5.7 ENGINEERING STANDARDS

1) Geometric Design Standards Adopted by Other Cities and Authorities

Geometric design standards adopted for urban expressways by the following cities and authorities are studied and summarized in Table 5.7.1. Standard cross sections of urban expressways are presented in Figure 5.7.1.

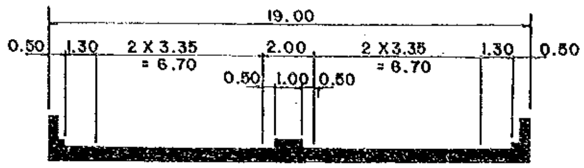
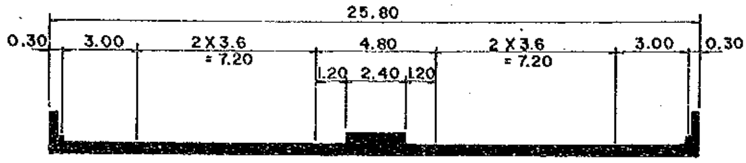
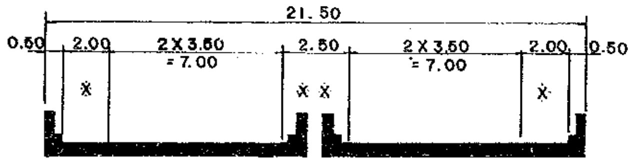
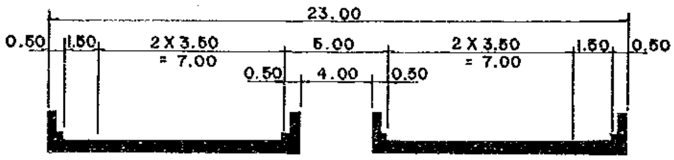
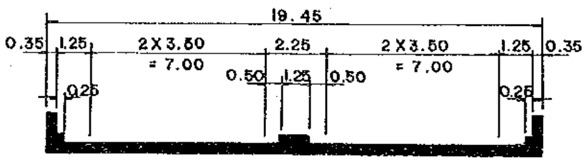
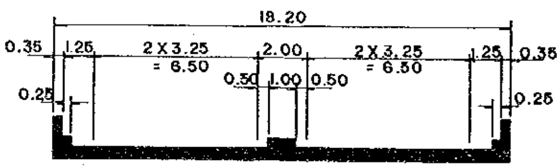
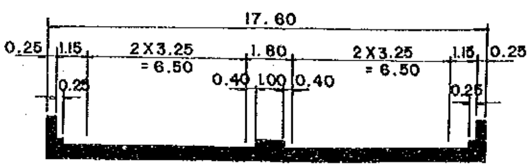
<u>Geometric Design Standards Studied</u>

- Urban Transport Study in Manila Metropolitan Area (UTSMMA)
- A Policy on Geometric Design of Highways and Streets (AASHTO)
- Bangkok Urban Expressway (First and Second Stages Expressway System), Thailand
- Jakarta Intra-Urban Expressway (South-West Ave.), Indonesia
- Metropolitan Expressway Public Corporation, Japan
- Hanshin Expressway Public Corporation, Japan

TABLE 5.7.1 GEOMETRIC DESIGN STANDARDS FOR URBAN EXPRESSWAY

		DESIGN SPEED (KM/HR)	LANE WIDTH (M	OUTER SHOULDER WIDTH (M)	MEDIAN WIDTH (M
	USTMMA	60	3.35	1.3 (with emergency parking bay at 500 m interval)	2.0
	AASHTO	80 to 112 (50 – 70 mile/hr)	3.60	3.0	4.8
	Bangkok Urban Expressway	80	3.50	2.0 Minimum 1.0 m)	2.5 (Minimum 1.6 m)
	Jakarta Intra–Urban Expressway	80	3.50	1.5	5.0
Metropolitan Expressway, Tokyo, Japan	Suburban Area	80	3.50	1.25 (With emergency parking bay at 300–500 m interval)	2.25
	Central Urban Area	60	3.25	1.25 (With emergency parking bay at 300–500 m interval)	2.00
Hanshin Expressway, Osaka, Japan	Central Urban Area	60	3.25	1.15 (With emergency parking bay at 300–500 m interval)	1.80

FIGURE : 5.7.1 STANDARD CROSS SECTIONS OF ELEVATED EXPRESSWAY BY OTHER CITIES/AUTORITIES

	DESIGN SPEED	STANDARD CROSS SECTION (Two - way Four - Lane)
URBAN TRANSPORT STUDY IN MANILA METROPOLITAN AREA (UTSMMA)	60 Km / Hr	
A POLICY ON GEOMETRIC DESIGN OF HIGHWAYS AND STREETS AASHTO	80 - 112 Km / Hr (50 - 70 Mile / Hr)	
BANGKOK URBAN EXPRESSWAY (Ist & 2nd Stages Expressway System)	80 Km / Hr	 ※ Min. = 1.00 m , ※※ Min. = 1.60 m
JAKARTA INTRA - URBAN EXPRESSWAY (SW - ARC)	80 Km / Hr	 (※ S-W Arc has actually 6 lanes)
METROPOLITAN EXPRESSWAY PUBLIC CORPORATION, JAPAN	80 Km / Hr (Suburban Area)	
	60 Km / Hr (Central Area)	
HANSHIN EXPRESSWAY PUBLIC CORPORATION, JAPAN	60 Km / Hr	

2) Geometric Design Standards For Metro Manila Expressways

Two major critical issues for establishing geometric design standards are as follows:

- Design Speed
- Shoulder Width

a) Design Speed

An expressway's primary function is to transport large volume of traffic with faster speed. Design speed of an expressway should be as high as possible. In case of urban expressways which pass through highly urbanized and developed areas, higher design standards usually require more lands to be acquired, which results in not only high projects costs but also difficult and prolonged implementation.

Therefore, design speed should be carefully selected so that primary function of an expressway is maintained, while difficulty in implementation of the project is kept within a reasonable limit.

Cities in Japan adopt rather low design speed of 60 km. per hour for the area highly developed where major land uses are commercial and business, while Bangkok Expressways are adopting design speed of 80 km per hour. Jakarta Intra-urban Expressways which are located outskirts of Jakarta (almost equivalent to a location of C-4 of Metro Manila), adopt a design speed of 80 km. per hour.

The Study Team studied two (2) options of design speed for Metro Manila Expressway System:

Option-1: Design speed of 80 km. per hour

Option-2: Design speed of 60 km. per hour for the area inside C-4 and 80 km. per hour for the area outside C-4

As the areas inside C-4 are highly developed, extensive ROW acquisition is quite difficult. Therefore, an expressway alignment will be so selected as to maximumly utilize existing public spaces such as existing at-grade major roads and rivers which control an expressway alignment to a great extent. At-grade major roads inside C-4 were designed with design speed of 60 km. per hour, thus it is practical to select design speed of 60 km. per hour for expressways inside C-4.

For expressways outside C-4, higher design standards than those inside C-4 are required due to the following viewpoints:

- Some of them will be, in future, linked with an inter-city expressway which has design speed of 80 to 100 km per hour.

- To reduce traffic burden of C-4, expressways outside C-4 should be planned with high design standards so that traffic on C-4 is attracted to expressways.

- To strengthen accessibility to and transport interlinkage among urban centers growing along and outside C-4, expressways should be planned with high design standards.

Thus, design speed of 80 km. per hour is most appropriate for expressways outside C-4.

It is recommended that Option-2, i.e. design speed of 60 km per hour for expressways inside C-4 and 80 km per hour for expressways outside C-4, should be adopted for Metro Manila Expressway System.

b) Outer Shoulder Width

Traffic demand for expressways in Metro Manila is high, thus all traffic lanes will be in use for the most of time of a day. Where shoulder width is not sufficient, a stopped vehicle will disrupt traffic not only on the occupied lane but on all lanes in that direction.

AASHTO recommends wide outer shoulder width of 3 meters. UTSMMA recommended outer shoulder width of 1.3 meters with the provision of emergency parking bays at an interval of about 500 meters.

The following two options were studied (see Figure 5.7.2):

Option-1: 2.0 meter outer shoulder will be provided throughout an expressway

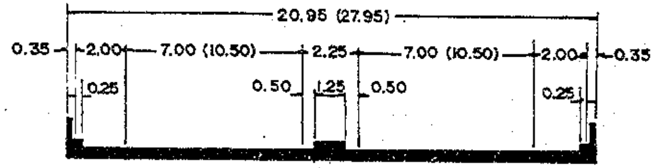
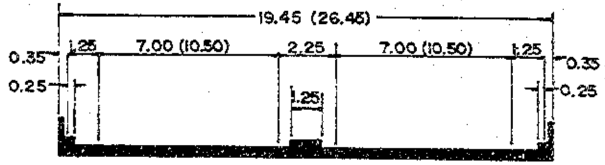
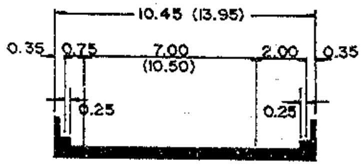
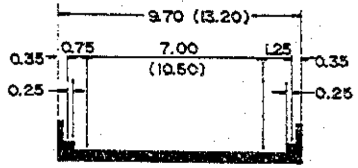
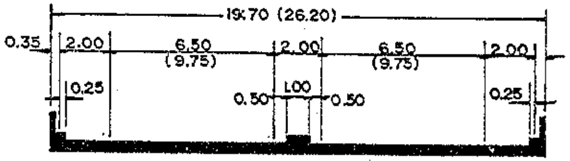
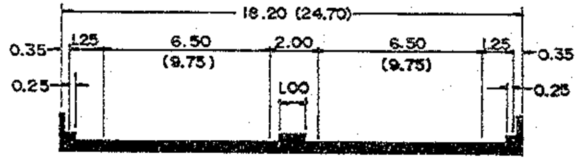
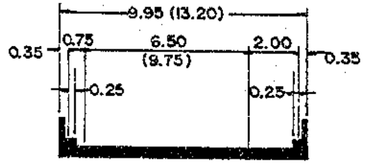
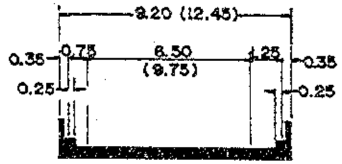
Option-2: 1.25 meter outer shoulder with emergency parking bay at an interval of 300 to 500 meters

There are many obsolete vehicles in use in Metro Manila. It is expected that a rate of vehicle breakdown on an expressway is high, wider outer shoulder width is desired to be provided throughout an expressway. In view of above, it is recommended that Option-1, i.e. 2.0-meter outer shoulder be provided throughout an expressway, should be adopted for Metro Manila Expressway System.

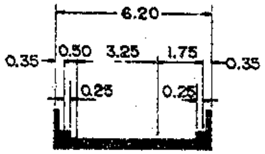
3) Recommended Geometric Design Standards

Recommended geometric design standards for a expressway, an interchange and an on-/off-ramp are summarized in Tables 5.7.2, 5.7.3 and 5.7.4, respectively.

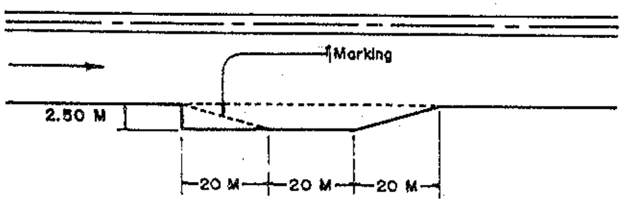
FIGURE 5.7.2 STANDARD CROSS SECTION ALTERNATIVES

		ALTERNATIVE – 1 (Without Emergency Parking Bay)	ALTERNATIVE – 2 (With Emergency Parking Bay at 300 – 500 m Interval)
CLASS-A Design Speed : 80 Km/Hr (Suburban Area)	Two – way 4 - lane (6 - lane)		
	One – way 2 - lane (3 - lane)		
CLASS-B Design Speed : 60 Km/Hr (Central Urban Area)	Two – way 4 - lane (6 - lane)		
	One – way 2 - lane (3 - lane)		

Scale 1 : 200 m



1 – Lane On-/Off- Ramp
Scale 1 : 200 m



Emergency Parking Bay
Not to Scale

TABLE 5.7.2 GEOMETRIC DESIGN STANDARDS FOR AN EXPRESSWAY

DESCRIPTION		UNIT	CLASS−A (OUTSIDE EDSA)	CLASS−B (INSIDE EDSA)
Design Speed		km/h	80	60
Lane Width		m	3.50	3.25
Inner Shoulder Width		m	0.75	0.75
Outer Shoulder Width		m	2.00	2.00
Median Width		m	2.25	2.00
Median Island Width		m	1.25	1.00
Horizontal Alignment	Minimum Radius	m	280 (230)	150 (130)
	Minimum Curve Length	m	140	100
	Maximum Superelevation	%	10.0	10.0
	Minimum Transition Length	m	70	50
Vertical Alignment	Maximum Gradient	%	4.0	5.0
	Minimum Radius of Vertical Curve (Crest)	m	5,000 (3,000)	2,000 (1,400)
	Minimum Radius of Vertical Curve (Sag)	m	3,000 (2,000)	1,500 (1,000)
	Minimum Vertical Curve Length	m	70	50
Minimum Stopping Sight Distance		m	140 (110)	85 (75)
Pavement Cross Fall		%	2.0	2.0
Composite Gradient		%	10.5	10.5
Vertical Clearance		m	4.7	4.7

Note: The figure in ( ) shows absolute minimum value to be used only when the conditions necessitate.

TABLE 5.7.3 GEOMETRIC DESIGN STANDARDS FOR AN INTERCHANGE

DESCRIPTION			UNIT	CASE-1	CASE-2	CASE-3
Design Speed			km/h	80	60	50
Lane Width			m	3.50	3.25	3.25
Inner Shoulder Width			m	0.75	0.75	0.75
Outer Shoulder Width		1-lane	m	2.00	2.00	2.00
		2-lane	m	1.25	1.25	1.25
Horizontal Alignment	Minimum Radius		m	280 (230)	150 (120)	100 (80)
	Minimum Curve Length		m	140	100	80
	Maximum Super-elevation		%	10.0	10.0	10.0
	Minimum Transition Length		m	70	50	40
Vertical Alignment	Maximum Gradient		%	4	5	6
	Minimum Radius of Vertical Curve (Crest)		m	5,000 (3,000)	2,000 (1,400)	1,200 (800)
	Minimum Radius of Vertical Curve (Sag)		m	3,000 (2,000)	1,500 (1,000)	1,100 (700)
	Minimum Curve Length		m	70	50	40
Minimum Stopping Sight Distance			m	140 (110)	85 (75)	65 (55)
Pavement Cross Fall			%	2.0	2.0	2.0
Composite Gradient			%	10.5	10.5	11.0
Vertical Clearance			m	4.7	4.7	4.7

Note:

- Use Case-1 when intersecting expressways are both Classes-A
- Use Case-2 when intersecting expressways are Class-A and Class-B or both Classes B
- Could be downgraded from Case-1 to Case-2 or Case-2 to Case-3, only when the conditions necessitate
- The figure in (   ) shows absolute minimum value to be used only when the conditions necessitate

TABLE 5.7.4 ON/OFF RAMP GEOMETRIC DESIGN STANDARD

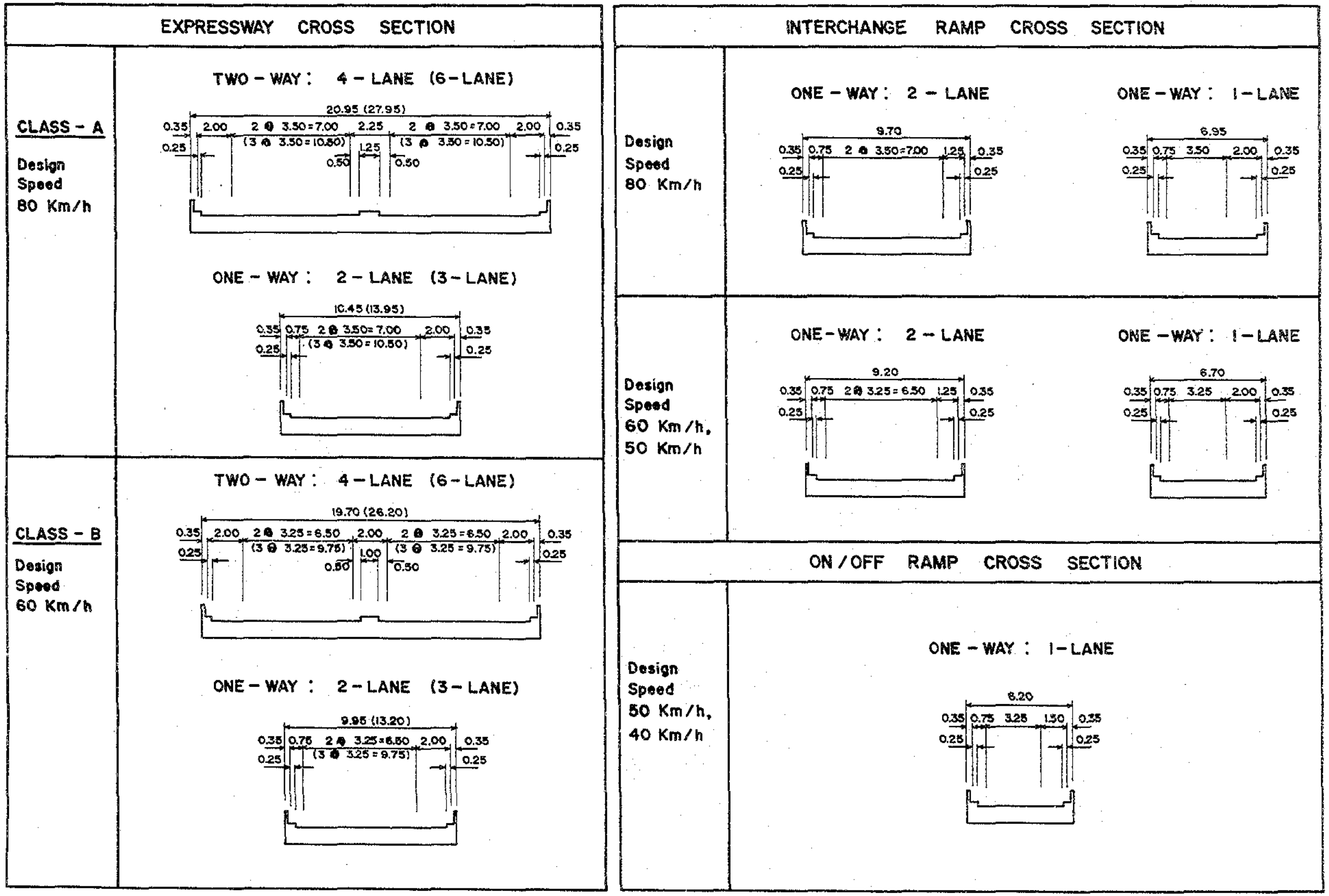
DESCRIPTION		UNIT	EXPRESSWAY CLASS-A	EXPRESSWAY CLASS-B
Design Speed of Street to be connected		km/h	80, 60, 50	80, 60, 50
Design Speed of on/off Ramp		km/h	50	40
Lane Width		m	3.25	3.25
Inner Shoulder Width		m	0.75	0.75
Outer Shoulder Width		m	1.50	1.50
Horizontal Alignment	Minimum Radius	m	90 (70)	50 (40)
	Minimum Curve Length	m	–	–
	Maximum Superelevation	%	10.0	10.0
	Minimum Transition Length	m	40	35
Vertical Alignment	Maximum Gradient	%	6.0	7.0
	Minimum Radius of Vertical Curve (Crest)	m	800	450
	Minimum Radius of Vertical Curve (Sag)	m	700	450
	Minimum Curve Length	m	40	35
Minimum Stopping Sight Distance		m	65 (55)	50 (40)
Pavement Cross Fall		%	2.0	2.0
Composite Gradient		%	11.0	11.0
Vertical Clearance		m	4.7	4.7

Note:
- Use design speed of 40 km/h in case for design speed of street of 40 km/h or ramp with toll facility
- The figure in ( ) shows absolute minimum value to be used only when conditions necessitate

TABLE 5.7.5 STANDARD SPEED CHANGE LANE

		EXPRESSWAY DESIGN SPEED	
		80 KM/H	60 KM/H
Single Acceleration Lane	Acceleration Length (m	160	120
	Taper Length (m) for Parallel Design	80	60
Single Deceleration Lane	Deceleration Length (m	110	90
	Taper Length (m) for Parallel Design	80	60

FIGURE : 5.7.3 PROPOSED STANDARD CROSS SECTIONS



5.8 URBAN EXPRESSWAY IN OTHER CITIES

Urban expressway network in four (4) cities, namely Bangkok, Jakarta, Tokyo and Osaka, was studied in order to get ideas on expressway configuration, intervals and extensions. A map showing an expressway network was prepared for each city. All four (4) maps were drawn at the same scale and a portion of Metro Manila is attached to each map (Refer to Appendix 5.8.1).

Bangkok

Present status of urban expressway development is as follows:

• First Stage of Expressway (in operation)	27 km.
• Second Stage Expressway (under construction by BOT scheme)	39 km.
Total	66 km.

In addition to above, implementation of 37 kms. of urban expressways has been committed and another 97 kms. of expressways are being proposed. When all of these are completed, Bangkok will have an urban expressway network of about 200 km.

The inner circumferential route composed of a part of First and Second Stage Expressways has an oblong shape extending about 8.5 kms. in the north-south direction and 3.8 kms. in the east-west direction which is almost equivalent to C-2 location in Metro Manila.

Jakarta

About 35 kms. of expressways composed of the North-South Link and the South-West Arc are currently in operation.

Another 89 kms. of expressways composed of Outer Ring Road, Harbour Road and the South-West Arc Extension are being studied. Upon completion of these expressways, Jakarta will have about 124 kms. of expressway network.

The inner ring road composed of the N-S Link, Harbour Road and the S-W Arc is located at an almost equivalent location of C-4 in Metro Manila.

The outer ring road has a radius of about 14 kms. which almost corresponds to C-6 location in Metro Manila.

Tokyo

As of April 1991, about 220 kms. of expressways are in service in Metropolitan Tokyo Area. Current target is to complete 270 km. of expressway system.

The inner circumferential route has a rectangular shape extending about 3 kms. in the north-south direction and about 2 kms. in the east-south direction. Seven (7) radial routes are connected with the inner circumferential route.

The central circumferential route has a radius of 5 to 6 kms. which is incomplete yet, thus causing traffic congestion of the inner circumferential route and sections of radial routes approaching to the inner circumferential route.

The inner circumferential route corresponds to C-1 location and the central circumferential route corresponds to a location between C-3 and C-4 in Metro Manila.

On/off ramp interval ranges from 0.3 to 1.8 km. in CBD and from 0.5 to 3.7 kms. in the areas outside CBD.

Osaka

Osaka-Kobe Urban Area has about 153 kms. of expressways in service as of April 1991. Current agent is to develop 235 kms. of expressway network.

The inner loop route has a rectangular shape extending about 4.3 kms. in the north-south direction and about 1.2 km in the east-west direction and is operated as one-way with 4-lane. Six (6) radials routes are connected with the inner loop route.

The inner loop route is located in narrower area than that of C-2 in Metro Manila.

Above discussions are summarized in Table 5.8.1.

