CHAPTER 5 TRAFFIC DEMAND FORECAST

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CHAPTER 5

TRAFFIC DEMAND FORECAST

5.1 TRAFFIC DEMAND FORECAST METHODOLOGY

5.1.1 Traffic Demand Forecast Procedure

Traffic demand will be forecasted for the target years 1990 and 2000, mainly on the basis of current traffic data (O–D table and traffic volumes on the existing roads) and future socio-economic framework (GNP, car ownership, land use and population of each traffic zone) and through the application of developed traffic models. The future traffic volume on each link will be calculated by assigning the estimated total future traffic demand on the future road network (with and without the project roads). This traffic volume will then become the basis for quantifying benefits accruing from the different alternative plans. These benefits will ultimately be used in the determination of the viability of the Project Roads.

1) Four-Step Method

The so-called 4-step method will be used for the estimation of trip generation/attraction, trip distribution, modal split and traffic assignment, in the order listed (see Figure 5.1–1). The 4-step method, which offers a relatively simple process of estimating future traffic and affords the opportunity of checking the estimated values at each step, is commonly used in urban transportation planning.

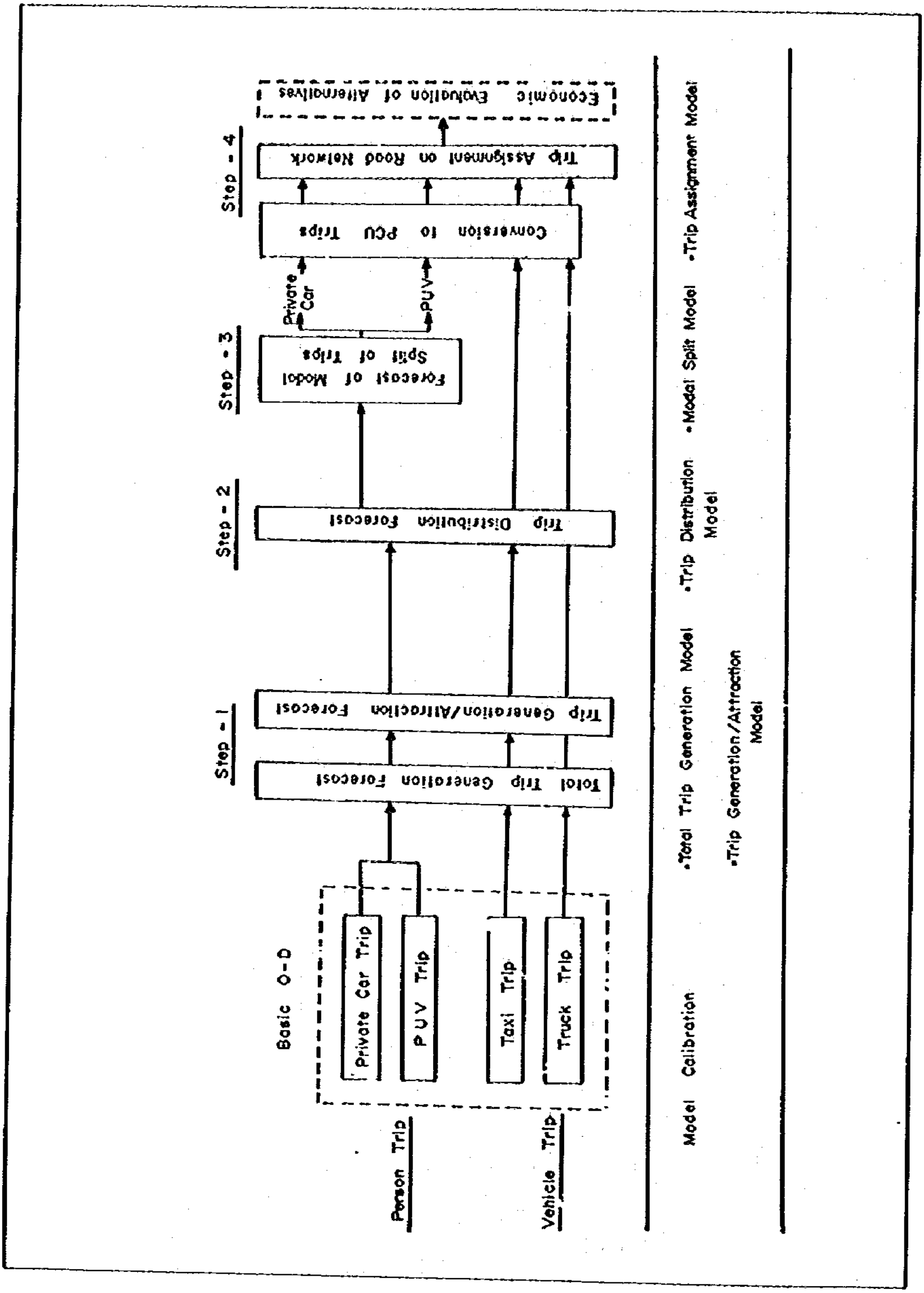
2) Model Application

Trips coming to and going out of the Study Area presently add to an insignificant 5.7% of the total number of trips having either or both origin and destination within the Study Area. With this view, future trip estimation has been accomplished by using a simple growth factor method for trips coming to and going out of the Study Area and by applying the developed models to trips having both origin and destination in the Area.

3) Basic O–D Table

A basic O–D table was prepared based on the O–D data of MMUTIP, as previously discussed. For private cars and PUVs, an O–D table has been prepared in the unit of person trip for the estimation of future trips. After modal split forecast, this O–D table in person trips will finally be converted to an O–D table in passenger car units (PCU). For taxis and trucks, O–D tables have been prepared separately for future estimation and converted to PCUs for the purpose of future traffic assignment.
to PCUs for the purpose of future traffic assignment.

FIGURE 5.1-1 FUTURE TRAFFIC VOLUME FORECAST PROCESS



4) Truck Traffic Estimation

Night population, number of workers, and other demographic indicators, which are reliable independent variables to explain the mobility of people, would not explain the movement of cargo for the purpose of estimating future truck traffic. Rather, economic indicators such as GRDP, which indicate the level of regional economic activities, are commonly used and believed appropriate. Therefore, future truck traffic increase has been estimated separately from the passenger traffic.

5.1.2 Trip Generation/Attraction Model

1) The Average Per Capita Trip Model

The average per capita trips varies by land use, i.e. relatively high in commercial zones and low in residential zones. Three (3) clusters of the average per capita trips were observed by mode. Cluster 1 involves traffic zones in commercial areas, expanding from Manila to south of the Pasig and around Quezon Memorial Circle, and zones in institutional areas where the transport activities in daytime are vigorous, but population at night are few.

Cluster 2 involves zones of Cubao and Makati, and zones along Quezon Boulevard, which are characterized as commercial/residential areas. Cluster 3 involves residential zones.

TABLE 5.1–1 THE AVERAGE PER CAPITA TRIPS

(trips/day)

	Cluster 1	Cluster 2	Cluster 3	Unit
Private car + PUV	2.845	1.862	1.495	person-trip
Taxi	0.062	0.037	0.030	vehicle-trip
Truck	0.022	0.014	0.009	vehicle-trip

2) Regression Model

Three (3) cases of trip generation/attraction model were studied using different variables and were compared and evaluated to arrive at the model with the highest correlation coefficient.

		Variables
Case 1	:	Population
Case 2	:	Number of employment
Case 3	:	Population and Number of employment

Among these cases, Case 3 model was judged to be the most desirable, showing highest correlation coefficient and lowest accumulative discrepancy between estimated generated/attracted trips and the actual trips.

TABLE 5.1–2 REGRESSION MODEL OF TRIP GENERATION/ATTRACTION

DEPENDENT VARIABLES	INDEPENDENT VARIABLES	FORMULA	CORRELATION COEFFICIENT
PRIVATE CAR & PUV PERSON TRIPS	POPULATION	Y = 1.80 x – 7100	0.97
	EMPLOYMENT	Y = 4.26 X – 22565	0.95
	POPULATION EMPLOYMENT	Y = 1.13 x + 1.85 x – 10050	0.99
TAXI VEHICLE TRIPS	POPULATION	Y = 0.04 x – 251	0.96
	EMPLOYMENT	Y = 0.09 x – 304	0.95
	POPULATION EMPLOYMENT	Y = 0.02 x + 0.05 x – 326	0.93
TRUCK VEHICLE TRIPS	POPULATION	Y = 0.01 x – 70	0.93
	EMPLOYMENT	Y = 0.03 x + 9	0.98
	POPULATION EMPLOYMENT	Y = 0.004 x + 0.02 x – 106	0.99

3) Model Selection

After comparing the two models, the average per capita model was adopted for its higher accuracy with regard to taxi and truck trips, although the two were comparable to each other in accuracy with regard to private car and PUV trips.

5.1.3 Distribution Model

1) Present Pattern Model vs. Gravity Model

Zone pair models are classified largely into the following two (2) types:

i) Present pattern model – Future O–D values are projected by expanding present O–D pattern.

ii) Gravity model – This is the application of Newton's law of gravity to trip distribution.

The selection of model for the forecast of future trip distribution depends on the degree of future transportation facilities development and changes in land use and population distribution structure.

When little changes are expected in such facilities and trip distribution pattern, the most likely candidate is the present pattern model, while, when substantial changes are expected as in the DIZ, gravity model is more suitable.

2) The Calibration of Gravity model selected as distribution model is a modified gravity model and is basically the gravity model developed by A.M. Voorhee. The modified gravity model is as follows:

$$X_{ij} = G_i \frac{A_j T_{ij}^{-\gamma}}{\sum_{\substack{j=1 \\ (j \neq i)}}^{n} A_j T_{ij}^{-\gamma}}$$

where:

X_{ij} = Interzonal trips from Zone i to Zone j

G_i = Generated trips from Zone i

A_j = Attracted trips to Zone j

γ = Parameter

The modified gravity models were calibrated by mode of transport. For the determination of γ, computer processing of the current O–D table was repeated until the γ was found which achieved a minimum discrepancy between the estimated and the current values. The resulting parameters of the gravity model for cars, taxis, and trucks are 1.11, 1.10 and 0.96, respectively, which express the intensity of distance as restraint. The fact that trucks show the smallest value of this parameter coincides with the real behavior that truck trips tend to be the longest.

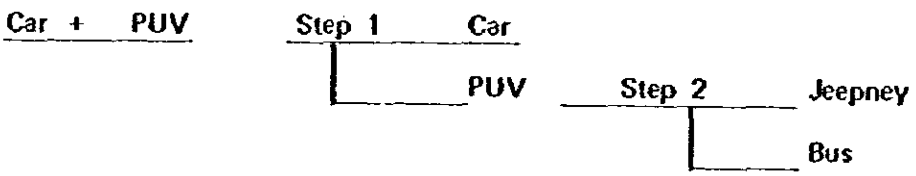
The resulting values of the corresponding coefficients of models are shown in Table 5.1–3. Correlation coefficients of any model was more than 0.9, showing a high accuracy.

TABLE 5.1–3 γ AND MULTIPLE CORRELATION OF DISTRIBUTION MODELS

Mode	γ	Multiple Correlation
All (Car, PUV)	1.11	0.960
Taxi	1.10	0.956
Truck	0.96	0.924

5.1.4 Modal Split Model

Future modal split has been estimated by binary choice method. The total person trip O–D were first sorted to car and PUV trips. Then PUV trips are divided into jeepney trips and bus trips.



1) Car versus PUV

A detailed factor analysis is out of the question due to the limitation of available data, but the analysis of the present practice showed that one of the serious factors in the modal choice was the car ownership, while trip length and service level of PUV were minor factors. In this Study, car-owning families are assumed to utilize the car at the rate of 73 percent and PUV, 27 percent, based on UTSMMA data, while non-car-owning families are assumed to utilize only the PUV. These assumptions had been checked based on MMUTIP data in 1980. The estimated car share of 26.0% shows little discrepancy against real share of 25.5% as shown in Table 5.1–4.
The car shares in years 1990 and 2000 are estimated to rise to 29.6% and 33.6%, respectively, based on said assumptions.

TABLE 5.1–4 MODAL SHARE: 1980, 1990, 2000

(Unit: %)

	1980 Real	1980 Estimated	1990	2000
Car share	25.5	26.0	29.6	33.6
PUV share	74.5	74.0	70.4	66.4
TOTAL	100.0	100.0	100.0	100.0

2) Jeepney versus Bus

The modal share among PUV's, such as share of jeepney versus bus, is greatly affected by policies and/or strategic factors. The general tendency of historical change in PUV mode was the introduction of faster and larger capacity vehicles. The introduction of the LRT system along Taft Avenue and Rizal Avenue in Metro Manila coincides with this tendency. The jeepneys presently play a major role in public transport, but transfer from jeepney to bus will occur in line with the future transport demand increase.

Current jeepney share on each road/street as listed in the Table below: share of jeepney on EDSA (c–4) is 14%, 40% on North Diversion Road, 60% or 70% on Katipunan and East Avenues, which are main bus routes, and a high 90% on other roads.

The bus can enjoy the advantage of a large capacity on major roads, which are now suffering from heavy traffic congestions, rather than on secondary or collector roads.

The future modal shares by road classification are assumed based on existing modal share between jeepneys and buses.

