width of existing road for a short period or by providing a temporary bridge.	-Traffic on the expressway may be stopped during the demolition of existing bridge. -Traffic on Adam Road may be kept by constructing a temporary bridge.
Construc-tion	-No influence on the expressway. -Construction will be easy.	-A good protection on the expressway will be needed during the demolition and construction of bridge . -Keeping the vertical clearance on the expressway during the construction will be difficult.

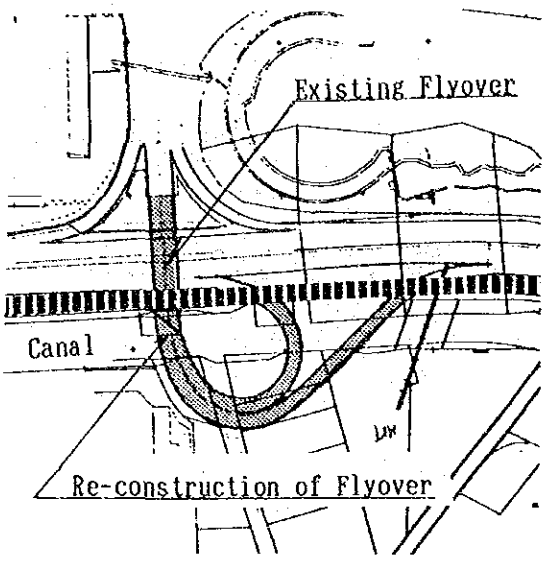
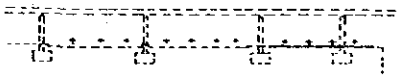
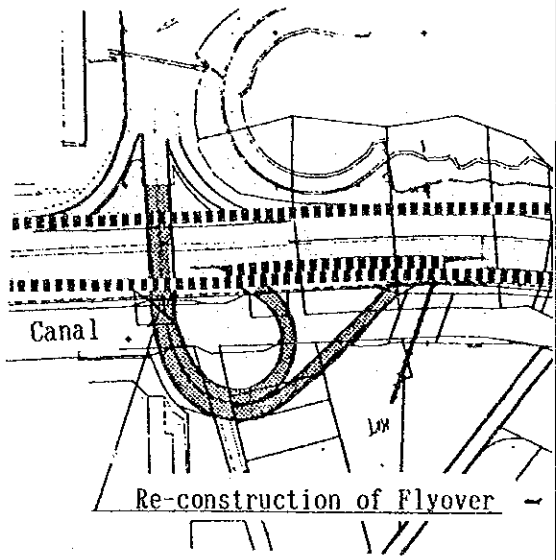
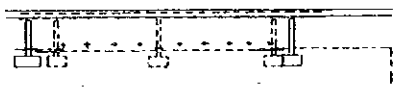
Mount Pleasant

	Additional 4 lanes at only one side of the existing expressway	Widening of 1 lane at both sides of the existing expressway
Sketch		
Traffic Management	-Keeping 6 lanes for the expressway will be possible. -Cross road will either be managed by keeping half of the width of existing road for a short period or by providing a temporary bridge. -The expressway will have a good horizontal alignment when re-aligned. ○	-Traffic on the expreeway may be stopped during the demolition of existing bridge. -Keeping the traffic on Mount Plesant Road by constructing temporary bridge.
Construc-tion	-No influence on the expreeway. -Construction will be easy. ○	-A good protection on the expressway will be needed during the demolition and construction of bridge. -Keeping the vertical clearance on the expressway during construction will be difficult

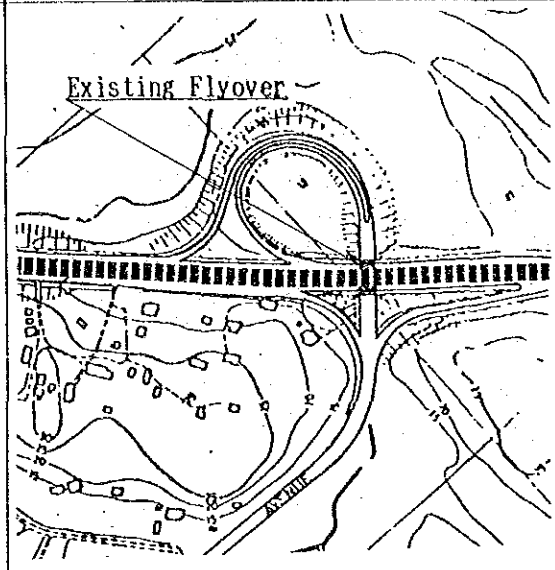
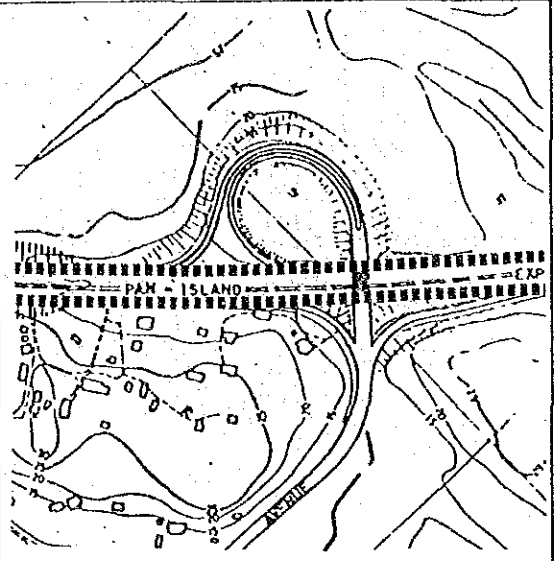
Thomson Flyover

	Additional 4 lanes at only one side of the existing expressway	Widening of 1 lane at both sides of the existing expressway
Sketch		
Traffic Management	-Keeping 6 lanes for the expressway will be possible. -OFF or ON Ramp cannot be used. -Keeping the existing cross road condition will be possible. ○	-Keeping 4 or 5 lanes for the expressway may be possible. -OFF or ON Ramp cannot be used. -Keeping the sxisting cross road condition will be possible.
Construc-tion	-No influence on cross road. -Construction will not be difficult ○	-Joining of the existing and the new superstructure will be needed. -Construction may not be easy, particularly in the control of width, as the existing width of the ramp is not constant.

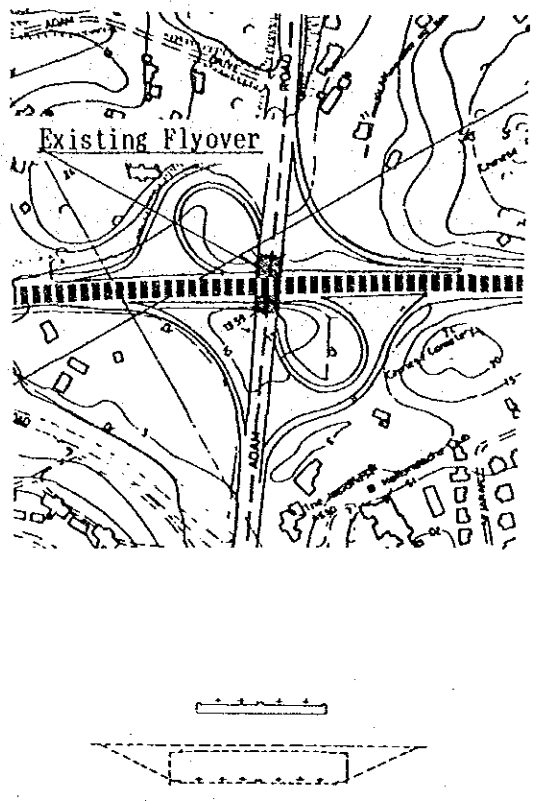
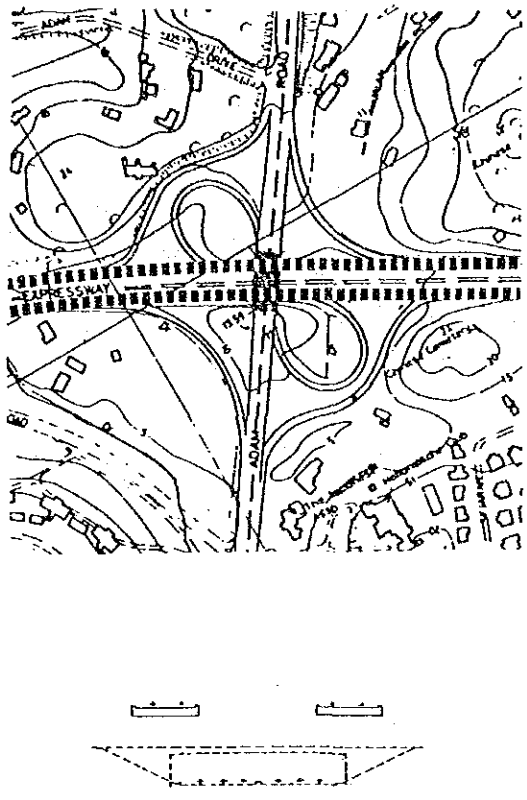
Toa Payoh Flyover

	Additional 4 lanes at only one side of the existing expressway	Widening of 1 lane at both sides of the existing expressway
Sketch	 	 
Traffic Management	-Keeping 4 lanes for the expressway will be possible during substructure construction. -Traffic on the expressway will be stopped during the demolition of existing bridge. -Traffic for the ramp can be kept by constructing a temporary bridge. -Additional 4 lanes at only one side of the existing expressway is impossible if the width is not enough	-Keeping 4 lanes for the expressway will be possible during substructure construction. -Traffic on the expressway will be stopped during the demolition of existing bridge. -Traffic for the ramp can be kept by constructing a temporary bridge. ○
Construc-tion	-All structure will be reconstructed. -A good protection on the expressway during the demolition and construction. -Construction in the canal will not be easy. △	-All structure will be reconstructed. -A good protection on the expressway will be needed during the demolition and construction of bridge -Construction in the canal will not be easy. △

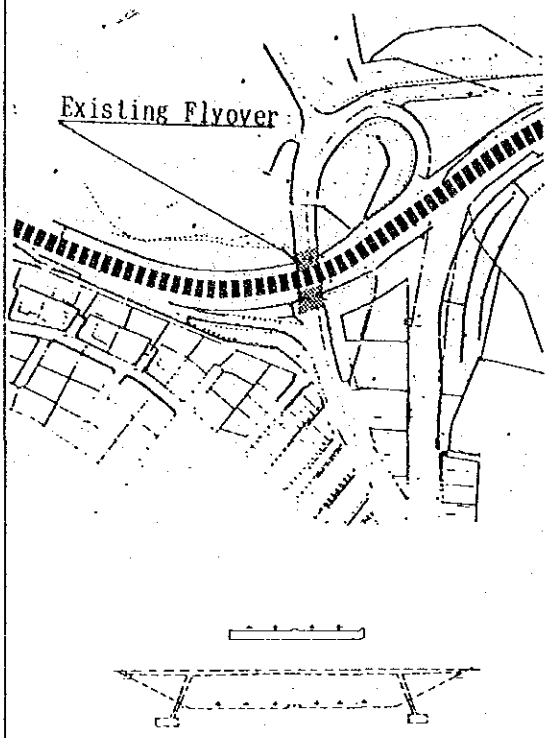
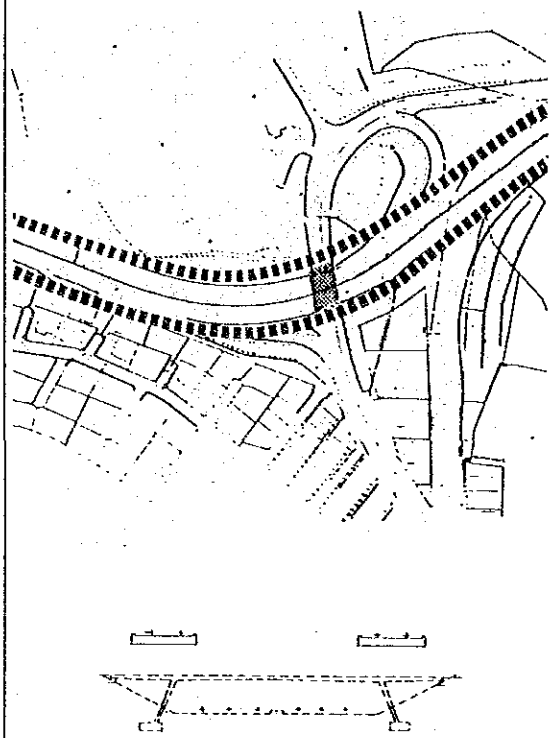
Eng Neo Flyover