TABLE 5.8.1 FEATURES OF EXPRESSWAY NETWORK IN OTHER CITIES

	BANGKOK	JAKARTA	TOKYO	OSAKA
Expressways in Service (km) 1/	27	34	220	153
Current Target of Expressway Network (km)	200	124	270	235
Inner Circumferential Route Location Corresponding to Metro Manila	C−2	C−4	C−1	C−1/C−2
Central/Outer Circumferential Route Location Correspon-ding to Metro Manila	−	C−6	C−3/C−4	
No. of Radial Routes Connected to Inner Circum-ferential Road	4	4	7	

Note: 1/ As of April 1991

CHAPTER 6

ALTERNATIVE EXPRESSWAY NETWORKS

CHAPTER 6

ALTERNATIVE EXPRESSWAY NETWORKS

6.1 ALTERNATIVE EXPRESSWAY NETWORK PLANS

1) Basic Principle for Alternative Scheme Formulation

Basic principle adopted for formulating alternative expressway network schemes is as follows:

- Present traffic pattern coincides with a present road network which is a radial-circumferential pattern. An expressway system of radial-circumferential pattern will also be appropriate for a short-to medium-term system.

- In addition to a radial-circumferential traffic distribution pattern, traffic demand, especially private traffic in the direction of north-south will be expected to increase greatly in the future. A long-term expressway system should be provided with north-south axes in the system.

- Due to limited number of corridors which have enough space to accommodate an expressway in the radial direction, all schemes will have almost same radial expressways, thus practically no alternatives for radial expressways.

- Alternative schemes will be formulated based basically on circumferential expressway corridors combinations.

- Alternative schemes will be formulated in accordance with the following viewpoints:

  a) To strengthen accessibility to Manila CBD, which is more appropriate corridor to collect/distribute traffic to/from Manila CBD, at C-2 or at C-3?

  b) To support and guide sound development of Urban Centers along and outside EDSA, and to improve transport linkage among these centers, which is more appropriate corridor to achieve the objective, at C-4 or at C-5?

2) Alternative Schemes

Five (5) basic schemes are prepared which are based basically on combinations of circumferential expressways as follows:

Scheme-1: C-2 and C-5 based expressway network
Scheme-2: C-2 and C-4 based expressway network
Scheme-3: C-3 and C-5 based expressway network
Scheme-4: C-4 based expressway network
Scheme-5: C-5 based expressway network

Conceptual network formation and planning objectives of 5 basic schemes are presented in Figure 6.1.1.

Scheme 1 has two (2) alternatives depending upon a route to be used in a C-2 corridor as follows:

Scheme 1A: Follow an alignment of at-grade C-2.
Scheme 1B: Follow an alignment of PNR

Scheme 3 has also two (2) alternatives depending upon a route to be used in a C-3 corridor as follows:

Scheme 3A: Follow an alignment of at-grade C-3

Scheme 3B: Southern section utilizes San Juan River and Northern section follows an alignment of at-grade C-3

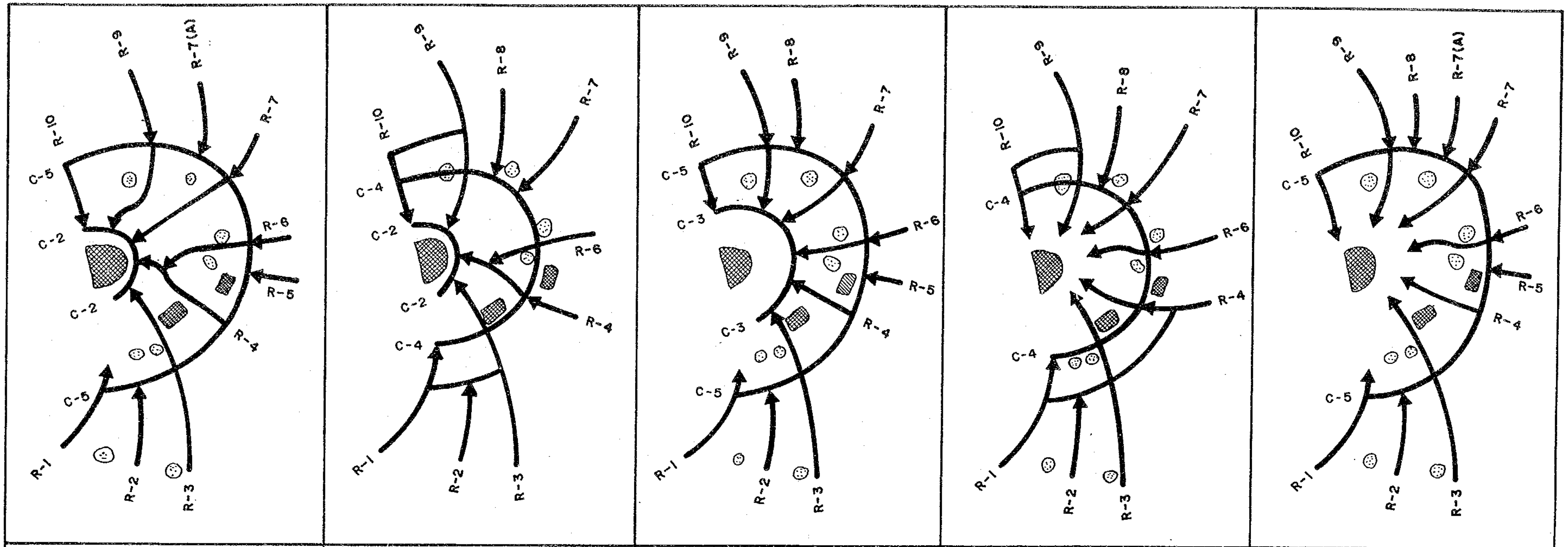
A total of seven (7) alternative schemes are prepared as shown in Figure 6.1.2 and summurized as shown in Table 6.1.1 (also refer to Appendix 6.1.1).

TABLE 6.1.1 PHYSICAL FEATURES OF ALTERNATIVE SCHEMES

SCHEME NO.	NO. OF ROUTES	TOTAL LENGTH (KM) 1/	NO. OF INTER-CHANGES	ON/OFF RAMPS	
				NO.	LENGTH (KM
Scheme 1A	2 Circumferentials 10 Radials	147.7	16	93	46.9
Scheme 1B	2 Circumferentials 10 Radials	149.3	16	93	46.9
Scheme 2	2 Circumferentials 9 Radials	140.7	14	84	43.3
Scheme 3A	2 Circumferentials 10 Radials	160.1	18	97	48.1
Scheme 3B	2 Circumferentials 11 Radials	149.5	17	95	47.3
Scheme 4	1 Circumferential 9 Radials	143.8	11	91	46.3
Scheme 5	1 Circumferential 11 Radials	138.3	12	84	42.6

Note: 1/ Length of Expressway No. R-1 is excluded

FIGURE 6.1.1 CONCEPTUAL NETWORK FORMATION AND PLANNING OBJECTIVES OF BASIC SCHEMES



SCHEME - 1	SCHEME - 2	SCHEME - 3	SCHEME - 4	SCHEME - 5
1) C-2 and C-5 based expressway network. 2) To activate socio-economic development of, and to improve accessibility to Manila CBD, traffic attracted to Radial Expressways is carried as closer to Manila CBD as possible and distributed by Circumferential Route No. C-2 located at the fringe of Manila CBD. 3) To support sound development of currently growing as well as newly emerging urban centers along and outside EDSA, accessibility to and interlinkage among these urban centers is to be strengthened by Circumferential Route C-5. 4) To cope with growing private traffic in the direction of north to south or vis-a-vis, two (2) north-south transport axes are to be formed; one axis by Routes No. R-3, C-2 and R-9 and the other by R-2, C-5 and R-7 (A).	1) C-2 and C-4 based expressway network. 2) To activate socio-economic development of and to improve accessibility to Manila CBD, traffic attracted to Radial Expressways is carried as closer to Manila CBD as possible and distributed by Circumferential Route No. C-2 located at the fringe of Manila CBD. 3) Currently growing urban centers along EDSA are to be directly connected with each other by Circumferential Expressway Route No. C-4. 4) A north-south transport axis is to be formed by Routes R-3 (SLE), C-2 and R-9 (NLE).	1) C-3 and C-5 based expressway network. 2) To avoid costly ROW acquisition along C-2, radial traffic is to be distributed at the location of C-3. Access to Manila CBD is made by at-grade streets. 3) To support sound development of currently growing as well as newly emerging urban centers along and outside EDSA, accessibility to and interlinkage among these urban centers is to be strengthened by Circumferential Route No. C-5. 4) Two (2) north-south transport axes are to be formed; one axis by Routes R-3, C-3 and R-9 and the other by R-2, C-5 and R-8.	1) C-4 based expressway network. 2) Only one circumferential expressway along EDSA is to be constructed and radial expressways are to be branched off from it towards inside and outside EDSA. 3) Radial expressways are to be extended as closer to Manila CBD as possible. 4) Currently growing urban centers along EDSA are to be directly connected with each other by Circumferential Expressway Route No. C-4. 5) Due to existing interchanges along EDSA, directional linkage at interchanges between expressways is limited, thus each expressway functions rather independently.	1) C-5 based expressway network. 2) To solve the problem mentioned in 5) of Scheme-4, Circumferential expressway is proposed to locate at C-5. 3) To support sound development of currently growing as well as newly emerging urban centers along and outside EDSA, accessibility to and interlinkage among these urban centers is to be strengthened by Circumferential Route No. C-5. 4) Radial expressways are to be extended as closer to Manila CBD as possible.

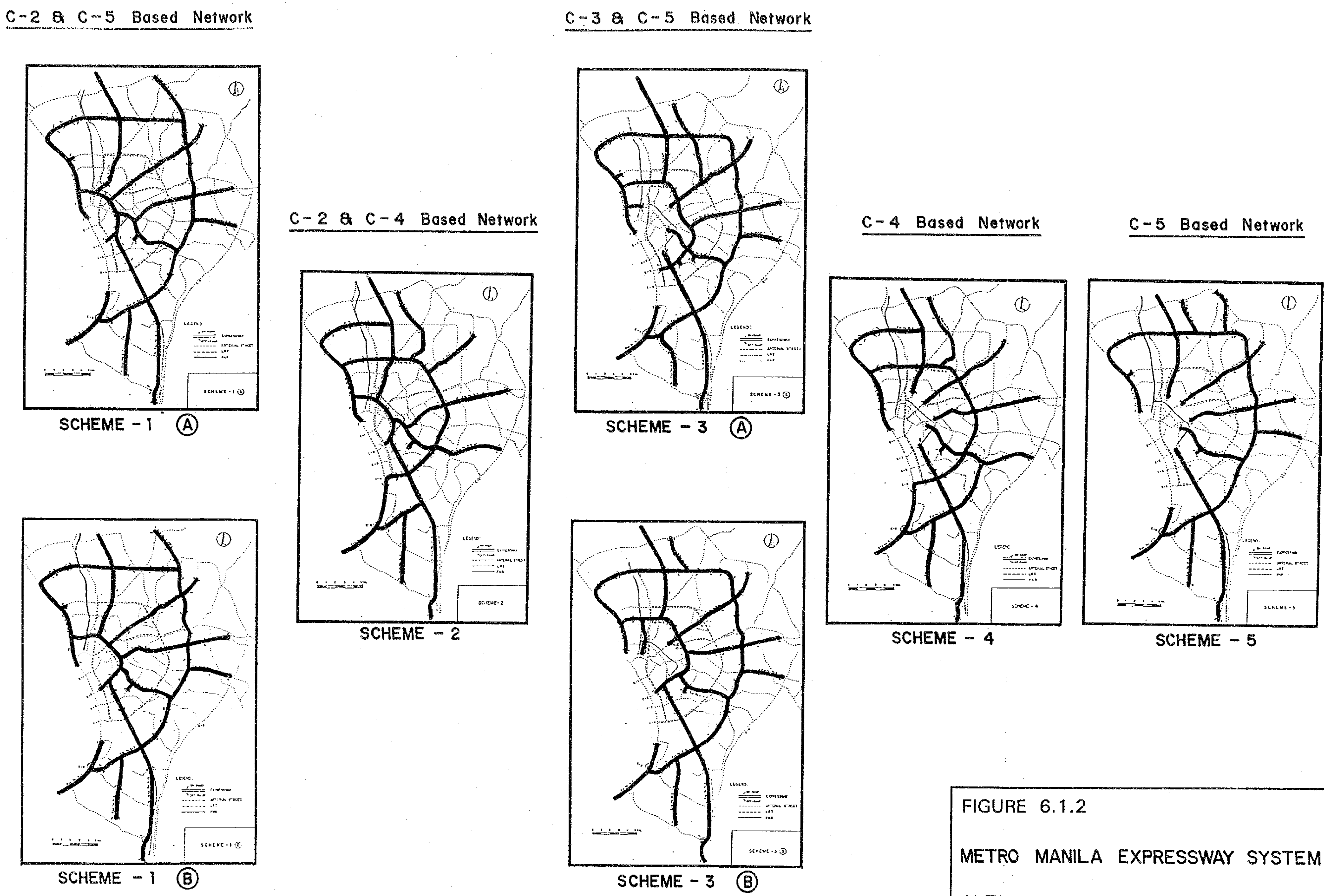


FIGURE 6.1.2

METRO MANILA EXPRESSWAY SYSTEM

ALTERNATIVE SCHEMES

6.2 TRAFFIC IMPACT OF ALTERNATIVE NETWORK PLANS

For the alternative expressway network plans worked out in section 6.1, the traffic assignments were made under the following assumed situation:

- year; 2010
- time value of private transport; P1.0/min./pcu
- toll; P20 flat

The results are summarized in Table 6.2.1 and explained briefly as follows:

(a) The construction of the expressways will contribute to the improvement of traffic situation of the existing roads. The total vehicle-hours of the existing roads will be reduced by 10% to 20% which will contribute to the improvement of travel speed by 3% to 10%. The efficiency of the overall road system including the expressways would also be improved accordingly.

(b) The number of expressway users varies by alternative ranging from 272 thousand to 336 thousand pcu/day, which is approximately 7% and 9% of the total private vehicle trips in the year 2010, respectively.

(c) The alternative comprising the EDSA route attracts the largest number of users where at present the heaviest private traffic demand is evident and expected to remain the same in the future.

TABLE 6.2.1 TRAFFIC IMPACTS OF ALTERNATIVE EXPRESSWAY NETWORK PLANS

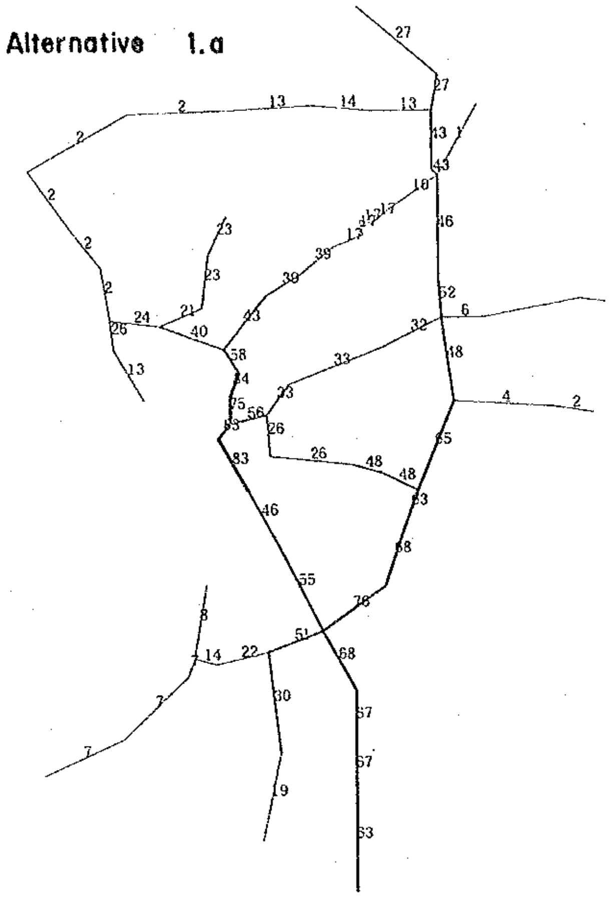
CASES		EXPRESSWAYS			OTHER ROADS				ENTIRE NETWORK			
		NO. OF USERS /DAY	SPEED (KPH)	V/C RATIO	VEH-KM (MIL.)	VEH-HR. (MIL.)	SPEED (KPH)	V/C RATIO	VEH-KM (MIL.)	VEH-HR. (MIL.)	SPEED (KPH)	V/C RATIO
Do Nothing		–	–	–	35.35	2.15	16.4	0.99	35.35	2.15	16.4	0.99
Alter-natives	1-A	265,086	40.0	0.57	31.25	1.81	17.2	0.97	36.09	1.93	18.7	0.89
	1-B	272,484	40.4	0.56	31.30	1.80	17.4	0.97	36.07	1.92	18.8	0.89
	2	335,717	36.1	0.61	31.07	1.77	17.6	0.97	36.17	1.91	18.9	0.90
	3-A	272,038	40.2	0.56	31.42	1.77	17.8	0.97	36.16	1.88	19.2	0.89
	3-B	275,002	43.7	0.61	31.33	1.74	18.1	0.97	36.16	1.85	19.6	0.90
	4	315,461	42.0	0.50	32.05	1.93	16.6	1.00	36.23	2.03	17.9	0.90
	5	237,765	41.8	0.50	32.26	1.92	16.8	0.99	36.30	2.02	18.0	0.90

The results of the assigned traffic volume on the expressway network are shown in Figure 6.2.1 (those for Alternative 1-B and Alternative 3-A were omitted since they show similar results as with Alternative 1-A and Alternative 3-B, respectively). The characteristics are outlined as follows:

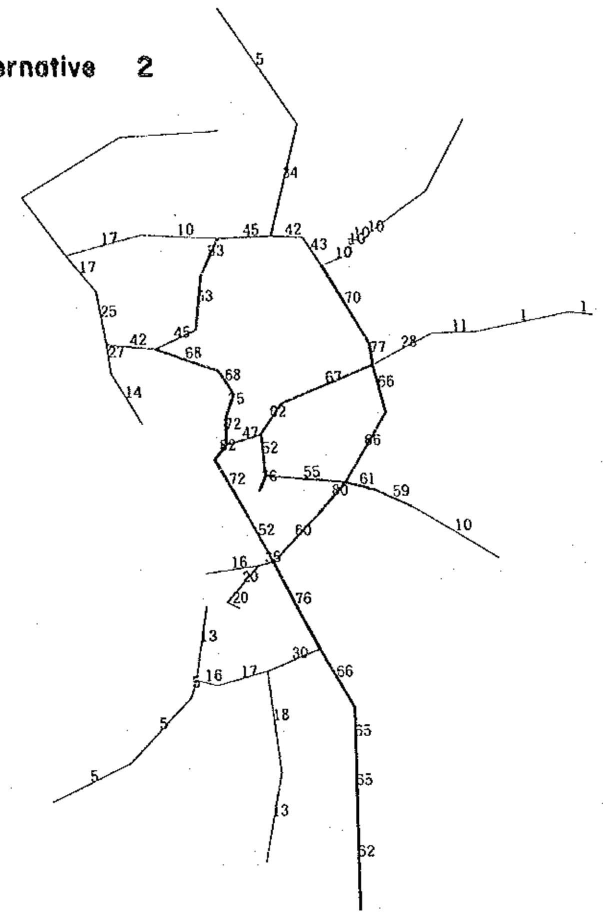
(a) The heaviest load routes are the north-south directions (such as the South Superhighway, EDSA, and C5 corridors) and the radial routes for the east and north-east directions.

(b) The heaviest traffic section carry about 80 thousand pcu in the year 2010.

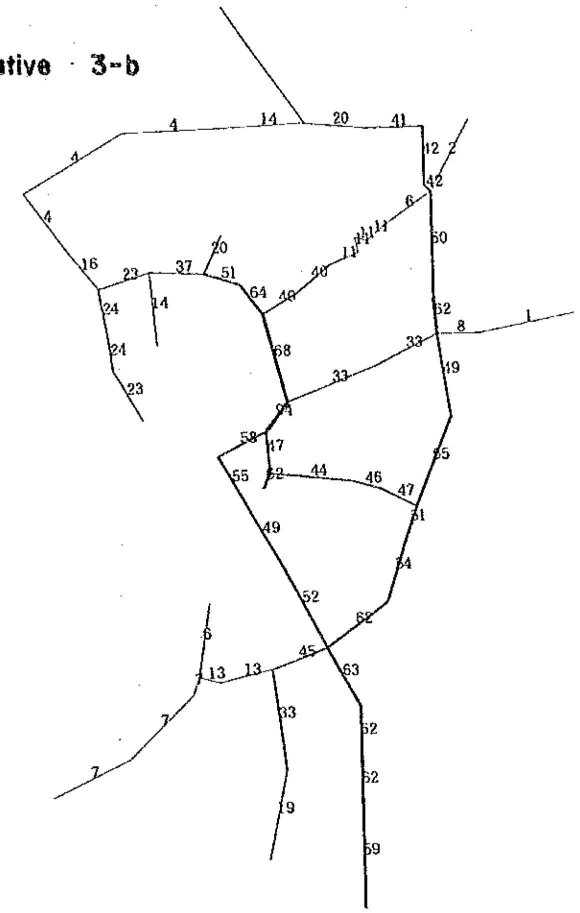
Alternative 1.a



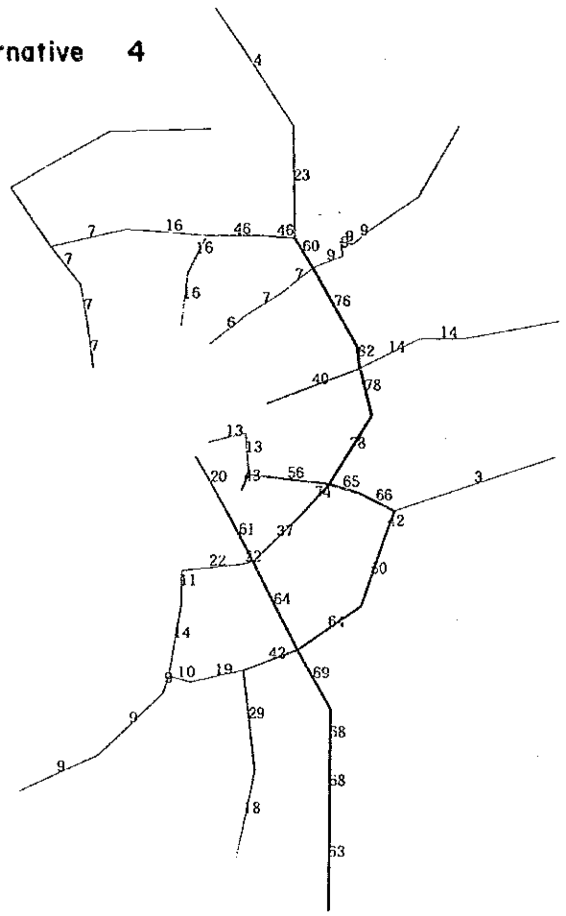
Alternative 2



Alternative 3-b



Alternative 4



Alternative 5

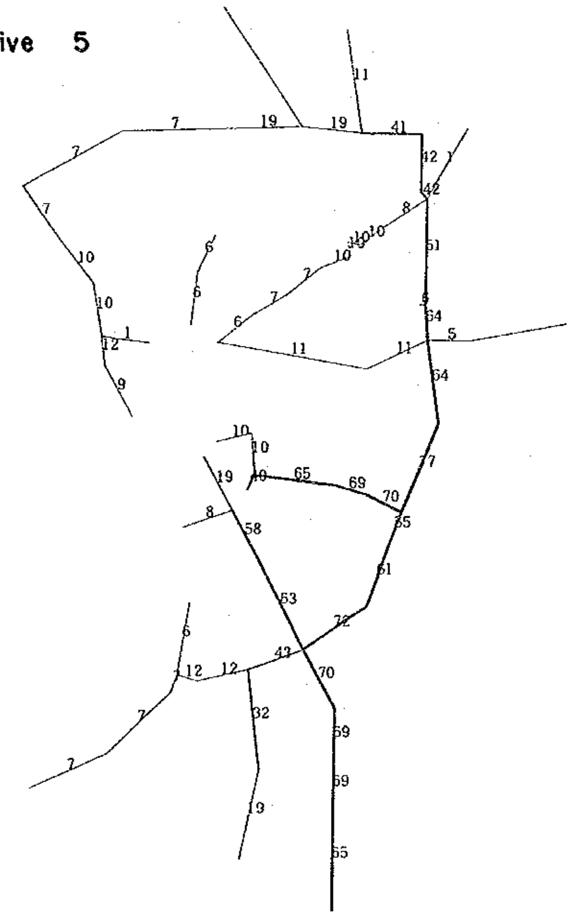


Figure 6.2.1

Assigned Expressway Traffic Volume for Alternatives

Year : 2010
Toll : P 20 flat

pcu / day / both directions

6.3 PRELIMINARY ENGINEERING STUDY AND COST ESTIMATE

1) Preliminary Engineering Study

Preliminary engineering study was undertaken for all expressway corridors of alternative schemes with regards to the following:

- Investigation of all available public spaces within expressway corridors
- Preliminary alignment studies for all routes using 1:10,000 scale topographic map
- Preliminary planning of interchange types and locations of on/off ramps
- Elevated expressway or at-grade expressway
- Two-way structure, one-way structure or double deck structure
- Preliminary assessment of types of foundations based on existing data

Results of preliminary engineering study are presented in Appendix 6.3.1.