TABLE 5.1–5 JEEPNEY AND BUS SHARES BY ROUTE

(Unit: %)

Route	Jeepney	Bus
EDSA (C–4)	14	86
North Diversion Road	40	60
East Avenue	63	37
Katipunan Avenue	67	33
Quirino Highway	90	10
Don Mariano Marcos Avenue	87	13
Aurora Boulevard	93	7
Tandang Sora Avenue	86	14

5.2 FUTURE TRAFFIC VOLUME

5.2.1 Total Trip Demand Growth

1) Average per Capita Trips

The total number of car and PUV trips that will be generated in the Study Area in the target years 1990 and 2000 have been estimated by the average per capita trip method, which is a highly accurate method. The growth factor method stipulated by the Manual of PPDO, MPWH, is to estimate the rate of traffic increase by the rates of income and population increases and the transport demand-income elasticity, and is more suitable for rural road planning than for urban road planning. The results of estimation by the average per capita trip method and the growth factor method are compared in Appendix 5.2–1.

Future taxi trips have been estimated at the increase rate as shown by car and PUV trips, as a result of estimation by the average per capita trip method, and future truck trips, by the same rate of increase as GRDP of the NCR.

The average per capita trips in Metro Manila grew from the 1.49 person trips per day in 1971 to 1.72 person trips per day in 1980, at an average annual increase rate of as high as 1.6%. This increase was a result of the expansion of economic activities and the accompanying increase in traffic demand, increase in the number of cars, and the improvement of public transportation facilities. The frequency of trips is strongly dependent on whether a person is a member of a car-owning or a non-car-owning family. The UTSMMA Study in 1971, calculated the average number of trips made by those who belonged to car-owning families at 2.11 person trips per day and 1.33 for those who belonged to non-car-owning families. Based on car ownership ratio and the overall average per capita trips, trips made by car owning families in 1980 was estimated at 2.37 person trips per day and 1.49 for non-car-owning families with an annual average growth rate of about 1.3%.

Assuming that the 1.3% annual average growth rate holds true up to year 2000, the average person trips per day of 3.07 and 1.93 for car owning and non-car owning families or an average per capita trips of 2.33 in year 2000 are higher than the present world average and, therefore, believed unrealistic. The assumption that the average annual increase of per capita trips of 0.7% is more realistic resulting to a 2.72, 1.72 and 2.07 person trips per day estimated for car owning, for non-car owning families and for overall average per capita trip, respectively.

2) Total Traffic in the Study Area

The volume of car and PUV trips generated in the Study Area was 11,423,000 person trips per day in 1980, and is estimated to increase to 16,651,000 and 22,621,000 person trips per day in 1990 and 2000, respectively. These estimated 1990 and 2000 values amount to about 1.46 to 1.98 times the 1980 figure, and these growth correspond to an average annual increase rates of 3.8% in the first decade (1980-1990) and 3.1% in the second decade (1990-2000), the decline being in line with the decline in population increase rates.

The volume of taxi trips is estimated to grow similarly with car and PUV trips from the 550,000 person trips per day 1980 to 802,000 in 1990 and to 1,090,000 in 2000. The volume of truck traffic is estimated to follow the economic activities at 5.9%, the annual average rate of GRDP to 301,000 person trips per day in 1990 and 536,000 person trips per day in 2000.

5.2.2 Transport Demand by Zone

The population of and the quantity of trip generation in the Study Area have been estimated and shown in Figure 5.2–1, together with their factors of growth from 1990 to 2000. When such factors of growth in various traffic zones are compared, the CBD (Manila) shows the lowest factor of 1.2, while traffic zones along EDSA 8 to 10 kilometers from the CBD show the factors of 1.8 to 2.2, those along C–5, some 15 kilometers from the CBD and where intensive development is expected, show the factors of over 3.0, and the Constitution Hill area, where the Capitol Hills Urban Land Reform Zone Project and other development projects are on-goin, shows the factor of 8.1. The farther away the traffic zone from the CBD, the higher the growth factor.

At present, traffic density of the areas along the Project Roads is 30 to 60 person trips per hectare, whereas, that of the areas along EDSA (C–4) is about 270. In the year 2000, traffic density in the areas along C–5 will be 140 to 200 person trips per hectare, which is about 2/3 of the present traffic density in the area along EDSA. Traffic density in the areas along C–6 will be 100 to 150 person trips per hectare, which is about 1/2 of the present traffic density in the area along EDSA.

Figure 5.2–2 shows the traffic movements within and to/from the Project Area in the year 2000. Trips which will terminate within the Project Area (intrazonal trips) will be 951,000 person trips per day, which are 4.0 times greater than the present. Trips to/from the eastern areas of the Project Area and to/from the northern areas will increase rapidly by the factors of 8.7 and 7.4, respectively. Although the growth ratio in trips to/from the CBD (Manila) is low at 2.2, the number of trips is still the highest at 511,000 person trips per day. The growth ratios of trips to/from the Caloocan areas and to/from Cubao and Makati areas are high at 3.5 and 3.7, respectively. The number of trips to/from these two (2) areas is also high at 424,000 to 487,000 person trips per day, respectively.

TABLE 5.2–1 FUTURE TRANSPORT DEMAND INCREASE IN 1990 AND 2000

		1971	1980	1990	2000	Growth Rate 1971–1980	Growth Rate 1980–1990	Growth Rate 1990–2000
Car Ownership		20.1	25.8	30.0	35.0	2.8%	1.5%	1.5%
Average Per Capita Trip [1]								
Car Owned		2.11	2.37[4]	2.54	2.72	1.3%	0.7%	0.7%
No Car Owned		1.33	1.49[4]	1.60	1.72	1.3%	0.7%	0.7%
Average		1.49	1.72	1.88	2.07	1.6%	0.9%	1.0%
Population [2] in the Study Area		–	6,641	8,857	10,928	–	2.9%	2.1%
Total Generated Car & PUV		–	11,423	16,651	22,621	–	3.8%	3.1%
Trips [3]	Taxi		550	802	1,090	–	3.8%	3.1%
from the Study	Truck		170	301	536	–	5.9%	5.9%
Area	TOTAL		12,143	17,754	24,247	–	3.9%	3.2%

[1] : In terms of Persons Trips (persons trips/day)

[2] : In Thousand persons

[3] : In thousand person trips per day

[4] : Estimated value by the Study

FIGURE 5.2-1 TRANSPORT DEMAND IN 2000

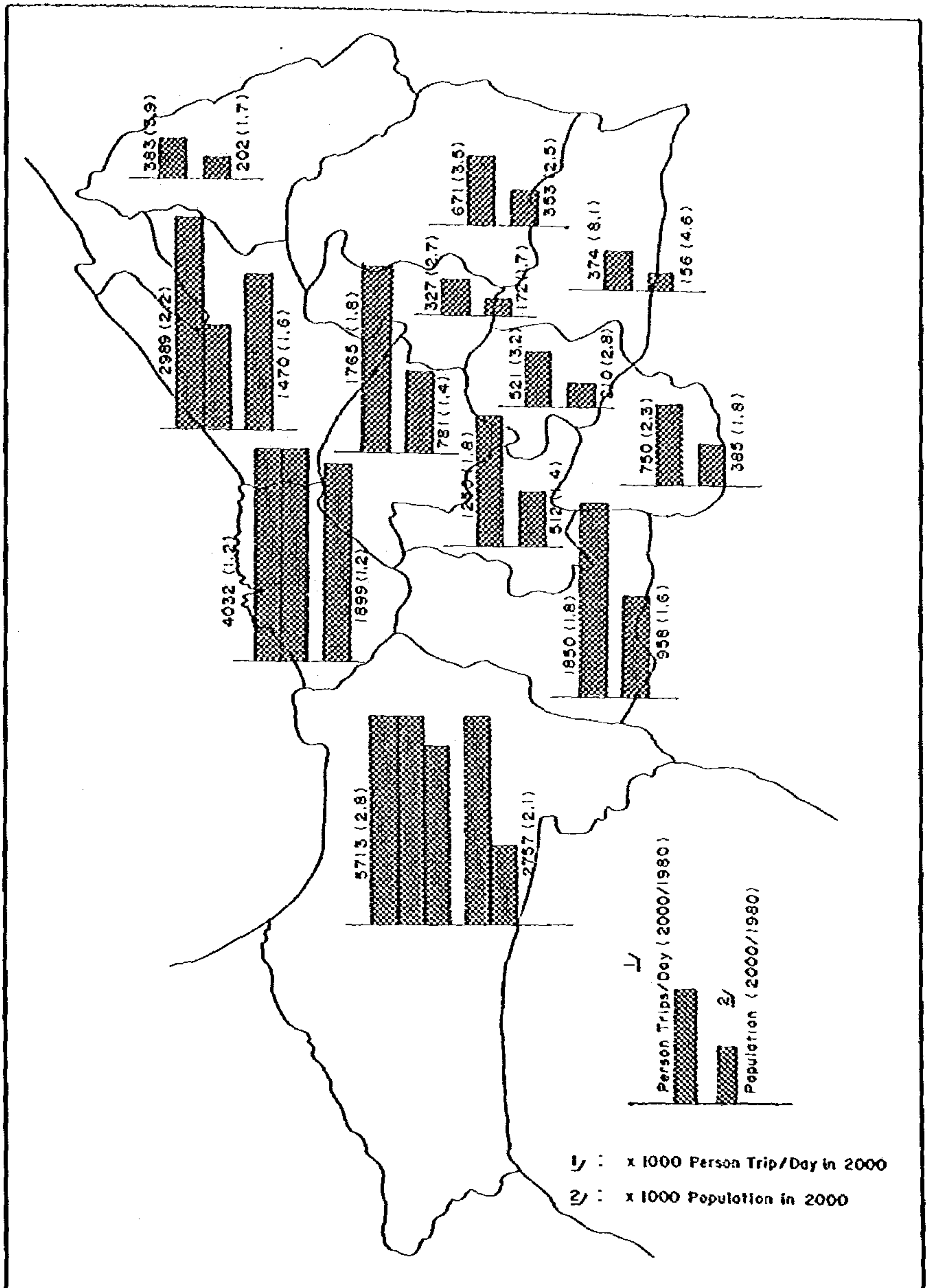
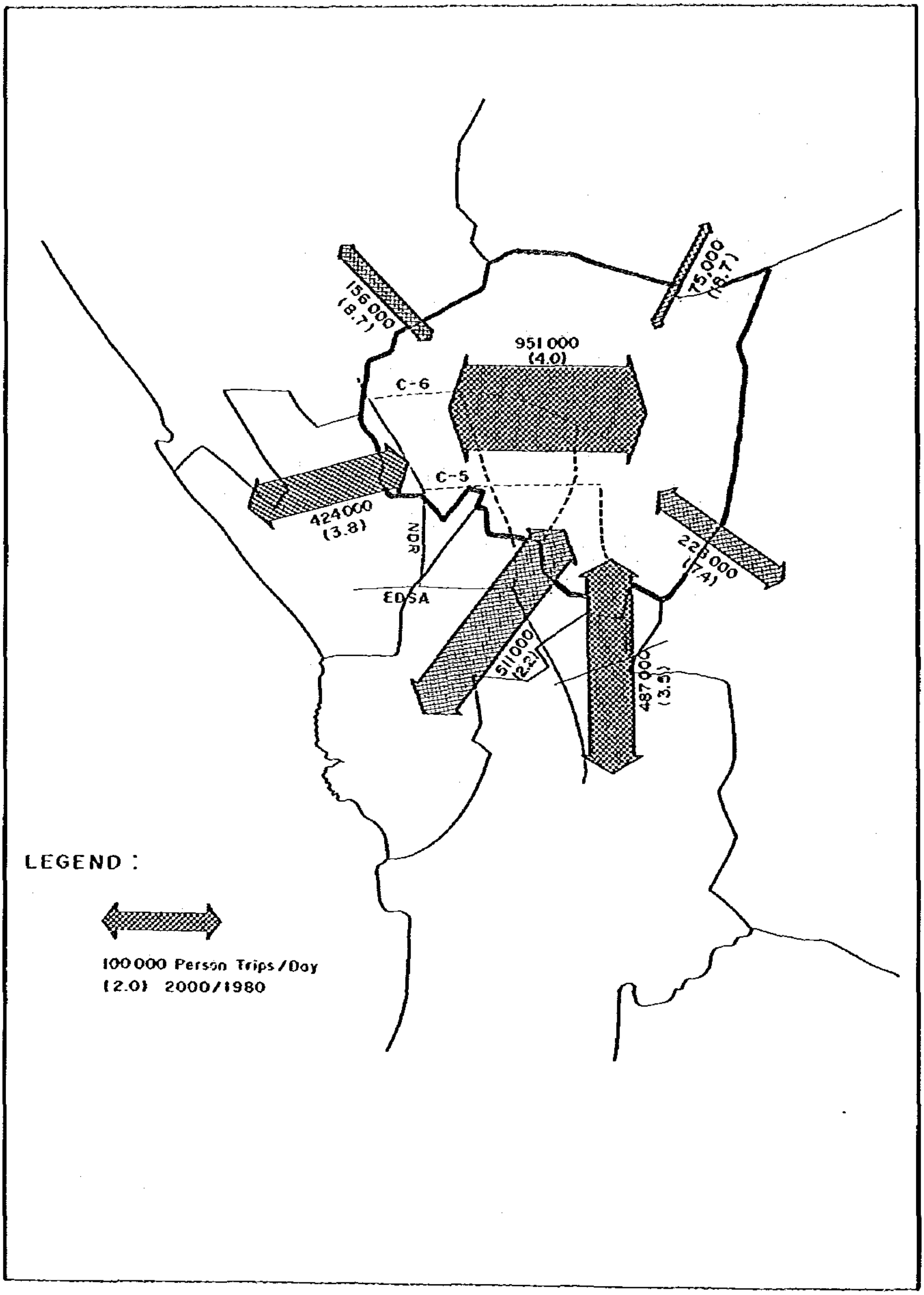