	Construction of new viaduct with 4 lanes in the center of the existing expressway	Construction of new 2 lanes viaduct at the both sides of the existing expressway
Sketch		
Traffic Management	-Keeping 4 lanes for the expressway will be possible. -Keeping the existing cross road condition will be possible. -The expressway will not have a good horizontal alignment when the piers are costructed in the middle of the expressway.	-Keeping 6 lanes for the expressway may be possible. -Keeping the existing cross road condition will be possible. ○
Construc-tion	-Construction will not be easy in the middle of the expressway. -No influence on cross road.	-Construction will be easy. -No influence on the expressway and cross road. ○

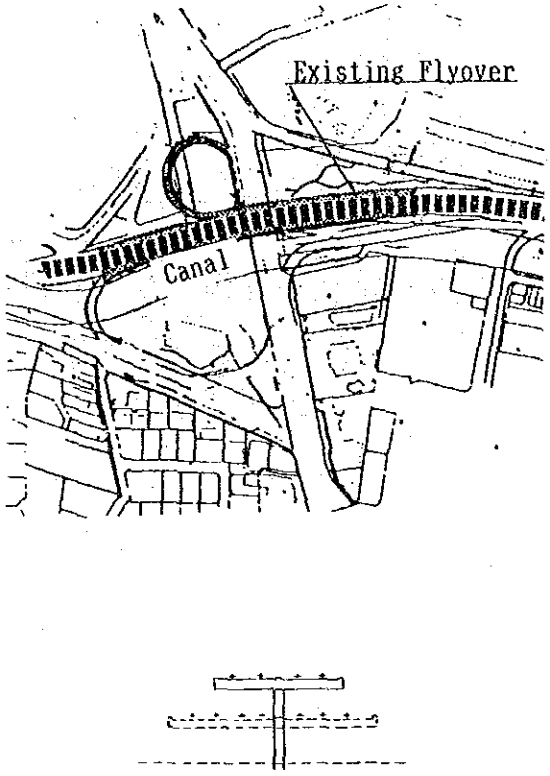
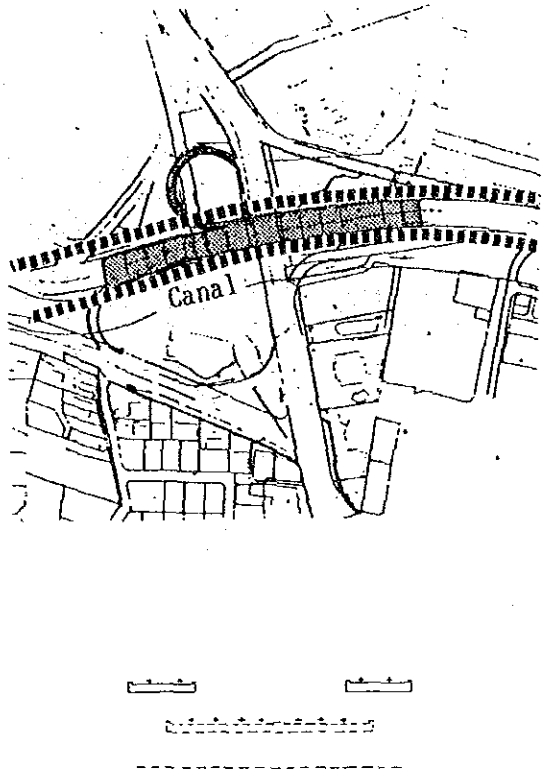
Adam Flyover

	Construction of new viaduct with 4 lanes in the center of the existing expressway	Construction of new 2 lanes viaduct at the both sides of the existing expressway
Sketch		
Traffic Management	-Keeping 4 lanes for the expressway will be possible. -Keeping the existing cross road condition will be possible. -The expressway will not have a good horizontal alignment when the piers are costructed in the middle of the expressway.	-Keeping 6 lanes for the expressway may be possible. -Keeping the existing cross road condition will be possible. ○
Construc-tion	-Construction will not be easy in the middle of the expressway. -No influence on cross road.	-Construction will be easy. -No influence on the expressway and cross road. ○

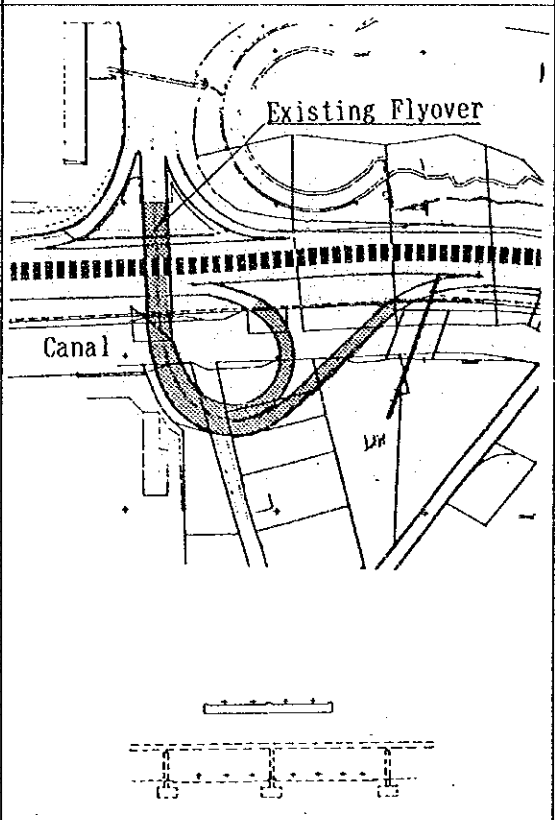
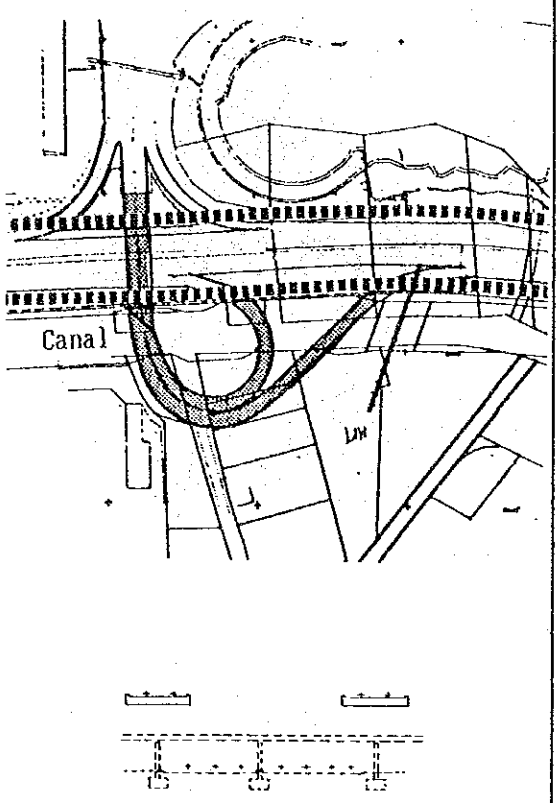
Mount Pleasant

	Construction of new viaduct with 4 lanes in the center of the existing expressway	Construction of new 2 lanes viaduct at the both sides of the existing expressway
Sketch		
Traffic Management	-Keeping 4 lanes for the expresssway will be possible. -No influence on cross road. -The expressway will not have a good horizontal alignment when the piers are costructed in the middle of the expressway.	-Keeping 6 lanes for the expressway may be possible. -Keeping the existing cross road condition will be possible. ○
Construc-tion	-Construction will not be easy in the middle of the expressway. -No influence on cross road.	-Construction will be easy. -No influence on the expressway and cross road. ○

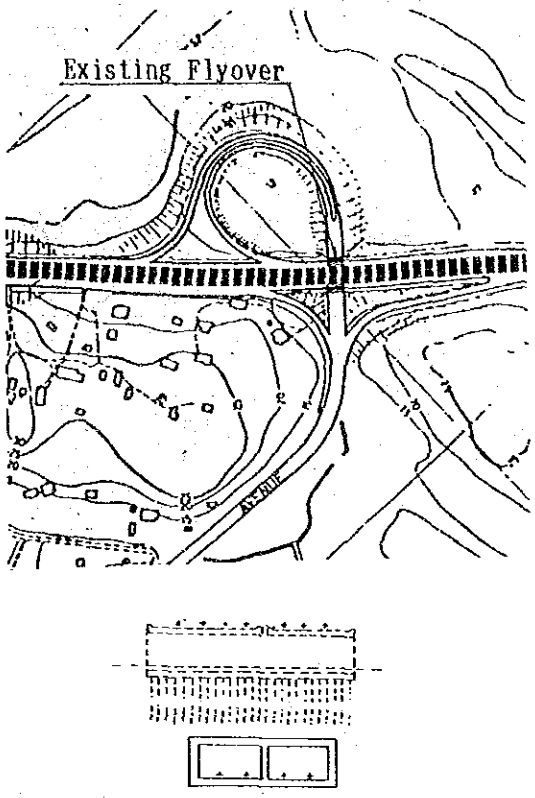
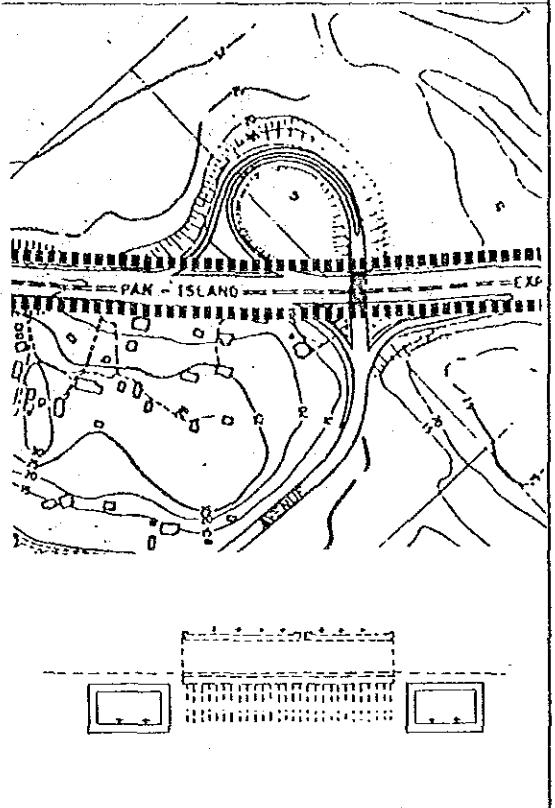
Thomson Flyover

	Construction of new viaduct with 4 lanes in the center of the existing expressway	Construction of new 2 lanes viaduct at the both sides of the existing expressway
Sketch		
Traffic Management		-Keeping 6 lanes for the expressway may be possible. -Keeping the existing cross road condition will be possible. ○
Construc-tion	-Construction will be impossible.	-Construction will be easy at the north side, but will not be easy for the canal at the south side. -No influence on the expressway and cross road. ○

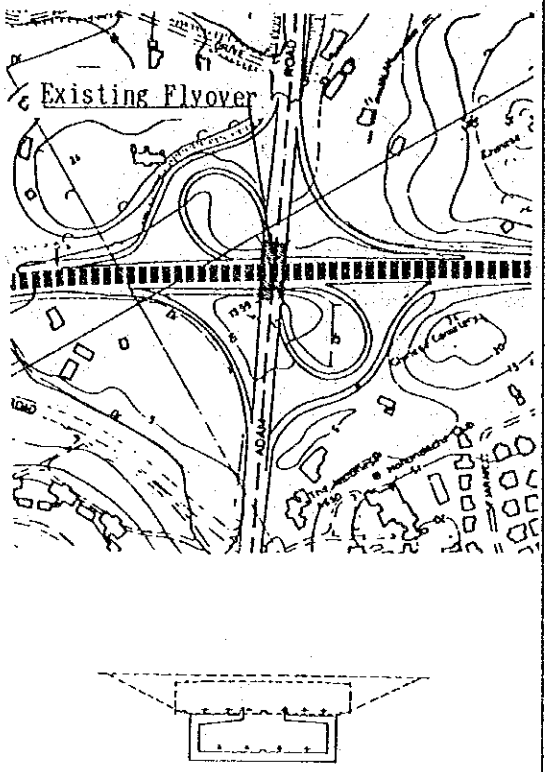
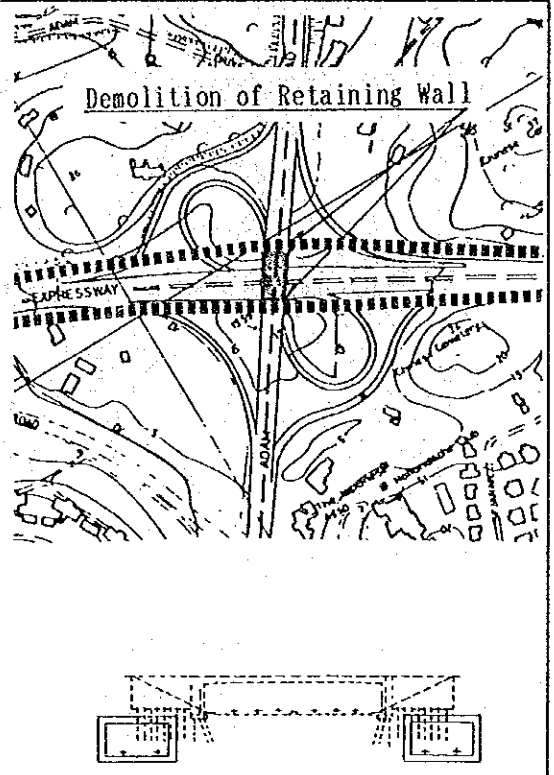
Toa Payoh Flyover