Implementation difficulty, structural complexity and environmental impacts, of each scheme were assessed based on the preliminary engineering study. Implementation difficulty was assessed based on the following factors: (See Table 6.3.1):

- Length of sections which require ROW acquisition
- Length of sections which require integrated structures with an expressway and a LRT line and close coordination between DPWH and DOTC with regards to implementation schedule, cost sharing, etc.

Structural complexity of each scheme was assessed by section length which requires more than 3rd level structures. (See Table 6.3.2).

Environmental impacts were assessed for the following aspects:

- Social impact by number of households affected in connection with ROW acquisition, which was roughly estimated based on simple field observation (See Table 6.3.3).
- Impact on traffic pollution by two factors, one is impact on residents within 20-meter corridor from an expressway who will be most directly affected and measured by section length along which land use is residential. The other is a horizontal clearance between an expressway and a building line which is proposed to be at least 5 meters. This factor was measured by section length which cannot satisfy the above criteria. (See Table 6.3.4).

TABLE 6.3.1 ASSESSMENT OF IMPLEMENTATION DIFFICULTY

ROUTE NO.	CRITICAL SECTION FOR IMPLEMENTATION	SCHEME NO.						
		1A	1B	2	3A	3B	4	5
C-2	• At Nagtahan Interchange, needs realignment and acquisition of R.O.W. (1.3 km) • Tayuman Street and Huertas Street require widening (3.2 km)	4.5	–	4.5	–	–	–	–
C-2 (PNR)	• Relocation of squatters within PNR R.O.W. (7.8 km) • Tayuman Street and Tayabas Street need widening (2.3 km)	–	10.1	–	–	–	–	–
C-3	• Section from San Juan Bridge to Buendia Avenue of at-grade C-3 will be constructed only between 2001 and 2010 due to R.O.W. acquisition problem (5.9 km) • Section from South Super Highway to Tramo Ave. is narrow (20 m.), of which widening is quite difficult (1.2 km)	–	–	–	7.1	–	–	–
C-3 (San Juan River)	• Private buildings and squatters occupy San Juan River banks. (2.9 km) • Section from Pasig River to Quirino Avenue requires R.O.W. acquisition. (0.6 km)	–	–	–	–	3.5	–	–
C-4	• Requires integrated structure with LRT Line (23.1 km) • Needs widening from Rizal Avenue Extension to Mabini Street (1.4 km) • Needs realignment at Ortigas Interchange (1.8 kms)	–	–	26.3	–	–	26.3	–
C-5	• Needs re-alignment from Santolan Road to Marcos Highway along Marikina River (1.9 km)	1.9	1.9	–	1.9	1.9	–	1.9
R-1 (R-1 Extension)	• Existing	0	0	0	0	0	0	0
R-2 (New Link)	• Entirely new alignment and requires extensive R.O.W. acquisition. (7.4 km)	7.4	7.4	7.4	7.4	7.4	7.4	7.4
R-3 (SSH, SLE)	• Needs R.O.W. acquisition near NAIA runway and ramps at Bicutan, Sucat and Alabang Interchange (5.9 km)	5.9	5.9	5.9	5.9	5.9	5.9	5.9
R-4 (Along Pasig River)	• Needs R.O.W. acquisition at the area surrounded by Pasig River and San Juan River (0.6 km) • Needs R.O.W. acquisition from Pasig River to Shaw Blvd. Ext. (4.0 km, Scheme 2 and 4)	0.6	0.6	4.6	0.6	0.6	4.6	0.6
R-5 (Ortigas Ave. Ext.)	• Ortigas Avenue Extension is narrow and at ramp sections, R.O.W. acquisition needed (1.0 km)	1.0	1.0	–	1.0	1.0	–	1.0
R-6 (Santolan, Marcos)	• Santalon Road at Camp Aguinaldo and Camp Crame is to be widened. • Requires extensive R.O.W. acquisition in San Juan (1.9 km except Scheme 3B, 1.0 km)	1.9	1.9	1.9	1.9	1.0	1.0	1.0
R-7 (Quezon Avenue)	• Section from C-2 to Rodriguez Avenue has to accommodate LRT Line. At-grade road will be covered by second level expressway and LRT. (1.3 km, Scheme 1A)	1.3	0.8	0	0	0	0	0
R-7B (Fair View)	• Section from C-5 to the existing Fair View Avenue needs R.O.W. acquisition (1.8 km)	1.8	1.8	–	–	–	–	3.3
R-8 (Mindanao Ave.)	• No problem	–	–	0	0	0	0	0
R-9 (Bonifacio, NLE)	• Section from Blumentrit Street to Del Monte Avenue is narrow and requires double deck structure (2.1 km)	2.1	2.1	2.1	0	0	0.8	0.8
R-10	• Section from Pasig River to Zaragoza Street requires realignment due to existing R-10/C.M. Recto Interchang (1.1 km)	1.1	1.1	1.1	1.1	0	1.1	0
R-10A	• Section along PNR requires squatters dislocation (0.85 km) • Section from PNR to A. Santos requires ROW acquisition (0.80 km)	–	–	–	–	1.7	–	–
	TOTAL	29.5	34.6	53.8	26.9	23.0	47.1	21.9

TABLE 6.3.2 ASSESSMENT OF STRUCTURAL COMPLEXITY

ROUTE NO.	SECTION REQUIRES MORE THAN 3RD LEVEL STRUCTURE	SCHEME NO.						
		1A	1B	2	3A	3B	4	5
C-2	Cross LRT 4 times. (0.54 x 4 = 2.2 km)	2.2	–	2.2	–	–	–	–
C-2 (PNR)	When PNR will be elevated in future, an expressway must be constructed at 3rd level (7.8 km)	–	7.8	–	–	–	–	–
C-3	Cross LRT 3 times and existing Buendia Overpass (0.54 x 4 = 2.2 km)	–	–	–	2.2	–	–	–
C-3 (San Juan River)	Cross LRT 2 times (0.54 x 2 = 1.1 km)	–	–	–	–	1.1	–	–
C-4	More than 3rd level all along C-4, except from Rizal Avenu Extension to R-10 (23.1 km)	–	–	23.1	–	–	23.1	–
C-5	At-grade or 2nd level. No 3rd level except at interchange	0	0	–	0	0	0	0
R-1 (R-1 Extension)	At-grade	0	0	0	0	0	0	0
R-2 (New Link)	2nd level all along the route	0	0	0	0	0	0	0
R-3 (SSH, SLE)	When PNR will be elevated in future, an expressway must be constructed at 3rd level. Solution for this is to construct an expressway over South Super Highway. At Buendia overpass and MSDR Interchange, and expressway must be 3rd and 4th level, respectively. (1.5 km)	1.5	1.5	1.5 + 1.8	1.5	1.5	1.5 + 1.8	1.5
R-4 (Along Pasig River)	At 5 existing bridges, an expressway will be at 3rd level (0.5 x 5 = 2.5 km)	2.5	2.5	2.5 + 1.4	2.5	2.5	2.5 + 1.4	2.5
R-5 (Ortigas Ave. Ext.)	All stretch will be double deck structure (5.3 km)	5.3	5.3	–	5.3	5.3	–	5.3
R-6 (Santolan-Marcos Highway)	• Double deck structure from C-4 to San Juan River (3.7 km except Scheme 3B and 5, 4.4 km)	3.7	3.7	3.7 + 1.4	3.7	4.4	3.7 + 1.4	4.4
R-7 (Quezon Avenue)	• Cross LRT at Welcome Rotonda and at C-4 Scheme 1A, B (1.1 km), other scheme (0.5 km)	1.1	1.1	0.5	0.5	0.5	1.0	0.5
R-7B (Fair View)	• None	0	0	–	–	–	–	0
R-8 (Mindanao Avenue)	• None	–	–	0.5	0.5	0	0.5	0
R-9 (Bonifacio – NLE)	• Double deck structure from Blumentritt to Del Monte Ave. (2.1 km) • Cross Balintawak I/C and Quirino Highway Overpass (1.1 km)	3.2	3.2	2.1 + 1.1 + 0.7	1.1	1.1	2.1 + 1.1 + 0.7	1.9
R-10	• None	0	0	0	0	0	0	0
R-10A	• None	–	–	–	–	0	–	–
	TOTAL	19.5	25.1	42.5	17.3	16.4	40.8	16.1

TABLE 6.3.3 ASSESSMENT OF SOCIAL IMPACT
– NUMBER OF HOUSEHOLDS AFFECTED –

ROUTE	SCHEME						
	1A	1B	2	3A	3B	4	5
C–2	1,300	200	1,300	200	–	–	–
C–2 (PNR)	–	7,500	–	–	–	–	–
C–3	–	–	–	0	–	–	–
C–3 (San Juan River)	–	–	–	–	800	–	–
C–4	–	–	300	–	–	300	–
C–5	300	300	0	300	300	0	300
R–1 (R–1 Extension)	–	–	–		–	–	–
R–2 (New Link)	300	300	300	300	300	300	300
R–3 (SSH, NLE)	2,500	2,500	2,500	2,500	2,500	2,500	2,500
R–4 (Along Pasig River)	1,700	1,700	2,900	1,700	1,400	2,900	1,700
R–5 (Ortigas Avenue Extension)	100	100	–	100	100	–	100
R–6 (Santolan, Marcos)	600	600	600	600	600	600	600
R–7 (Quezon Avenue)	0	0	0	0	0	0	0
R–7B (Fair View)	300	300	–	–	–	–	200
R–8 (Mindanao Avenue)	–	–	0	0	0	0	0
R–9 (Bonifacio, NLE)	200	200	200	100	100	100	100
R–10	300	300	300	300	0	300	0
R–10A(PNR, Abad Santos)	–	–	–	–	800	–	–
Interchanges	2,000	2,100	2,000	2,400	2,300	1,500	1,500
TOTAL	9,600	16,100	10,400	8,500	9,200	8,500	7,300

TABLE 6.3.4 ASSESSMENT OF IMPACT ON TRAFFIC POLUTION

ROUTE NO.	A. Section Length which passes through residential area B. Section Length of which clearance between expressway and building line is less than 5 meters	SCHEME						
		1A	1B	2	3A	3B	4	5
C−2	A. 7. 2 km B. From Andalucia to Juan Luna (2.2 km x both sides = 4.4 km)	11.6	−	11.6	−	−	−	−
C−2 (Along PNR)	A. 12.0 km B. None	−	12.0	−	−	−	−	−
C−3	A. 12.5 km B. None	−	−	−	12.5	−	−	−
C−3 (Along San Juan River)	A. 8.5 km B. None	−	−	−	−	8.5	−	−
C−4	A. 14.6 km B. None	−	−	14.6	−	−	14.6	−
C−5	A. 10.5 km B. None	10.5	10.5	−	10.5	10.5	−	10.5
R−1 (R−1 Extension)	A. − B. −	−	−	−	−	−	−	−
R−2 (New Link)	A. 14.7 km B. None	14.7	14.7	14.7	14.7	14.7	14.7	14.7
R−3 (SSH, SLE)	A. 7.8 km B. None	7.8	7.8	7.8	7.8	7.8	7.8	7.8
R−4 (Along Pasig River)	A. 2.5 km, or 2.3 km, or 9.5 km B. None	2.5	2.5	9.5	2.5	2.3	9.5	2.5
R−5 (Ortigas Avenue)	A. 4.0 km B. None	4.0	4.0	−	4.0	4.0	−	4.0
R−6 (Santolan, Marcos)	A. 10.8 km, or 91. km B. None	10.8	10.8	10.8	10.8	9.1	9.1	9.1
R−7 (Quezon Avenue)	A. None B. From C−2 to Welcome Rotonda (1.3 km x both sides = 2.6 km)	2.6	1.6	0	0	0	0	0
R−7B (Fair View)	A. 13.4 km B. None	13.4	13.4	−	−	−	−	13.4
R−8 (Mindanao Avenue)	A. 18.0 kms or 3.5 km B. None	−	−	16.0	18.0	3.5	16.0	3.5
R−9 (Bonifacio, NLE)	A. 2.9 km, or 1.4 km B. From Del Monte Avenue to EDSA (2.4 x both sides = 4.8 km)	7.7	7.7	7.7	6.2	6.2	6.8	6.8
R−10 (R−10)	A. 4.4 km or 3.2 km B. None	4.4	4.4	4.4	4.4	3.2	4.4	3.2
R−10A(PNR, Abad Santos)	A. 3.3 km B. None	−	−	−	−	3.3	−	−
	TOTAL	90.0	89.4	97.1	91.4	73.1	82.9	75.5

2) Preliminary Cost Estimate

For the purpose of cost comparison of alternative schemes, rough cost of each scheme was estimated for civil work cost and ROW acquisition cost which includes improvement cost under the following assumptions and conditions:

Civil Work Cost

- Number of lanes was assumed to be 4 lanes.

- For an elevated expressway:

Span Length	:	30 meters
Superstructure	:	AASHTO type PC girder
Substructure	:	T-shaped or Rigid Frame or Double Deck types depending upon conditions
Foundation	:	Spread footing or pile foundation (pile length is assumed 20 meters), depending upon location

- For an at-grade expressway:

Earth work	:	quite rough estimate only based on 1:10,000 topographic map
Pavement structure	:	20 cm subbase (30 cm for Manila Bay low land) 23 cm PCC
Grade Separation at intersection	:	Cost per one intersection based on representative cost of typical grade separation

- Price level used: March 1992

ROW Acquisition Cost

- ROWs for proposed at-grade roads are assumed to be acquired prior to construction of an expressway. ROW costs are estimated only when lands are required in addition to existing/proposed at-grade road ROW, and for these expressways which follow new alignment.

- Land value used was 1990 zonal value

- Cost of improvement was roughly estimated based on land use

Roughly estimated cost of each scheme is shown in Table 6.3.5 and summarized as follows:

	LOWEST	SECOND LOWEST	HIGHEST
Total Cost			
Civil Work	Scheme 5	Scheme 1-A	Scheme 2
ROW	Scheme 5	Scheme 3-B	Scheme 2
Total	Scheme 5	Scheme 3-B	Scheme 2
Cost per km.			
Civil Work	Scheme 5	Scheme 1-A, 1-B, 3-B	Scheme 2
ROW	Scheme 5	Scheme 3-A, 3-B	Scheme 2
Total	Scheme 5	Scheme 3-B	Scheme 2

TABLE 6.3.5 SUMMARY OF COST OF EACH SCHEME

SCHEME NO.	TOTAL EXPRESS-WAY LENGTH (KM)	ON/OFF RAMP NO.	ON/OFF RAMP LENGTH (KM)	NO. OF INTER-CHANGE	CIVIL WORK COST (MILLION P)	R. O. W. COST (MILLION P)	TOTAL COST (MILLION P)
1A	147.7	93	46.9	16	48,200 (326)	7,900 (54)	56,100 (380)
1B	149.3	93	46.9	16	48,600 (325)	7,800 (52)	56,400 (378)
2	140.7	84	43.3	14	53,100 (377)	9,700 (69)	62,800 (446)
3A	160.1	97	48.1	18	52,800 (330)	7,000 (44)	59,800 (374)
3B	149.5	95	47.3	17	48,600 (325)	6,700 (45)	55,300 (370)
4	143.8	91	46.3	11	51,500 (358)	8,000 (56)	59,500 (414)
5	138.3	84	42.6	12	43,100 (312)	5,500 (40)	48,600 (352)

Note: Figure in ( ) shows cost per km
Costs are rough estimate only

6.4 EVALUATION OF ALTERNATIVE NETWORK PLANS

The five alternatives and two variations were evaluated to select the most adequate one for further detailed study. The evaluation at this stage of the Study was made with regard to the following:

(a) Transportation Aspect: On private transport, traffic assignment gives the best estimated number of expressway users, while on public transport aspect, a key indicator assumed in this exercise is availability of expressway close to inner CBD (or Manila CBD) the most significant public transport generation/attraction area. With regard to traffic impact on at-grade roads, an indicator of vehicle-hours is the most appropriate one to express contribution of expressway introduction.

(b) Urban Development Aspect: The urban development aspects of major concern in the Study are whether or not expressways contribute to revitalization of the inner CBD and to match or meet demands of suburbanization. The former aspect is the closeness of expressways to the inner CBD, while the latter is the availability of expressways outside EDSA, especially more or less along C-5 areas.

(c) Construction Aspect: This aspect involves complexity of expressway structures and difficulties in actual implementation. The former aspect is explained by total length of expressway sections involving complicated structures (more specifically explained in section 6.3), while the latter, by the implementation difficulty due mainly to ROW acquisition and squatters dislocation expected (more specifically explained in section 6.3).

(d) Environmental Aspect: This aspect includes social and traffic pollution elements. The former is interpreted in terms of number of households to be dislocated. The extent of traffic pollution due to expressways is difficult to estimate but is roughly estimated taking into account the population who reside or are engaged in activities in the affected areas categorized by distance from expressways.

(e) Economic Aspect: Economic impacts of expressways in Metro Manila are varied and extensive of which the most important benefits is the savings of vehicle operating cost and passenger time due to increase in road traffic capacities with high standard of services. As an indication of the direct benefit, the saving was estimated for the year 2010 based on the assumed time value of P60/hr for private transport and P20 for public transport.

(f) Financial Aspect: The financial viability of expressways is a critical factor when the project is to be implemented either on BOT scheme or is required to be financially independent due to the constraints of public expenditure. Since the anticipated beneficiaries are mostly private transport users, it would be difficult for the government to justify subsidy to the project. Single year toll revenue was estimated based on the assumed traffic toll of P20 per trip.

Summary of the evaluation results are shown in Table 6.4.1, and outlined as follows:

Scheme 2 and Scheme 4

Both Schemes involve construction of an expressway along EDSA and attract the highest level of expressway users, however, these Schemes are not recommended due to the following reasons:

- Introduction of an expressway along EDSA is physically close to impossible due to existing grade separation structures and proposed LRT Line-3. (Refer to Appendix 5.5.1).

- Four-leg interchanges are required to interconnect an EDSA Expressway and radial expressways, requiring very wide areas for interchanges. All proposed interchange sites have been fully developed with commercial/business buildings, therefore, ROW acquisition for proposed interchanges is practically impossible.

- EDSA by itself is already functioning as the most important transport axis in Metro Manila. If an expressway is constructed along EDSA, transport system relies more heavily on EDSA than present, and traffic will be concentrated along this corridor as well as intersecting roads. Metro Manila should have alternative transport axes aside from EDSA so that excessive traffic concentration on a certain corridor will be avoided.

- Due to physical constraints along EDSA, these Schemes are the most costly ones.

Scheme 5

This Scheme realizes the most easiest implementation and the least adverse environmental impacts and requires the least investment, however, is not recommended due to the following reasons:

- This Scheme attracts the least expressway users. Accordingly, traffic impact on at-grade roads and generation of economic benefits is the least among alternative Schemes.

- An expressway network within EDSA is rather scarce and is not closed, thus, traffic distribution function is not attained by this expressway system, but relies on at-grade road network system. Traffic problem inside EDSA will not be improved drastically by this Scheme.

Scheme 1-A and Scheme 1-B

Comparison of Schemes 1-A and 1-B indicates superiority of the former, as follows:

- In terms of transport and urban development aspects as well as cost effectiveness and financial viability, both Schemes are evaluated almost even and there is no big difference between the two.

- Scheme 1-B utilizes PNR ROW where thousands of squatters are settled, therefore, relocation of affected squatters will create serious social problems which also seriously affect the implementation of the project.

- PNR has currently no plan to elevate PNR line in order to avoid at-grade crossings with roads, but it may wish to do so in future as demands grow. Thus, Scheme 1-B requires close coordination between PNR and DPWH.

TABLE 6.4.1 SUMMARY OF ALTERNATIVE SCHEME EVALUATION

EVALUATION FACTORS	WEIGHT OF EVALUATION FACTORS (POINTS)	ALTERNATIVE SCHEME						
		1–A	1–B	2	3–A	3–B	4	5
LENGTH (km)	--	148	149	141	160	150	144	138
PROJECT COST (Billion Peso)	–	56.1	56.4	62.8	59.8	55.3	59.6	48.7
1. Transport	30							
1) For Private transport 1/	(15)	265 (7.5)	272 (8.0)	336 (15.0)	272 (8.0)	275 (8.0)	315 (12.5)	238 (5.0)
2) For Public transport	(5)	Good (5.0)	Good (5.0)	Fair (3.0)	Fair (3.0)	Fair (3.0)	Fair (3.0)	Fair (3.0)
3) Impact on At–grade roads 2/	(10)	1,810 (8.0)	1,800 (8.0)	1,770 (9.0)	1,770 (9.0)	1,740 (10.0)	1,930 (4.0)	1,920 (4.0)
2. Urban Development	20							
1) Vitalization of inner CBD	(10)	Good (10.0)	Good/ Fair (8.0)	Good (10.0)	Fair (6.0)	Fair (6.0)	Fair (6.0)	Fair (6.0)
2) To Meet Sub–urbanization	(10)	Good (10.0)	Good (10.0)	Fair (6.0)	Good (10.0)	Good (10.0)	Fair (6.0)	Fair (6.0)
3. Implementation	15							
1) Structural–Complexity 3/	(5)	19.5 (4.0)	25.1 (3.5)	42.5 (1.0)	17.3 (4.5)	16.4 (5.0)	40.8 (1.0)	16.1 (5.0)
2) Implementation Difficulty 4/	(10)	29.5 (8.0)	34.6 (7.0)	53.8 (3.5)	26.9 (8.5)	23.0 (9.5)	41.1 (6.0)	21.9 (10.0)
4. Environment	15							
1) Social Impact 5/	(10)	9,600 (7.5)	16,100 (1.0)	10,400 (6.5)	8,500 (8.5)	9,200 (8.0)	8,500 (8.5)	7,300 (10.0)
2) Traffic Pollution (air, noise) 6/	(5)	90.0 (2.0)	89.4 (2.0)	97.1 (0.5)	91.4 (2.0)	73.1 (5.0)	82.9 (3.5)	75.5 (5.0)
5. Cost Effectiveness 7/	10	6.6 (6.5)	7.0 (7.0)	7.6 (7.5)	8.4 (8.5)	10.1 (10.0)	3.0 (3.0)	3.8 (4.0)
6. Financial Viability 8/	10	1.9 (5.5)	1.9 (5.5)	2.4 (8.0)	1.9 (5.5)	1.9 (5.5)	2.8 (10.0)	1.7 (4.5)
Total Score	100	(74.0)	(65.0)	(70.0)	(73.5)	(80.0)	(63.5)	(62.5)
Ranking		2	5	4	3	1	6	7

NOTES:

1/ No. of expressway users under the assumed level of P20/trip flat toll and P1.0/min/pcu time value (1,000 pcu/day)
2/ Aggregate vehicle–hours of all at–grade roads (1,000 veh–hours)
3/ Total length of expressway sections involving complex structure (km.)
4/ Total length of expressway sections where implementation difficulties are expected (km.)
5/ No. of households affected
6/ Total length of expressway sections along which land use is residential or clearance between an expressway and building line is less than 5 meters (km.)
7/ Single year direct benefits (savings of VOC and passenger time) in year 2010 (Billion Pesos)
8/ Single year toll revenue in year 2010 (P20/trip) (Billion Pesos)
* Figure in ( ) shows scored points.