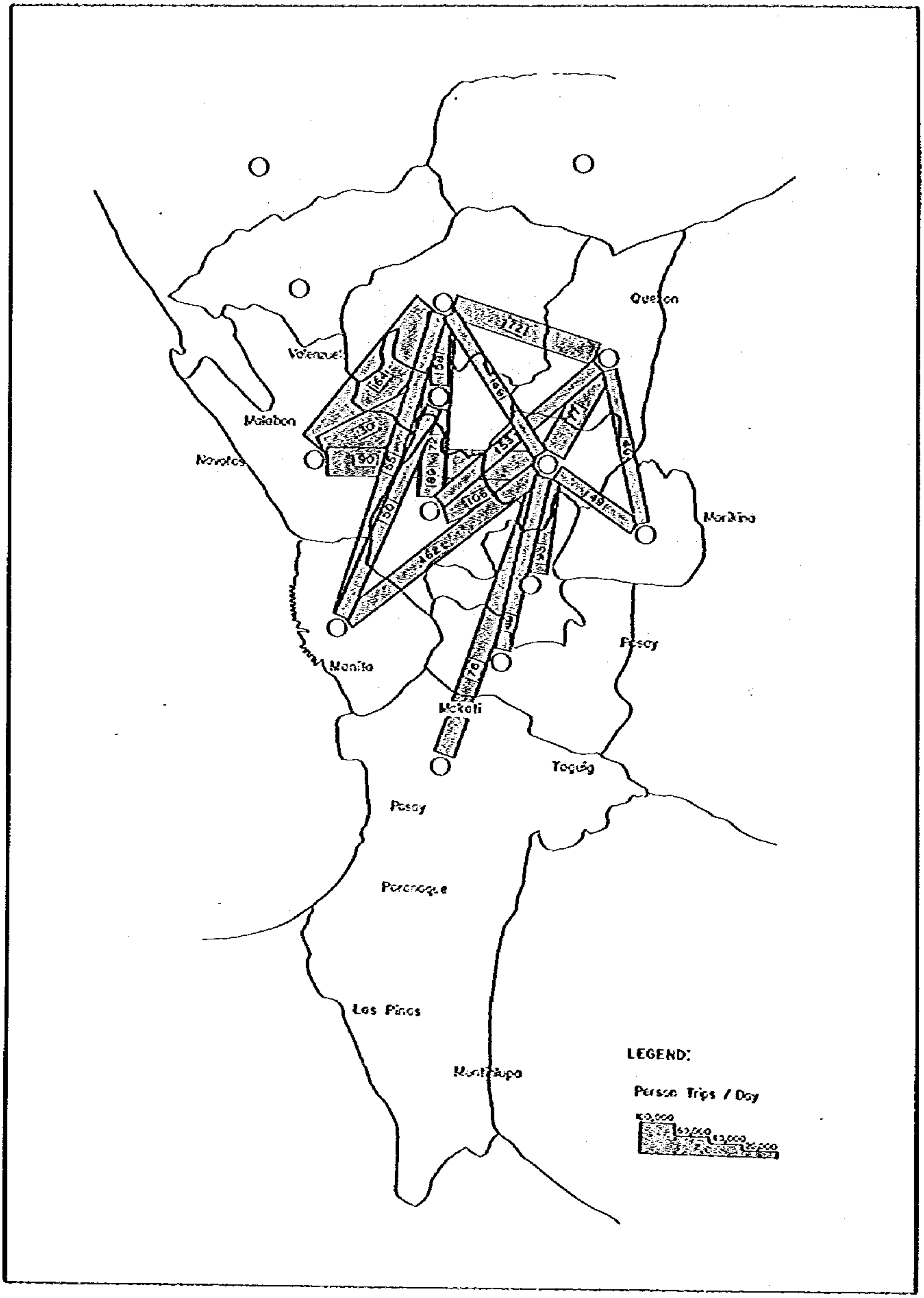
FIGURE 5.2-2 FUTURE TRANSPORT DEMAND FROM/TO PROJECT AREA



5.2.3 Car vs. PUV

The share of private car to the total person trips (persons using private cars and/or public utility vehicles), was estimated to increase from 25.5% in 1980 to 33.6% in year 2000 mainly due to the predicted increase of car ownership which has a low transport efficiency. This change in modal split also reflects the degree of transport efficiency i.e. to transport 1,000 person trips in 1980 requires only 194 pcu to 219 pcu in year 2000 or an increase of about 13%. For this reason, the PUV system should be strengthened to be an efficient transport system thereby maximizing the use of available road space, or more passengers transported per unit length of road.

FIGURE 5.2–3 DESIRED LINE OF CAR AND PUV IN 2000



CHAPTER 6 SELECTION OF OPTIMUM ROUTES AND FORMULATION OF ALTERNATIVE PLANS

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CHAPTER 6

SELECTION OF OPTIMUM ROUTES AND FORMULATION OF ALTERNATIVE PLANS

6.1 ROAD DEVELOPMENT POLICY FOR NCR

6.1.1 Road Development

NCR is plagued by chronic traffic congestion, accidents, and nuisance to the public. The Government formulated a short term, medium range, and long range transportation programs to improve the existing traffic problems and cope with the future traffic demand.

The Urban Transportation Study for Metropolitan Manila Area (UTSMMA) completed in 1973 prepared the long range transportation plan while the Metro Manila Transport, Land Use and Development Planning Project (MMETROPLAN) in 1977 established the short and medium range programs. Both plans contemplated on an efficient traffic management, the improvement of public transport facility, and road development of the road network consisting radial and concentric patterns.

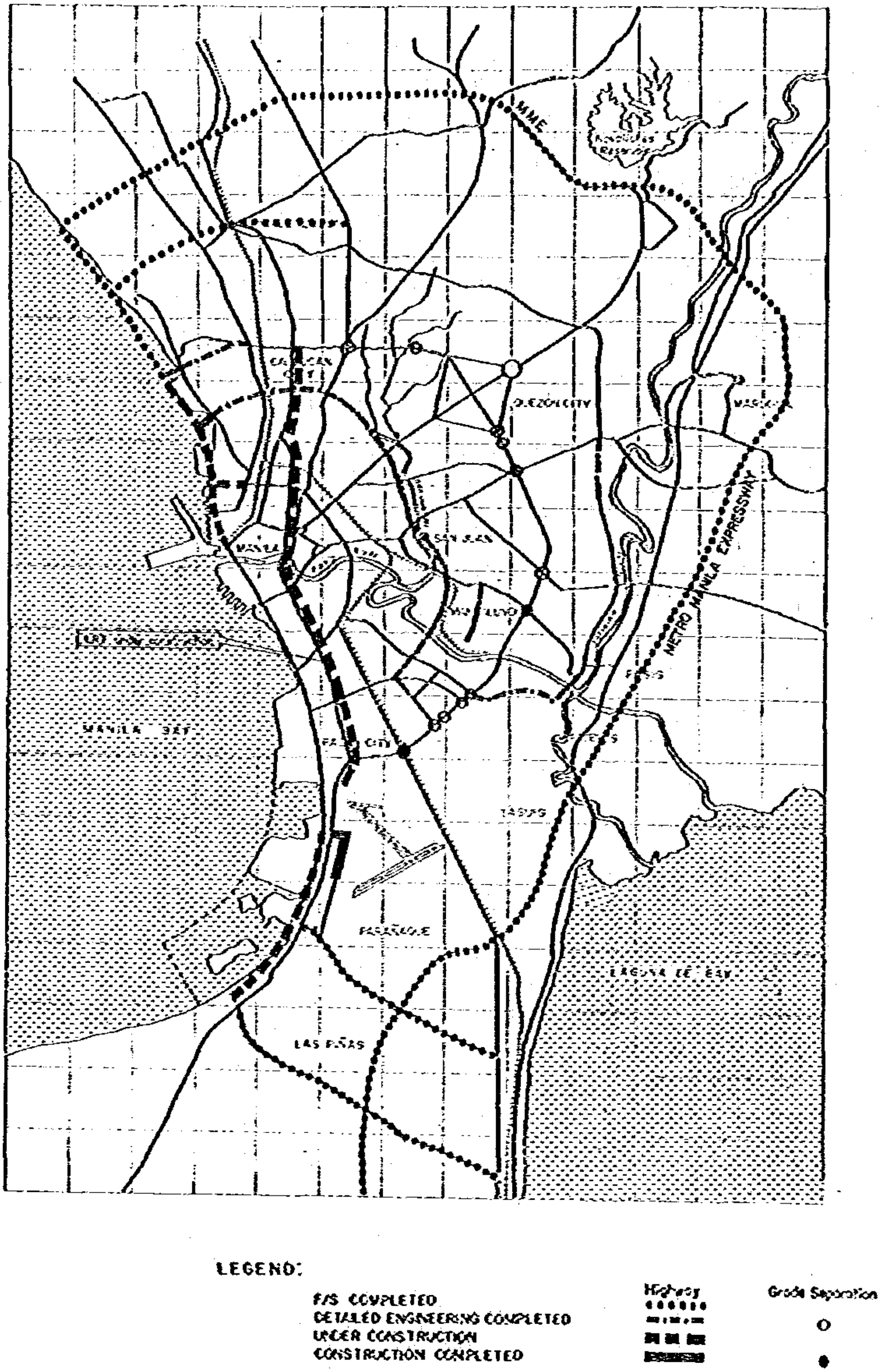
These studies recommended that road development be urgently started with priority emphasis on the missing major links inside C–4 and the development of the major roads in the northern and southern suburbs where future urbanization are expected. In response, the Government has commenced successive implementations of road development projects inside C–4 and formulations of plans in the suburban areas. Progress to date of the major road projects is shown in Figure 6.1–1.

Detailed design of all the roads inside C–4 has been completed and the construction of some of these roads has started. Only three (3) interchanges along C–4, namely, the EDSA/MSDR, EDSA/Shaw and EDSA/Cubao interchanges had been completed so far. The C–3 project has been delayed due to the difficulty in the acquisition of road right-of-way, which is the greatest problem in the implementation of road projects in urban areas. Feasibility studies and detailed engineering have been started for projects outside C–4.

6.1.2 Future Road Development

The CIF Study identified the following "committed projects" and assigned priority ranking of non-committed projects for the next five years (1983-1987):

FIGURE 6.1-1 CURRENT STATUS OF HIGHWAY PROJECTS



Committed Projects

a) R–10 Project

R–10 (from Del Pan Bridge to C–4)

C–2 (from R–10 to Juan Luna)

C–3 (from R–10 to Rizal Avenue Extension)

C–4 (from R–10 to Rizal Avenue Extension)

b) C–3

San Juan Bridge

c) Makati-Mandaluyong Link Road

d) R–1 (from the end of Roxas Boulevard to Zapote)

Non-Committed Projects

First Priority

Circumferential Road 3: Northern Section

Metro Manila Outer Major Roads Project: Southern Package and Northern Package

Second Priority

EDSA (C–4) Interchanges

Circumferential Road 3: Eastern Section

Third Priority

Imelda Avenue Extension (R–4)

Circumferential Road 3: between R–4 and Shaw Boulevard

Thus, a high priority is assigned to road development in the northern and southern suburbs, where future urbanizations are expected.

6.2 RELATED PROJECTS AND IMPLEMENTATION

The future road network in the NCR and in the DIZ will be the basis of identifying the roles and functions of the project roads as well as the determination of their construction timing. The established implementation schedule of related road projects is shown in Figures 6.2–1 and –2, based on the Five-Year Infrastructure Program (1983-1987) of MPWH, the CIF Study recommendations, and discussions with the concerned offices of MPWH. (See Appendices 6.2–1 and –2 for the description of these related road projects).

The feasibility study of the Metro Manila Expressway (MME) conducted by the Construction and Development Corporation of the Philippines recommended its alignment along the C–6 project. It was agreed that due to the developmental function of C–6, C–6 will be constructed ahead of the MME. During the traffic study, it was established that the traffic on the MME in year 2000 will only be about 10,000 PCU per day, meaning the construction of MME before 2000 will not be feasible. In view of this, the original plan to have the 50.00-meter right-of-way of the MME at the center of the C–6 right-of-way was deleted.