	Construction of new viaduct with 4 lanes in the center of the existing expressway	Construction of new 2 lanes viaduct at the both sides of the existing expressway
Sketch		
Traffic Management	-Keeping 4 lanes for the expressway will be possible. -Keeping the existing cross road condition will be possible. -The expressway will not have a good horizontal alignment when the piers are constructed in the middle of the expressway.	-Keeping 6 lanes for the expressway will be possible. -Keeping the existing cross road condition will be possible. ○
Construc-tion	-Construction will not be easy in the middle of the expressway. -No influence on cross road.	-Construction will be easy. -No influence on the expressway and cross road. ○

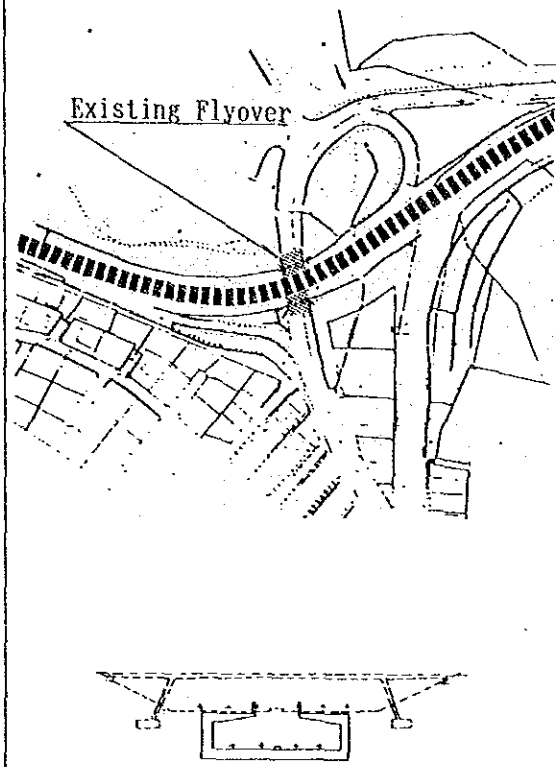
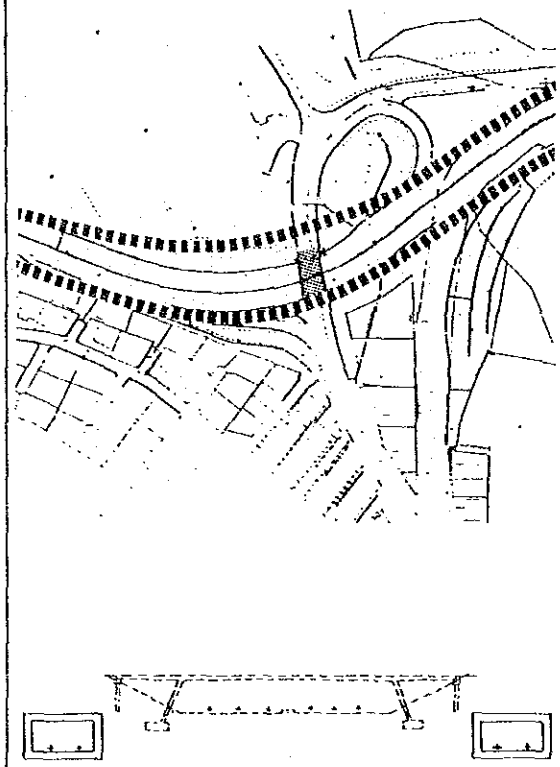
Eng Neo Flyover

	Construction of new 4 lanes semi-coverd depressed type in the center and under the existing expressway	Construction of new 2 lanes semi-coverd depressed type at each side of the existing expressway
Sketch		
Traffic Management	-Keeping 6 lanes for the expressway will be possible. -Keeping the existing cross road condition will be possible.	-Keeping 6 lanes for the expressway may be possible. -Cross road will either be managed by keeping half of the width of existing road or by stopping for a short period. ○
Construc-tion	-Construction may be very difficult under the pile foundation. (Under-pinning, freezing method, etc, is necessary) -No influence on cross road.	-Construction will be easy. -No influence on the expressway. ○

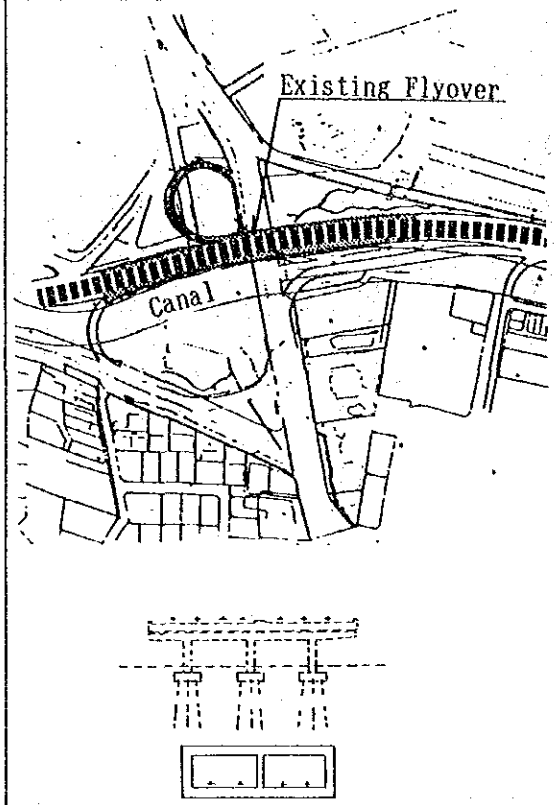
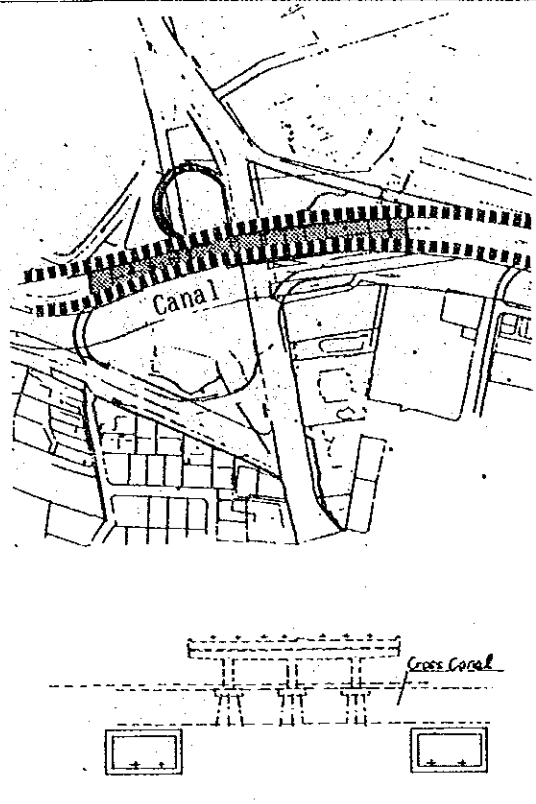
Adam Flyover

	Construction of new 4 lanes semi-coverd depressed type in the center and under the existing expressway	Construction of new 2 lanes semi-coverd depressed type at each side of the existing expressway
Sketch		
Traffic Management	-Keeping 3 lanes for the expressway will be possible. -Keeping the existing cross road codition will be possible.	-Keeping 6 lanes for the expressway will be possible. -Cross road will either be managed by keeping half of the width of existing road for a short period or by providing a emporary bridge. ○
Construc-tion	-Construction will be difficult under the existing bridge. -No influence on cross road.	-Construction will not be easy. -No influence on the expressway. ○

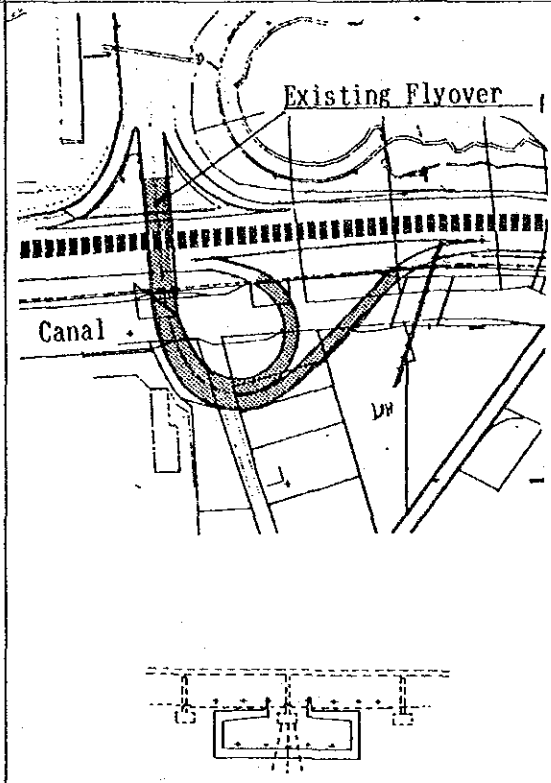
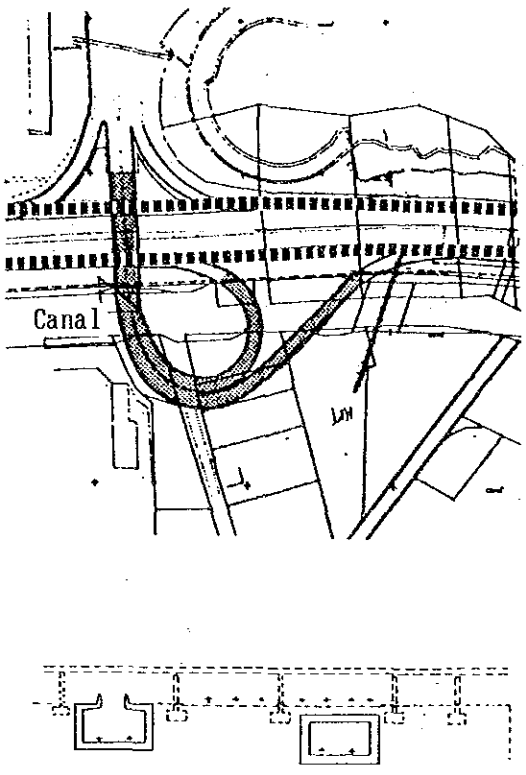
Mount Pleasant Flyover

	Construction of new 4 lanes semi-coverd depressed type in the center and under the existing expressway	Construction of new 2 lanes semi-coverd depressed type at each side of the existing expressway
Sketch		
Traffic Management	-Keeping 3 lanes for the expressway will be possible. -Keeping the existing cross road condition will be possible.	-Keeping 6 lanes for the expressway will be possible. -Cross road will either be managed by keeping half of the width of existing road for a short period or by providing a temporary bridge. ○
Construc-tion	-Construction will be difficult under the existing bridge. -No influence on cross road.	-Construction will not be easy. -No influence on the expressway. ○

Thomson Flyover

	Construction of new 4 lanes semi-coverd depressed type in the center and under the existing expressway	Construction of new 2 lanes semi-coverd depressed type at each side of the existing expressway
Sketch		
Traffic Management	-Keeping 6 lanes for the expressway will be possible. -Keeping the existing cross road condition will be possible.	-Keeping 6 lanes for the expressway will be possible. ○
Construc-tion	-Construction may be very difficult under the pile foundation. (Under-pinning, freezing method, etc, is necessary) ×	-Construction may be very difficult for new structure under the canal. ×

Toa Payoh Flyover

	Construction of new 4 lanes semi-coverd depressed type in the center and under the existing expressway	Construction of new 2 lanes semi-coverd depressed type at each side of the existing expressway
Sketch		
Traffic Management	-Keeping 3 lanes for the expressway will be possible. -Traffic on the expressway will be stopped during the demolition of existing bridge. -Traffic for the ramp can be kept by constructing a temporary bridge.	-Keeping 3 lanes for the expressway will be possible. -Keeping the existing cross road condition will be possible. ○
Construc-tion	-All structure may be reconstructed. -Construction will not be easy.	-Construction will not be easy under the bridge and near the piers. -No influence on cross road. ○

APPENDIX 8

Appendix 8.1 MR8.3 : Examination construction procedure on the PIE section

Subject: Alternative study in structural aspect on the PIE section

Construction procedure and scale of civil works have been studied through examining the structural viability.