Scheme 3-A and Scheme 3-B

Comparison of Schemes 3-A and 3-B clearly indicates the superiority of Scheme 3-B.

- In terms of private and public transport aspects, urban development aspect and financial viability, both Schemes are evaluated even.

- Scheme 3-B is superior in terms of traffic impact on at-grade roads, implementation (both structural complexity and implementation ease), traffic pollution and cost effectiveness.

- Although Scheme 3-A is superior to Scheme 3-B in terms of social impacts, difference of both Schemes is minor.

Based on above discussion, Scheme 1-A and Scheme 3-B were left for detailed comparison. Comparison of two schemes indicates the superiority of Scheme 3-B as follows:

Scheme 1-A

- This Scheme provides more direct access to the inner center (or Manila CBD), so that it will promote revitalization of the traditional CBD with improved accessibility of private transport.

- This Scheme will also provide better opportunities for public transport to use the expressways to/from the inner center area where the largest public transport demand distributes.

- One of the major disadvantages of this Scheme is that the inner circumferential expressway (or Expressway Route C-2) has short extension, therefore, only five (5) radial expressways can be connected with it, interchange interval is short and number of on/off ramp locations is also limited. Thus, traffic functionality of the inner circumferential expressway is much inferior to Scheme 3-B.

Scheme 3-B

- This Scheme matches better future private transport demand (the largest desire line exists between Quezon City and Makati).

- Superiority of this Scheme is obvious in the aspects of impact on at-grade roads, implementation (both structural complexity and implementation ease), traffic pollution and cost effectiveness.

- Also this Scheme is slightly superior in the aspects of private transport and social impact.

- This Scheme is inferior only in the aspects of public transport and vitalization of inner CBD (or Manila CBD).

The selection of the alternatives depends on how the evaluation aspects are weighted. In this Study, aspects of meeting private transport demand, functionality of inner circumferential expressway, implementation and construction ease and cost effectiveness have been more seriously taken into account than the aspect of direct access to and vitalization of the inner CBD.

It is recommended that Scheme 3-B be selected for Metro Manila Urban Expressway System.

CHAPTER 7

RECOMMENDED URBAN EXPRESSWAY SYSTEM

CHAPTER 7

RECOMMENDED URBAN EXPRESSWAY SYSTEM

7.1 RECOMMENDED URBAN EXPRESSWAY NETWORK

1) Expressway Network Configuration

Of the seven (7) schemes studied, Scheme 3-B was selected as the most appropriate urban expressway system for Metro Manila, of which configuration is basically a circumferential and radial pattern.

Scheme 3-B or Metro Manila Urban Expressway System (MMUES), composes of two (2) circumferential expressways, namely Route C-3 and Route C-5, and 11 radial expressways. Routes C-3 and C5 are located 6 to 8 km. apart and are connected with each other by six (6) radial expressways at an interval of 4 to 8 kms. In the area inside Route C-3, three (3) radial expressways are extended towards Manila CBD. In the area outside Route C-5, eight (8) radial expressways are extended towards outer area of Metro Manila, three (3) in the south, two (2) in the east and three (3) in the north.

Two north-south transport axes are formed, one by Routes R-3, C-3 and R-9 which connects existing inter-city expressways of North and South Luzon Expressways and the other by Routes R-2, C-5 and R-8 to cope up with growing traffic demand in that direction.

MMUES is presented in Figure 7.1.1 with Metro Manila Tollway which is regarded as committed and to be implemented by the Philippine National Construction Corporation (PNCC).

MMUES includes about 150 kms. of expressways, 17 interchanges, 11 each of entrances and exits at the beginning/end of an expressway, 47 on-ramps and 51 off-ramps of which layout is shown in Figure 7.1.2.

Characteristics of recommended MMUES are summarized as follows:

- MMUES intends to contribute to strengthening of Metro Manila major road network from traditional radial/circumferential pattern to north-south ladder pattern. Although the expressway routes are to be constructed mainly along the existing road space, planning intension is placed to strengthen north-south axes to meet the urban development trend and policy.

- MMUES intends to strengthen the major road network in more balanced manner, while at the same time it contributes to relieving traffic concentration in the inner city and especially along EDSA.

- MMUES intends to meet transport development needs both from short-term as well as from long-term viewpoints. R-91/C3/C2/R3 axis with branches is expected to directly meet the present urban transport demands, while R8/C5/R1-R2 axis is expected to generate organized urban/transport activities in the outer areas where urbanization is in rapid progress.

- MMUES will be integrated effectively with existing/planned major roads at strategic points so that road users can have alternative high quality services. This will vitalize socio-economic activities in Metro Manila.

- MMUES will be constructed in such a way that future requirements of construction space by urban rail transit such as LRT and PNR could be adequately satisfied.

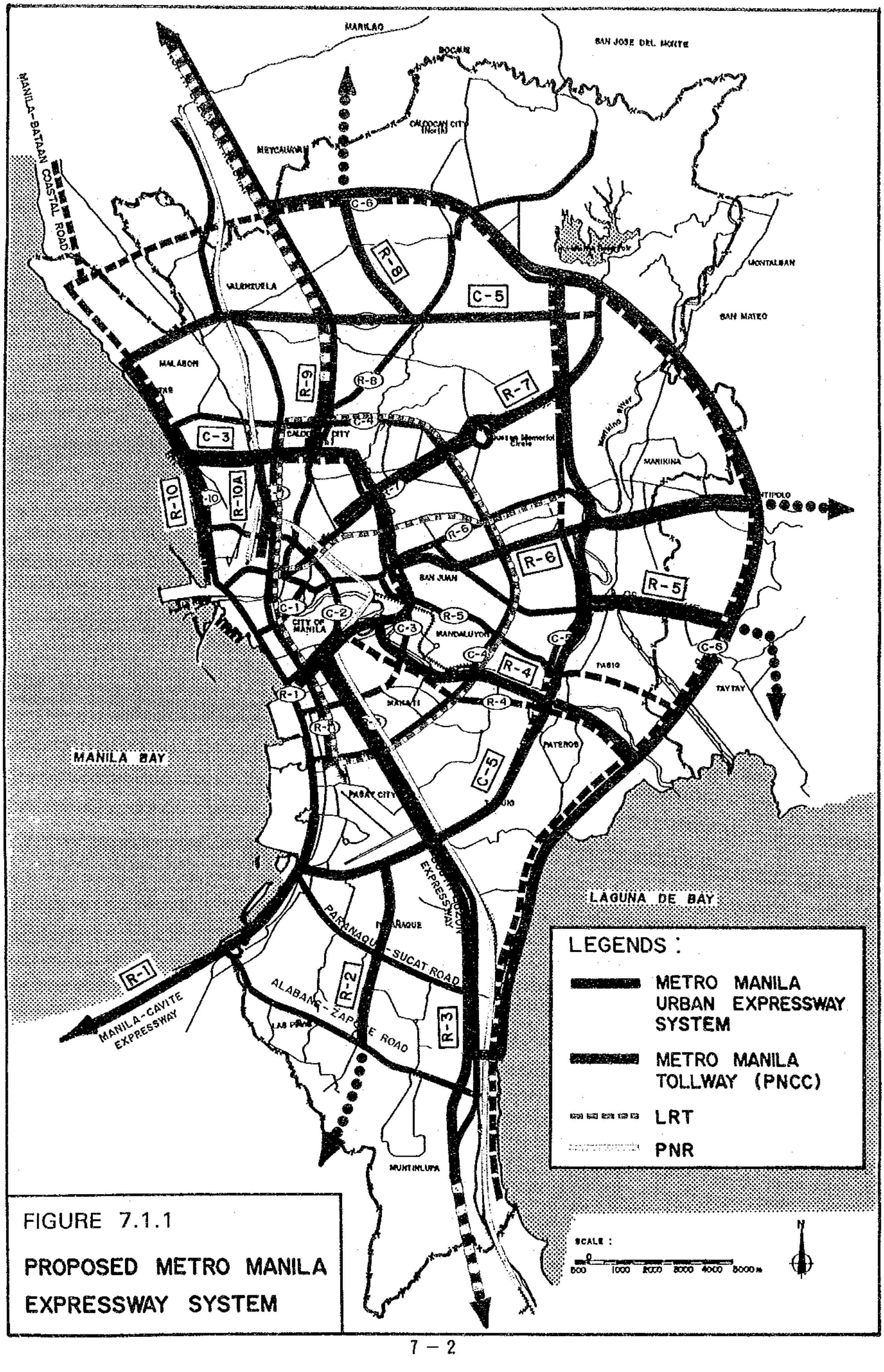


FIGURE 7.1.1

PROPOSED METRO MANILA EXPRESSWAY SYSTEM

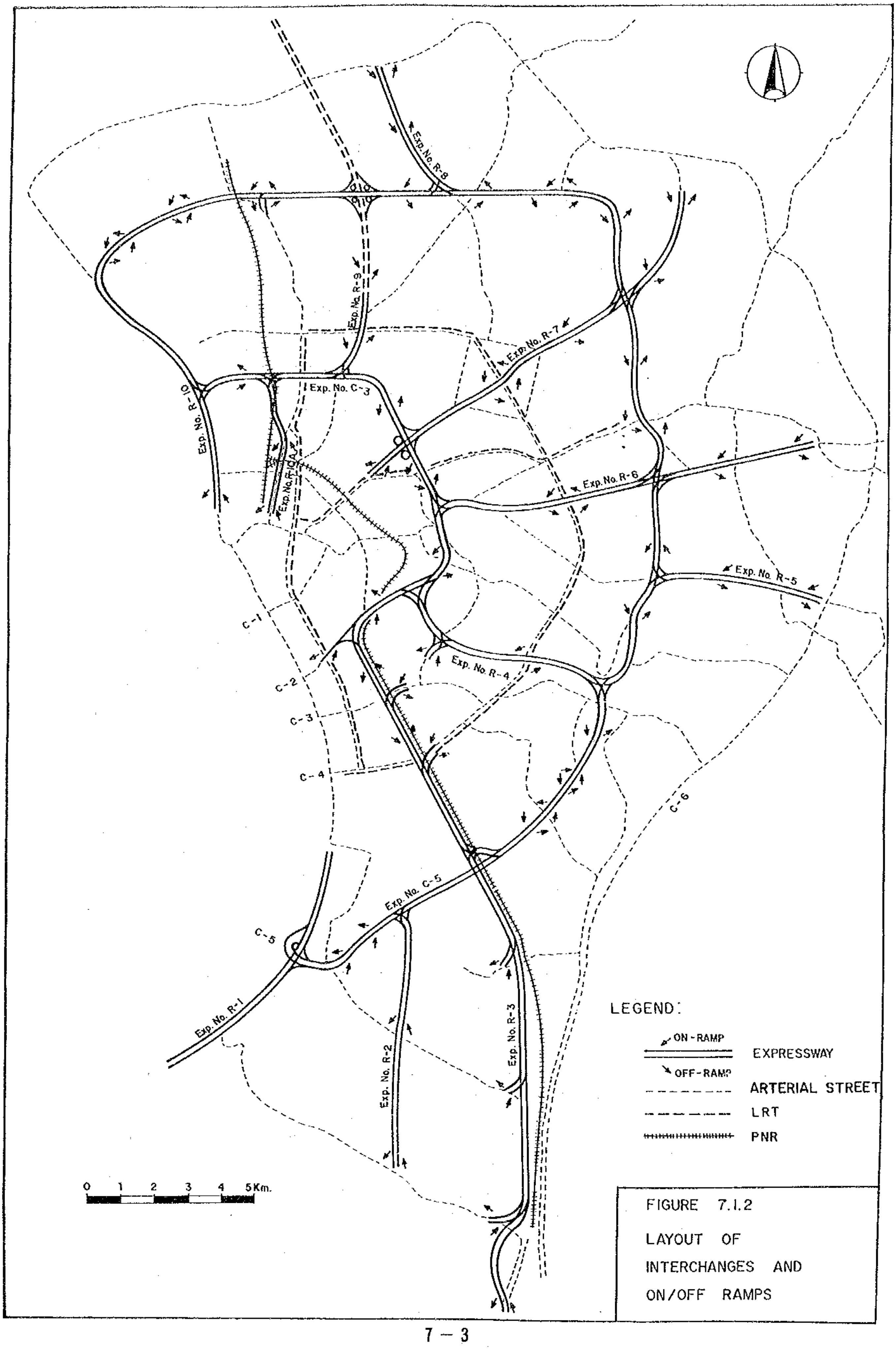


FIGURE 7.1.2

LAYOUT OF INTERCHANGES AND ON/OFF RAMPS

2) Outline of Each Expressway

Outline of each expressway is summarized in Table 7.1.1 and discussed below:

Expressway Route C-3

This route serves as an inner circumferential expressway and distributes traffic to/from radial expressways.

The route starts at Quirino Ave./Adriatico intersection and follows Quirino Ave. towards the east up to about Paco Station of PNR. From that point, the route extends towards northeast direction and crosses Aurora Blvd., then turns to northward direction following San Juan River or an at-grade C-3 up to Sgt. River St. At the intersection between Araneta Ave. and Sgt. Rivera St., the route goes towards the west until it merges with Expressway Route R-10 which is the end of the route.

The route has an approximate length of 17.5 kms. and will be an elevated expressway.

The expressway crosses over LRT Line-1 at Taft Ave., LRT Line-2 at E. Rodriguez Ave.and LRT Line-1 at Rizal Ave. Extension.

The route between Araneta Ave. and R-10 utilizes ROW at-grade C-3 where DPWH is encountering difficulty in acquiring ROW. ROW acquisition for at-grade C-3 will be one of key factors to realize this route, therefore, should be expedited.

The interchange between this route and Route R-7 (Quezon Avenue - Commonwealth Ave. Route) will be a 4-leg interchange requires ROW acquisition of wide area. All other interchanges with radial expressways are planned to be 3-leg interchanges.

Expressway Route C-5

Located inbetween the inner circumferential expressway (Route C-3) and the outer circumferential expressway (Metro Manila Tollway committed by PNCC), this route functions as the central circumferential expressway. At the same time, the route takes a role as the important north-south transport axis serving for traffic in the rapidly urbanizing areas as well as guiding the sound urban development of suburban areas.

The route follows more or less the alignment of at-grade C-5, and has an approximate length of 46 kms. The section from Route R-1 to Route R-3 (along SLE) can be an at-grade expressway utilizing wide at-grade C-5 ROW of 60 meters.

The section from Route R-3 to Route R-4 (along Pasig River) can also be an at-grade expressway accommodated within the 60-m ROW of at-grade C-5. Construction of an at-grade C-5 is on-going in this section, which will be converted to an expressway with provisions of service roads on both sides in future.

The section from Route-4 to Route-7 (along Quezon Ave. and Commonwealth Ave.) will have to be elevated, as the ROW of an at-grade C-5 is 40 meters.

TABLE 7.1.1 OUTLINE OF EXPRESSWAYS COMPRISING OF MMUES

	ROUTE NO.	ROUTE LOCATION	LENGTH (KM.)	ELEVATED OR AT-GRADE	STATUS OF AT-GRADE ROAD	NOTES
Circumferential Expressways	C-3	• Inner Circumferential Expressway • Starts at Quirino Avenue Adriatico intersection and follows Quirino Ave., PNR, and San Juan River up to Aurora Blvd. From Aurora Blvd. to R-10, follows more or less alignment of at-grade C-3	17.5	• All elevated	• At-grade C-3 from A. Mabini St. to Araneta Ave. is still incomplete. Sections from A. Mabini St. to Rizal Ave. Ext. and from Rizal Ave. Ext. to Araneta Ave. is scheduled to be completed by 2000 and 1995, respectively	• Major alignment alternatives, along at-grade C-3 or along San Juan River
	C-5	• Central Circumferential Expressway • Follows more or less the alignment of at-grade C-5	45.8	• At-grade from R-1 to R-4 and from Luzon Ave. to R-10 • Elevated from R-4 to Republic Ave.	• Still incomplete except section from Pasig River to Commonwealth Ave. • Sections from R-1 to SLE and from Commonwealth Ave. to R-10 are scheduled to be completed by 2000, section from SLE to R-4 by 1995	• Sections from R-1 to SLE, from Commonwealth Ave. to NLE and from NLE to R-10 are proposed to be implemented by BOT Scheme
Radial Expressways	R-1	• Along Manila Bay Coastal Line • Existing R-1 Ext.itself is utilized	-	(• Completed as at-grade road)		• PEA has a plan to convert this to a tollway
	R-2	• New link. Passes through about the center between South Luzon Expressway (SLE) and R-1 Extension	7.4	• At-grade or elevated	• No at-grade road	• At-grade expressway if 60-m ROW can be acquired if not, elevated expressway • Candidate for connection with future inter-city expressway
	R-3	• Called as Manila South Tollway (MST) • Along South Super Highway (SSH) and SLE from Quirino Ave. to Alabang	20.8	• All elevated except 1-km section near NAIA	• Both SSH and SLE are existing	• Major alignment alternatives, over PNR ROW or over SSH
	R-4	• Along Pasig River from Route C-3 to Route C-5	7.2	• All elevated		• Mostly along the southern bank of the River. Partially the northern bank utilized
	R-5	• Along Ortigas Ave. Ext. from C-5 to C-6	5.3	• All elevated	• Ortigas Ave. Ext. is being widened and completed by 1995	• Ortigas Ave. Ext.'s ROW is not wide enough, double deck type of structure needed • Candidate for connection with future inter-city expressway
	R-6	• Along Santolan Road and Marcos Highway from Route C-3 to Sumulong Highway	12.0	• All elevated	• Santolan Road has to be widened	• Careful alignment study especially inside EDSA needed • Candidate for connection with future inter-city expressway
	R-7	• Along Quezon Ave. and Commonwealth Ave. from Welcome Rotonda to Capitol Hills	12.4	• Elevated from Welcome Rotonda to Quezon Memorial Circle • Quezon Memorial Circle be underpassed • At-grade along Commonwealth Ave.	• Both Quezon Ave. and Commonwealth Ave. existing with wide ROW	
	R-8	• Along Mindanao Ave. from C-5 to C-6	4.7	• At-grade or elevated	• Mindanao Ave. between C-5 and C-6 is still missing and to be completed by 2000	• At-grade expressway, if 60-m ROW is acquired • Candidate for connection with future inter-city expressway
	R-9	• Along A. Bonifacio Ave. and North Luzon Expressway from C-3 to about 0.5 km north of toll plaza	3.8	• All elevated	• Both A. Bonifacio and NLE existing	• ROW of A. Bonifacio is rather narrow, a double deck type of structure may be required
	R-10	• Along at-grade R-10 from Moriones Ave. to C-5	8.6	• All elevated	• 25-m portion of 50-m ROW completed • Ultimate stage will be completed by 2010	• One half of ROW occupied by squatters. Relocation of them needed
	R-10A	• Along Abad Santos Ave. and PNR North Line from C-1 to C-3	4.0	• All elevated	• Abad Santos Ave. is existing	• Relocation of squatters along PNR needed
		T O T A L	149.5			

The section from Route R-7 to Republic Ave. follows the alignment of Luzon Ave. which utilizes the 60-m ROW of MWSS and will have to be elevated due to existing MWSS aqueducts.

The section from North Luzon Expressway to R-10 can be an at-grade expressway accomodated within the 60-m ROW of at-grade C-5.

The at-grade C-5 is partially developed. Existing sections of the at-grade C-5 are only between Shaw Blvd. and Santolan Road (called E. Rodriguez Ave.) and between Aurora Blvd. and Commonwealth Ave. (called Katipunan Ave.). The rest of the sections are still non-existent. Thus, one of the most priority projects of DPWH is to complete at-grade C-5. DPWH intends to implement the following sections by BOT scheme:

Sections Proposed To Be Implemented by BOT

- Section from R-1 to South Luzon Expressway
- Section from Commonwealth Avenue to North Luzon Expressway
- Section from North Expressway to R-10

If these sections are implemented by BOT, these will be access-controlled for toll collection and can be included in a part of Expressway Route C-5. Instead, service roads should be developed to provide access to abutting areas.

Expressway Route R-1

This route has been completed with partially access controlled standard and runs along the southern Manila Bay coastal line on the reclaimed land. The route provides the important link between the western area of Cavite Province where industrial estates as well as residential areas are being developed and Manila CBD.

Public Estate Authority (PEA) has a plan to convert this to a tollway.

Expressway Route R-2

The area between R-1 extension and South Luzon Expressway suffers lack of major roads, particularly in the north-south direction. The area is rapidly urbanizing and accessibility problem is becoming more serious year by year.

The route traverses almost center of the said area from C-5 to Alabang-Sucat Road and extends for about 7.5 kms.

The first step is to construct an at-grade road with 40 to 60-m ROW. When a 60-m ROW can be acquired, an at-grade expressway will be accommodated within the ROW. When a 40-m ROW is only feasible due to difficulty in acquiring wide ROW, an expressway will be an elevated type.

This route can be extended towards Manila CBD only up to C-5. Extension of the route further than that point is not feasible, blocked by Ninoy Aquino International Airport (NAIA).

This route provides good opportunity to be connected with a new inter-city expressway serving the areas south of Metro Manila in future.

Expressway Route R-3

This route is also called as Manila South Tollway (MST) and located along South Super Highway (SSH) and South Luzon Expressway (SLE). It starts at the intersection between Quirino Ave. and SSH, then runs towards the south up to Alabang Interchange of SLE. Total length of the route is approximately 21 kms.

There are two options for its alignment, one is to utilize PNR ROW and the other SSH and SLE ROW. Most of the sections of this route will be elevated over PNR or SSH/SLE.

This corridor is one of the most heavily traffic loaded ones. The route will greatly improve accessibility to Makati CBD. Connections with EDSA and C-5 should be carefully studied. The former has physical constraints due to the existing MSDR interchange and the latter due to proximity to NAIA.

Expressway Route R-4

The route runs along Pasig River from Route C-3 to Route C-5 for an extension of about 7.2 kms. and is constructed as an elevated structure.

It will be constructed mostly along the southern bank of Pasig River, however, the northern bank will be partially utilized along Coronado St. in Mandaluyong.

Factories, warehouses and residential houses have been built up to the edge of the river banks and squatters have also been settled along the banks, therefore, social impact study should be carafully undertaken.

Access ramp to Makati CBD from this route will be very important, which will branch off at about Sta. Ana Race Track, then go over South Ave. and be extended close to Buendia Ave.

Expressway R-5

The route will be constructed over Ortigas Ave. Extension from C-5 to C-6 for an extension of about 5.3 kms.

This route serves for traffic from the southern part of eastern Metro Manila and Rizal Province to various urban centers/CBDs.

Ortigas Ave. Extension's ROW is not wide enough to accomodate a 4-lane expressway, therefore, a double deck type of structure will be required.

Expressway Route R-6

The route functions as the vital link to directly connect the eastern area with Manila CBD. It branches off from Route C-3 (the inner circumferential expressway), passes through San Juan and goes over Santolan Road and Marcos Highway. The estimated length of the route is about 12 kms.

As Santolan Road has narrow ROW, land acquisition of Camp Aguinaldo and Crame as well as private lands is required.

A careful alignment study for the section near Expressway Route C-3 must be done where a lot of ROW acquisition is involved. The route can be a good candidate to be connected with future inter-city expressway extending eastern area of Metro Manila.