FIGURE 6.2-1 EXPECTED ROAD CONSTRUCTION SCHEDULE

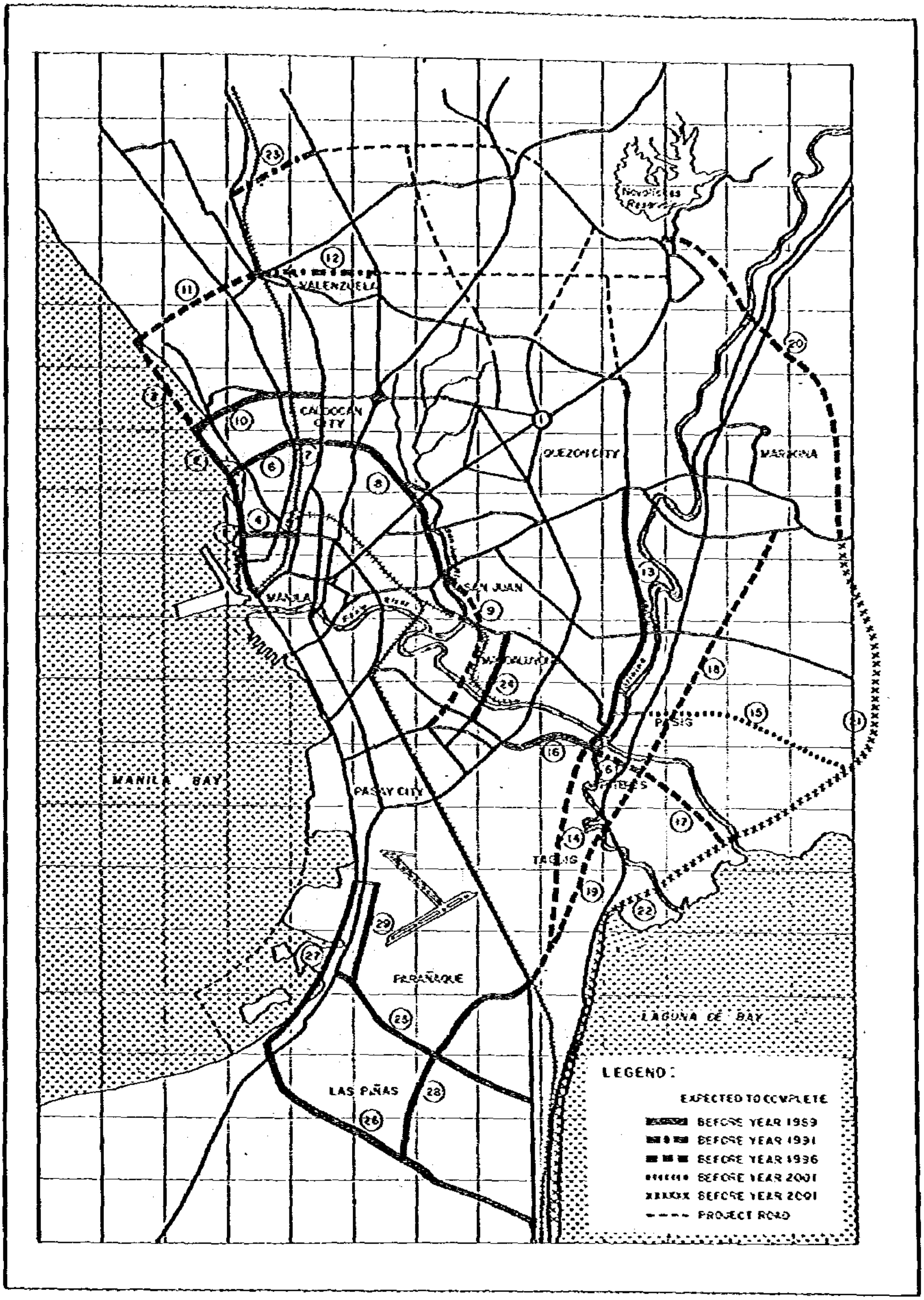
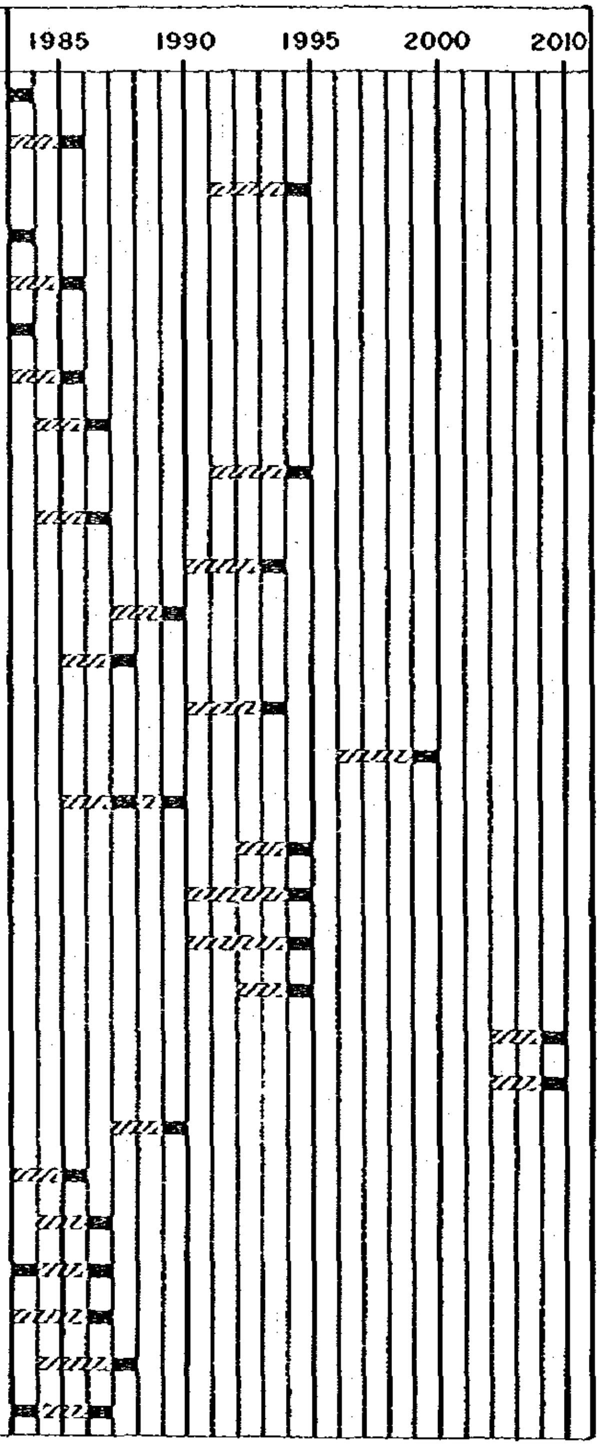


FIGURE 6.2-2 EXPECTED ROAD CONSTRUCTION SCHEDULE

No.	ROAD SECTION
1	R-10 (C-1/BANGKULASI)
2	R-10 (BANGKULASI/C-4)
3	M-B COASTAL ROAD (C-4/C-5)
4	C-2 (R-10/JUAN LUNA)
5	C-2 (JUAN LUNA/GOV. FORBES)
6	C-3 (R-10/MABINI ST.)
7	C-3 (MABINI ST./RIZAL AVE. EXT.)
8	C-3 (RIZAL AVE. EXT./R.M.MAGSAYSAY BLVD.)
9	C-3 (R.M.MAGSAYSAY BLVD./AYALA AVE.)
10	C-4 (R-10/RIZAL AVE. EXT.)
11	C-5 (R-10/McARTHUR HIGHWAY)
12	C-5 (McARTHUR HIGHWAY/NORTH EXPRESSWAY)
13	C-5 (R-6/R-4)
14	C-5 (R-4/SOUTH EXPRESSWAY)
15	R-5 EXTENSION
16	IMELDA AVE. (GUADALUPE/JUAN LUNA)
17	IMELDA AVE. (JUAN LUNA/C-6)
18	MME (MARIKINA/IMELDA AVE.)
19	MME (IMELDA AVE./SOUTH EXPRESSWAY)
20	C-6 (NOVALICHES RESERVOIR/MARIKINA)
21	C-6 (MARIKINA/IMELDA AVE.)
22	C-6 (IMELDA AVE./SOUTH EXPRESSWAY)
23	C-6 (NORTH EXPRESSWAY/McARTHUR HIGHWAY)
24	MAKATI TO MANDALUYONG LINK ROAD 1/
25	PARAÑAQUE - SUCAT ROAD
26	ZAPOTE - ALABANG ROAD 2/
27	R-1 (MANILA - CAVITE COASTAL ROAD)
28	LOOP ROAD (BICUTAN TO ZAPOTE/ALABANG ROAD)
29	IMELDA AVE. (SOUTH TRAVO ROAD) 3/



1/ SEGMENT 1 - MID 1984, SEGMENT 2 & 3 - 1986

2/ ON-GOING - 1984, STAGE-1 OF SOUTHERN PACKAGE - 1987

3/ STAGE 1 - 1984, STAGE 2 & 3 - 1987

6.3 ROLE AND FUNCTION OF THE PROJECT ROADS

Generally, roads and highways can be classified into the following four groups.

1) Major roads

Major roads are those principal arterial routes which form the main avenues of communication for inter-urban movements handling traffic of relatively long distance trips. Contained in this group are roads which are frequently referred to as freeways, expressways and major arterial roads.

2) Secondary Major Roads

Secondary major roads connect major sources of traffic with major roads. They accommodate traffic of relatively long distance trips flowing to and from major roads and have the structure of a fairly high standard.

3) Collector Roads

Collector roads which supplement the major roads and principally distribute traffic between major roads and local roads. As an integral part of the road network, collector roads function as "major roads" within the area surrounded by them and usually constitute the contour of residential areas. Collector roads are designed with relatively lower standard.

4) Local Roads

Local roads provide access to abutting properties and their network layout and traffic control are subject to particular care to keep through traffic out of residential areas.

The Project Roads and related roads within the DIZ were classified according to this classification.

1) C–5

This circumferential road which will function as a distributor of traffic thereby preventing through traffic from entering into the urban centers, belongs to the classification of a major road. The completion of C–5 will substantially contribute to the improvement of traffic along C-4, the most important thoroughfare in the NCR. For the decongestion of C–4, the construction of the C–5 project, together with the section of C-5 between Aurora Blvd. (R–6) and Imelda Ave. (R–4) and the extension of R–4 from EDSA to C–5, is of vital importance. C–5 will also share traffic between Metro Manila and the northern parts of Luzon that are presently using the MNE and the MacArthur Highway and, locally, it will distribute traffic from Quirino Highway to Mindanao Avenue and/or Visayas Avenue. C–5 is also an important boulevard leading to the Batasang Pambansa.

2) C–6

This is the outermost circumferential road of the NCR whose function is the same with that of C–5, and classified as a major road. When constructed, C–6 will attract some of the existing traffic on Aurora Boulevard, which is the major access of the eastern towns of Metro Manila to Quezon City across the Marikina River and at the same time will improve the traffic condition in these areas. C–6 will also distribute traffic on the Quirino Highway to Mindanao Avenue and/or Visayas Avenue. In the future, C–6 will become an important road for connection between satellite cities that will be developed on the fringes of the NCR.

3) Mindanao and Visayas Avenues

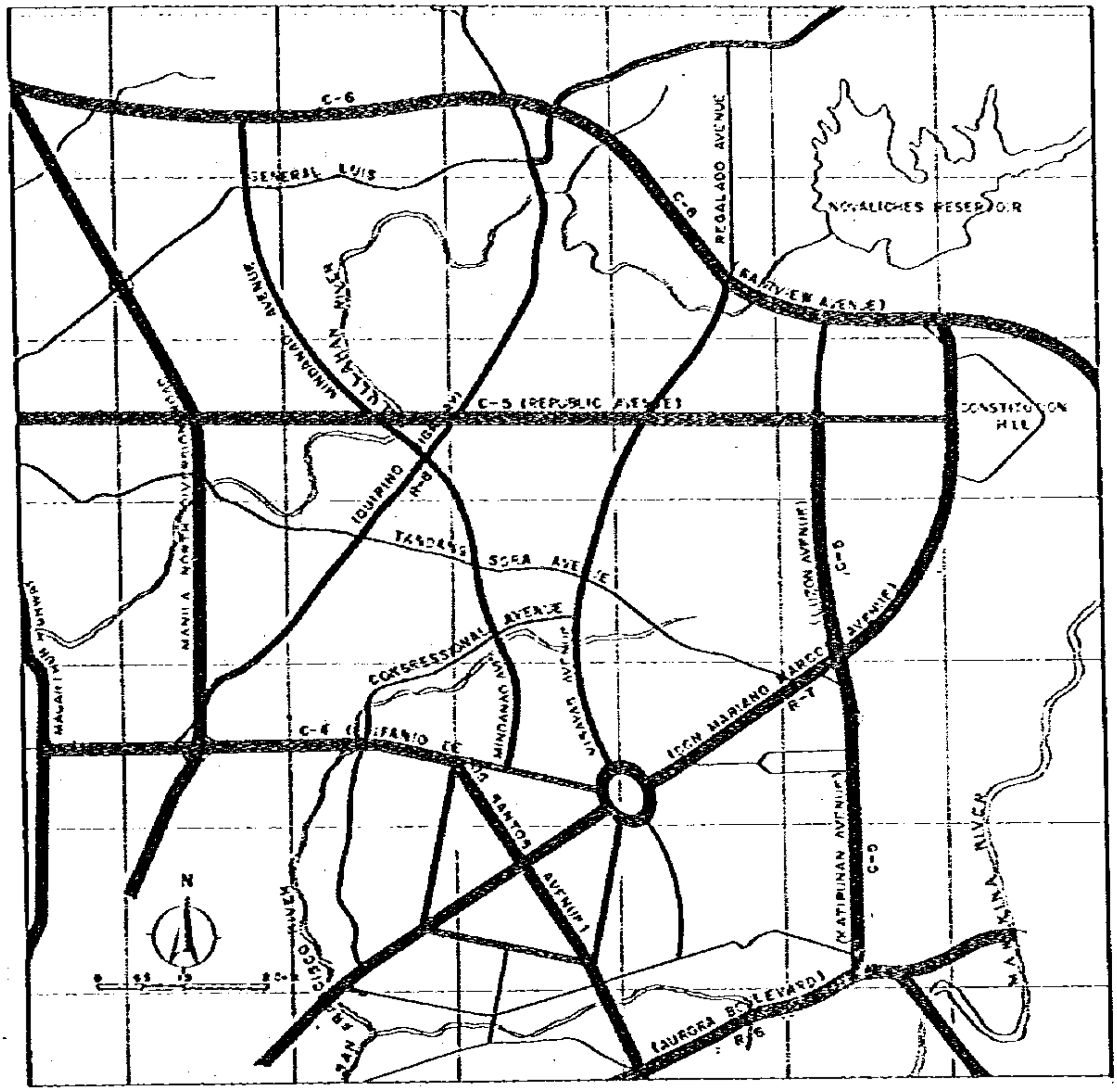
These roads belong to a secondary major road and their main function will be to attract traffic presently using existing congested radial roads via C–5 and C–6. Also, they will lead generated traffic along its length and traffic from Quirino Highway to C–4 and/or C–5.