Construction procedure applied in Alternatives is listed in Table A with the remarks on each Alternative. Scale of civil works has been approximated as shown in the plan reductions on Table B-1,B-2. Therein scale and methods of civil works are outlined with comments for each Alternative and location in accordance with Alternative Evaluation Criteria.

Characteristics of selected two Alternatives have been roughly drawn as described in the following.

Alternative I (same grade widening)

Negative:
- One lane out of 3 lanes is occupied by widening work.
- Widening work influences for long distance and continuously to the existing PIE under service.
- Median relocation is required on some sections.
- Pedestrian bridge (2) is to be demolished.
- Right of Way enlarges.

Positive:
- Economical alternative.
- The present accustomed view will be conserved.

Alternative IV(grade separation along PIE)

Negative:
- Partial friction to outer lane traffic on PIE.
- Bridge work predominates with costly result.
- Merging section to PIE requires the wider Right of way.
- Drastic change in landscape will take place.

Positive:
- Carriageway of existing PIE is serviceable during construction works except for the Merging section.
- A chance is reserved to widen the PIE carriageway in future.

In view of structural viability, the above two Alternatives are still competitive each other. Briefing the comparison, the latter plan seems inferior to the former in economy and conventional construction method.

Attachment: Table A-1,2,3 Construction Work Item
Table B-1,2 Construction Working Procedure
Table C-1,2,3,4 Evaluation on Construction Aspect

Table A-1 Construction Work Item

Main work item		Alternative I (partly II) Widening at the same grade as the existing PIE				Alternative IV Widening of grade separation from the existing PIE			
		Thomson I/C	Thomson to Toa Payoh	Toa Payoh I/C	Toa Payoh to Kim Keat	Thomson I/C	Thomson to Toa Payoh	Toa Payoh I/C	Merging between Toa Payoh/Kim Keat
Road Work	Site access road	–	–	–	○	–	○	○	○
	Traffic detour	○	–	○	–	–	–	–	–
	Rampway relocation	○	–	○	–	–	–	–	–
	Earth cut/Embankment	○	○	○	○	–	–	–	○
	Subgrade/Pavement	○	○	○	○	–	–	–	○
	Median relocation	○	○	–	–	–	–	–	–
Structural Work	Demolition	○	○	○	○	–	–	–	–
	Structure excavation	○	–	○	–	○	○	○	○
	Pile driving	○	–	○	–	○	○	○	○
	Retaining wall	○	–	○	○	–	–	–	○
	Box culvert	–	–	–	–	–	–	–	–
	Bridge pier/Erection	○	–	○	–	○	○	○	○
	Other specific work	-Demolition of rampway viaduct -Protection over Thomson Road	-Demolition of pedestrian bridge	-Overbridge demolition -Long span curved girder over canal -MRT close boring -Soil stabilize	-Demolition of pedestrian bridge	-Long span girder -Large diameter boring(RCD) -Protection over PIE traffic	-None	-Long span curved girder -MRT close boring -Soil stabilize	-*Long span s-curved* girder -Protection over PIE traffic
Remarks		- Road work predominates, so economical. - Median relocation requires carefull traffic control. - Demolition work generates noise.				- Bridge work predominates, so costly. - Site access roads are necessary. - Pile driving generates noise.			

Table A-2 Construction Work Item

Main work item		Alternative I (partly II) Widening of the same grade as the existing PIE						
		Bukit Timah to Eng Neo	Eng Neo I/C	Eng Neo to Adam Road	Adam I/C	Adam Road to Mount Pleasant	Mount Pleasant I/C	Mount Pleasant to Thomson
Road Work	Site access road	–	–	–	–	–	–	–
	Traffic detour	–	–	–	○	–	–	–
	Rampway relocation	–	○	–	○	–	○	–
	Earth cut/Embankment	○	○	○	○	○	○	○
	Subgrade/Pavement	○	○	○	○	○	○	○
	Median relocation	○	–	○	○	–	○	○
Structural Work	Demolition	–	○	–	○	–	–	○
	Structure excavation	–	○	○	○	○	○	○
	Pile driving	–	○	–	○	○	○	–
	Retaining wall	–	○	○	○	○	○	○
	Box culvert	–	–	–	○	–	○	–
	Bridge pier/Erection	–	○	–	–	○	–	–
	Other specific work	-None	- Protection over Eng Neo Avenue	-None	-Demolition of retaining wall and pile -Unified box culvert with overbridge	-None	-None	-Demolition of pedestrian bridge
Remarks		- Road work predominates. - Median relocation requires carefull traffic control. - Demolition work generates noise. - Demolition, gider widening and unifying work are close works to the existing structure and traffic.						

Table A-3 Construction Work Item

Main work item		Alternative IV Widening of grade separation from the existing PIE						
		Merging Alternative between Bukit Timah and Eng Neo	Eng Neo I/C	Eng Neo to Adam Road	Adam I/C	Adam Road to Mount Pleasant	Mount Pleasant I/C	Mount Pleasant to Thomson	Merging Alternative between Mount Pleasant and Thomson
Road Work	Site access road	○	○	○	○	○	○	○	○
	Traffic detour	○	–	–	–	–	–	–	○
	Rampway relocation	–	–	–	–	–	–	–	–
	Earth cut/Embankment	○	–	–	–	–	–	–	○
	Subgrade/Pavement	○	–	–	–	–	–	–	○
	Median relocation	–	–	–	–	–	–	–	–
Structural Work	Demolition	–	–	–	–	–	–	–	–
	Structure excavation	○	○	○	○	○	○	○	○
	Pile driving	○	○	○	○	○	○	○	○
	Retaining wall	○	–	–	–	–	–	–	○
	Box culvert	–	–	–	–	–	–	–	–
	Bridge pier/Erection	○	○	○	○	○	○	○	○
	Other specific work	-Protection over PIE traffic -Cast-in-situ 3 span continuous PC girder	-None	-None	-None	-None	-Protection over PIE traffic	-None	-Protection over PIE traffic -Cast-in-situ 3 span continuous PC girder
Remarks		- Bridge work predominates. - Site access roads are necessary. - Merging section requires wide swell of the Right of Way of PIE. - In the Merging section prestressing girder work of cast-in-situ is required.							

Table B-1 Construction Working Procedure (Thomson ~ Kim Keat Link)

	Thomson Interchange	Thomson~Toa Payoh	Toa Payoh Interchange	Toa Payoh~Kim Keat
At grade Widening	1.Widening of at-grade highway section on the north side. 2.Construction of rampway. 3.Switching of rampway traffic. 4.Demolition of existing rampway viaduct. 5.Foundation and pier for widening flyover of PIE. 6.Gider erection work by crane for 4 lanes viaduct. 7.Bridge surfacing. 8.Median shifting.	1.Widening of at-grade highway section on both sides. 2.Demolition of pedestrian bridge. 3.Median shifting. 4.Roadway surfacing.	1.Widening of at-grade highway section on both sides 2.Construction of rampway viaduct 3.Soil stabilization for foundation work close to MRT tunnel 4.Precast pile installation in bored hole for viaduct foundation. 5.Demolition of overbridge 6.Reconstruction of overbridge 7.Switching of rampway traffic 8.Demolition of existing rampway viaduct 9.Median shifting 10.Roadway surfacing	1.Widening at-grade highway section on both sides. 2.Demolition of pedestrian bridge. 3.Surfacing for demolished ground.
Viaduct Alternative	1.Foundation work(RCD pile) for viaducts 2.Sheeting and structural excavation for piers 3.Pier building and backfilling 4.Girder erection by crane 5.Bridge surfacing and railing 6.Cast-in-situ PC 3 span continuous girder by bent support	1.Access road preparation. 2.Pile driving for pier foundation. 3.Sheeting and structural excavation for piers. 4.Pier building and backfilling. 5.Protection for traffic under road 6.Girder erection by crane. 7.Bridge surfacing and railing.	1.Access road preparation. 2.Clearing and leveling site. 3.Soil stabilization for foundation work close to MRT tunnel. 4.Precast pile installation in bored hole for viaduct foundation. 5.Sheeting and structural excavation for piers. 6.Pier building and backfilling. 7.Protection for traffic under road 8.Girder erection by crane. 9.Cast-in-situ PC 3 span continuous girder by bent support.	1.Access road preparation. 2.Widening of at-grade highway section on both sides. 3.Diverging of PIE traffic. 4.Pile driving for pier foundation. 5.Sheeting and structural excavation for piers. 6.Pier building and backfilling. 7.Retaining wall for viaduct approach. 8.Girder erection by crane. 9.Cast-in-situ PC continuous girder by bent support and prestressing. 10.Bridge surfacing and railing. 11.Roadway surfacing.

Table B-2 Construction Working Procedure(Bukit Timah ~ Thomson)

	Bukit Timah ~ Eng Neo	Eng Neo Interchange	Eng Neo ~ Adam	Adam Interchange
At grade Widening	1.Widening of at-grade highway section on both sides or on the north sides in part. 2.Roadway surfacing. 3.Median shifting.	1.Widening of at-grade highway section on both sides. 2.Construction of rampway traffic. 3.Switching of rampway traffic. 4.Sheeting for demolition of abutment. 5.Demolition of wings. 6.Demolition of bridge railing. 7.Pile driving for abutment widening 8.Building of abutment wing and back-filling. 9.Girder erection for widening lanes 10.Bridge surfacing and railing.	1.Widening of at-grade highway section on both sides. 2.Earth cut and retaining wall. 3.Roadway surfacing. 4.Median shifting.	1.Construction of rampway. 2.Sheeting and covering Adam Road. 3.Demolition of retaining wall on piles. 4.Structural excavation for Box culvert. 5.Cutting off the buried piles. 6.Pile driving and building the Box culvert. 7.Filling and pavement above the Box culvert. 8.Switching of rampway traffic. 9.Widening of at-grade highway section on the south side.(Grubbing and Earth cut) 10.Road surfacing of widened lanes and rampway. 11.Median shifting. 12.Demolition of abandoned rampway.
Viaduct Alternative	As for Merging Alternative. 1.Access road preparation. 2.Widening of at-grade highway section on both sides. 3.Diverging of PIE traffic. 4.Pile driving for pier foundation. 5.Sheeting and structural excavation for piers. 6.Pier building and backfilling. 7.Retaining wall for viaduct approa-ch. 8.Girder erection by crane. 9.Cast-in-situ PC continuous girder by bent support and prestressing. 10.Bridge surfacing and railing. 11.Roadway surfacing.	1.Access road preparation. 2.Pile driving for pier foundation. 3.Sheeting and structural excavation for piers. 4.Pier building and backfilling. 5.Girder erection by crane. 6.Bridge surfacing and railing.	1.Access road preparation. 2.Pile driving for pier foundation. 3.Sheeting and structural excavation for piers. 4.Pier building and backfilling. 5.Girder erection by crane. 6.Bridge surfacing and railing.	1.Access road preparation. 2.Pile driving for pier foundation. 3.Sheeting and structural excavation for piers. 4.Pier building and backfilling. 5.Girder erection by crane. 6.Bridge surfacing and railing.