Expressway Route R-7

This corridor is one of the most heavily traffic loaded ones in Metro Manila. Particularly, private trip demand along this corridor is expected to increase sharply.

The route starts at Welcome Rotonda and goes along Quezon Ave. and Commonwealth Ave. up to Batasang Pambansa. The route has a length of about 12.4 kms.

The expressway will be elevated from Welcome Rotonda up to Quezon Memorial Circle. It will pass under Quezon Memorial Circle and be at-grade along Commonwealth Ave.

Expressway Route R-8

The route passes along Mindanao Ave. from C-5 to C-6 for an extension of about 4.7 kms. Proposed ROW of Mindanao Ave. is 38 meters, however, which should preferably be 60 meters so that an at-grade expressway can be accommodated within ROW.

The route is a possible candidate to be connected with an inter-city expressway which will be needed in addition to North Luzon Expressway in future.

Expressway Route R-9

The route is connected with North Luzon Expressway and serves as a vital link to distribute traffic from NLE into area of Metro Manila or vis-a-vis.

The route starts at Expressway Route C-3, goes over A. Bonifacio Ave. and NLE and ends at about 0.5 km. north Of NLE Toll Plaza. It has a length of about 3.8 kms.

A. Bonifacio Ave. has rather narrow ROW (28 meters), therefore, a double deck type of structure may have to be planned.

Expressway Route R-10

The route will be constructed over at-grade R-10 from Moriones Ave. to C-5 for an extension of about 8.6 kms.

The route is a vital link to serve for traffic to/from Manila International/Domestic Harbors.

At-grade R-10 has a wide ROW of 50 meters, however, one half of ROW has been occupied by squatters. Relocation of affected people will have to be done so as to minimize social problems.

Expressway Route R-10A

The route will provide direct access to the northern part of Manila CBD.

The route branches off from Expressway Route C-3, then extends towards Manila CBD utilizing ROW of PNR North Line and Abad Santos Ave. and ends at C-1. It has an extension of about 4 kms.

PNR ROW has been occupied by a lot of squatters, relocation of affected people should be so done that social problems be minimized.

7.2 STAGE DEVELOPMENT PLAN

1) Stage Development Alternatives

As MMUES requires huge amount of capital investment, it must be implemented in accordance with proper stage development plan.

Basic principle adopted for developing alternatives is as follows:

- Inner circumferential expressway, i.e. Route C-3 and other spine radial expressways should be firstly constructed to form inner transport core, so as to mitigate rapidly worsening traffic situation inside EDSA.

Based on the above principle, three (3) alternatives were studied as follows: (See Figure 7.2.1):

Alternative-A: Traffic Demand Oriented Plan

Expressway routes which attract heavy traffic are to be constructed first in order to improve overall transport efficiency of Metro Manila

Alternative-B: Balanced Area Development Oriented Plan

In addition to inner transport core, one radial expressway is to be constructed in each area of south, east and north in order to achieve balanced area development

Alternative-C: Makati CBD Access Improvement Oriented Plan

Expressway routes which surround Makati CBD are to be constructed first to strengthen accessibility to Makati CBD

2) Assessment of Alternatives

Alternative-C will surely improve accessibility to Makati CBD, however, accessibility improvement of Manila CBD which is another huge traffic generating source, is rather neglected. Thus, Alternatives-A and B were left for comparison.

Only difference between Alternatives-A and B is whether Route R-7 (along Quezon Ave. and Commonwealth Ave.) or Route R-6 (along Santolan Road and Marcos Highway) be constructed first.

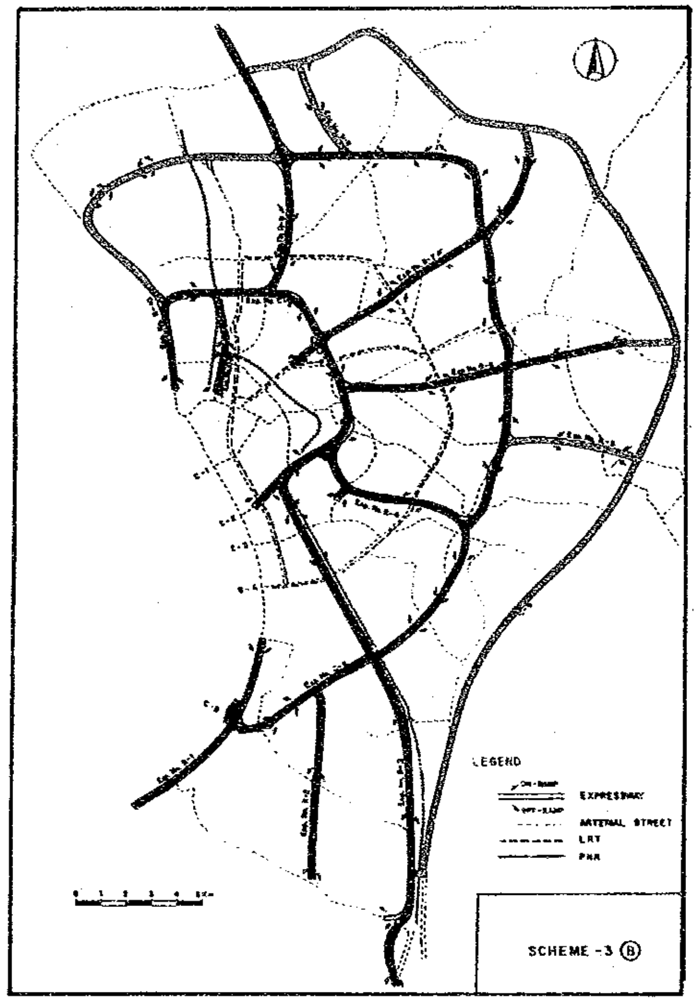
<u>Route R-7</u>

- Route R-7 serves the area where car ownership rate is and will be high, thus attracts more traffic than Route R-6.
- Route R-7 can be built over Quezon Ave. without additional ROW acquisition except interchange area. Section along Commonwealth Ave. which has 95-meter ROW can be an at-grade expressway.

FIGURE 7.2.1 STAGE DEVELOPMENT ALTERNATIVES

ALTERNATIVE - A

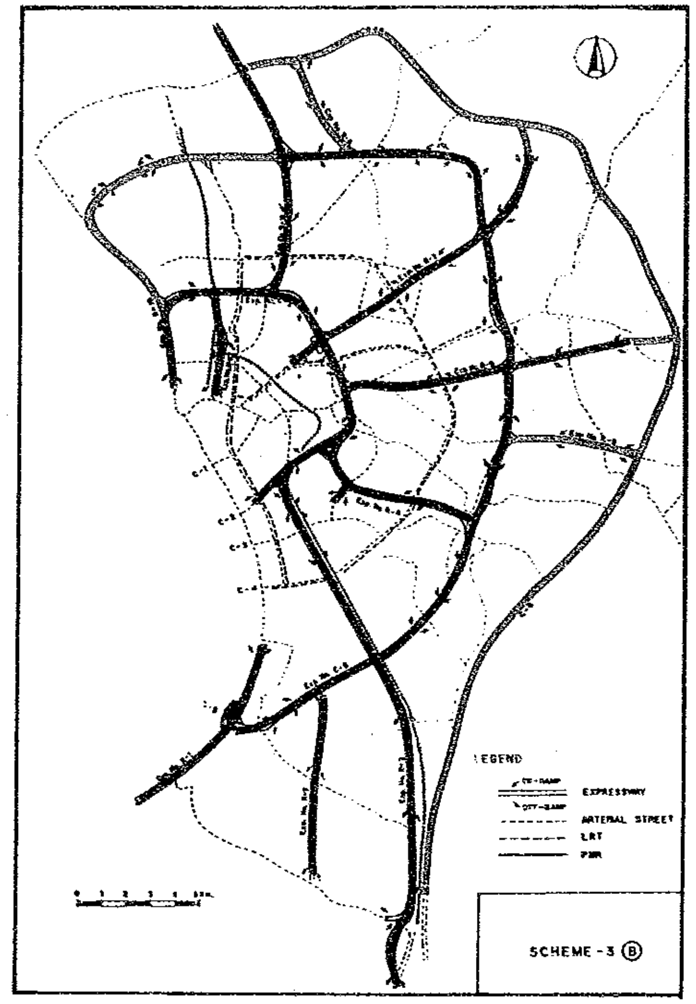
* TRANSPORT DEMAND ORIENTED PLAN



FIRST STAGE	–	60.0 km.
SECOND STAGE	–	66.1 km.
THIRD STAGE	–	69.8 km.
TOTAL		195.9 km.

ALTERNATIVE - B

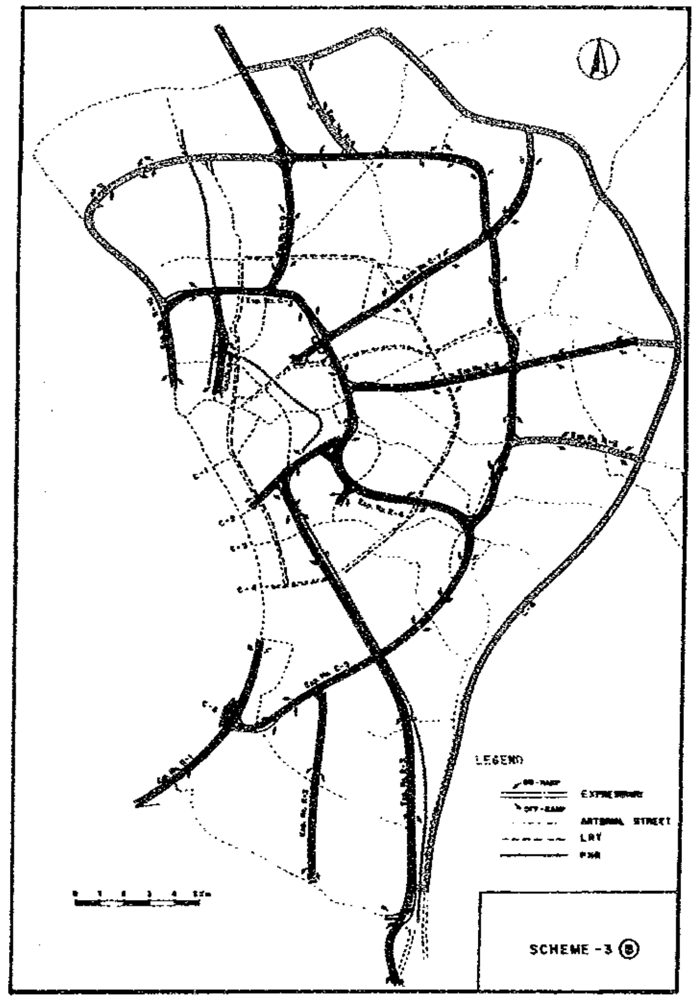
* BALANCED AREA DEVELOPMENT PLAN



FIRST STAGE	–	59.6 km.
SECOND STAGE	–	66.5 km.
THIRD STAGE	–	69.8 km.
TOTAL		195.9 km.

ALTERNATIVE - C

* MAKATI CBD ACCESS IMPROVEMENT PLAN



FIRST STAGE	–	63.4 km.
SECOND STAGE	–	62.7 km.
THIRD STAGE	–	69.8 km.
TOTAL		195.9 km.

NOTE: THIRD STAGE includes Metro Manila Tollway (46.4 km.)

Route R-6

- Route R-6 will be a major transport axis in the eastern area where transport facilities are less developed.

- In the area surrounded by Pasig River, EDSA, Aurora Blvd. and C-2, all at-grade roads are narrow and congested, however, widening of these roads are quite difficult due to heavy roadside development. Therefore, there is a strong need to construct new transport axis in this area.

- Route R-6 requires extensive ROW acquisition along Santolan Road and San Juan area.

In view of above, it is recommended that Route R-7 be constructed first, while preparation for Route-6 construction such as an alignment study, determination of ROW acquisition areas and ROW acquisition be undertaken during implementation of Route R-7.

Thus, Alternative-A is recommended for a stage developmenmt plan of MMUES.

3) Project Cost

Project cost of MMUES is about P55 billion including civil work and ROW acquisition, which can be further brokendown into these by stages; P23 billion, P24 billion and P8 billion for Stage I, Stage II and Stage III, respectively.

TABLE 7.2.1 PROJECT COST BY STAGE

P million

STAGE	CIVIL WORK	ROW ACQUISITION	TOTAL
Stage I	20,744	2,639	23,383
Stage II	20,468	3,314	23,782
Stage III	7,375	734	8,109
TOTAL	48,587	6,687	55,274

7.3 EXPRESSWAY OPERATION AND MAINTENANCE PLAN

Expressways require adequate management to maintain designed service level for users; travel speed, safety and comfort. Major areas to be looked into at this stage of the study are management of expressway facilities, traffic management and control, toll rate and collection which are explained below.

1) Management of Expressway Facilities

Management of various expressway facilities is to maintain expressway in good condition to ensure safety and comfort of users, economic life of facilities and to keep the right-of-way free from illegal use.

In view of that MMUES is mostly elevated expressways, major maintenance works consist of the following:

Inspection

- Daily inspection to identify maintenance needs, damages, obstacles on the expressways, etc.
- Intensive inspection to judge structural soundness, probably every 5 years.
- Emergency inspection just after an earthquake, a typhoon, a fire below or nearby expressway, vehicular collision with an expressway substructure, etc. to evaluate damaged portions.

Routine Maintenance

- Cleaning of road surface, storm water drainage system, traffic control facilities, toll collection facilities, lighting facilities, etc.
- Repainting road markings
- Crack sealing of deck slabs of superstructure and other concrete structures
- Sealing and patching of AC pavement
- Minor repair of expressway facilities

Periodic Maintenance and Repair

- Repair of expansion joints, deck slabs, and other parts of viaducts
- Repair of toll collection facilities
- Repair of traffic control facilities
- Repair of other facilities
- Overlay of pavement
- Repainting of steel structures

Emergency Maintenance and Repair

- Damages made by vehicles collision with expressway facilities and calamities

Improvement

- Installation of additional noise barriers and other facilities related to environmental protection
- Improvement of traffic safety facilities

Inspection should be done by administration. Other maintenance works can be done by contract, particularly periodic maintenance and repair works and improvement works.

2) Traffic Management

Traffic management for expressways includes the following activities.

(a) Traffic Control: Traffic control for expressways to provide users with smooth and safe traffic through

- enforcement of speed limit: Speed limit can be enforced in coordination with traffic police by way of patrol or vehicular speed controller.

- enforcement of restrictions on vehicle type and weight limit: Type of vehicles which are not allowed to use expressways should include slow moving vehicles, motorcycles, tricycyle, present jeepney and trailers. Axle load scale could be installed at selected toll gates where heavy vehicles or overloaded trucks are expected. Restrictions cover total weight, axle load, width, height, length of vehicles.

- regulation of traffic entry at ramps: In order to prevent congestions or to mitigate traffic congestions occured on expressways, traffic entry to expressways will be regulated at relevant toll gates.

(b) Accident Management: Accidents on expressways are to be handled effectivity to minimize the disturbance to traffic flow. Emergency bay and emergency telephone need to be provided at appropriate intervals (say about every 500 meters). Rescue facilities/equipment for breakdown vehicles are also to be provided.

(c) Traffic Information System: For effective control of traffic flow, traffic information need to be properly collected and processed. Main components are as follows:

- Collection of traffic data: vehicle detections (loop or ultrasonic) are to be installed at adequate intervals (say about 500 meters).

- Closed circuit TV for surveillance: TV cameras are to be installed at junctions, curved sections etc to monitor traffic conditions. Pictures are transmitted via cable to the monitor in traffic control centre.

- Patrol car: Traffic information from patrol cars will be sent via wireless to traffic control centre.

- Traffic data processing: Various traffic data/information collected are processed using computer for effective traffic management and control. .

- Traffic information: Various information needed by drivers such as traffic congestions, accidents, vehicle breakdown, closure of toll gates, road conditions, etc. will be provided using variable message and graphic signs. Changeable message sign can also be provided on surface streets to guide expressway users adequately.

A concept of the entire traffic management system can be illustrated as shown in Figure 7.3.1.

3) Toll Rate and Collection

Although toll rate needs to be charged according to trip length on expressways, flat rate system is usually adopted for urban expressways. For MMUES, flat rate system is applied due to following reasons:

- To minimize stoppage at toll booths to handle heavy traffic effectively.
- To attract traffic with longer trip length to encourage functional complement between expressway and surface street
- To lessen provision of toll collection facilities. Under flat rate system, toll booths can be provided only at entrance ramps.

In order to reduce service time at toll booths, vehicle types should be farther grouped, say, into large vehicle and ordinary vehicle. Issuance of season tickets is also considered effective for reduction of service time.

Toll collection will be made manually. Number of tickets sold will be compared with actual vehicle traffic volume counted with automatic traffic counter.

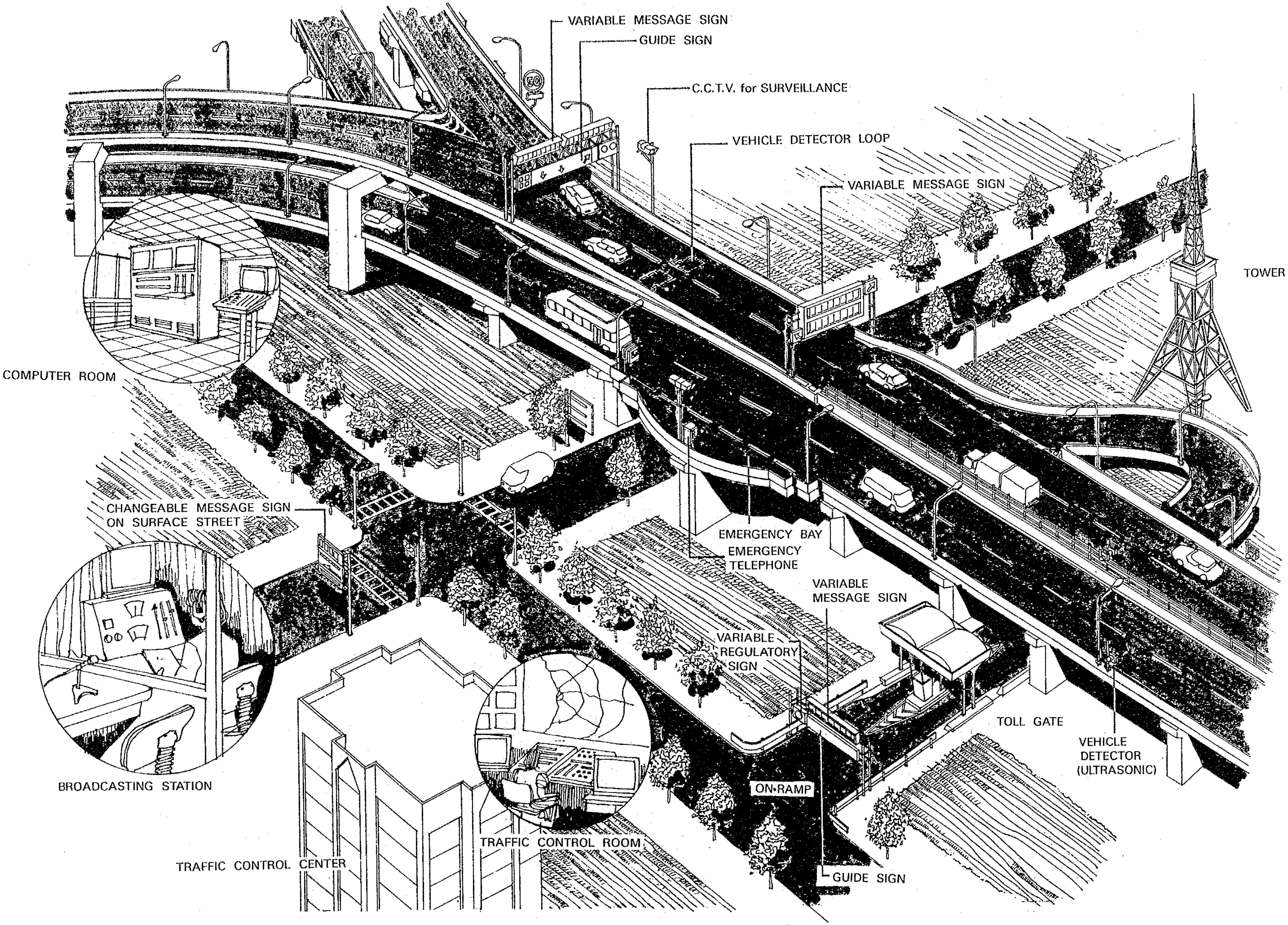


FIGURE 7.3.1 CONCEPTUAL PLAN OF TRAFFIC MANAGEMENT SYSTEM

7.4 PUBLIC TRANSPORTATION ON EXPRESSWAY

One of the important function expected for Metro Manila urban expressways is that expressways are not only to serve private transport but also to provide opportunities for the improvement of public transport services. Although no quantitative analysis on the forecast of public transport demand via expressways is expected that potential demand exist in the following areas;

(a) Provincial buses: As urban expressways are linked with intercity expressways both in the north and the south via inner areas where a number of bus terminals are located, there would be a strong patronage of those buses, of which travel time would be greatly affected by worsening traffic congestions in Metro Manila.

(b) Urban buses: Bus services in Metro Manila have been changing. Introduction of Love Bus in the early 1980s has made air-conditioned bus services at higher fare popular. With an increase of average income, worsening traffic congestions, difficulties of car parking in CBD etc, intermediate demand between ordinary bus/jeepney service and private car transport has been growing. Expansion of urban area also tends to lengthen average trip length of transport users. Therefore, with urban expressways it is also expected that public transport passengers with longer trip length and requiring better services would use expressways if bus services are provided adequately in terms of services and routing. Expressway bus service could also encourage diversion from private car use.

Present jeepneys may be restricted from using expressways because that jeepneys are suitable more for demand with short trip and their physical standards do not comply with high standard roadways.

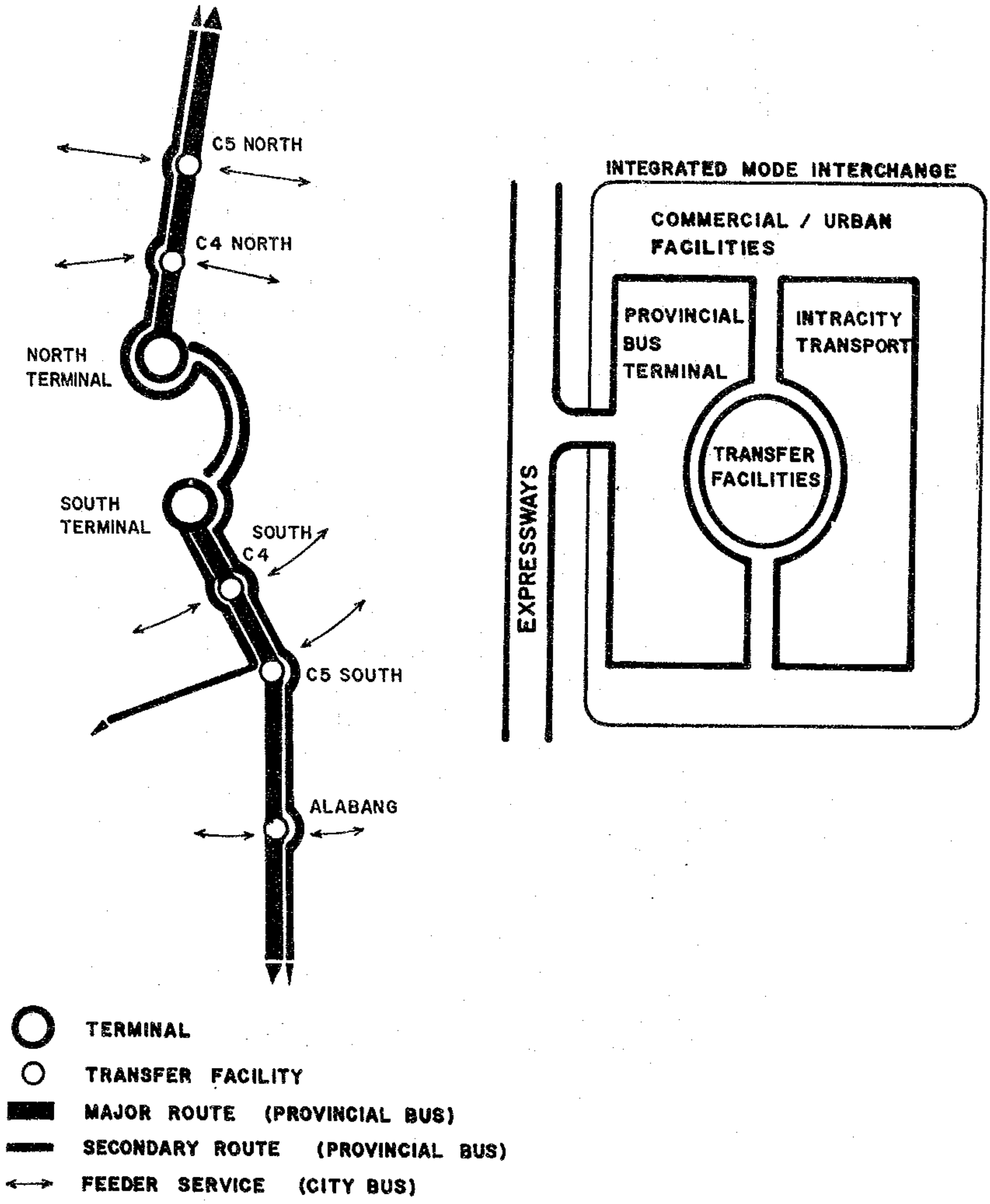
On the proposed expressways it is considered that no special facilities for expressway bus services might be needed. However, if large-scale common bus terminal is developed by integrating existing small ones (there has been plans/proposals on the construction of integrated bus terminals), the terminal could be provided with direct access from the expressways.