4) Other Related Roads

Manila North Expressway is an inter-metropolitan speedway, while Aurora Boulevard and Don Mariano Marcos Avenue are major roads. Quirino Highway, which was classified as a major road, should probably be considered a secondary major road in view of its low standard. Tandang Sora Avenue and General Luis Road are collector roads. (See Figure 6.3–1).

In addition to their traffic function, the project roads will function as developmental roads. As discussed in Section 3.1.4, the project area presently lacks adequate major roads, and therefore, sporadic concentrations of development activities are seen in the areas along the existing roads. The strong development pressure on the project area, will necessitate the construction of the project roads to accelerate development of this area into an orderly land use.

FIGURE 6.3-1 FUTURE ROAD NETWORK IN THE PROJECT AREA



LEGENDS

MAJOR ROAD

SECONDARY MAJOR ROAD

COLLECTOR ROAD

6.4 STEPS TO ALTERNATIVE PLANS

The major steps used in the establishment of candidate routes up to the formulation of alternative plans are shown in Figure 6.4-1 and are described below:

1) Selection of Candidate Routes

Candidate routes were established by first determining the general corridor of each project road, and within the corridor, control points, such as open areas, existing roads reserved right-of-way that could be utilized including those areas that should be avoided, such as schools, churches, commercial centers, high density residential areas, were marked in an aerial photo. From this map, all possible alignments of each project road were established and were screened down to two or three competitive routes.

2) Selection of Preferred Routes

The candidate routes of each project road were evaluated individually using such factors as social and environmental impacts, engineering impacts, difficulty of implementation and construction cost, but without considering their contribution to the achievement of a well balanced road network. One or two of the candidate routes were selected for each project road as the preferred routes.

3) Selection of Alternative Road Networks

The preferred routes were combined into a number of alternative road networks.

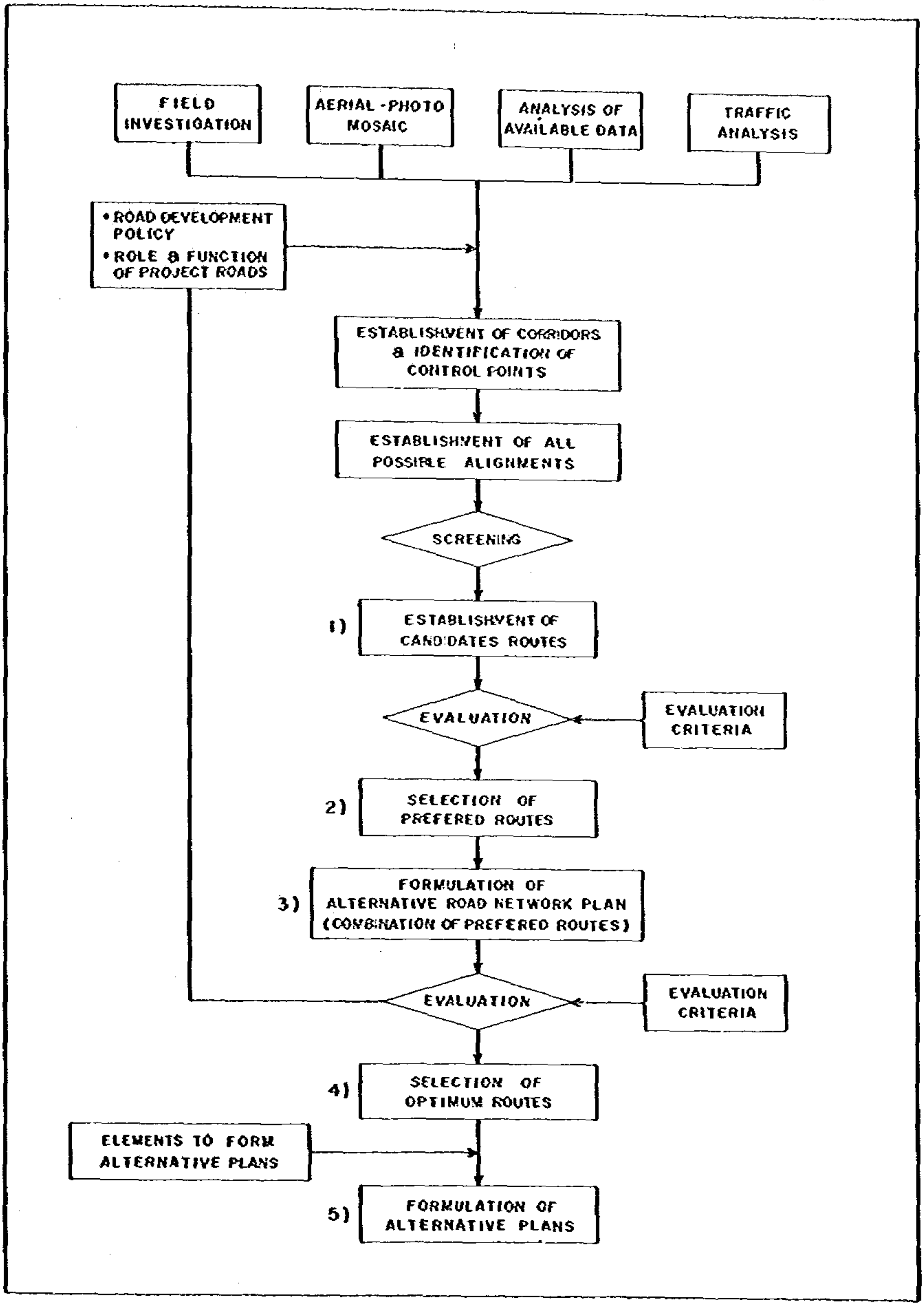
4) Selection of Optimum Route

Optimum road network is selected from the alternative networks, and the optimum route of each Project Road is finally determined.

5) Formulation of Alternative Plans

Different numbers of lanes and phasing of construction of the recommended optimum routes were considered in formulating alternative plans.

FIGURE 6.4-1 PROCEDURE FOR ALTERNATIVE PLAN FORMULATION



6.5 SELECTION OF CANDIDATE AND OPTIMUM ROUTES

6.5.1 Basic Policy

The basic policies in the establishment of the candidate route were as follows:

1) Establishment of a Harmonious and Well-balanced Road Network

The project roads, as parts of the major road network, should be located to function effectively with the overall transport system of the NCR.

2) Compatibility With Land Use

The alignment should, as much as possible, avoid affecting developed areas, such as a subdivision, a commercial complex, a school compound, etc. It should improve the accessibility of existing and proposed development centers.

3) Establishment of the Most Economical Alignment

The assessment of the alignment should not only be from the construction cost, right-of-way acquisition and property compensation costs, but also from its effect on transport cost.

4) Establishment of a Smooth Alignment

The alignment should be within the accepted geometric design standards.

5) Least Adverse Impact on Social Environment

To reduce problems during the implementation of the project, the alignment should be selected with the least number of houses, people, public facilities, etc. affected.

6) Maximum Use of Existing Road and Reserved Right-of-Way

As much as possible existing roads and land already acquired or reserved for road construction should be utilized.

7) Maximum Development Impact

The project roads should be a catalyst in the development of the area.

8) Possibility of Future Extension

Possibility of future extension of the Project Roads to cope with the future urban expansion.

6.5.2 Determination of Corridor

Prior to the establishment of the candidate routes, the corridor of each project road was first defined as shown in *Figure 6.5–1*.

1) C–5 Corridor

Selections of the route which are existing or have been determined in previous studies are as follows:

* location of the interchange of the Manila North Expressway and C–5 by the Manila-Bataan Coastal Road Study.
* alignment of Republic Avenue between the Manila North Expressway and Don Mariano Marcos Avenue.
* existing section of Katipunan Avenue between Aurora Boulevard and the University of the Philippines.

Based on the above, the C–5 corridor has been determined taking into account the following:

a) Appropriate interval between C–5 and circumferential road C–4/C–6

b) Appropriate intervals between C–5 and radial roads, Visayas Avenue and Don Mariano Marcos Avenue

c) Appropriate interval between C–5 and Tandang Sora Avenue

2) C–6 Corridor

The location of the interchange of the Manila North Expressway and C–6 has been determined by the Manila-Bataan Coastal Road Study.

Factors taken into consideration were as follows:

a) appropriate interval between C–6 and C–5

b) appropriate interval between C–6 and General Luis Road

c) limited area between La Mesa Dam and the Government Center Project Area

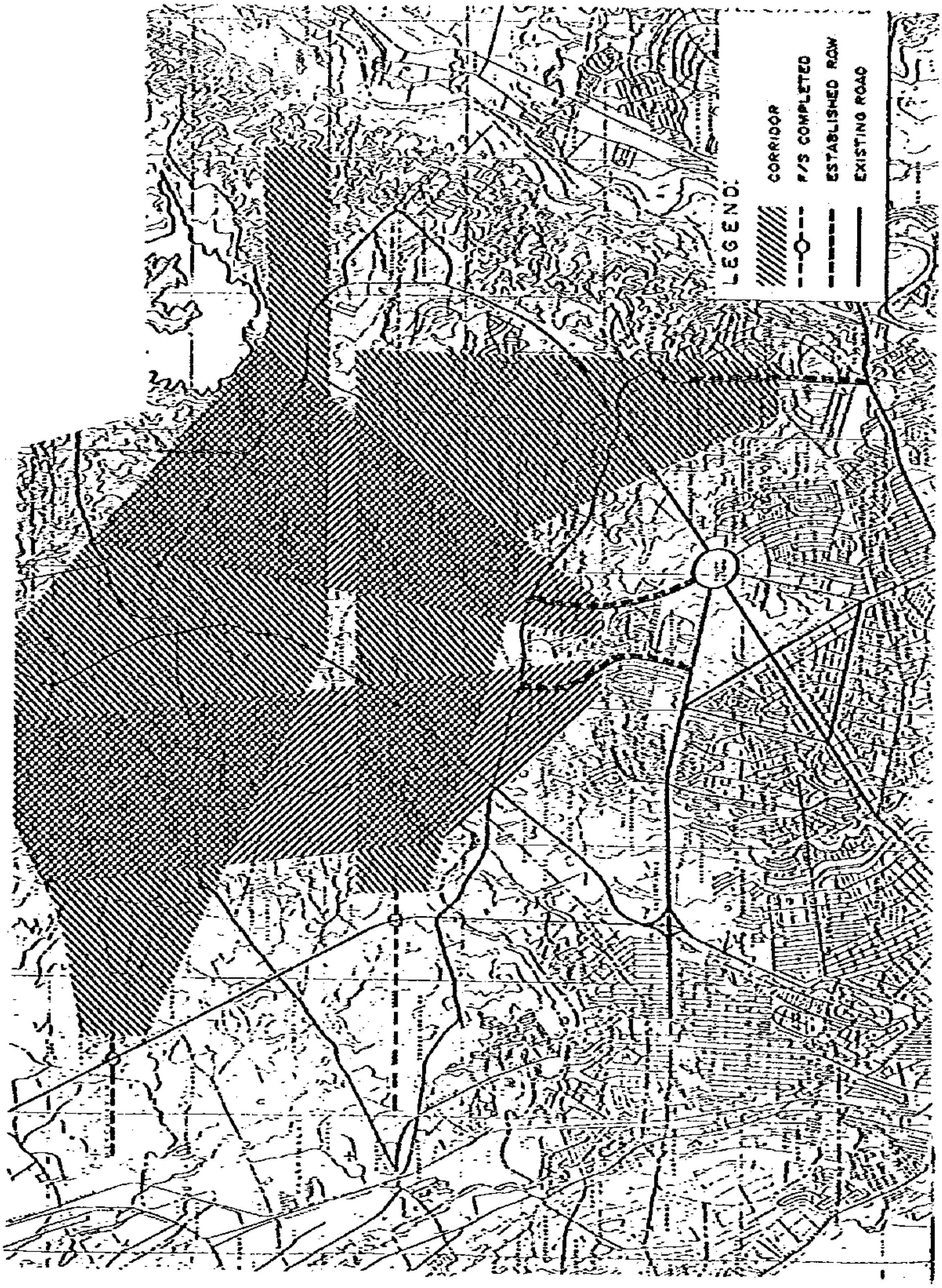
d) development plan of Fairview Subdivision

3) Mindanao Avenue Corridor

Existing is the 1.1–km. section from the North Avenue

Factors considered were as follows:

FIGURE 6.5–1 CORRIDOR MAP



a) reserved right-of-way between the end of existing section and about 1 km. south of Quirino Highway

b) appropriate intervals between Mindanao Avenue and its parallel roads, Visayas Avenue, Manila North Expressway and Quirino Highway

4) Visayas Avenue Corridor

Existing is the section between Elliptical Road and Tandang Sora Avenue.