Table B-2 Continued

	Adam ~ Mount Pleasant	Mount Pleasant Interchange	Mount Pleasant ~ Thomson
At grade Widening	1.Widening of at-grade highway section on both sides. 2.Earth cut and retaining wall. 3.Bridge widening at Kheam Hock Road 4.Roadway surfacing.	1.Widening of at-grade highway section on the north side.(Grubbing and Earth cut) 2.Construction of rampway. 3.Sheeting and covering Mount Pleasa-nt Road. 4.Structural excavation for Box culvert. 5.Building the box culvert. 6.Filling and pavement above the box culvert. 7.Road surfacing of widened lanes and rampway. 8.Switching of rampway traffic. 9.Demolition of abandoned rampway and planting. 10.Median shifting.	1.Widening of at-grade highway section on the north side. 2.Earth cut and retaining wall. 3.Demolition of pedestrian bridge. 4.Road surfacing. 5.Meadian shifting.
Viaduct Alternative	1.Access road preparation. 2.Pile driving for pier foundation. 3.Sheeting and structural excavation for piers. 4.Pier building and backfilling. 5.Girder erection by crane. 6.Bridge surfacing and railing.	1.Access road preparation. 2.Pile driving for pier foundation. 3.Sheeting and structural excavation for piers. 4.Pier building and backfilling. 5.Girder erection by crane. 6.Bridge surfacing and railing.	As for Merging Alternative 1.Access road preparation. 2.Widening of at-grade highway section on both sides. 3.Diverging of PIE traffic. 4.Pile driving for pier foundation. 5.Sheeting and structural excavation for piers. 6.Pier building and backfilling. 7.Retaining wall for viaduct approach. 8.Girder erection by crane. 9.Cast-in-situ PC continuous girder by bent support and prestressing. 10.Bridge surfacing and railing. 11.Roadway surfacing. * Viaduct section is almost the same as the other location.

Table C-1 Evaluation on Construction Aspect for Alternative Alternative I

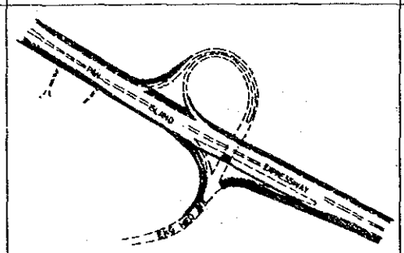
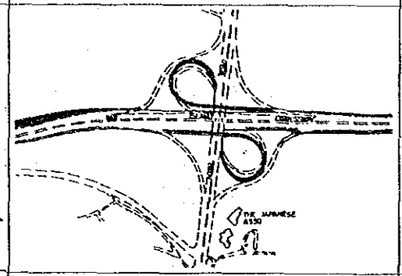
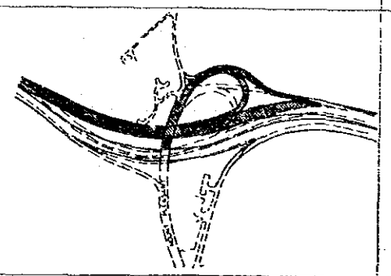
PERIOD	I T E M		EVALUATION	Bukit Timah IC~Eng Neo IC, Eng Neo IC~Adam IC Adam IC~Mt. Pleasant IC, Mt. Pleasant~Thomson IC	Eng Neo Interchange	Adam Interchange	Mount Pleasant Interchange	Comment
ALTERNATIVE I	Widening at the same grade as the existing PIE by 4 lanes to the north side at Mt.Pleasant IC 4 lanes to the south side at Adam IC 1 lane each to both sides at Eng Neo IC							
UNDER CONSTRUCTION	Traffic management	Capacity	Construction space	Demolitoin work of pedestrian bridge requires one-way closed in one night. Outer lanes of PIE is occupied by widening work at both sides.	Carrigeway's width is narrow about 1m due to railing demolition.	Outer lanes of PIE is occupied by widening work at both sides.Adam Road is to be closed of one way during pile driving.	Lane width 3.6m reduces 3.0m during meadian shifting.	
			Working hour	To avoid traffic congestion in the day,hauling materials should be performed in the night.	Usualy daytime. At the case of girder erection by crane, Eng Neo Ave. is required to close in the night.	All day working for widening of PIE.	Hauling materials should be performed in the night to avoid traffic congection in busy daytime. Loop	
	Construction	Construction technic	Safety & Security	Traffic control during widening work to prevent accident is necessary.	Protection for ENA during demolition work of railing and substructure.Safety equipment along PIE is required during construction.	Not in paticular.	Not in paticular.	
			Difficulty	Not in particular.	Not in particular.	Demolition work of retaining wall within sheeted hollow place.A box culvert is to form in unified structural with existing abutment.	Abutment of overbridge shall be supported during excavation work of adjacent box culvert.	
		Construction period	Construction method	Earth work, Pavement work, Median relocation, Cut and lifting for demolition of pedestrian bridge,Bridge widening..	Sheeting,Demolition,Pile driving,Abutment and wing building,Girder erection by crane,Earth work,Surfacing,Pavement,etc.	Road earthwork, Pile driving, Sheeting, Demolition ,excavation, Box culvert building, Pavement.	Earth work,Pile driving,Platform building,Box culvert building,Pavement,Road surfacing,Median sifting.	
			Site condition	Culvert canal locates pralel to the north side along PIE. Residence nearby in places.	Few residence nearby.	Hilly site with Chinise Cemetery located walry and Japanese Association.	Condominium locates nearby.	
			Construction period					
	Environment Impact	Noise & Vibration	Construction equipment	Cutting equipment to demolish pedestrian bridge. Breaker for concrete demolition,Pile driving.	Vibro-penetrating machine for sheetpiling,Breaker for concrete demolition,Pile driving machine.	Bulldozer, Backhoe, Diesel hamaer for piling,Dump truk, Trailor, Breaker, Crane, Concrete pump truk, Generator, Pump, Vibrator, Vibro-hammer.	Excavation equipment,Dump truks,Trailors,Pile driving machine,Crane to lift re-bars,Road roller,etc.	
			Working hour	Hauling materials in the night.Demolition of pedestrian bridge in one night. Girder erection by crane in the night.	Hauling materials and girder by trailor in the night. Demolition work in the daytime for a few weeks .	Hauling materials by trailor and concrete placing are done in the night.	Hauling materials and concrete casting,pavement are to be done in the night.	
	Initial	Land acquisition & Compensation	Cost estimate	Catholic Junior College. A few residences.		The Japanese Association		
		Construction	Cost estimate					
ACROUNCTEST IO	Maintenace Cost	Ventilation	Cost estimate					
		Drainage	Cost estimate					
	Environment Impact	Aesthetic		nearly same as present.	nearly same as present.			

Table C-3 Evaluation on Construction Aspect for Alternative IV

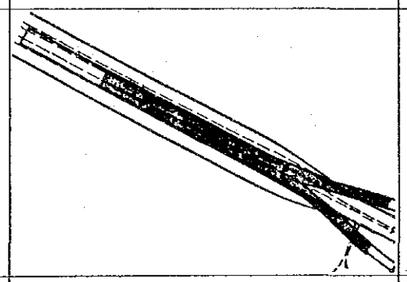
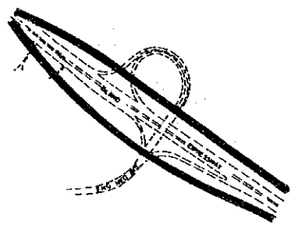
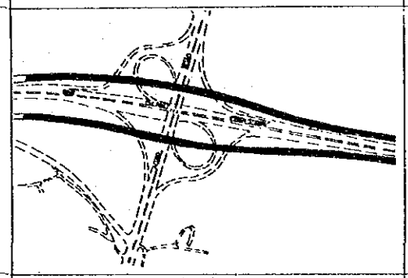
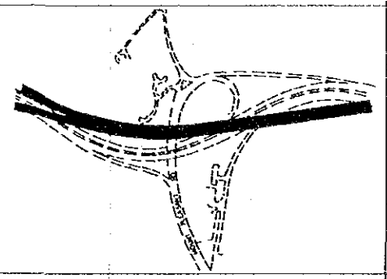
PERIOD	ITEM		EVALUATION ITEM	Merging	Eng Neo Interchange	Adam Interchange	Mount Pleasant Interchange	Comment
ALTERNATIVE IV	Widening by grade separation from the existing PIE through 2 lane 2 way separated viaducts.							
UNDER CONSTRUCTION	Traffic management	Capacity	Construction space	One of 3 lanes of PIE curves in small radius during road work and bridge building.	Construction space is available.	Shoulder belt way be occupied for construction at pier location.	A little effect to shoulder during excavation work for foundation. Inner lane is required to reduce during construction of pier on the median.	
			Working hour	Daytime, otherwise hauling materials in the night.	Usualy daytime. At the case of girder erection over Eng Neo Ave., the Ave. is required to close in the night.	Daytime only, otherwise hauling materials in the night.	Hauling and concrete placing shall be performed in the night to avoid traffic congestion.	
	Construction	Construction technic	Safety & Security	Protection is required for PIE during pier building and girder erection.	Not in particular.	Protection is required for PIE and rampway during pier bulding and girder erection.	Small curve and short sight-distance on PIE roadway requires effective guard railing and warning signs.	
			Difficulty	Long span bridge over PIE is required.	Not in particular.	Not in paticular.	Long span bridge over PIE is required.	
		Construction period	Construction method	Road earth work. Pile driving. Pier-building, PC box concreat casting, prestresting, etc.	Pile driving, Sheeting, Pier building, Girder erec-tion, Bridge surfacing, Pavement, etc.	Pile driving, Sheeting, Excavation, Casting RC concrete, Girder erection,	Pile driving, Sheet piling, Pier building, Girder erection by bent, Bridge surfacing, Protection works, Excavation and Filling.	
			Site condition	Some residences nearby.	Access road to the site is required. Some residence nearby.	Hilling site with Chinese Cenetary located nearby and Japanese Association.	Bukit Timah bound viaduct traverse close to condominium buildings. Condominium locates nearby constr-uction site.	
			Construction period					
	Environment Impact	Noise & Vibration	Construction equipment	Pile driving machine. Vibro-penetrating machine.	Pile driving machine, Vibro-penetrating machine.	Backhoe, Diesel hammer for piling, Damp truck, Crane, Concrete pump truck, Mixing truck, Generator, Pump, Vibrator, Vibro-hammer.	Pile driving machines, Vibro-penetrating machine, Excavation equipment, Crane.	
			Working hour	Daytime only.	Hauling materials and girder by trailor in the night.	Houling materials and concrete placing are done in the night.	Concrete placing goes night to use mixing truk and vibrator. Hauling materials in the night.	
	Initial	Land acquisition & Compensation	Cost estimate	A few residences.	Some residence is required to relocate.			
		Construction	Cost estimate					
AFTER CONSTRUCTION	Maintenace Cost	Ventilation	Cost estimate					
		Drainage	Cost estimate					
	Environment Impact	Aesthetic		Drastic change in view will take place.	Drastic change will take place.		Bukit Timah bound viaduct traverse close to condominium buildings.	