A concept of integrated provincial bus terminal is that provincial buses could directly access/egress to/from the terminal via expressway where passengers are provided with convenient transfer between urban transport system as well as adequate passenger facilities. For example, the terminal concept can be illustrated as shown in Figure 7.4.1. The terminals could be either centralized or decentralized in two locations; one for the north and one for the south, depending upon the demand pattern, availability of space, impact on the local conditions, etc.

Another important implication of expressway construction with bus/jeepney services is the utilization of road space on the at-grade roads where expressways are constructed. Since private traffic along these roads is provided expressways, at-grade road space should be redesigned to facilitate public transport services such as bus lanes, bus bays and stops as well as better passenger facilities.

Figure 7.4.1

Concept of Integrated Provincial Bus Terminal



7.5 INTEGRATED EXPRESSWAY AND URBAN DEVELOPMENT

Constructing expressways in an effective integration with urban development is important from the following viewpoints:

(a) Promoting effective suburbanization for road-based large cities like Metro Manila: Accessibilities of large urban areas tend to worsen quickly if they are totally rely on roads transport. Progress in suburbanization creates many bottlenecks along the roads to/from the city centre. Expressways would contribute to encouraging more effective suburbanization through development of suburban centres which can be linked with the CBD via expressways, decentralization of socio-economic activities, development of satelite towns/industrial estates and so on.

(b) To internalize the economic effects of expressways to cross-subsidize the project: Impacts of expressways on urban development are considered significant. Expressways improve accessibilities of affected areas greatly, provide quality transport services, thus enhance urban development potentials and land prices. By internalizing the development opportunities through direct involvement or institutional mechanism such as taxation, additional revenues could be generated to cover portion of expressway construction costs.

(c) To expand the coverage of beneficiaries: Expressways might not benefit local communities where expressways are constructed. One of the possible areas to share the benefits of expressways with local communities is the use of expressways with local communities is the use of space under expressways to be made available in some locations. Although there might be institutional implications among agencies, the proposed expressway alignments and the use of available rigth-of-way are to be incorporated with city plan of relevant cities/municipalities for possible effective use of the space and facilities such as parking lot, children's playground, park, community centre/facilities, low cost housing, market and shops, etc.

More concrete measures to be taken into account are as follows:

(a) To strengthen accessibilities by providing additional quality access to the following major traffic generating sources as shown in Figure 7.5.1.

<u>Manila CBD:</u> Traffic attracted on radial expressways is distributed by Route C-2 and access to Manila CBD is made via at-grade roads. Three (3) radial expressways (Routes R-3, R-10 and R-10A) provide direct access to Manila CBD.

<u>Makati CBD:</u> Access to Makati CBD is made by Routes R-3 and R-4. Traffic from Quezon City to Makati CBD is provided with two (2) routes; one is via Route R-7, C-3 and R-4 (or R-3) and the other is via Routes C-5 and R-4.

Traffic from the south to Makati CBD is also provided two (2) routes; one is directly by Route R-3 and the other is is via R-2 (or R-1), C-5 and R-4.

In addition to above expressways, EDSA will continue to function as a major access route to Makati CBD. Thus, accessibility to Makati CBD will be greatly strengthened.

Ortigas CBD, Commercial Complex along EDSA and Suburban Center: Route C-5 is located fairly close to these traffic generating sources, therefore, it strengthens accessibility to these.

Manila Port and Navotas Fishery Port: Route R-10 provides direct access to these ports.

Ninoy Aquino International Airport (NAIA): Access to NAIA is provided by Route C-5.

For the above areas, locations of ramps are to be effectively planned and if the developers want to shoulder the cost of additional facilities for providing direct links with expressways, it is to be duly considered.

(b) To prepare urban development plans integrated with expressways for the areas where suburbanization has yet to be experienced and large development potentials exist.

(c) To modify existing city plans and zoning in such a way that urban developments take place desirably.

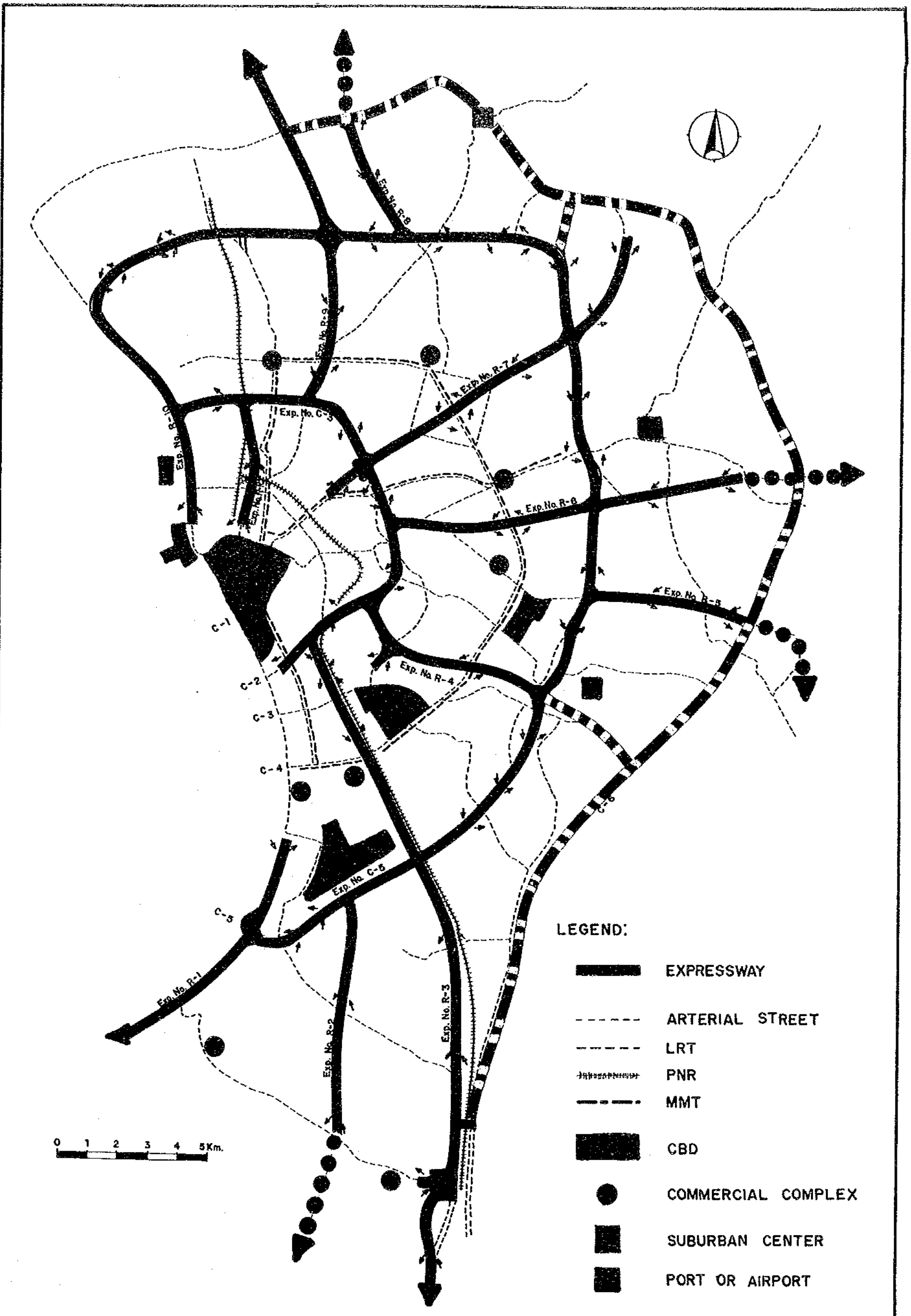


FIGURE 7.5.1 EXPRESSWAY NETWORK AND MAJOR TRAFFIC GENERATING SOURCES

7.6 ENVIRONMENTAL CONSIDERATIONS

Metro Manila's top four environmental problems are solid waste management, flooding, water pollution and air pollution which are inter-related. They are caused by a continued rapid population growth, a lack of comprehensive and environment-oriented landuse master plan, and ineffective mechanisms to coordinate and enforce land development controls. Transportation development being a key determinant of landuse has an indirect affect on key environmental problems of the region.

Environmental impacts relevant to the development of MMUES were examined by reviewing checklists of potential environmental impacts associated with expressway projects. Type of impacts can be classified into those being area-wide type associated with landuse and urbanization effects and those more localized type associated with the sizes of proposed expressway alignments. The impacts were thus classified into categories, such as those related to landuse, air pollution, water pollution, and others. Environmental parameters considered are more specifically as follows:

<u>Land Use Aspects:</u>

- The probable land use effect on urban areas within the Coastal Margin and the Guadalupe Plateau.
- The extent of increased urbanization which may be induced in the Marikina Valley and the Laguna Lakeshore zones, both of which have limited capacities for intensive urbanization.
- The potential effect of intensifying industrial activities along C-5 which borders the Marikina River.
- The adequacy of complementary infrastructure plans (e.g., flood control and wastewater treatment) for the Marikina Valley and the Laguna Lakeshore area should increased urbanization be induced there by transportation development.
- Localized land use effects around proposed expressway interchanges and on-off ramps.
- Adequacy of existing land use zoning in preventing uncontrolled urbanization which may be induced by transportation development.

<u>Air Quality Aspects:</u>

- The probable effect of the project on traffic conditions and air pollution problems.
- Specific effects on traffic emissions of the two serious air pollutants in Metro Manila: particulate matter and lead.
- Expected effects on traffic emissions on gaseous pollutants: sulfur oxides, nitrogen oxides, and carbon monoxide.
- Possibility of generating objectionable odors during construction and operation.

Water Quality Aspects:

- Effect on surface hydrology, such as the pattern of surface drainage and streamflows.

- Changes in runoff rates due to paving and compaction of ground.

- Effect on river pollution, specifically in relation an alternative using riverbank alignments (R-4 and C-3).

- Access to waterways for cleaning and maintenance in relation to alternative of riverbank alignments.

- Production of excessive silt runoff during construction which could clog drains and impair downstream water quality.

- Effect of construction activities on groundwater.

Noise and Vibration:

- Will project construction increase noise to levels exceeding standards?

- Will people be exposed to serious noise levels during the operation of the project?

- Will vibration effects during project construction and operation be significant?

Impacts of Relocation and ROW Acquisition:

- How many squatters will be relocated, and what measures are needed to protect their welfare?

- What are the effects in terms of private land acquisition?

- Will the proposed expressways limit local area acess or cut off existing communities?

Traffic Safety and Potential Hazards:

- What is the overall effect of the proposed expressways on traffic safety conditions?

- Are there hazards posed to pedestrians and traffic during project construction?

CHAPTER 8

EVALUATION OF EXPRESSWAY NETWORK

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EVALUATION OF EXPRESSWAY NETWORK

8.1 EVALUATION PROCEDURE

This chapter deals with farther evaluation of recommended expressway network and its stage development. Evaluation was made from traffic, urban development and landuse, environmental, economic and financial viewpoints. Since there are not many examples of intra-urban toll expressways in developing cities, particular attentions were placed in this study on the assessment of the impact of toll level under different assumed time value of road users, and that of traffic congestions on at-grade roads. Implication between financial viability and economic viability was also carefully looked into.

8.2 TRAFFIC IMPACT

1) Expressway Traffic Volume by Level of Toll and Time Value under the current economic level of road users in Metro Manila, expressway patronage is greatly affected by level of toll and time value, as well as the traffic congestion level of at-grade roads. A series of traffic assignments were made to analyze in detail the impact of these factors. The results are shown in Table 8.2.1 and Table 8.2.2 and summarized as follows:

(a) Considering that the estimated overall private transport demand in terms of pcu for years 1990, 2000, and 2010 are 1.5, 2.7, and 3.7 millions a day, respectively (Refer to Table 4.5.2), the maximum potential expressway traffic (under toll free situation) is roughly 15 to 20% of the above total traffic.

(b) Although there is potential demand (under toll-free situation) for expressways, e.g., 219 thousand in 1990 under Stage I network, when toll is charged, there will be little actualized expressway traffic. With P10 toll, there will only be 32 thousand users. However, by year 2010, potential expressway demand will be doubled and actualized expressway traffic will increase by more than five times.

(c) It is explicit that the dominant factors which determine the expressway traffic when toll charged are (1) time value of car users, (2) traffic congestion level on surface roads, and (3) level of toll. Particularly, the first two factors are critical than the third one. The elasticity of toll becomes less significant as perceived time value increases.

(d) As is clearly seen in Table 8.2.2, if the traffic situation worsens, e.g., either traffic capacities decrease due to ineffective traffic management or network deficiencies or traffic demand increases due to change in assumed private car utilization behavior, etc., the number of expressway users increase significantly. This implies constructing a toll expressway could be delayed if the existing roads are utilized to a maximum extent and planned at-grade roads projects are timely completed.

(e) The comparison of Stage (I + II) and Stage (I + II + III) cases indicates an insignificant increase in expressway traffic. This implies that further expansion of toll expressway system towards the outskirt would not be justifiable before year 2010.

The range of estimated expressway traffic is shown in Figure 8.2.1 which has been prepared based on Table 8.2.1. The figure gives a clear picture that patronage of expressways varies considerably depending not only on toll level and time value of users but also on the extent of the network. Considering relatively small increase in expressway traffic of the Stage (I) network after year 2000, the network should be expanded to Stage (I + II) network then but not to Stage (I + II + III) before year 2010.

2) Expressway Traffic Volume on the Network

The estimated traffic volume on the selected network (Alternative 3-B) by stage is shown in Figure 8.2.2. For this exercise, it is assumed that the toll level and time value are P20 flat and P1.0/min/pcu, respectively for all cases. Some characteristics noted are as follows:

(a) For year 2000, the north-south corridors such as SSH/C2/C3 and C5 routes have relatively heavy traffic volumes. Although a critical section has about 70 thousand pcu, the major sections carry relatively moderate traffic volumes of 40 thousand and 60 thousand pcu per day. Addition to Stage III network will only result in underutilization.

(b) For year 2010, (I + II) network would be well utilized which would require the full four-lane structure for most of the sections. Although the addition of Stage III would also attract some expressway traffic in the outer area due to the progress of suburbanization, the overall expressway traffic would not increase significantly but encourage diversion of the traffic from Stage (I + II) network.

3) Impact of Expressway on At-grade Roads

Expressways are expected to relieve traffic congestions on at-grade roads. The impacts of expressways are as follows:

(a) The impacts are significant on the roads in the corridors where expressways are built, particularly along SSH/MSE, C2, Quezon Avenue and southern sections of C5. Other radial roads such as A. Bonifacio, E. Rodriguez, Shaw Blvd. as well as Buendia would also be relieved.

(b) EDSA traffic would not be lessened along most of the sections. This is mainly due to the following reasons;

- Destination are located along EDSA. In order for the EDSA traffic divert expressways, it requires considerably long detour via congested radial roads.

- As urbanization makes progress, the local traffic alongside EDSA would increase considerably which makes the percentage of the traffic with long trip relatively insignificant.

This analysis suggests that mere construction of C5 alone would not be sufficient to relieve traffic congestions along EDSA. It has to be associated the improvement of radial roads which provide important access/egress of C5 and links between EDSA and C5.

TABLE 8.2.1 ESTIMATED NO. OF EXPRESSWAY USERS

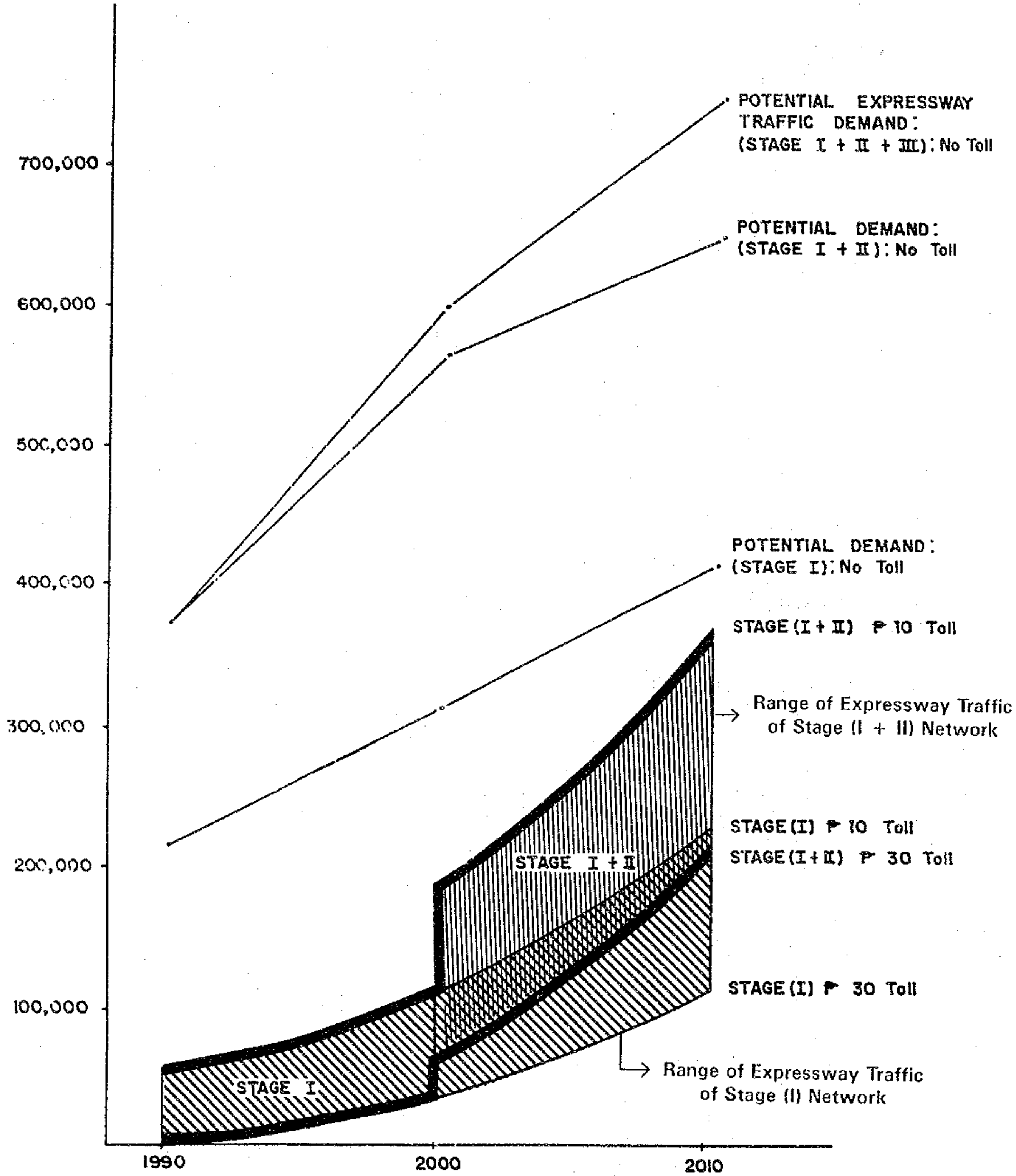
000 PCU

ASSUMED TIME VALUE (P/MIN/PCU)	ASSUMED TOLL (P/TRIP)	STAGE I			STAGE (I+II)		STAGE (I+II+III)
		(1990)	2000	2010	2000	2010	2010
	Free	(222)	351	418	563	649	751
P0.5	P10	(31)	98	154	152	245	269
	P20	(2)	46	96	68	148	165
	P30	(0)	27	52	34	81	102
P0.7	P10	(59)	113	194	187	303	324
	P20	(11)	79	126	107	195	214
	P30	(0.5)	39	94	60	140	154
P1.0	P10	(84)	134	236	236	348	374
	P20	(30)	99	158	149	245	269
	P30	(9)	75	120	102	190	205
P1.5	P10	(105)	174	267	271	412	442
	P20	(65)	116	202	195	308	334
	P30	(30)	98	160	149	246	268

TABLE 8.2.2 IMPACT OF AT-GRADE ROAD CAPACITIES ON EXPRESSWAY TRAFFIC

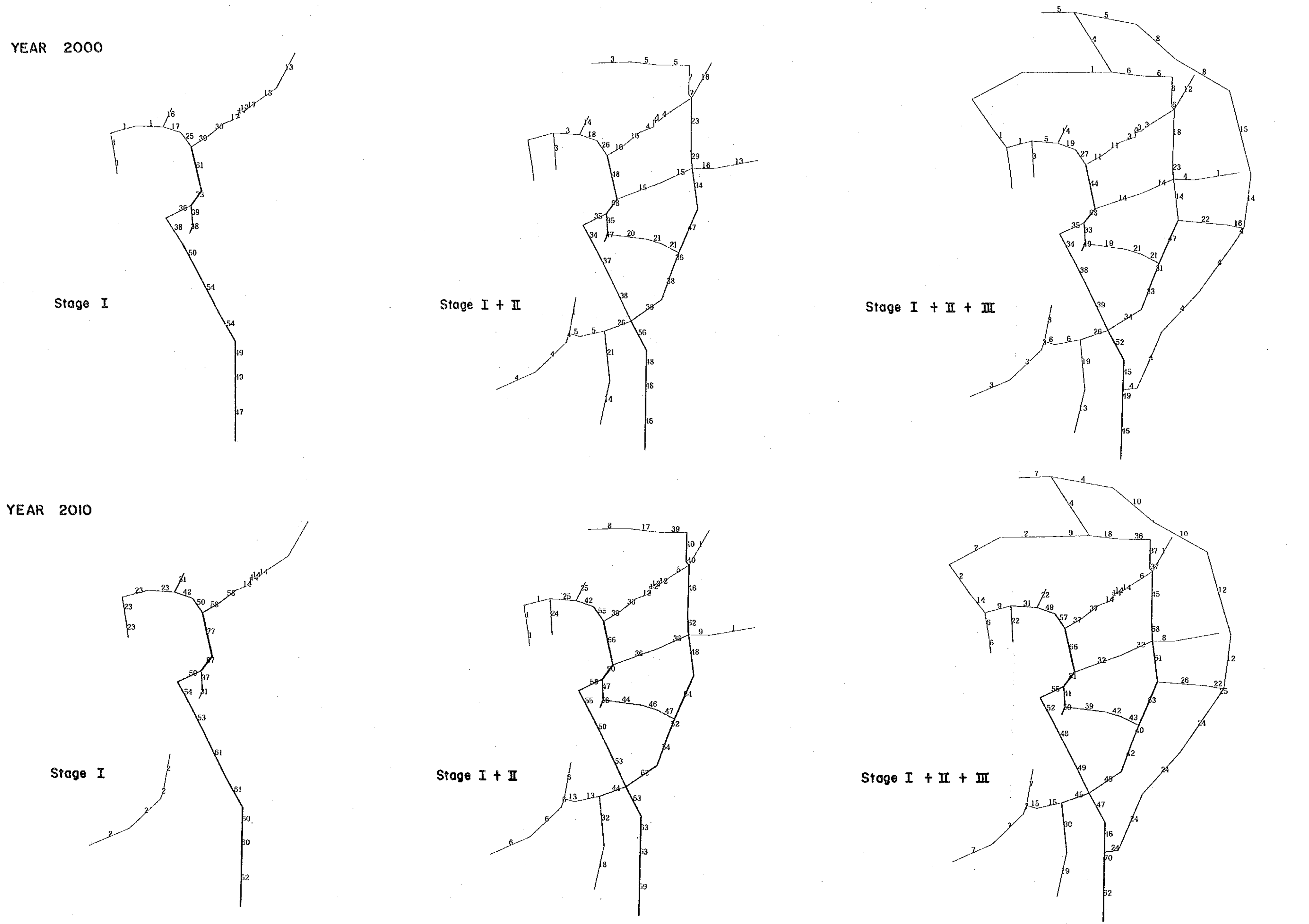
ASSUMED SCENARIO		EXPRESSWAY TRAFFIC					
TIME VALUE/ TOLL LEVEL	DECREASE IN AT-GRADE ROADS CAPACITIES	STAGE I		STAGE I+II		STAGE (I+II+III)	
		000 PCU	RATIO	000 PCU	RATIO	000 PCU	RATIO
1990 P0.5/ P10	±0%	(31)	(1.0)	–		–	
	10% less	(67)	(2.2)				
	20% less	(93)	(3.0)				
	30% less	(134)	(4.3)				
2000 P0.7/ P10	±0%	79	(1.0)	107	(1.0)	–	
	10% less	110	(1.4)	166	(1.6)		
	20% less	148	(1.9)	240	(2.2)		
	30% less	199	(2.5)	318	(3.0)		
2010 P1.0/ P20	±0%	158	(1.0)	245	(1.0)	269	(1.0)
	10% less	210	(1.3)	327	(1.3)	369	(1.4)
	20% less	260	(1.7)	414	(1.7)	469	(1.7)
	30% less	300	(1.9)	480	(2.0)	552	(2.1)
2010 P1.5/ P30	+0%	160	(1.0)	246	(1.0)	268	(1.0)
	10% less	212	(1.3)	326	(1.3)	365	(1.4)
	20% less	258	(1.6)	415	(1.7)	467	(1.7)
	30% less	302	(1.9)	482	(2.0)	555	(2.1)

FIGURE 8.2.1
ESTIMATED NO. OF EXPRESSWAY USERS (PCU)



1/ The estimated time value for private transport is ₱0.5/min/pcu for 1990, ₱0.7 for 2000 and ₱1.0 for 2010.