Factors considered were:

a) section between Tandang Sora Avenue and Republic Avenue whose parcellary survey has been completed.

b) appropriate intervals between Visayas Avenue and its parallel roads, Mindanao Avenue, Quirino Highway and C–5.

6.5.3 Identification of Control Points

Field reconnaissance, investigation of aerophoto mosaics, collection of data and reports of related development projects were conducted to identify the control points.

The following are the summary of major control points by each project road (refer to Figure 6.5–2).

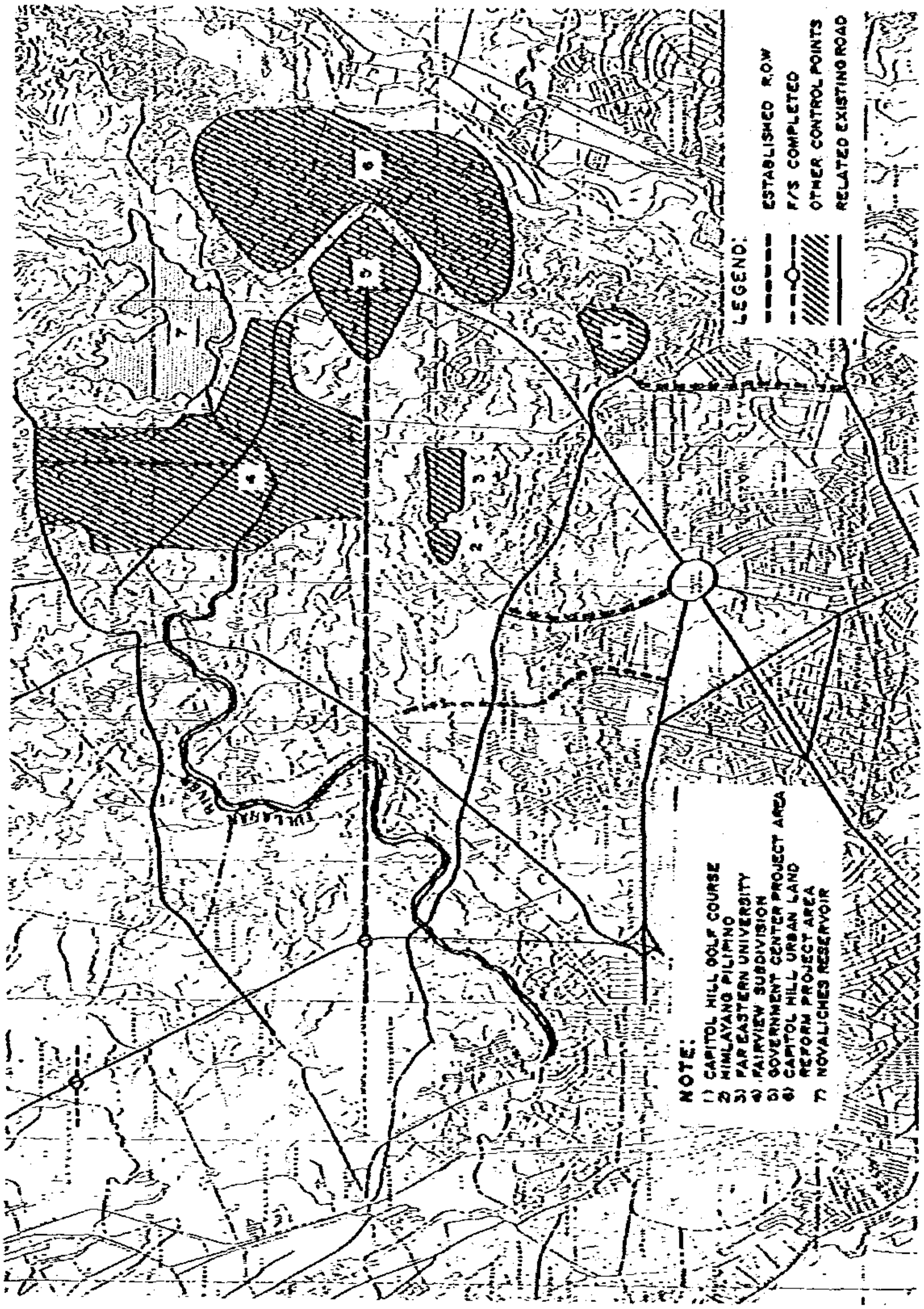
1) Major Control Points of C–5

- proposed interchange of MNE and C–5
- right-of-way of the proposed Republic Avenue
- proposed expansion plan of the Far Eastern University (partial construction started)
- Himlayang Pilipino (existing cemetery)
- Capitol Hills Golf Course
- existing section of Katipunan Avenue

2) Major Control Points of C–6

- proposed interchange of MNE and C–6
- La Mesa Dam (Novaliches Reservoir)
- Government Center Project Area
- Capitol Hills Urban Land Reform Project Plan
- Fairview Subdivision

FIGURE 6.5-2 MAJOR CONTROL POINTS



3) Major Control Points of Mindanao Avenue

- existing section of Mindanao Avenue
- reserved right-of-way for the extension
- intersection of Republic Avenue and Quirino Highway
- Tullahan River

4) Major Control Points of Visayas Avenue

- existing section of Visayas Avenue
- Himlayang Pilipino
- a tributary of San Francisco River

6.5.4 Establishment of Candidate Routes

After evaluating several possible routes, competitive candidate routes were established as shown in Fig. 6.5–3. Factors considered in the establishment of candidate routes are summarized in Appendix 6.5–1.

The following are the descriptions of each candidate route:

1) C–5

Route A–1

a) This route which utilizes Luzon Avenue connects Katipunan Avenue with the proposed Republic Avenue in the shortest alignment, and would have the easiest right-of-way acquisition, as the right-of-way of the Republic Avenue as well as Luzon Avenue had been reserved.

b) Passes approximately midway of the two north-south direction roads, the Don Mariano Marcos Avenue and Visayas Avenue. However, this route would be too far from C–4 (about 6 kms.) and too close to C–6 (about 2 kms.).

c) Appropriate design must be introduced at the intersection of Republic Avenue and Luzon Avenue to assure smooth flow of traffic along C–5.

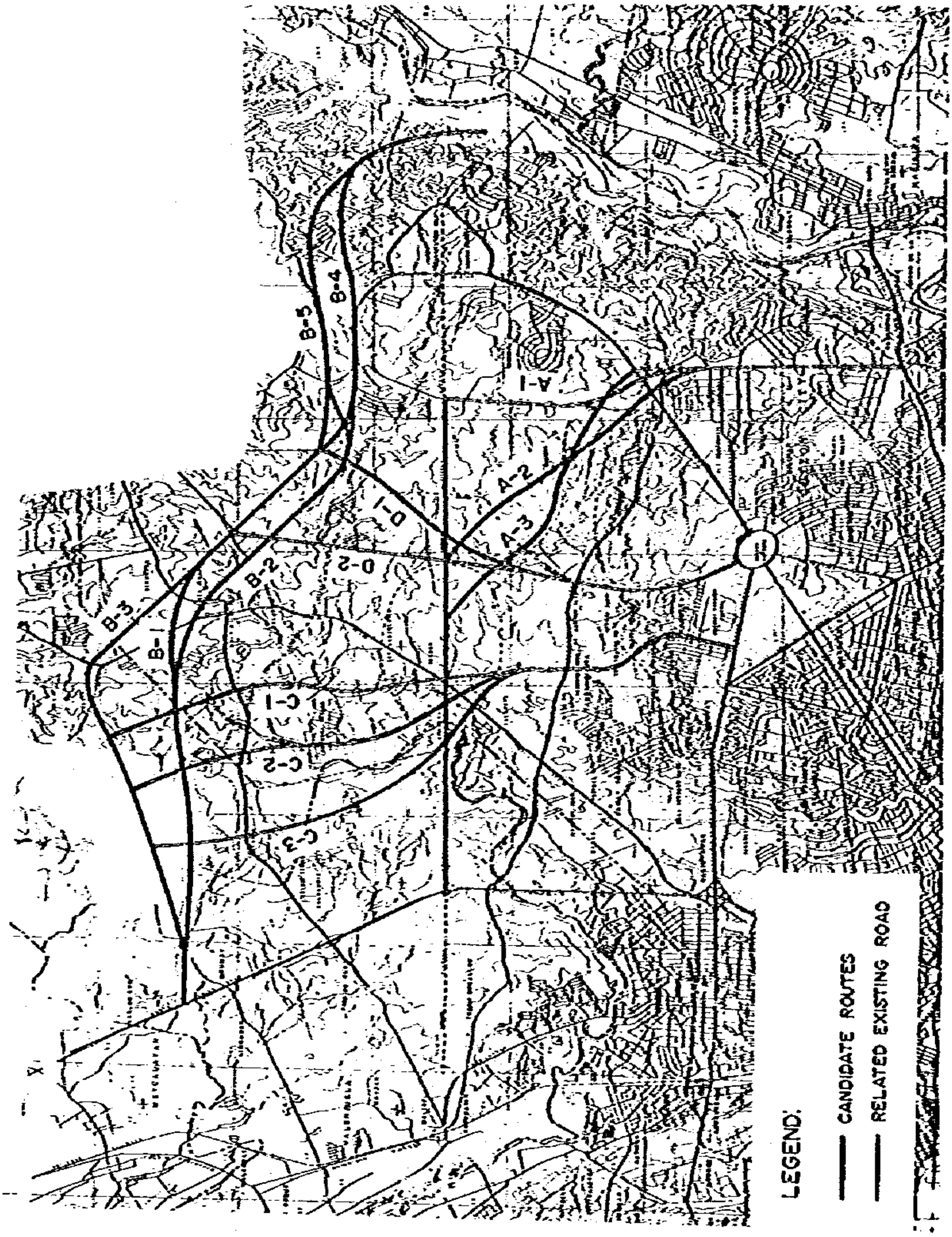
d) Scattered and few developments along Luzon Avenue

e) Passes through densely built-up area near the intersection of Don Mariano Marcos Avenue similar to the other candidate routes.

Route A–2

a) Passes between the Far Eastern University and Himlayang Pilipino, providing adequate intervals between this route and two (2) circumferential roads, C–4 and C–6.

FIGURE 6.5-3 CANDIDATE ROUTES



b) Follows the general alignment of a circumferential road, proposed by UTSMMA

c) Passes through three (3) subdivisions

d) Encroaches the Far Eastern University compound, which would require adjustment in the development plan of FEU

e) This route, Republic Avenue and Route D–1 of Visayas Avenue would intersect each other in short distance (less than 500 meters), requiring careful design of intersections.

f) Creates a triangular shaped area bounded by Republic Avenue, and Visayas Avenue.

Route A–3

a) Traverses the western side of Himlayang Pilipino

b) Intervals between this route and two (2) circumferential roads, C–4 and C–6, are provided evenly. However, this route will be too close to Tandang Sora Avenue.

c) Passes through four (4) subdivisions.

d) Four (4) major intersections, namely, this route/Visayas Avenue, this route/Republic Avenue, Republic Avenue/Visayas Avenue and Republic Avenue/Quirino Highway, are closely located at about 1 km. distance, making traffic management difficult.

2) C–6 Candidate Routes

Route B–1

a) Balanced distribution of C–4, C–5 and C–6 is considered

b) Fairview Avenue, the main road of Fairview Subdivision will be utilized

c) Passes near the Novaliches town proper

d) Passes through one (1) subdivision.

Route B–2

a) Balanced distribution of C–4, C–5 and C–6 is considered

b) Traverses open land behind the Fairview Subdivision

c) Passes through the fringe of Novaliches town proper

d) Passes through three (3) subdivisions.

Route B–3

a) The longest among the candidate routes avoiding Novaliches town proper and developed subdivisions and residential areas.

b) Unbalanced distribution of C-4, C-5 and C-6

c) Passes through two (2) subdivisions.

Route B-4

a) Follows the Fairview Avenue requiring careful design taking into consideration the division of lots.

b) Located about the middle of the area bounded by Republic Avenue and Novaliches Reservoir

c) Passes through six (6) subdivisions between Don Mariano Marcos Avenue and Marikina River.

Route B-5

a) Runs close to Novaliches Reservoir to avoid directly affecting the Fairview Subdivision

b) Too close to Novaliches Reservoir, therefore, northern half of this road will not be effective for any traffic

c) Don Mariano Marcos Avenue must be extended to connect with this route

d) Passes through three (3) subdivisions between Don Mariano Marcos Avenue and Marikina River.

3) Mindanao Avenue

Route C-1

a) Smooth and direct alignment

b) Too close to Quirino Highway and too far from the Manila North Expressway

c) Creates six (6) leg intersection (Republic Avenue, Quirino Highway and Mindanao Avenue)

d) Passes through six (6) subdivisions.