Table C-2 Evaluation on Construction Aspect for Alternative I

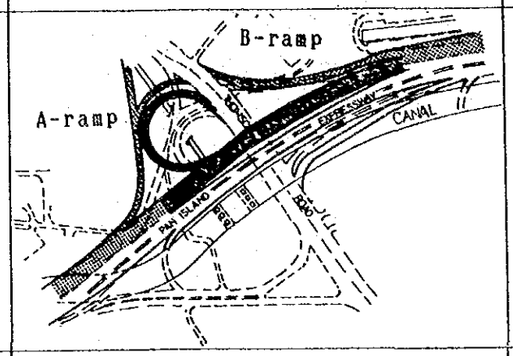
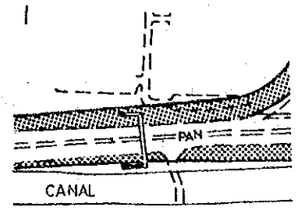
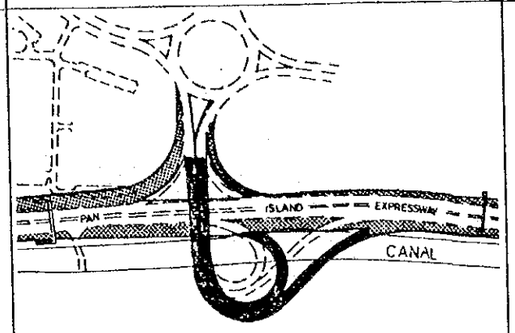
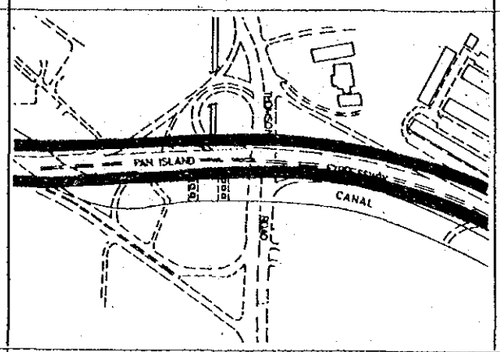
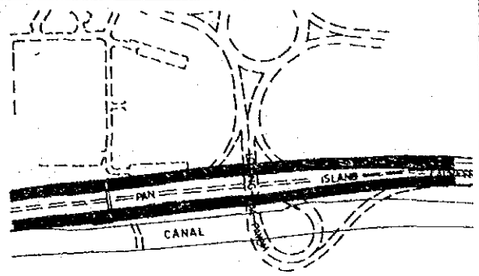
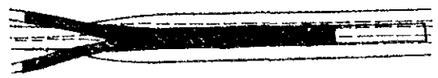
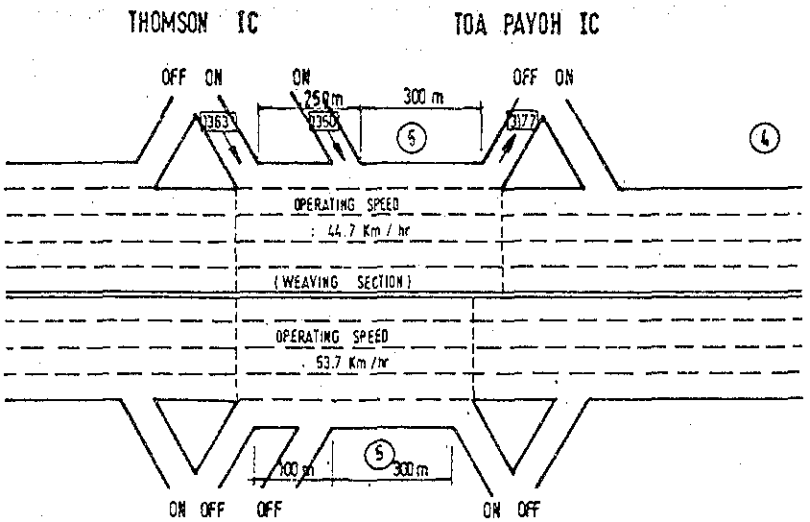
PERIOD	ITEM			Thomson Interchange	Thomson ~ Toa Payoh Toa Payoh~ Kim Keat	Toa Payoh Interchange	Comment
ALTERNATIVE I	Widening at the same grade as the existing PIE by 4 lanes to the north side at Thomson IC 1 lane each to both sides at Toa Payoh IC						
CONSTRUCTION UNDER	Traffic management	Capacity	Construction space	A-rampway traffic switch to B-ramp through signalized intersection.Outer lane of PIE bound for Changi is occupied by widening work.	Demolition of pedestrian bridge requires oneway closed in one night.Outer lanes of PIE is occupied by widening work at both sides.	Outer lanes of PIE is occupied by widening work at both sides. Traffic requires closing oneway by one -way during demolition of overbridge.	Carriageway reduces to 2 lanes per direction.
			Working hour	Girder erection over Thomson road should be perfor -med in the night by closing traffic.	To avoid traffic congestion in the day, hauling sh -ould be performed in the night.	To avoid traffic congestion hauling should be per -formed in the night.Demolition in the night.	Influential.
	Construction	Construction technic	Safety & Security	Girder erection work and demolition of existing rampway structures require caution.	Traffic control during widening work to prevent accidents is necessary.	Protection for PIE during reconstruction work of overbridge.	Influential.
			Difficulty	Demolition work adjacent to PIE main structures require careful handling.	Not in particular.	Demolition works requires noise protection and waste dumping.Long span curved bridge over canal needs foundation close to MRT shielded tunnel.	Demolition work is influential.
		Construction period	Construction method	Pile driving,Excavation,Pier building,Road earthwo -rk,Girder errection by crane, Demolition,Bridge surfacing,Pavement,etc.	Earth work,Pavement work,Median relocation,Cut and lifting for demolition of pedestrain bridge.	Pile driving,Concrete cutting,Demolition and Erect -ion of overbridge,Soil stabilizing around shielde d tunnel.	Demolition work is influential.
			Site condition	Construction space is available. Residence and Po-lice Academy locate nearby, food center under the flyover.Condminium locates at the north-east.	Toa Payoh condminium at the north,Open canal along the south side.	Sun Yot Sen villa and a school locate at the south vicinity.Toa Payoh Gardens and condominium locate at the north vicinity.	
			Construction period				
	Environment Impact	Noise & Vibration	Construction equipment	Pile driving machine,Vibro-penetrating machine for sheet piling,Breaker for concrete demolition, and Cutter for re-bar,etc.	Cuttig equipment to demolish pedestrain bridge.	Pile driving machine,Cutting equipment to demolish concrete slab,Breaker for pier demolition.	Demolition work is influential.
			Working hour	Demolition work in the daytime for months. Pile driving in the daytime for 1 month.	Hauling in the mnight.Demolition of pedestrain bridge in one night.	Hauling materials and girders by trailor in the night. Demolition work in the night for 2 months.	Noise in the daytime.
	Initial	Land acquisition & Compensation	Cost estimate	Ground of Police Academy, Car park of condominium.	Toa Payoh Gardens pool, Athletic stadium.	School ground,Toa Payoh Gardens.	Public facilities.
		Construction	Cost estimate				Economic.
AFTER CONSTRUCTION	Maintenace Cost	Ventilation	Cost estimate				N.A.
		Drainage	Cost estimate				N.A.
	Environment Impact	Aesthetic		Dark space under PIE flyover deepend by widening and require skylight let in through the separation			Nearly same as present.

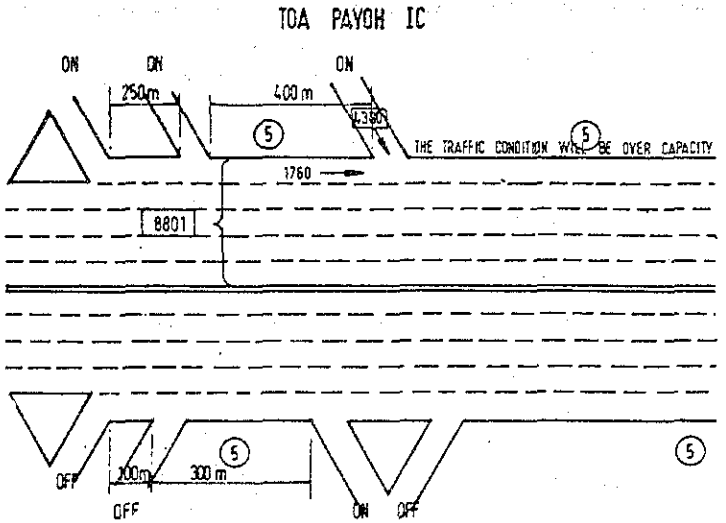
Table C－4 Alternative Ⅳ

PERIOD	I T E M		EVALUATION	Thomson Interchange	Toa Payoh Interchage	Merging between Toa Payoh and Kim Keat	Comment
ALTERNATIVE Ⅳ	Widening by grade separation from the existing PIE through 2 lane 2 way separated viaducts.						
UNDER CONSTRUCTION	Traffic management	Capacity	Construction space	Shoulder belt may be occupied for construction at pier location.	Shoulder belt may be occupied for construction at pier location.	One of 3 lanes of PIE curves in small radius during road work and bridge building.	Slightly got worse.
			Working hour	Daytime only, otherwise hauling materials in the night.	Daytime only,otherwise hauling materials in the night.	Daytime,otherwise hauling materials in the night.	Ordinary.
	Construction	Construction technic	Safety & Security	Protection is required over carriageways of PIE & rampway during superstructure construction.	Protection is required for PIE and rampway during pier building and girder erection.	Protection is required for PIE and rampway during pier building and girder erection.	Influential.
			Difficulty	Close boring adjacent to canal tunnel requires caution.Long span bridge over canal tunnel.	Long span bridge over the rampway and MRT is requred. Foundation construction close to MRT shielded tunnel.	Not in particular.	Influential.
		Construction period	Construction method	Large diameter R.C.D.foundation. Erecting girder method. Pier building.Road earthwork.Prestressing. Bridge surfacing. Pavement,etc.	Earth work for carriageway,Soil stabilizing,Pile driving,Pier building,Erecting girder method,etc.	Road earth work.Pile driving.Pier-building,PC box concreat casting,prestresting,etc.	Influential.
			Site condition	Construction space is available. Residence and Police Academy locate nearby, food center under the flyover.	Apartments are nearby.Construction performed at green belt at the north side of PIE,so Tree plant -ing and ditch need relocation.	Toa Payoh sports area at the north. Open canal along the south side.	
			Construction period				
	Environment Impact	Noise & Vibration	Construction equipment	Pile driving machine,Vibro-penetrating machine,and boring machine for Reverse Circulation Drill.	Pile driving machine,Vibro-penetrating machine,	Pile driving machine.Vibro-penetrating machine.	Ordinary.
			Working hour	Daytime only.	Daytime only.	Daytime only.	Ordinary.
	Initial Cost	Land acquisition & Compensation	Cost estimate		Access to working site occupies park area.	Access to working site pass through the Toa Payoh sports area.	Ordinary.
		Construction	Cost estimate				Costly.
AFTER CONSTRUCTION	Maintenace Cost	Ventilation	Cost estimate				N.A.
		Drainage	Cost estimate				N.A.
	Environment Impact	Aesthetic		Drastic change in view will take place.	Drastic change in view will take place.	Drastic change in view will take place.	Influential.

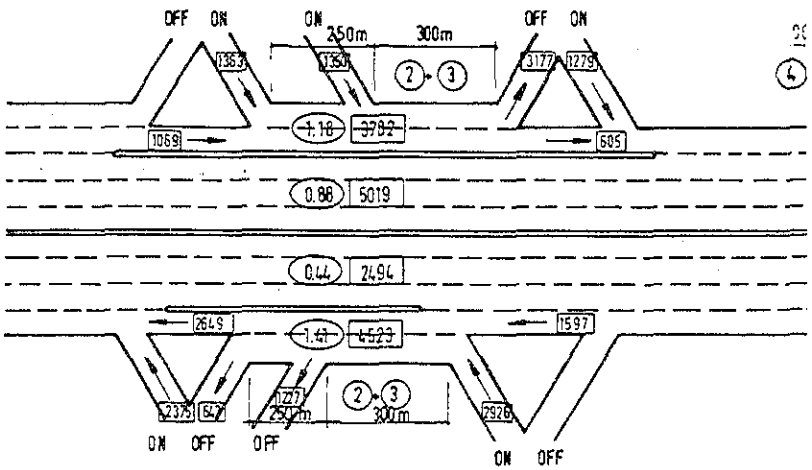
ALTERNATIVE I-1-a



ALTERNATIVE I-1-c



ALTERNATIVE I-1-b



ALTERNATIVE I-1-d

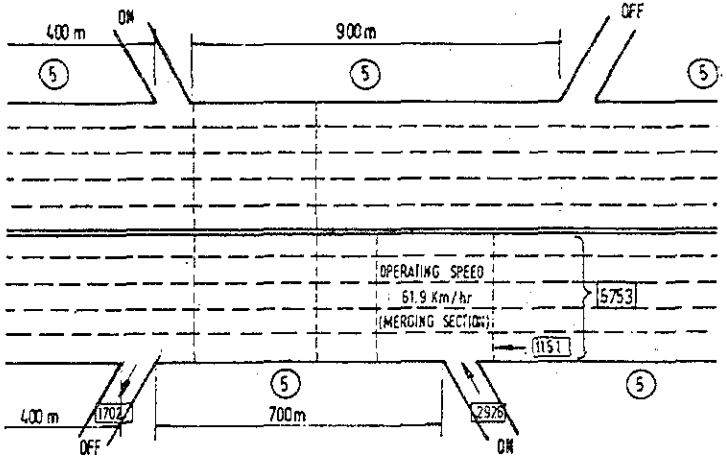
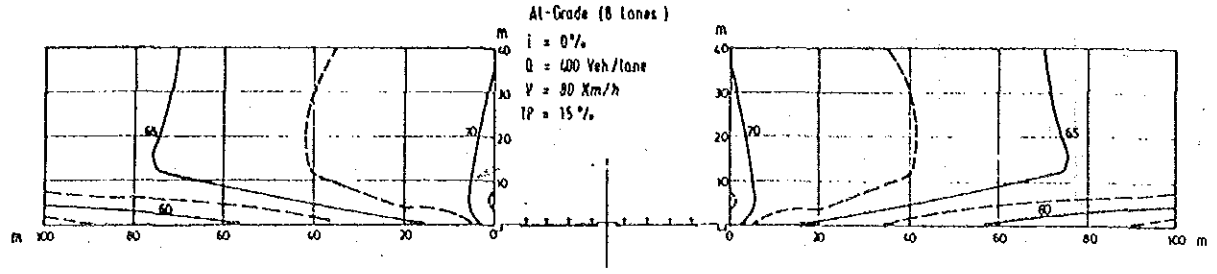