Figure 8.2.2 Expressway Traffic Volume by Stage and Year



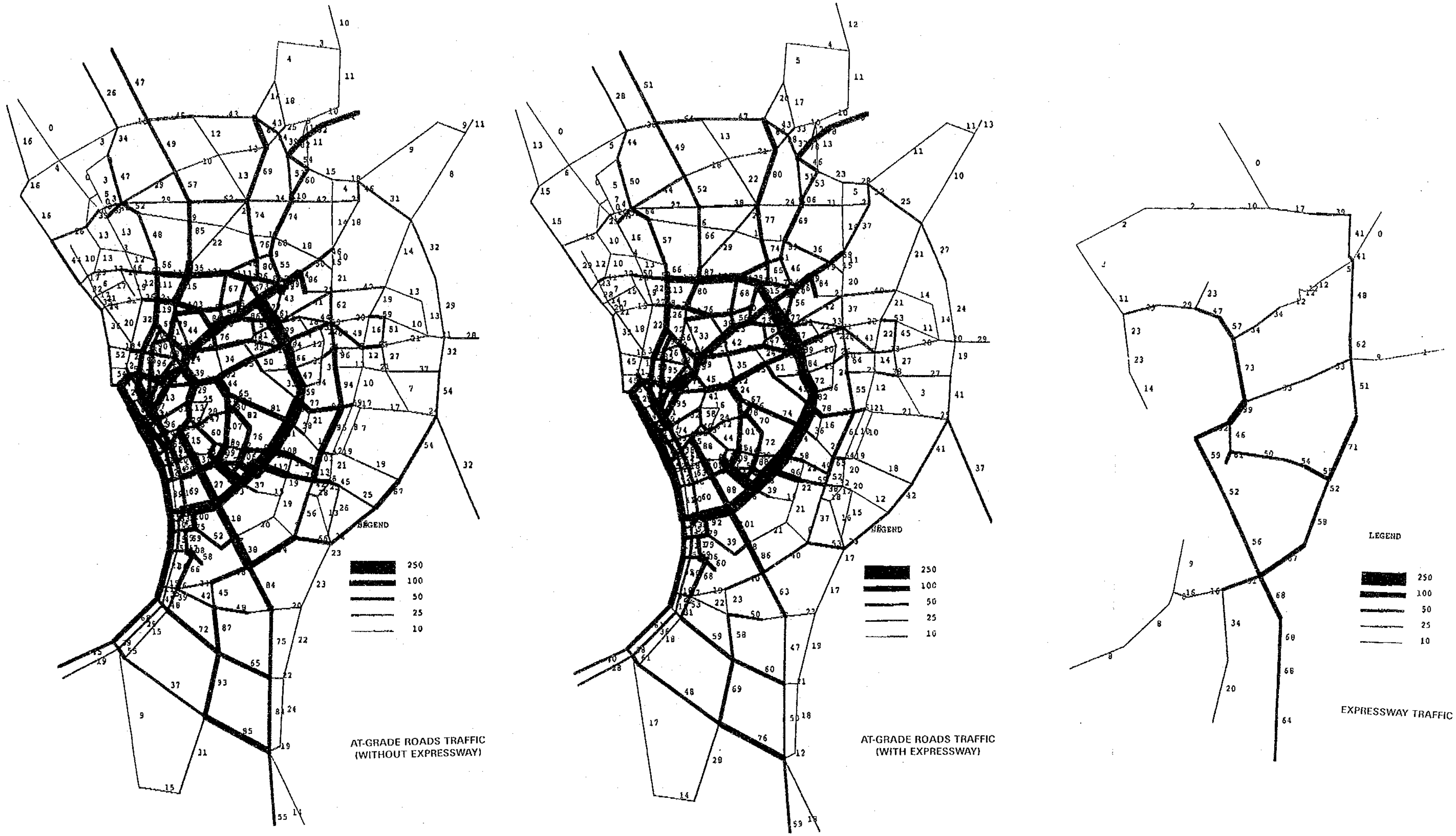


FIGURE 8.2.3
IMPACT OF EXPRESSWAYS ON AT-GRADE ROADS

Assumed Situation : Year 2010, Stage (I + II), Toll P20 Flat

8.3 IMPACT ON URBAN DEVELOPMENT/LANDUSE

Accessibilities and landuse are highly interactive. A mass transit based city tend to have a limited number of strong and concentrated urban centers, while a private car based city has a number of weak and dispersed centers. Decrease in accessibility, say, due to traffic congestions, forces people to alter their travel pattern thus encouraging dispersed developments.

Taking into account the fact that roads remain the major urban transport mode in the far future and planned LRT is constructed mostly along the already built-up areas, relative impact of the roads is considered very much significant. It is expected that a high quality road system (expressway) would bring about significant impact on future urban development/landuse in Metro Manila mainly in the following areas:

(a) Stage I expressways, which is intended to meet present private transport needs directly, would not change the landuse greatly but strengthen the following activities and urban development trends:

- CBD function, especially of Makati and, to a lesser extent, of Malate and the inner core areas

- Suburbanization towards the south and north-east where Metro Manila should extend

- Port/Airport related activities

(b) Stage II component, on the other hand, would affect the future landuse and urban development significantly if adequate landuse planning and control measures are associated. Possible favorable impacts include:

- Creation of new strong urban centers outside EDSA, especially along C5. This includes possible development of military bases and publicly owned lands.

- Integration of all major urban centers to each other and with new urban areas via the expressway network, with a north-south ladder pattern rather than a radial-circumferential pattern, would encourage urban development along the Guadalupe Plateau in compliance with the overall urban development strategy of MMA.

- A new branch expressway route towards the south is expected to play a great role in reorganizing the existing chaotic landuse, enhancing optimum urban development, and linking the CALABARZON area effectively.

Negative impacts of expressways which, however, depend upon how they are to be dealt with should also be taken into account, such as:

(a) Construction of expressway structures in the existing roadways reduce their traffic capacities, thus accessibilities by vehicle to/from the roadside establishments/facilities. Without due consideration this will not adversely affect socio-economic activities in the influence area but also reduce the overall efficiency of the road network.

(b) Distribution of benefits among landowners varies depending upon the location of ramps and their access roads.

8.4 ENVIRONMENTAL IMPACT

1) Legal Requirements and Procedure

In order for the MMUES project to be implemented, it needs to secure an Environmental Compliance Certificate (ECC) from the Environmental Management Bureau (EMB) of the Department of Environment and Natural Resources. The DPWH, as the project proponent, is responsible for obtaining the ECC.

The ECC is a legal requirement for projects classified as "environmentally critical." The MMUES falls under the category of "major road" which is an "environmentally critical project". This is according to the classification given in Presidential Decree No. 2146 of 1981.

In order to get an ECC, a formal Environmental Impact Assessment (EIA) needs to be conducted. Results of the EIA are presented in an environmental impact statement (EIS) which is submitted to the EMB for review. A review committee within the EMB recommends approval of the EIS, including issuance of the ECC. In its review of the EIS, the EMB may call for public hearings. If it is not satisfied with the EIS, the EMB returns the document to the proponent for further study and no ECC is given.

Before conducting the EIA, there should be coordination between the DPWH and the EMB in order to agree on the "SCOPE" of the EIA and to facilitate the later issuance of an ECC. Basically, the scoping identifies what the key issues and potential environmental impacts are, so that these become the focus of the EIA. The scoping is usually based on an initial environmental impact study. The completed preliminary environmental survey can be used both as background document (project description) for the EMB and as a basis for EIA scoping.

There is no formal regulation as to when the EIA should be done in relation to project development. To approve a master plan, an ECC is not required. For the master plan, therefore, an overall environmental assessment is desirable although a detailed EIA is not required. However, to implement projects under the master plan requires an ECC which depends on the formal EIA. If the MMUES is implemented as separate project packages, each project will need an ECC and must undergo an EIA.

The ECC is now required by the National Economic Development Authority's (NEDA) Investment Coordinating Committee (ICC) before it authorizes foreign assisted projects. If an ECC is not available at the time the project is submitted to NEDA for approval, a certification from EMB to the effect that the project is complying with EIA procedures is required in order for NEDA to authorize the project.

Legal requirements and procedure is illustrated in Figure 8.4.1.

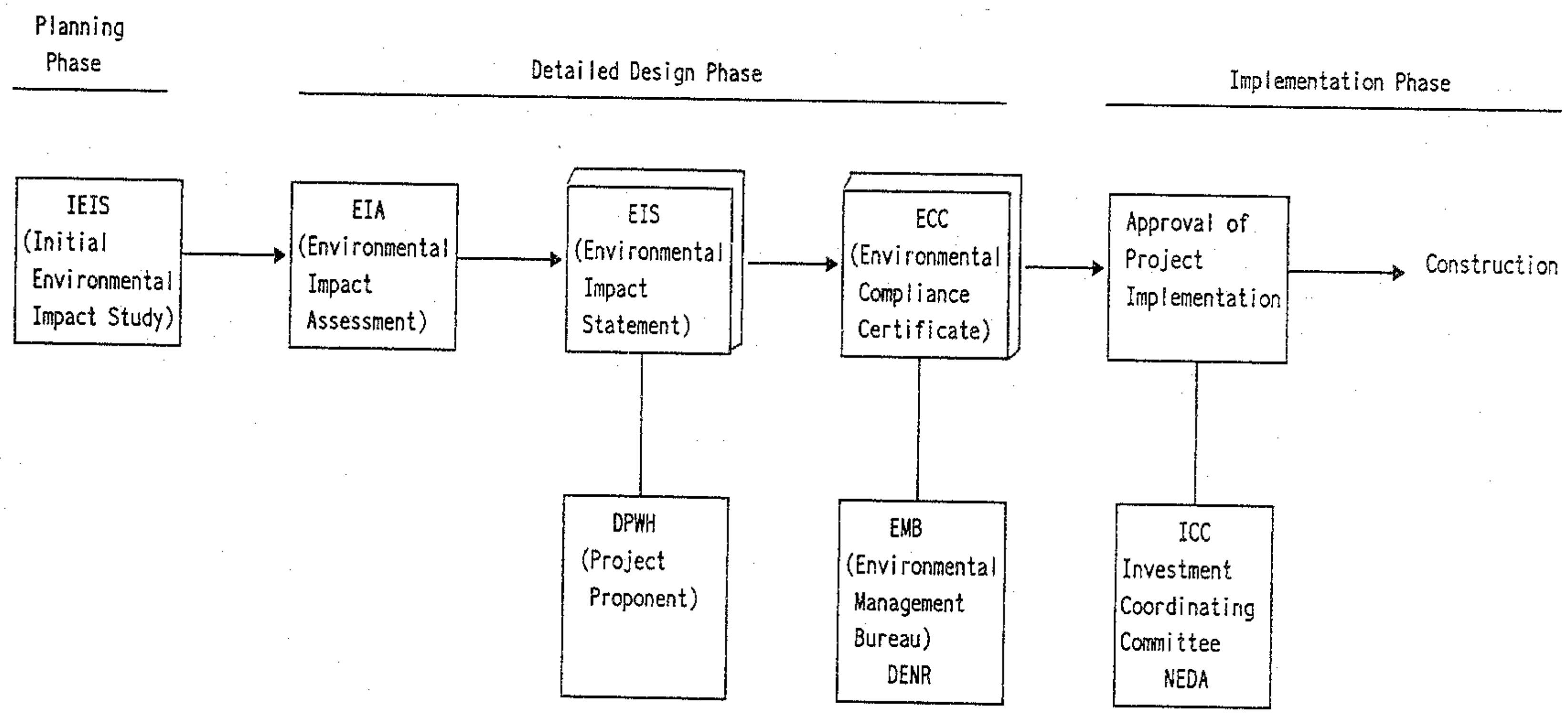


FIGURE 8.4.1 LEGAL REQUIREMENTS AND PROCEDURE ON ENVIRONMENTAL ASSESSMENT

2) Environmental Impact

Major environmental issues with regard to expressways development in Metro Manila comprise landuse, air quality, water quality, noise and vibration, squatter relocation and ROW acquisition, traffic safety and so on. The scoping of the MMUES project is presented in Appendix 8.4-1 and summarized as follows:

a) Impact on Landuse

Uncontrolled process of landuse development is often the root of major environmental problems such as solid waste disposal, recurrent flooding, water quality degradation, squatter settlement which are closely interrelated. Environment impacts of the MMUES on landuse are as follows:

(i) Overall Landuse Effect

The MMUES is designed to address the worsening traffic condition in Metro-Manila's core area (inside EDSA).

The basic design of the MMUES is compatible with the MMA's Regional Development Framework Plan which has identified the Guadalupe Plateau as the area in the region most suited to development.

The spinal transport corridors formed by C-3 and C-5, including R-7, will promote the MMA's desired development pattern.

The MMUES design also strengthens the north-south transport axis which will promote the desired direction of development toward the north-east and southern zones (and less emphasis on the eastern zone formed by the Marikina Valley).

Improvement of traffic in the inner core area of the MMR will promote redevelopment of the Coastal Margin, which is a positive effect.

(ii) Impact on Urbanization in the Marikina Valley

Expressway Route R-6 (in combination with completion of C-5's existing at-grade sections and the PNCC'S proposed C-6 or Metro Manila Tollway project) would provide more convenient access to the Marikina Valley. Collectively, these would accelerate present pace of urbanization in the Valley.

Parts of the Marikina Valley are vulnerable to flooding and existing waste management infrastructure is inadequate. Still, the increased urbanization of the Marikina Valley seems inevitable. What is important is to carefully regulate the process to prevent it from becoming uncontrolled, and to coordinate the provision of infrastructure (transport, flood control, wastewater treatment).

The potential environmental problems due to rapid urbanization of the Marikina Valley needs to be approached from a regional and multisectoral basis, rather than from a transport development basis alone. Coordination and regulation of development are the key mitigation measures.

(iii) Impact on Industrial Activities along C-5 and E. Rodriguez

Expressway Routes C-5 and R-5 (extension from C-5 along Ortigas Avenue) may intensify the existing (light to medium) industrial activities in the vicinity.

Added industrial wastes and effluents from this area -- especially from food processing industries -- could increase organic pollution of the Lower Marikina River (which connects with the Pasig). Control of the intensity of industrial development in the area is important as part of overall land use management and to anticipate possible effects of an expressway which could further attract industries.

A zoning ordinance established in 1981 is the basis for regulating land use in the MMR. The existing zoning ordinance is able to regulate types of land uses, but is not fully capable of regulating intensity of development for each land use type. Guidelines and regulatory standards governing intensity of permitted land uses should be provided to supplement the existing Zoning Ordinance.

2) Impact on Air Quality

Traffic emissions are the principal source of air pollution in Metro Manila. Particulate matter is the most serious air pollutant in the region and motor vehicles are the dominant source, particularly those that use diesel. Lead is the second most serious air pollutant, and it is emitted mainly by cars and private utility vehicles. High emission rates of these pollutants are promoted by slow and stop-go traffic conditions. At present, the gaseous pollutants (SO_2, NO_2 and CO) are not yet observed to be at serious levels. The impacts of MMUES are as follows:

(i) Overall Effect

Without an expressway system, traffic congestion will worsen and air pollution will worsen even more. With an expressway, there are two effects to consider. By diverting private traffic into the expressways, the at-grade roads will be decongested.

An expressway network will have a favorable impact on air pollution by speeding up traffic flow, improving fuel efficiency, and reducing vehicular emission rates.

There are two favorable effects. Air pollution (especially PM, lead and CO) from vehicles using the expressway will be significantly lower than without the expressway. In addition, air pollution from at-grade traffic will also be lower compared to without an expressway.

(ii) Effect on Particulate Matter (PM) Emissions

In 1991, about 12,000 tons of particular matter were emitted, mostly by vehicles that use diesel fuel. Unless conditions improve, PM emissions are expected to grow by a factor of 2.19 by year 2005, based on current growth trends in vehicle population.

An estimated 65% of particulate matter emissions come from trucks, buses, jeepneys and taxis. These vehicles are likely to remain dominant user of existing at-grade roads. Increasing the average traffic speed on these roads by 10% will reduce PM emission rates to some extent. Diversion of trucks into the expressways will reduce PM emissions from these vehicles.

Overall, the expected reduction in PM emission rates may not be enough to offset the increase in the total number of vehicles so that total future emissions will still rise (although not as much as without the MMUES). Solving PM pollution in Metro Manila will require other measures, such as removing the subsidy on diesel fuel, phasing out of dilapidated buses and jeepneys that are heavy smoke belchers, and intensification of DENR's anti-smoke belching campaign.

(iii) Effect on Lead Emissions

Gasoline engines generate almost all of the lead emissions from vehicles. Baseline projections show that lead emissions will increase by a factor of 2.32 by year 2005, mainly as a result of increasing vehicle population. In a recent study (Vehicular Emission Control Planning Project of DENR-ADB, 1992), it was found that lead concentrations along ADB-EDSA exceeded the guideline of 1.5 ug/m^3 during 4 out of 7 months of observations.

Recent estimates show that 58% of lead emissions come from utility vehicles, and 39% from cars. Most of the lead-emitting utility vehicles are private vehicles (vans, pick-ups) which use gasoline. These types of private vehicles are expected to use the expressways. Because of improved traffic flow, lead emissions from these vehicles will be lower.

Total lead emissions may still rise due to increasing vehicle population and fuel consumption, but not as much as without the expressway system.

Also, high lead concentrations at present traffic congested areas will be reduced as more of the lead emitting private vehicles are diverted into the expressways.

Also, atmospheric dispersion of lead emissions will be aided by the fast traffic on the elevated expressways. In future, measures such as phasing in of lead-free fuel may become necessary.

(iv) Effect on Gaseous Pollutants Emissions (So_2, NO_2, CO)

Diesel engines produce six times more SO_2 than gasoline engines, while gasoline engines produce 30 times more CO than diesel engines. NO_2 emissions from gasoline and diesel engines are not far apart. NO_2 is a key agent in the occurence of photochemical smog. Although at present these three pollutants are not observed to be at serious levels, emissions are expected to double in about 15 years at which time their effects will become more significant.

Private cars (which use gasoline) are expected to use the expressways more than other types of vehicles. Consequently, CO emissions rates from cars using the expressways will go down since emissions of CO are far greater for idling, low speeds and rapid changes of speed than at moderate steady speeds (about 43 kph on the proposed expressways).

However, NO_2 emission would increase because this gas tends to be produced in larger amounts at higher speeds and rapid accelerations.

To the extent that at-grade traffic flow is also improved, SO_2 emission rates from public vehicles (which use diesel) may be reduced also.

Overall, smog is not seen as a significant threat in the MMR. The region's tropical maritime climate is characterized by good ventilation and infrequent occurence of temperature inversions (that trap polluted air near the ground).

c) Impact on Water Quality

Environmental impacts of the MMUES on water quality are as follows:

(i) Impact on Surface Hydrology

Except for Routes the alternative riverbank alignments for portions C-3 and R-4, most of the proposed MMUES will follow existing transport corridors and road alignments.

No major changes in ground surface relief and streamflow regimes are expected. Earlier options to use the Pasig River for R-4 and the San Juan River for C-3 have been eliminated due to probable adverse flooding effects caused by backwater and reduction in streamflow capacity.

(ii) Effects on Runoff Rates

Most of the MMUES will pass through already urbanized areas where much paving and ground compaction have already occured. For most of the MMR, this effect will be minimal.

(iii) Effect on River Pollution

Parts of riverbanks, particularly along the San Juan River, are presently occupied by squatters. Throwing of garbage into rivers contributes to pollution and also clogs the waterway.

Relocation of squatters from riverbanks will reduce pollution from both dumping of garbage and disposal of domestic wastes directly into waterways, particularly the San Juan River. However, the river is already too polluted from other sources so that overall impact of removing squatter sources may be small.

(iv) Impact on Cleaning and Maintenance of Waterways

The Pasig River is wide enough for dredging and maintenance to be done easily. The San Juan River (only 45 to 60 m wide) is too shallow and not navigable except by small boats.

Expressways route R-4 along the Pasig riverbank will not affect acess to the river for navigation and river maintenance. The bottom of the San Juan River is adobe and dredging will have little benefit. Also, the San Juan river gradient is probably steep enough to prevent much deposition. Cleaning -- mostly of floating garbage - is natural through flushing of the river during the rainy season. Access by small boats will not be prevented by a riverbank elevated expressway.