Route C-2

a) Avoids a six-leg intersection

b) Three (3) intersections at Republic Avenue/Quirino Highway, Quirino Highway/ Mindanao Avenue and Republic Avenue/Mindanao Avenue will be closely located within 300-500 meters distance. Careful design of intersections is required.

c) Creates a triangular shaped area bounded by Republic Avenue and Quirino Highway

d) As the west side of this route is bounded by Tullahan River, development impact of this route is less

e) The area east of Tullahan River will be served by Quirino Highway and this route, while the area west of Tullahan River would have no road

f) Passes six (6) subdivisions.

Route C–3

a) Accelerates development of the area between Tullahan River and the Manila North Expressway

b) Three (3) intersections (Republic Avenue/Mindanao Avenue, Republic Avenue/ Quirino Highway and Mindanao Ave./Quirino Highway) are closely located within 500-609 meters. Careful design of intersection is required.

c) Creates a triangular shaped area bounded by Republic Avenue and Quirino Highway

d) As the area between Tullahan River and the Manila North Expressway is less developed, land acquisition will be easier.

e) North-south direction roads are almost evenly distributed

f) Passes through three (3) subdivisions.

4) Visayas Avenue

Route D–2

a) Passes at the middle of the area bounded by Don Mariano Marcos Avenue and Quirino Highway

b) Intersects diagonally with C–6, therefore, intersection must be designed carefully

c) When Route B–2 of C–6 is selected, two adjacent intersections (C–6/Visayas Avenue and Fairview Avenue/Visayas Avenue) will be created.

Route D–2

a) Importance is placed on smooth alignment

b) Mindanao Avenue inside the Fairview Subdivision will be part of this route

c) Intersects C–6 diagonally

d) When Route B–2 of C–6 is selected, two adjacent intersections (C–6/Visayas Avenue and Fairview Avenue/Visayas Avenue/Mindanao Avenue) will be inevitable.

6.5.5 Selection of Optimum Route

1) Selection of Preferred Routes

Criteria for the candidate routes evaluation were established as shown in Fig. 6.5–4. The rating method was adopted to evaluate candidate routes. Details of the evaluation is presented in Appendix 6.5–2. One or two candidate routes which got higher points were selected as preferred routes. The results are summarized as follows:

Project Road	*Preferred Routes*
C–5	A–1 and A–2
C–6	B–1 and C–4
Mindanao Avenue	C–2 and C–3
Visayas Avenue	D–1 and D–2

2) Selection of Optimum Route

The preferred routes for each project road were used in the formulation of different route network for further evaluation. Fig. 6.5–5 shows the eight (8) different alternative road network plans and their evaluation using the established criteria and the rating method is tabulated in Table 6.5–1.

3) Conclusion

The result of the evaluation of the eight (8) alternative road network plans shows that plans 2 and 4 have the highest rating with 88.2 and 83.3 points, respectively.

The alignment of C–5 is the only difference between the two plans. Plan 4 has a more balanced distribution of Circumferential Roads 4, 5 and 6, while Plan 2, has a more balanced distribution of the overall road network. The advantages of Plan 2 over Plan 4 are as follows:

* balanced distribution of north-south direction roads which would accelerate a well-balanced development of the area.
* most economical plan
* smooth flow of traffic on C–5 can be attained at the intersection of Republic Avenue and Luzon Avenue by providing efficient channelization or grade separation
* Far Eastern University development plan will not be affected
* most extensive use of existing roads and reserved right-of-way.

Plan 2 was selected as the optimum road network in the area. The optimum route of each project road is summarized as follows:

Project Road	*The Optimum Route*
C–5	A–1
C–6	(B–1) + (B–4)
Mindanao Avenue	C–3
Visayas Avenue	D–1

FIGURE 6.5-4 EVALUATION CRITERIA

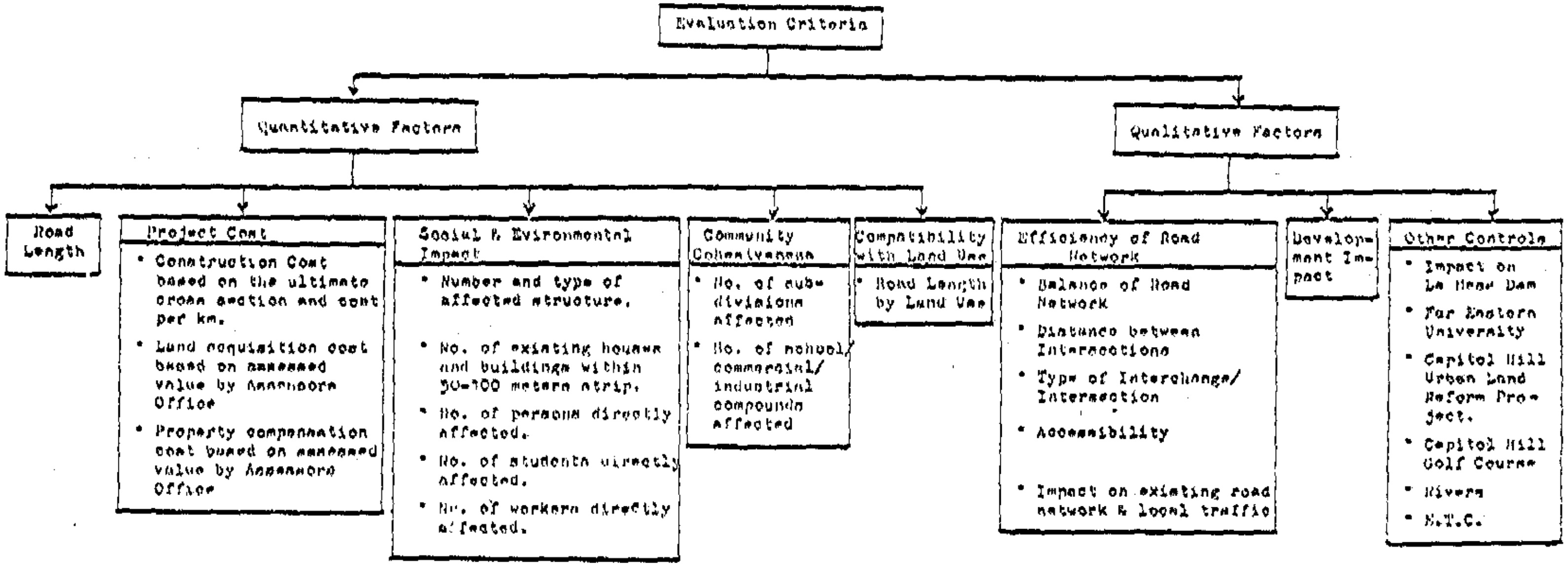
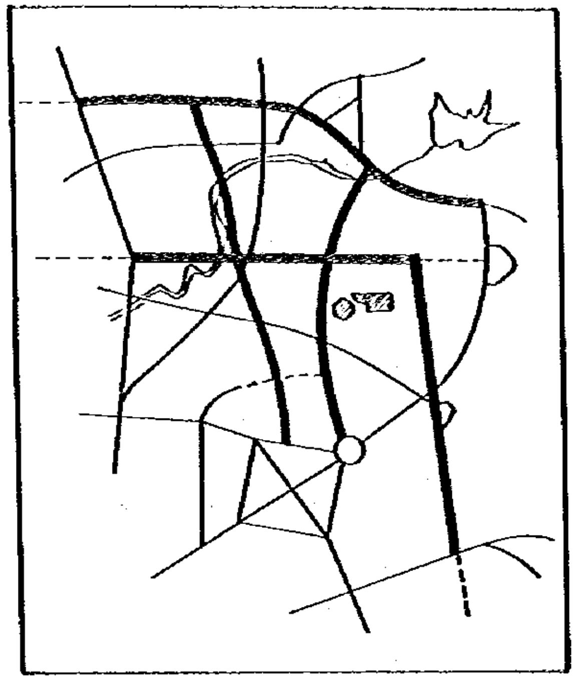
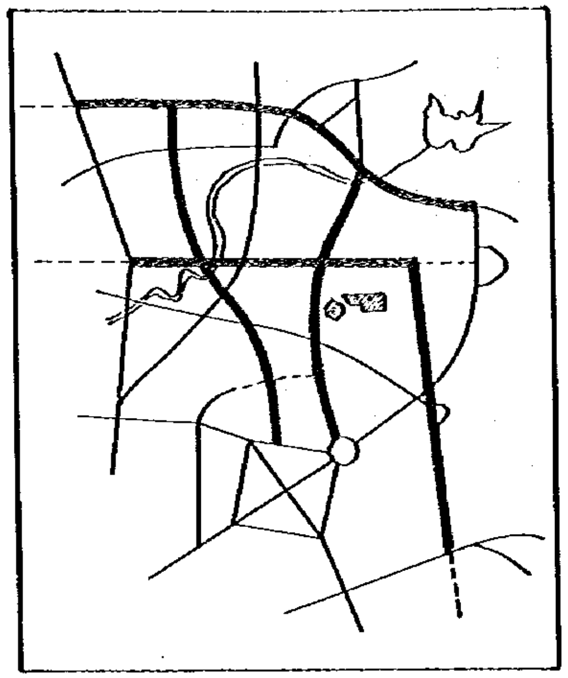