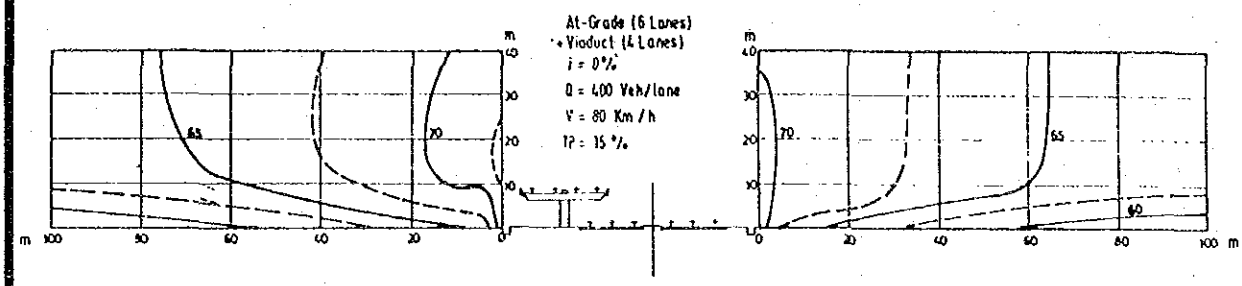
FIGURE 1

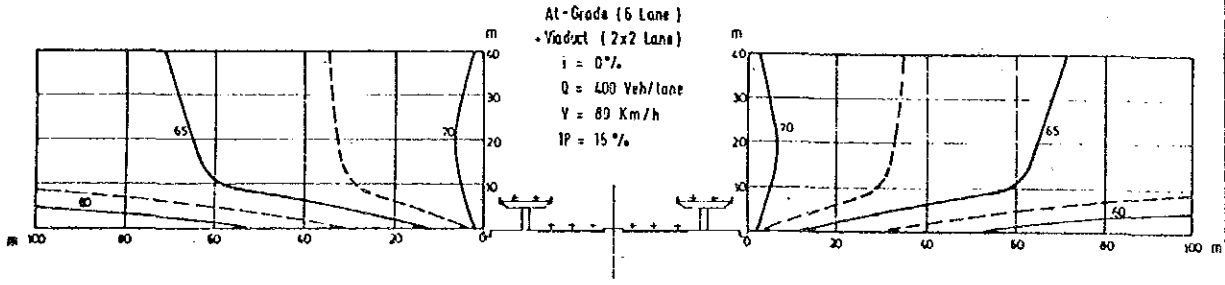
FIGURE 2

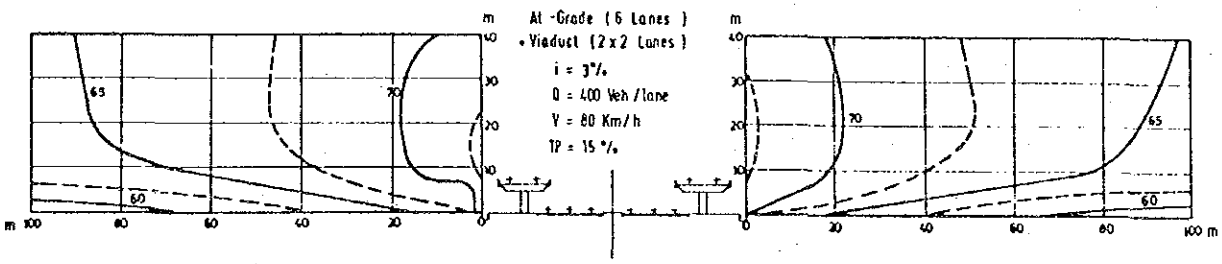
VOLUME (PCU/hr)
VOLUME / CAPACITY

Appendix 8.2 MR8.3 : Evaluation of traffic treatment on the PIE section from Thomson IC to Kim Keat Link

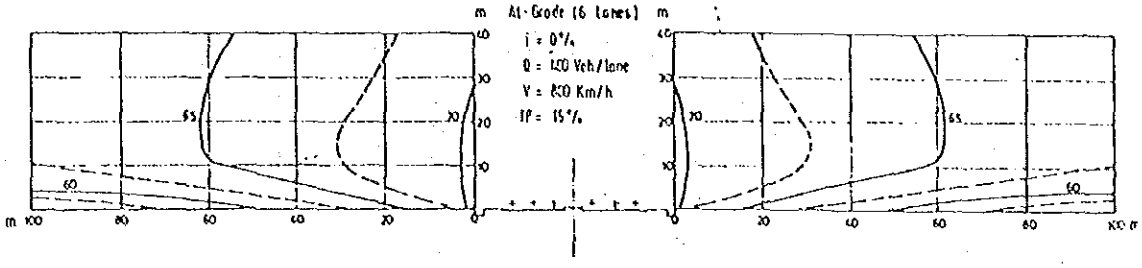


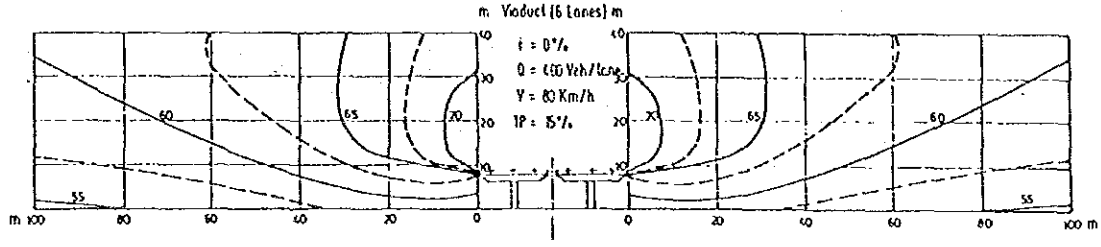


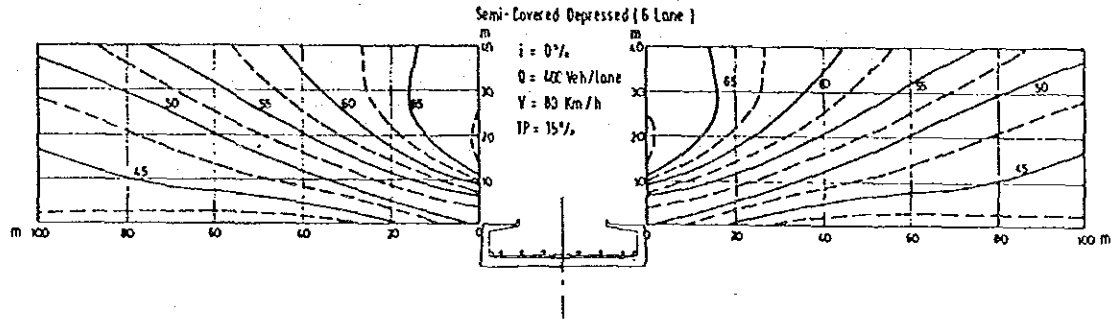


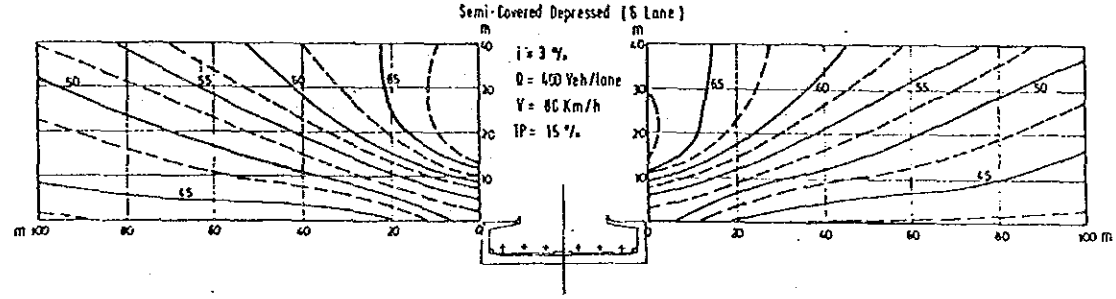


Appendix 8.3. MR8.3: Noise level of PIE under service









Appendix 8.3. MR8.3: Noise level of KLE and PYE under service

Appendix 8.4 MR8.3 : Evaluation of alternatives traffic aspect.

ALTERNATIVE I-1-c

	R = ∞ i = 4 %	R = 400 i = 4 %	R = 1200 i = 3 % TUNNEL	R = 2500 i = 3 %	R = 400 i = 3 %	R = ∞ i = 3 %	
Rsi	0	1	0	0	1	0	
Isi	1	1	0	0	0	0	
Tsi	0	1	1	0	0	0	
Rsi x Isi x Tsi	1	3	1	0	1	0	6

INDEX	1.00

ALTERNATIVE II-2-c

	R = ∞ i = 3 % TUNNEL	R = 800 i = 3 % TUNNEL	R = ∞ i = 8.5 % TUNNEL	R = 2500 i = 3 % TUNNEL	R = 400 i = 3 %	R = ∞ i = 0.3 %	
Rsi	0	0	0	0	1	0	
Isi	0	0	0	0	0	0	
Tsi	1	1	1	1	0	0	
Rsi x Isi x Tsi	1	1	1	1	1	0	5

INDEX	0.83

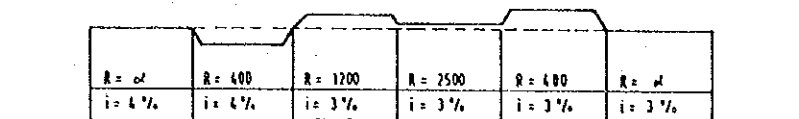
ALTERNATIVE III-1-a

	R = ∞ i = 3 %	R = 400 i = 0.3 %	R = 800 i = 0.3 %	R = 1200 i = 0.3 %	R = 1200 i = 0.3 %	R = 2500 i = 0.3 %	R = 400 i = 0.3 %	R = ∞ i = 0.3 %	
Rsi	0	1	0	0	0	0	2	0	
Isi	0	0	0	0	0	0	0	0	
Tsi	0	0	0	0	0	0	0	0	
Rsi x Isi x Tsi	0	1	0	0	0	0	1	0	2

INDEX	0.25

Appendix 8.4(1) INDEX VALUE OF EVALUATION ON TRAFFIC CAPACITY (KLE)

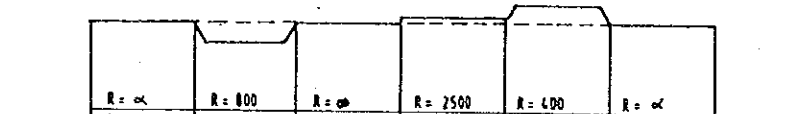
ALTERNATIVE I-1-c



	R = ∞ i = 4 %	R = 400 i = 4 %	R = 1200 i = 3 % TUNNEL	R = 2500 i = 3 %	R = 480 i = 3 %	R = ∞ i = 3 %	
Rsi	1.0	3.0	1.1	1.0	3.0	1.0	
Isi	2.2	2.2	1.8	1.8	1.8	1.8	
Tsi	1.0	1.4	1.4	1.0	1.0	1.0	
Rsi x Isi x Tsi	2.2	9.24	2.77	1.8	5.4	1.8	23.21

INDEX	3.87

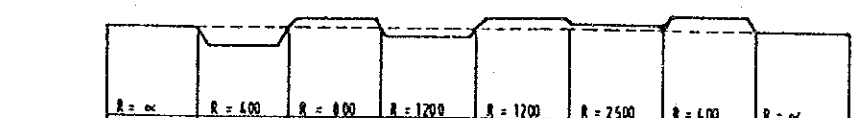
ALTERNATIVE II-2-c



	R = ∞ i = 3 % TUNNEL	R = 800 i = 3 % TUNNEL	R = ∞ i = 0.5 % TUNNEL	R = 2500 i = 3 % TUNNEL	R = 480 i = 3 %	R = ∞ i = 0.3 %	
Rsi	1.0	1.3	4.1	1.0	3.0	1.0	
Isi	1.8	1.8	1.0	1.8	1.8	1.0	
Tsi	1.4	1.4	1.4	1.4	1.0	1.0	
Rsi x Isi x Tsi	2.52	3.28	5.74	2.52	5.4	1.0	20.46