(v) Impact of Construction on Drains and Down Stream Water Quality

Most of the expressway system will follow existing road alignments and will be elevated. Earthwork/grading will therefore be minimal. Excavation for the supporting columns of the expressway structures is the main source of waste soil and silt runoff. Construction specifications will provide for proper waste disposal.

Provided that spoils are properly disposed, silt runoff will be minimal.

(vi) Impact on Groundwater

In the Guadalupe Plateau, groundwater (in confined aquifers) is found at depths from 15 to 60 meters. Although excavation will not reach these aquifers, piling (estimated to be from 20 to 30 meters) could create passageways for polluted surface water (particularly along rivers) to contaminate the groundwater. No pumping of groundwater during construction is expected.

Where depth to groundwater is less than 30 meters, possibility of contamination of groundwater by polluted surface water resulting from excavation and piling activities should be avoided (particularly along the San Juan River alignment). This precauting is applicable mainly during construction, as all excavations and piles will be sealed to prevent contact of polluted surface water with the groundwater. Thus, the effect on groundwater is not expected to be significant.

d) Impact on Noise and Vibration

Environmental impacts of the MMUES on noise and vibration are as follows:

(i) Impact of Project Construction on Noise Level

Relatively high levels of noise will occur during construction, and these may exceed the 65 db and 75 db acceptable noise levels set for residential and commercial areas, respectively. These standards apply to areas directly fronting a 4-lane road or wider.

There is minimal risk of hearing loss from short-duration exposure to high noise levels during project construction. Bore piling should be used instead of driven piles in noise-sensitive areas.

(ii) Impact of Expressway Operation on Noise Level

Existing noise levels in the MMR are reported to be generally above the 50 db level that can cause annoyance. Out of the 150 km length of proposed MMUES, 73 km will pass through areas in which land use is residential or where clearance between expressway and building line is less than 5 meters. Proposed expressway routes are mostly along existing traffic corridors where traffic noise is already present.

Elevating the expressway will itself have the effect of mitigating traffic noise. In sensitive areas where effects of traffic noise may become significant (near schools and hospitals, or where traffic noise levels rise above 75 db) noise shields along some expressway section may have to be installed. Available data show that traffic noise is attenuated rapidly from about 70 db to 55 db at a distance of 100 m from the road's edge (with traffic speed of 50-60 kph and traffic volume of 6000 veh/hr).

(iii) Vibration Effects

Traffic-induced vibration is generated on the road and adjacent structures by passage of vehicles, and is mainly influenced by traffic volume. The poorer the road pavement condition, or where traffic consists of heavy vehicles, the greater the vibration effects. Vibration caused by at-grade traffic is potentially higher than that resulting from elevated traffic. Pile driving (using impact equipment) during construction can generate significant vibration effects.

No significant adverse effects (in terms of annoyance to people or structural damage to buildings) due to traffic-induced vibration are expected. This is because much of the MMUES will be massive elevated structures which will have the effect of reducing vibration.

Pile foundations will transmit vibration waves deep into the ground. Where there are buildings located within 5 to 10 meters from the road edge, bore piling is recommended to reduce vibration during construction.

For at-grade expressways, maintenance of road pavement surface during operation will reduce traffic-induced vibration.

e) Impact of Relocation and ROW Acquisition

Impacts of the MMUES are as follows:

(i) Squatters and Relocation

The MMUES will utilize parts of the PNR right-of-way for the SSH portion and the riverbanks of the Pasig and San Juan Rivers. In these areas, numerous squatters are present. First estimates of the number of squatter households at the Routes where most affected squatters found are given below:

No. of Squatter Households

C-3	San Juan River	800
R-3	SSH/MST	2,500
R-4	Pasig River	1,400
R-10 A	Abad Santos	800
	T O T A L	5,500

A recently passed law, RA 7279 of 1992, stipulates rules and procedures for squatter relocation.

Relocation is a significant social impact which can be traumatic for those affected. However, areas along the PNR railway line and the banks of the San Juan and Pasig Rivers are considered danger zones, and are not covered by an existing moratorium on squatter relocation. Squatter removal from these areas will, overall, be beneficial in terms of reducing public safety hazards. But problems in finding suitable resettlement sites for such large number of families could arise. Improper relocation can generate public resistance. It can also create adverse environmental effects, such as pollution from domestic wastes and increased safety hazards from unplanned settlements.

Roughly, if 5,500 households are to be relocated and assuming that half of them are resettled in Bulacan and the rest in Cavite, an estimate of relocating cost is P184 million. If housing in relocation sites is also provided -- such as a basic row house costing about P25,000 per unit - an added cost of roughly P137 million will be required. What is important to note is that the cost of relocating squatters could be very high. Other approaches to squatter relocation need to be examined.

(ii) ROW Acquisition

Private land acquisition will be mainly in the sites proposed for the 17 Interchanges, and those areas needed for new routes.

The effect is mainly financial in view of the high cost of private land acquisition along prime commercial and residential areas affected. Resistance from private landowners can become a problem. Zonal valuations (for tax purposes) used for valuing private land acquisition are significantly lower than prevailing market prices. This effect could be significant for the new routes, especially R-2 which will cross prime residential areas in Paranaque.

(iii) Impact on Local Community

Acess-limited expressways (including road widening) may have the effect of limiting local access routes because of more widely spaced crossings. They may also divide existing communities that are cut across by the road.

Proposed expressways (except the new route R-2) are along existing routes, and will therefore not cut across existing communities or residential subdivisions. Elevated structures will not affect local area access routes below.

f) Impact on Traffic Safety and Hazards

Impacts of the MMUES are as follows:

(i) Traffic Accidents

Metro Manila accounts for 75 to 80% of reported traffic accidents. The high density of intersections along main streets is an important factor. 75% of pedestrian accidents occur at intersections and near intersections.

An expressway system to divert high speed traffic from urban streets and intersections has the potential to reduce pedestrian accident rates. However, accidents involving vehicles could increase due to faster traffic speeds on the expressways (estimated to be 40 to 45 kph). Overspeeding and poor speed modulation are main reasons for reported traffic accidents in Metro Manila at present. Enforcement of speed limits on the expressways, adequate lighting, and adequate space provision for stranded vehicles are needed during expressway operation.

(ii) Hazards posed to Pedestrians and Traffic During Project Construction

Construction of elevated structures, including installation of massive prefabricated components, could pose hazards to pedestrians and vehicles nearby.

Construction hazards can be minized by providing adequate clearance for construction work. Appropriate warning signs and provisions for adequate lighting will be incorporated in the construction contract specifications.

8.5 ECONOMIC ASSESSMENT

1) Methodology

Primary objective of the economic assessment at this stage of the Study is to determine a range of economic viability of the expressways with particular regard to stage development and toll level. In order to meet the objective, a methodology taken in this study is to compare average annual cost of the project with estimated benefits of selected years. Costs and benefits are priced at 1992 level.

2) Project Cost

The project cost (at this stage of the study, only initial construction cost is considered) has been annualized over assumed economic life of the project at assumed discount rate of 15%.

The total project of P55.3 billion, is further brokendown into those by stage as shown in Table 8.5.1. The first stage requires P23.4 billion, the second stage P23.8 billion, and the third stage P8.1 billion. Their average annual costs over 20 years of assumed economic life under 15% opportunity cost of capital are: P8.8 billion for the entire project, and P3.7 billion, P3.8 billion, and P1.3 billion for Stage I, Stage II and Stage III, respectively.

TABLE 8.5.1 AVERAGE ANNUAL COST OF THE PROJECT

	CONSTRUCTION COST (P/BILLION)	AVE. ANNUAL COST (P/BILLION)[2/]
Stage I	23.38	3.73
Stage II	23.78	3.80
Stage III [1/]	8.11	1.30
Total	55.27	8.83

[1/] Excluding the cost of Metro Manila Toll Road (PNCC franchised toll road) along C6.

[2/] Excluding maintenance and operation cost

3) Benefits

Economic benefits due to the construction of expressways are expected to be significant, not only in transportation but also in urban development and environment areas. However, many of those benefits are difficult to be quantified. Estimate of the benefits at this stage of the study are limited to major and direct ones which are savings in vehicle operating costs and travel time. The benefits were estimated based on vehicle operating costs and assumed time value by major vehicle type. (Refer to Table 8.5.2).

TABLE 8.5.2 VEHICLE OPERATING COSTS BY MAJOR VEHICLE TYPE

SPEED (KPH)	CAR	BUS	JEEPNEY
5	3.5650	3.4672	14.7355
5–10	3.1685	2.8872	11.6938
10–15	2.6459	2.1259	7.6820
15–20	2.4607	1.8641	6.2681
20–25	2.3598	1.7185	5.5722
25–30	2.3140	1.6655	5.2110
30–35	2.2800	1.6538	5.0230
35–40	2.2762	1.6673	5.0227
40–45	2.2839	1.7030	5.1203
45–50	2.2995	1.7554	5.2974
50–55	2.3236	1.8284	5.5418
55–60	2.3592	1.9213	5.8474
60–65	2.4027	2.0196	6.2160
65–70	2.4510	2.1406	6.7050
70–80	2.4764	2.2046	6.9831

TABLE 8.5.3 ESTIMATED TIME VALUE

P/hr/pcu

VEHICLE TYPE	1990	2000	2010
Private (Car)	30	42	60
Public (Bus/Jeepney)	60	85	120

The estimated benefits are summarized in Table 8.5.4 and Figure 8.5.1. Benefits vary significantly by development stage and toll level. Especially, the impact of toll level which directly affect the expressway traffic is very significant. As toll level becomes higher, the benefits decrease sharply because the benefits due to the expressway are less than the increase in transportation costs on at-grade roads due to the reduction in capacities of at-grade roads resulting from expressway construction on the at-grade roads.

4) Assessment

The estimated benefits were compared with the average annual project costs that indicates the following:

(a) The economic impact of Stage I alone is limited but with the addition of Stage II, the benefits will increase sharply. However, the first year benefits exceed the annual average project cost around 1995 for the toll free situation and around early 2000 for the P10 toll situation.

(b) The first year benefits of Stage I exceed the annual average project cost before 1995 for toll free situation but only in early 2000 for P10 toll situation. It seems that the first stage alone does not generate sufficient economic benefits for subsequent years.

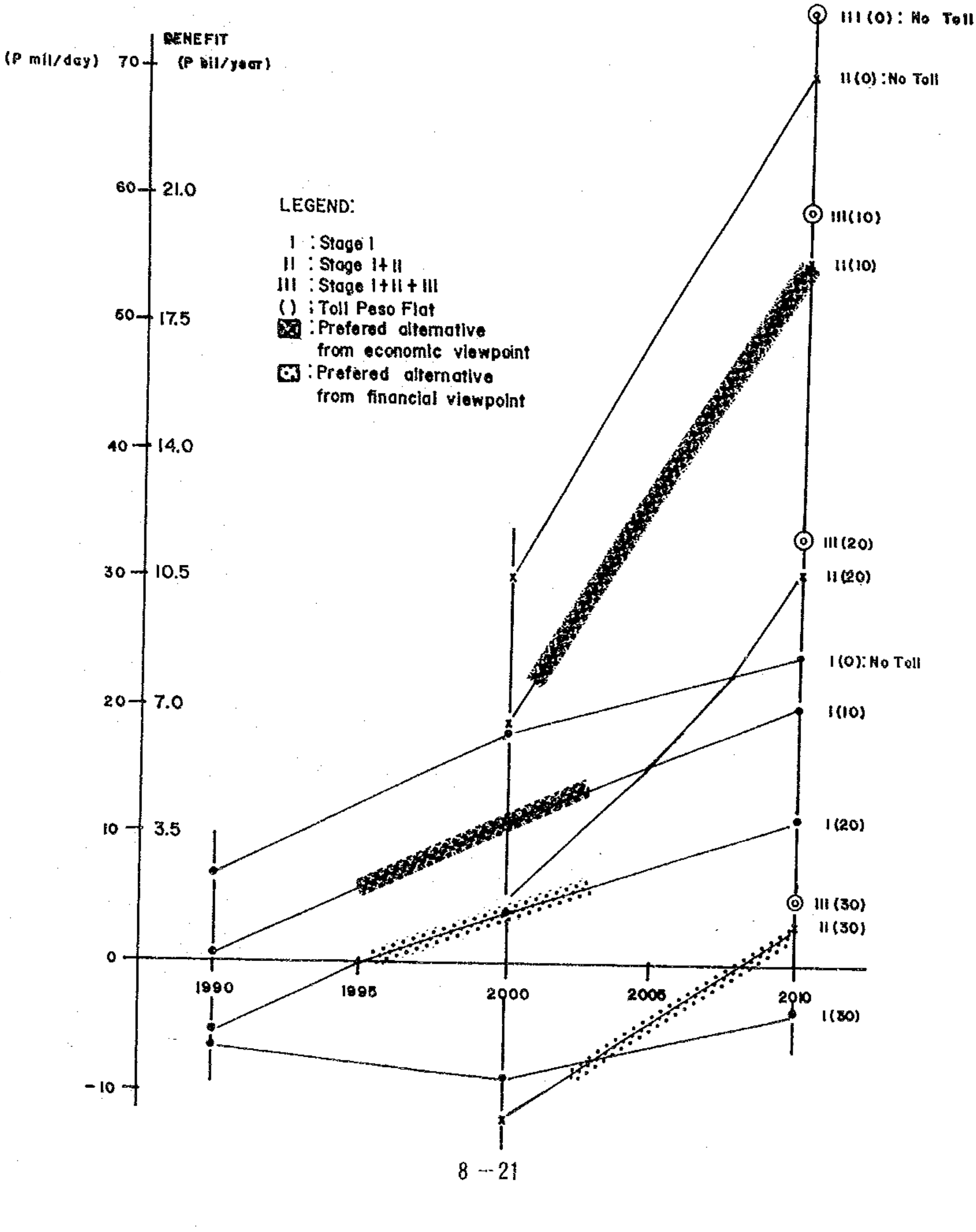
(c) From the economic viewpoint, the proposed expressways should not charge a toll of more than P10 for Stage I and 20 for Stage II, which should be implemented no earlier than late 1990's and late 2000s.

TABLE 8.5.4 ESTIMATED ECONOMIC BENEFITS UNDER DEVELOPMENT STAGE

P million/day

ASSUMED TOLL (P/TRIP)	STAGE (I)			STAGE (I+II)		STAGE (I+II+III)
	(1990)	2000	2010	2000	2010	2010
Free	6.61	18.24	24.44	30.47	68.92	77.05
P10	0.68	11.11	21.11	18.59	55.23	58.99
P20	−5.41	4.39	11.46	4.59	31.64	33.12
P30	−6.43	−8.10	−2.88	−11.68	4.02	5.55

FIGURE 8.5.1 ESTIMATED ECONOMIC BENEFITS BY DEVELOPMENT STAGE



8.6 FINANCIAL ASSESSMENT

1) Methodology

Financial assessment of the project at this stage of the study was undertaken similarly as in economic assessment by comparing average annual cost of the project with toll revenues of selected years estimated by development stage and toll level. Costs and revenue are priced at 1992 level.

2) Project Cost

For financial assessment, average annual cost of the project was estimated based on assumed project life of 30 years and 5% interest rate. Low interest rate was assumed by taking into account of the availability of various soft loan in official development assistance programs which is applicable to this type of projects. As shown in Table 8.6.1, the average annual costs of the project are P3.6 billion for the entire project and P1.52 billion, P1.55 billion and P0.53 billion for Stage I, Stage II, And Stage III, respectively.

TABLE 8.6.1 AVERAGE ANNUAL COST OF THE PROJECT

	CONSTRUCTION COST (P/BILLION)	AVE. ANNUAL COST (P/BILLION)[2]
Stage I	23.38	1.52
Stage II	23.78	1.55
Stage III [1]	8.11	0.53
Total	55.27	3.60

[1] Excluding the cost of Metro Manila Toll Road.

[2] Excluding maintenance and operation cost

3) Revenue

Revenue from the project is assumed entirely to be from toll, which are estimated as shown in Table 8.6.2 and illustrated in Figure 8.6.1 for different toll level and development stages. It is to be noted that as is typically seen from Stage I development for year 2000 (Refer to Table 8.6.2) toll revenue will not be maximized by increasing toll level because increase in toll leads to decrease in expressway traffic.

4) Assessment

Financial outlook of the project is different from economic one. Optimum solution from the economic viewpoint does not comply to that from financial aspect or vice versa. Results of the assessment are as follows:

(a) From the financial aspect, the most profitable solution is to charge a toll of P20 for the first stage and P30 for the second stage. However, both stages would not be able to generate sufficient revenue to cover the project. As is shown in Table 8.6.1, for Stage 1 average annual cost is about P1.5 billion, while for Stage (I + II) about P3.1 billion. Roughly about a half of the project cost can be covered by toll revenue.

(b) The best option from the financial aspect, however, would only generate minimal economic benefit as shown in Figure 8.5.1.

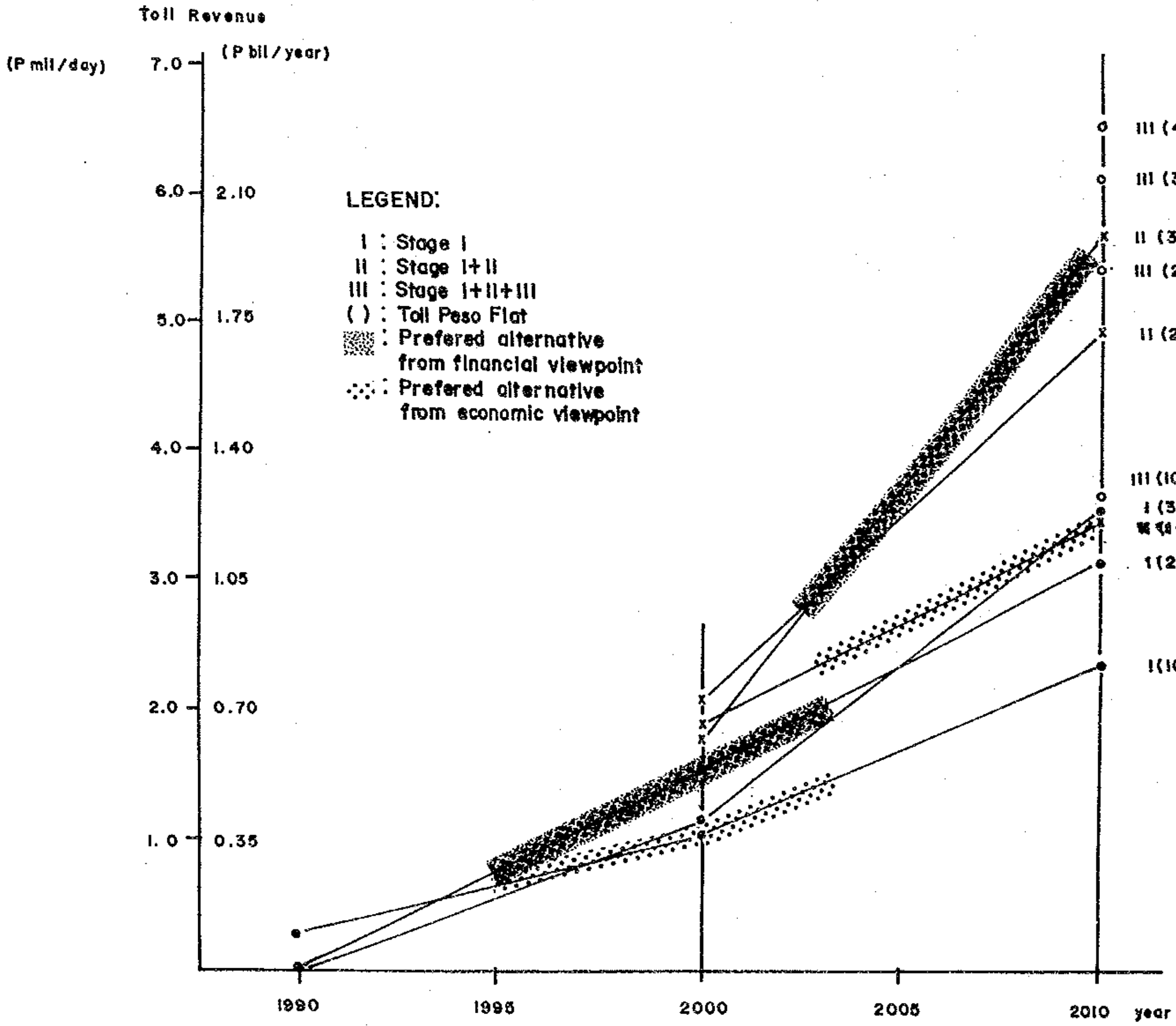
(c) The options which satisfy the minimum economic requirements (P10 for the first stage and P20 for the second stage) generate toll revenue 20 to 30% less than that of the most profitable options.

TABLE 8.6.2 ESTIMATED TOLL REVENUE BY DEVELOPMENT STAGE

(P million/day)

ASSUMED TOLL	STAGE (I)			STAGE (I+II)		STAGE (I+II+III)
(P/TRIP)	(1990)	2000	2010	2000	2010	2010
P10	(0.31)	1.13	2.36	1.87	3.48	3.74
P20	(0.03)	1.57	3.16	2.13	4.90	5.37
P30	(0)	1.16	3.60	1.79	5.68	6.14
P40	(****)	****	3.94	****	6.04	6.55

FIGURE 8.6.1 ESTIMATED TOLL REVENUE BY DEVELOPMENT STAGE (P mil/day)



8.7 OVERALL ASSESSMENT

On the basis of the analysis and assessment made on the development of expressways in Metro Manila, it is to be concluded that there is needs of and roles to be played by urban expressways with due consideration of the following:

(a) The project is economically feasible, but its economic viability is considered less significant compared with that of at-grade major roads because of the huge differences in construction costs. Economic feasibility is especially high when toll is low, say P10 or below.

(b) The project is difficult to be justified from financial viewpoint. Roughly speaking, toll revenue could cover about only one half of the construction cost. Taking into account of that the size of the investment is large, expressway users are mostly private transport, its economic viability is less significant than that of at-grade roads, the project should be basically financed by itself with minimal financial committment of the Government.

(c) Financial viability of the project (when it is assumed that the project cost is to be more or less covered by toll revenue) is greatly affected by congestions on at-grade roads and time value of road users, because the key factor that expressways attract the traffic is faster travel time. Present Metro Manila situation does not warrant attractive expressway patronage at toll rate which is sufficient to cover the investment.

(d) The project (toll expressway) would bring about significant impacts both on transportation and urban development with particular regard to the following areas:

- The project would encourage the desired urban development along north-south directions. The conventional radial-circumferential major roads network will be effectively integrated with the expressways with north-south ladder pattern.

- The inner north-south axis of expressway relieve the congested inner areas and SSH corridor, and provide vital links between north and south intercity expressways, between international port/airport and industrial centres. The inner axis is expected more to strengthen the existing urban and transport function of Metro Manila.

- The outer axis, on the other hand, intends more to encourage effective urban development in the areas outside EDSA where suburbanization has been in rapid progress with insufficient transport infrastructure . As EDSA functions as a strong urban development axis, future Metro Manila requires a similar strong transport infrastructure where development of new urban centers is encouraged.

Accordingly, the coordinated development of expressways with urban development is the very important aspect of the project not only from effective urban/transportation development but also from financial viewpoints to internalize project benefits expected from urban development.

(e) Improvements of traffic situation on at-grade roads due to the construction of expressways depend upon patronage level of expressways and the manner how expressway structures are designed because at-grade roads capacities would be reduced by expressway facilities to be constructed.

Accordingly, how to plan the use of and manage the traffic on at-grade is to be duly taken into account.

(f) Although little adverse environmental impacts are expected from the project, the project should be more closely integrated with city plans of relevant local governments (cities/municipalities) to maximize the benefits of the project at local community level.

(g) Expressways requires effective management of the system and facilities. Ineffectiveness in management would directly affect adversely safety, traffic efficiency, financial profile of expressways as well as the economy expected to be derived from the project.