INDEX	3.43

ALTERNATIVE III-1-a



	R = ∞ i = 3 %	R = 400 i = 0.3 %	R = 800 i = 0.3 %	R = 1200 i = 0.3 %	R = 1200 i = 0.3 %	R = 2500 i = 0.3 %	R = 400 i = 0.3 %	R = ∞ i = 0.3 %	
Rsi	1.0	3.0	1.3	1.1	1.1	1.0	3.0	1.0	
Isi	1.8	1.0	1.0	1.0	1.0	1.0	1.0	1.0	
Tsi	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	
Rsi x Isi x Tsi	1.8	3.0	3.0	1.1	1.1	1.0	3.0	1.0	15.0

INDEX	1.88

Appendix 8.4(2) INDEX VALUE OF EVALUATION ON TRAFFIC SAFETY (KLE)

ALTERNATIVE I - a

	R = 400 i=0.3‰	R = ∝ i=0.3‰	R = 400 i=0.3‰	R = ∝ i=0.3‰	R = 400 i=0.3‰	R = 1200 i=0.3‰	R = ∝ i= 4 ‰	R=1200 i= 4 ‰ TUNNEL	R = ∝ i=0.3‰ TUNNEL	R=3000 i=0.3‰ TUNNEL	R=1200 i=0.3‰ TUNNEL	R = ∝ i= 0.3‰	R=1200 i=0.3‰	R = ∝ i= 1 ‰	
Rsi	1	0	1	0	1	0	0	0	0	0	0	0	0	0	
Isi	0	0	0	0	0	0	1	1	0	0	0	0	0	0	
Tsi	0	0	0	0	0	0	0	1	1	1	1	0	0	0	
Rsi x Isi x Tsi	1	0	1	0	1	0	1	2	1	1	1	0	0	0	9

INDEX	0.64

ALTERNATIVE II - a

	R = 400 i=0.3‰	R = ∝ i=0.3‰	R = 400 i=0.3‰	R = ∝ i=0.3‰	R = 400 i=0.3‰	R = ∝ i=0.3‰	R = 1500 i= 3 ‰	R = 800 i=1.6‰	R = 600 i=1.6‰	R = ∝ i=1.6‰	R=1200 i=0.3‰	R = ∝ i=0.3‰	R=1200 i=0.3‰	R = ∝ i=0.3‰	
Rsi	1	0	1	0	1	0	0	0	0	0	0	0	0	0	
Isi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Tsi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Rsi x Isi x Tsi	1	0	1	0	1	0	0	0	0	0	0	0	0	0	3

INDEX	0.21

ALTERNATIVE II - b

	R = 400 i=0.3‰	R = ∝ i=0.3‰	R = 400 i=0.3‰	R = ∝ i=0.3‰	R = 400 i=0.3‰	R = ∝ i=0.3‰	R = 1500 i=0.5‰ TUNNEL	R = 800 i= 2 ‰ TUNNEL	R = 600 i= 2 ‰ TUNNEL	R = ∝ i=0.3‰ TUNNEL	R=1200 i= 2 ‰	R = ∝ i= 2 ‰	R=1200 i=0.3‰	R = ∝ i=0.3‰	
Rsi	1	0	1	0	1	0	0	0	0	0	0	0	0	0	
Isi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Tsi	0	0	0	0	0	0	1	1	1	1	0	0	0	0	
Rsi x Isi x Tsi	1	0	1	0	1	0	1	1	1	1	0	0	0	0	7

INDEX	0.50

ALTERNATIVE II - c

	R= 400 i=0.3‰	R = ∝ i=0.3‰	R= 400 i=0.3‰	R = ∝ i=0.3‰	R= 400 i=0.3‰	R = ∝ i=0.3‰	R= 1500 i= 1 ‰ TUNNEL	R= 800 i= 2 ‰ TUNNEL	R= 600 i= 2 ‰ TUNNEL	R = ∝ i= 3 ‰ TUNNEL	R=1200 i=0.3‰ TUNNEL	R = ∝ i=0.3‰ TUNNEL	R=1200 i=0.3‰	R = ∝ i=0.3‰	
Rsi	1	0	1	0	1	0	0	0	0	0	0	0	0	0	
Isi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Tsi	0	0	0	0	0	0	1	1	1	1	1	1	0	0	
Rsi x Isi x Tsi	1	0	1	0	1	0	1	1	1	1	1	1	0	0	9

INDEX	0.64

ALTERNATIVE III - a

	R = 400 i=0.3‰	R = ∝ i=0.3‰	R = 400 i=0.3‰	R = ∝ i=0.3‰	R = 400 i=0.3‰	R = 1100 i=0.3‰	R = 1200 i= 3 ‰	R = ∝ i= 3 ‰	R = 3000 i=1.2‰	R = 1200 i=0.3‰	R = ∝ i=0.3‰	R=1200 i=0.3‰	R = ∝ i= 1 ‰	
Rsi	1	0	1	0	1	0	0	0	0	0	0	0	0	
Isi	0	0	0	0	0	0	0	0	0	0	0	0	0	
Tsi	0	0	0	0	0	0	0	0	0	0	0	0	0	
Rsi x Isi x Tsi	1	0	1	0	1	0	0	0	0	0	0	0	0	3

INDEX	0.23

ALTERNATIVE III - b

	R = 400 i=0.3‰	R = ∝ i=0.3‰	R = 400 i=0.3‰	R = ∝ i=0.3‰	R = 400 i=0.3‰	R = 1100 i=0.3‰	R = 1200 i= 1 ‰ TUNNEL	R = ∝ i= 1 ‰ TUNNEL	R = ∝ i= 2 ‰ TUNNEL	R = 1200 i= 2 ‰ TUNNEL	R = ∝ i= 2 ‰	R=1200 i=0.3‰	R = ∝ i= 1 ‰	
Rsi	1	0	1	0	1	0	0	0	0	0	0	0	0	
Isi	0	0	0	0	0	0	0	0	0	0	0	0	0	
Tsi	0	0	0	0	0	0	1	1	1	1	0	0	0	
Rsi x Isi x Tsi	1	0	1	0	1	0	1	1	1	1	0	0	0	7

INDEX	0.54

Appendix 8.4(3) INDEX VALUE OF EVALUATION ON TRAFFIC CAPACITY (PYE)

ALTERNATIVE I - a

	R=400 i=0.3‰	R=∝ i=0.3‰	R=400 i=0.3‰	R=∝ i=0.3‰	R=400 i=0.3‰	R=1200 i=0.3‰	R=∝ i= 4 ‰	R=1200 i= 4 ‰ TUNNEL	R=∝ i=0.3‰ TUNNEL	R=3000 i=0.3‰ TUNNEL	R=1200 i=0.3‰ TUNNEL	R=∝ i=0.3‰	R=1200 i=0.3‰	R=∝ i= 1 ‰	
Rsi	3.0	1.0	3.0	1.0	3.0	1.1	1.0	1.1	1.0	1.0	1.1	1.0	1.1	1.0	
Isi	1.0	1.0	1.0	1.0	1.0	1.0	2.2	2.2	1.0	1.0	1.0	1.0	1.0	1.0	
Tsi	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.4	1.4	1.4	1.4	1.0	1.0	1.0	
Rsi x Isi x Tsi	3.0	1.0	3.0	1.0	3.0	1.10	2.2	3.39	1.4	1.4	1.54	1.0	1.1	1.0	25.13

INDEX	1.80

ALTERNATIVE II - a

	R=400 i=0.3‰	R=∝ i=0.3‰	R=400 i=0.3‰	R=∝ i=0.3‰	R=400 i=0.3‰	R=∝ i=0.3‰	R=1500 i= 3 ‰	R=800 i=1.6‰	R=600 i=1.6‰	R=∝ i=1.6‰	R=1200 i=0.3‰	R=∝ i=0.3‰	R=1200 i=0.3‰	R=∝ i=0.3‰	
Rsi	3.0	1.0	3.0	1.0	3.0	1.0	1.0	1.3	1.9	1.0	1.1	1.0	1.1	1.0	
Isi	1.0	1.0	1.0	1.0	1.0	1.0	1.3	1.0	1.0	1.0	1.0	1.0	1.0	1.0	
Tsi	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	
Rsi x Isi x Tsi	3.0	1.0	3.0	1.0	3.0	1.0	1.3	1.3	1.9	1.0	1.1	1.0	1.1	1.0	21.7

INDEX	1.55

ALTERNATIVE II - b

	R=400 i=0.3‰	R=∝ i=0.3‰	R=400 i=0.3‰	R=∝ i=0.3‰	R=400 i=0.3‰	R=∝ i=0.3‰	R=1500 i= 1 ‰ TUNNEL	R=800 i= 2 ‰ TUNNEL	R=600 i= 2 ‰ TUNNEL	R=∝ i= 3 ‰ TUNNEL	R=1200 i=0.3‰	R=∝ i=0.3‰	R=1200 i=0.3‰	R=∝ i=0.3‰	
Rsi	3.0	1.0	3.0	1.0	3.0	1.0	1.0	1.3	1.9	1.0	1.1	1.0	1.1	1.0	
Isi	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.3	1.3	1.8	1.0	1.0	1.0	1.0	
Tsi	1.0	1.0	1.0	1.0	1.0	1.0	1.4	1.4	1.4	1.4	1.0	1.0	1.0	1.0	
Rsi x Isi x Tsi	3.0	1.0	3.0	1.0	3.0	1.0	1.4	2.37	3.46	2.52	1.0	1.0	1.1	1.0	21.85

INDEX	1.56

ALTERNATIVE II - c

	R=400 i=0.3‰	R=∝ i=0.3‰	R=400 i=0.3‰	R=∝ i=0.3‰	R=400 i=0.3‰	R=∝ i=0.3‰	R=1500 i=0.5‰ TUNNEL	R=800 i= 2 ‰ TUNNEL	R=600 i= 2 ‰ TUNNEL	R=∝ i=0.3‰ TUNNEL	R=1200 i= 2 ‰ TUNNEL	R=∝ i= 2 ‰ TUNNEL	R=1200 i=0.3‰	R=∝ i=0.3‰	
Rsi	3.0	1.0	3.0	1.0	3.0	1.0	1.0	1.3	1.9	1.0	1.1	1.0	1.1	1.0	
Isi	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.3	1.3	1.0	1.3	1.3	1.0	1.0	
Tsi	1.0	1.0	1.0	1.0	1.0	1.0	1.4	1.4	1.4	1.4	1.4	1.4	1.0	1.0	
Rsi x Isi x Tsi	3.0	1.0	3.0	1.0	3.0	1.0	1.4	2.37	3.46	1.4	2.00	1.82	1.1	1.0	26.55

INDEX.	1.90

ALTERNATIVE III - a

	R=400 i=0.3‰	R=∝ i=0.3‰	R=400 i=0.3‰	R=∝ i=0.3‰	R=400 i=0.3‰	R=1100 i=0.3‰	R=1200 i= 3 ‰	R=∝ i= 3 ‰	R=3000 i=1.2 ‰	R=1200 i=0.3‰	R=∝ i=0.3‰	R=1200 i=0.3‰	R=∝ i= 1 ‰	
Rsi	3.0	1.0	3.0	1.0	3.0	1.1	1.1	1.0	1.0	1.1	1.0	1.1	1.0	
Isi	1.0	1.0	1.0	1.0	1.0	1.0	1.8	1.8	1.0	1.0	1.0	1.0	1.0	
Tsi	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	
Rsi x Isi x Tsi	3.0	1.0	3.0	1.0	3.0	1.0	1.98	1.8	1.0	1.1	1.0	1.1	1.0	20.98

INDEX	1.61

ALTERNATIVE III - b

	R=400 i=0.3‰	R=∝ i=0.3‰	R=400 i=0.3‰	R=∝ i=0.3‰	R=400 i=0.3‰	R=1100 i=0.3‰	R=1200 i= 1 ‰ TUNNEL	R=∝ i= 1 ‰ TUNNEL	R=3000 i= 2 ‰ TUNNEL	R=1200 i= 2 ‰ TUNNEL	R=∝ i= 2 ‰	R=1200 i=0.3‰	R=∝ i= 1 ‰	
Rsi	3.0	1.0	3.0	1.0	3.0	1.1	1.1	1.0	1.0	1.1	1.0	1.1	1.0	
Isi	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.3	1.3	1.3	1.0	1.0	
Tsi	1.0	1.0	1.0	1.0	1.0	1.0	1.4	1.4	1.4	1.4	1.0	1.0	1.0	
Rsi x Isi x Tsi	3.0	1.0	3.0	1.0	3.0	1.1	1.54	1.4	1.82	2.0	1.3	1.1	1.0	22.26

INDEX	1.71

Appendix 8.4(4) **INDEX VALUE OF EVALUATION ON TRAFFIC SAFETY (PYE)**