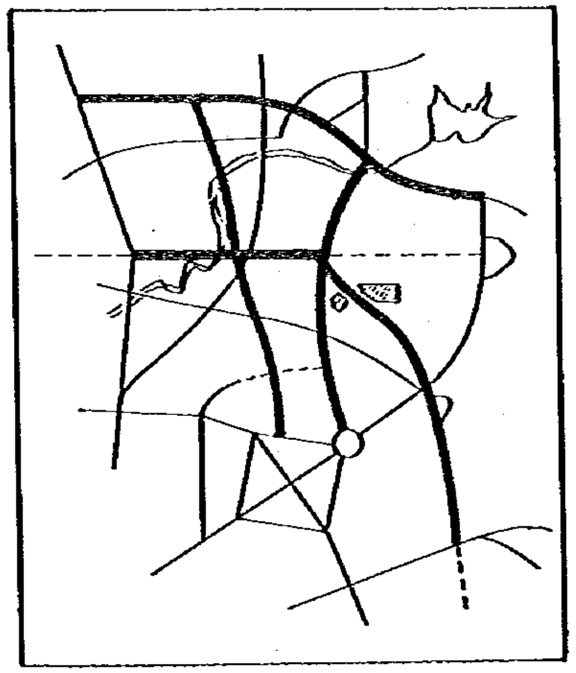
FIGURE 6.5-5 ROAD NETWORK ALTERNATIVES



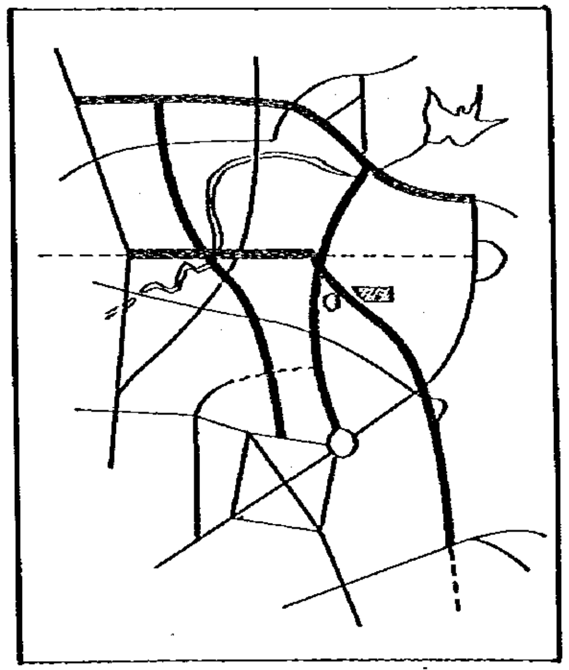
PLAN - 1



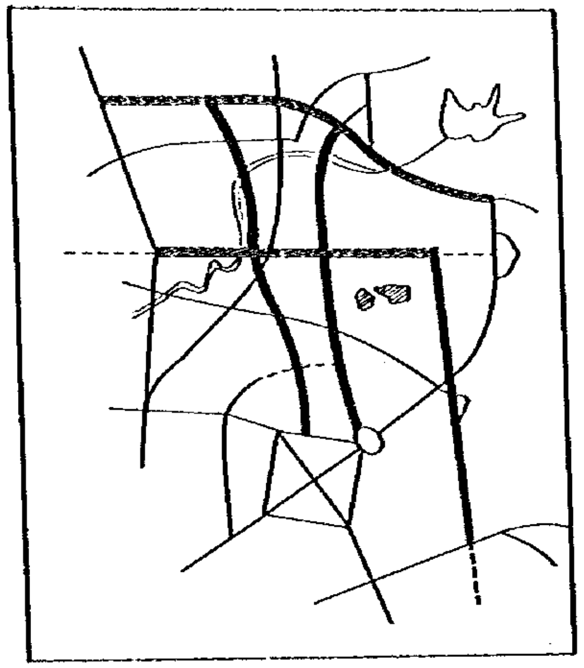
PLAN - 2



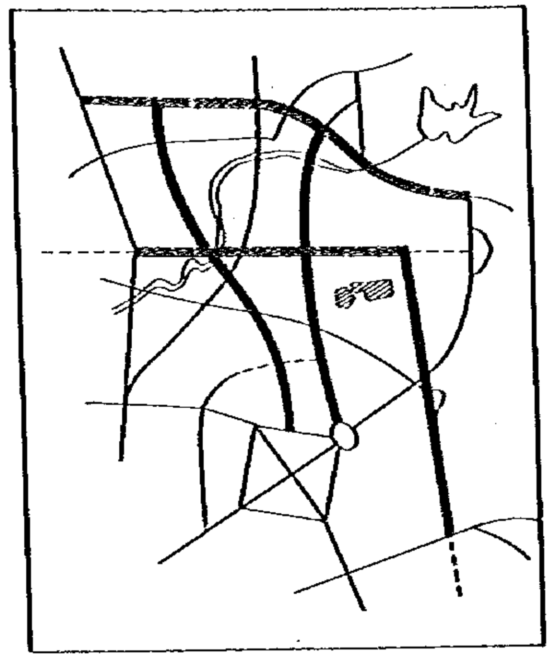
PLAN - 3



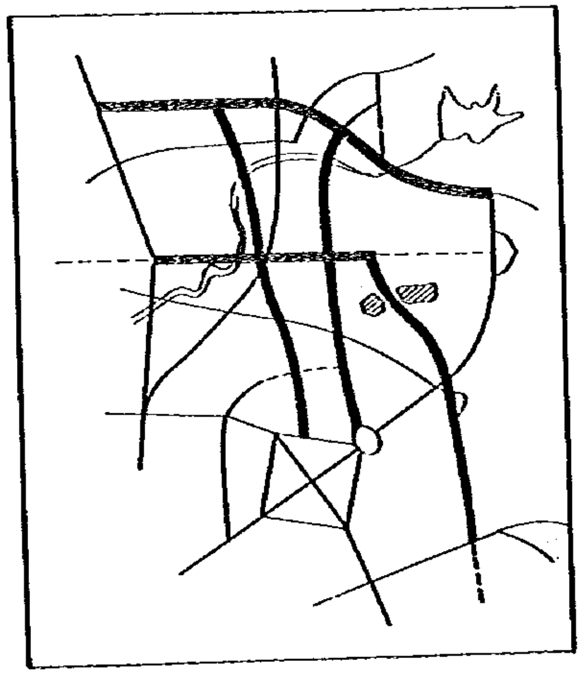
PLAN - 4



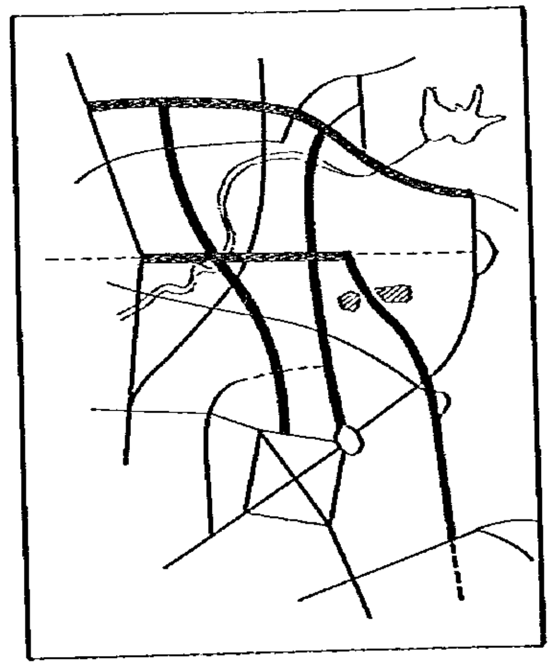
PLAN-5



PLAN-6



PLAN-7



PLAN-8

TABLE 6.5–1 EVALUATION OF PROPOSED ROAD NETWORK

	WT.	Plan 1		Plan 2		Plan 3		Plan 4		Plan 5		Plan 6		Plan 7		Plan 8	
• TOTAL LENGTH (Km.)		42,2		42,5		40,7		41,0	43,1	43,1		43,4		41,6		41,9	
• ROAD NETWORK SYSTEM	15	Table 6.5–2	12.8		13,2		12.9		13,4		12.4		12.6		13.2		13.4
• SOCIAL/ENVIRONMENTAL IMPACT	(20)		(17.6)		(18.4)		(17.5)		(18.5)		(13.5)		(14.0)		(13.7)		(14.6)
Houses/Other Facilities Within R.O.W.	5.5	872	5.1	868	5.3	869	5.3	865	6.5	905	3.3	901	3.5	902	3.5	898	3.7
Persons Affected	3.5	5100	3.4	5090	3.5	5100	3.4	5080	3.5	5300	2.1	5280	2.2	5290	2.2	5270	2.3
Road Length in Open Areas	3.0	21,8	2.3	22,7	2,7	22,3	2.5	23,1	3.0	20,9	1,8	21.8	2,3	21,4	2,1	22,4	2.6
Road Length Following Existing Road R.O.W.	2,5	16,2	2,5	14,9	2,2	13,1	1,8	11,8	1,5	16,2	2,5	14,9	2,2	13,1	1.8	11,8	1,5
Subdivisions Affected	3,0	15,3	2,4	15,8	2,2	12,6	3,0	13,1	2,9	17,1	1,9	17,6	1,8	14,4	2,6	14,9	2,4
Road Length in Residential Area (Km., %)	2.5	5.1	1.9	4.0	2.5	5.8	1.5	4.7	2.1	5.1	1.9	4.0	2.5	5.8	1.5	4.7	2.1
• ENGINEERING ASPECT	(10)		(9.6)		(8.8)		(9.3)		(8.5)		(9.7)		(8.7)		(9.4)		(8.5)
Accessibility Problems Km (>2.00 M. Height)	3.0	5.4	2.9	7.1	1.9	5.5	2.8	7.2	1.8	5.2	3.0	6.9	2.0	5.3	2.9	7.0	1.9
Horizontal Alignment (No.)	1.0	16	0.9	15	1.0	17	0.8	16	0.9	16	0.9	15	1.0	17	0.8	16	0.9
Vertical Alignment, Km. (> 3%)	1.0	3.4	0.9	4.1	0.9	3.1	1.0	3.1	1.0	2.9	1.0	4.6	0.8	3.6	0.9	4.2	0.8
No. of Intersections	2.0	18	2.0	18	2.0	19	1.8	19	1.8	18	2.0	18	2.0	18	2.0	18	2.0
Difficulty of Providing Future G.S.	2.0	3	1.9	2	2.0	3	1.9	2	2.0	3	1.9	2	2.0	3	1.9	2	2.0
Major Bridge Structures	1.0	10	1.0	10	1.0	10	1.0	10	1.0	11	0.9	11	0.9	11	0.0	11	0.9
• DIFFICULTY OF IMPLEMENTATION	(10)		(9.5)		(8.9)		(8.7)		(8.1)		(8.8)		(8.2)		(8.0)		(7.3–
Land Area To Be Acquired (Ha.)	5.5	261.1 (132.8)*	5.5	262.4 (135.5)*	5.1	264.9 (141.4)*	4.2	266.2 (144.0)*	3.8	264.5 (136.3)*	5.0	265.8 (138.9)*	4.6	268.3 (144.8)*	3.7	269.6 (147.2)*	3.3
No of Permanent Structures	4.5	18	4.0	19	3.8	16	4.5	17	4.3	19	3.8	20	3.6	17	4.3	18	4.0
• COST (₱Million)	(30)	1,330.8	(26.4)	1,317.5	(27.2)	1,355.0	(23.2)	1,342.6	(23.9)	1,350.6	(23.2)	1,337.3		1,375.7	(19.9)	1,362.4	(20.8)
Land Acquisition	0.9	618.6	7.3	600.8	9.0	631.7	6.1	613.9	7.8	625.8	6.6	608.0	9.0	638.9	5.4	621.1	7.1
Compensation	9.0	49.6	7.1	50.0	6.9	49.4	7.2	49.8	7.0	51.1	6.5	51.5	6.3	50.9	6.6	51.3	6.5
Construction	12.0	662.6	12.0	666.7	11.3	674.8	9.9	678.9	9.1	673.7	10.1	677.3	9.4	685.9	7.9	690.0	7.2
• DEVELOPMENT OF AREA WEST OF TULLAHAN RIVER	7.5	Table 2.9–7	4.5		6.4		4.5		6.4		4.5		6.4		4.5		6.4
• OTHER FACTORS	7.5	Table 6.5–2	4.9		5.3		4.5		4.5		4.9		5.3		4.5		4.9
TOTAL POINTS			85.3		88.2		80.6		83.3		77.0		80.4		73.2		75.9
RANKING			2		1		4		3		6		5		8		7

(*) Excludes existing but unacquired ROW

(*) excludes existing but unacquired ROW

TABLE 6.5–2 COMPARATIVE EVALUATION OF ALTERNATIVE NETWORK PLANS

	Plan – 1	Plan – 2	Plan – 3	Plan – 4
ROAD NETWORK SYSTEM	a) North–south direction roads are evenly distributed b) Middle section of C–5 is far from C–4 and close to C–6 c) A triangular shaped area is formed creating 3 adjacent intersections at about 500 meters apart.	a) Same as a) of Plan–1 b) Same as b) of Plan–1 c) Same as c) of Plan–1 but a 800 meters apart	a) Even distribution of C–4, C–5 and C–6 b) North-south direction roads is inferior to Plans 1 & 2. c) Two triangular shaped areas are formed creating 6 adjacent intersections. d) C–5 is close to Tandang Sora Ave.	Same as Plan–3 except that the 3 adjacent intersections (Quirino/Republic/Mindanao) is better than Plan–3.
DEVELOPMENT OF AREA WEST OF TULAHAN RIVER	No Direct Impact	Development Accelerated	No Direct Impact	Development Accelerated
OTHER FACTORS			i) Far Eastern University Development Plan is affected	1) Same as i) of Plan–3

	Plan – 5	Plan – 6	Plan – 7	Plan – 8
ROAD NETWORK SYSTEM	a) Middle section of C–5 is far from C–4 and close to C–6 b) Visayas Ave. extension too close to Quirino Ave. c) Same as c) of Plan–1	a) Same as a) of Plan–5 b) Same as b) of Plan–5 c) Same as c) of Plan–2	a) Intervals of C–4, C–5, and C–6 is good. b) Same as a) of Plan–5 c) Same as c) of Plan–1 d) C–5 is close to Tandang Sora Ave.	a) Same as a) of Plan–7 b) Same as b) of Plan–7 C) Same as C) of Plan–2 d) Same as d) of Plan–7
DEVELOPMENT OF AREA WEST OF TULLAHAN RIVER	No Direct Impact	Development Accelerated	No Direct Impact	Development Accelerated
OTHER FACTORS			i) Same as i) of Plan–3	i) Same as i) of Plan–3

6.6 FORMULATION OF ALTERNATIVE PLANS

6.6.1 Policy

Alternative development plans of the recommended optimum routes were formulated for the purpose of determining the scale and scope, and the timing and phasing of construction of each road, to achieve the maximum impacts. The following are the factors used in the formulation of alternative plans:

Type of pavement

Type of intersection and grade separation

Type of bridge and drainage structure

Number of lanes

Phasing of construction

The first three factors can be evaluated independently. The types selected as a result of independent evaluation have been therefore used in all alternative plans. Thus, formulated alternative plans differ only in the last two factors.

The following basic policies were adopted in the formulation of alternative plans:

1) That the entire routes of the project roads be constructed in the first stage (Stage 1) of implementation for the achievement of an even distribution of roads in the Project Area indispensable to the acceleration of an orderly urbanization aside from its function of providing a road facility to meet the traffic demand in the area.

2) That the Project Road construction be in two stages within the study period of 1989 to 2008; that two kinds of alternatives be formulated: (1) those which aim at the achievement of minimum investment by constructing the minimum number of lanes needed to meet traffic demand in each stage, and (2) those which aim to achieve a higher traffic efficiency in the Project Area as a whole by constructing slightly more lanes than needed to meet the demand in each phase; and that in either alternatives bus/jeepney lane be installed in Stage 2 to allow the efficient use of available lanes.

3) That, in view of the huge amount of annual investment needed for the simultaneous construction of all the project roads in one stage (Stage 1) which can cause financial difficulty, the construction work of Stage 1 be divided into two consecutive phases, Phase 1 and Phase 2.

4) That the completion of Stage 2 construction be at least five years after the completion of Stage 1 construction.

5) That whichever of the alternative plans may be selected, same schedule be applied for the implementation of the upgrading, improvement, or construction of existing or new

related roads which will be needed in addition to the Project Roads to satisfy the traffic demand in the project area.

6.6.2 Road Network Analysis

On the basis of the established future road network of the DIZ, including the project roads, a non-capacity constraint traffic assignment was undertaken, which allows trips to select the shortest route regardless of actual road capacity for years 1980, 1990 and 2000. The purpose of this is to get an indication on the traffic demand on the road network. Figure 6.6–1 which shows the result of the non-capacity constraint traffic assignment for year 2000 indicates that:

1) Quirino Highway, with its present limited capacity, will attract large volume of traffic which would require further widening. This, however, is practically impossible due to the present roadside development. To decongest this road, some of the traffic should be diverted to C–6 and Visayas Avenue via Regalado Avenue at the north of Novaliches town proper and also to C–5 (Republic Avenue) and Mindanao Avenue at the south of Novaliches town proper.

2) Tandang Sora Avenue, which is also difficult to widen due to roadside development, would be handling traffic more than its capacity. The strengthening of C–5, as well as Visayas and Mindanao Avenues is therefore, necessary to attract most of this traffic.

3) EDSA or C–4, which is the most important thoroughfares in Metro Manila would be handling traffic more than its capacity. C–5 and C–6 should be planned to a standard, attractive enough to complement EDSA.

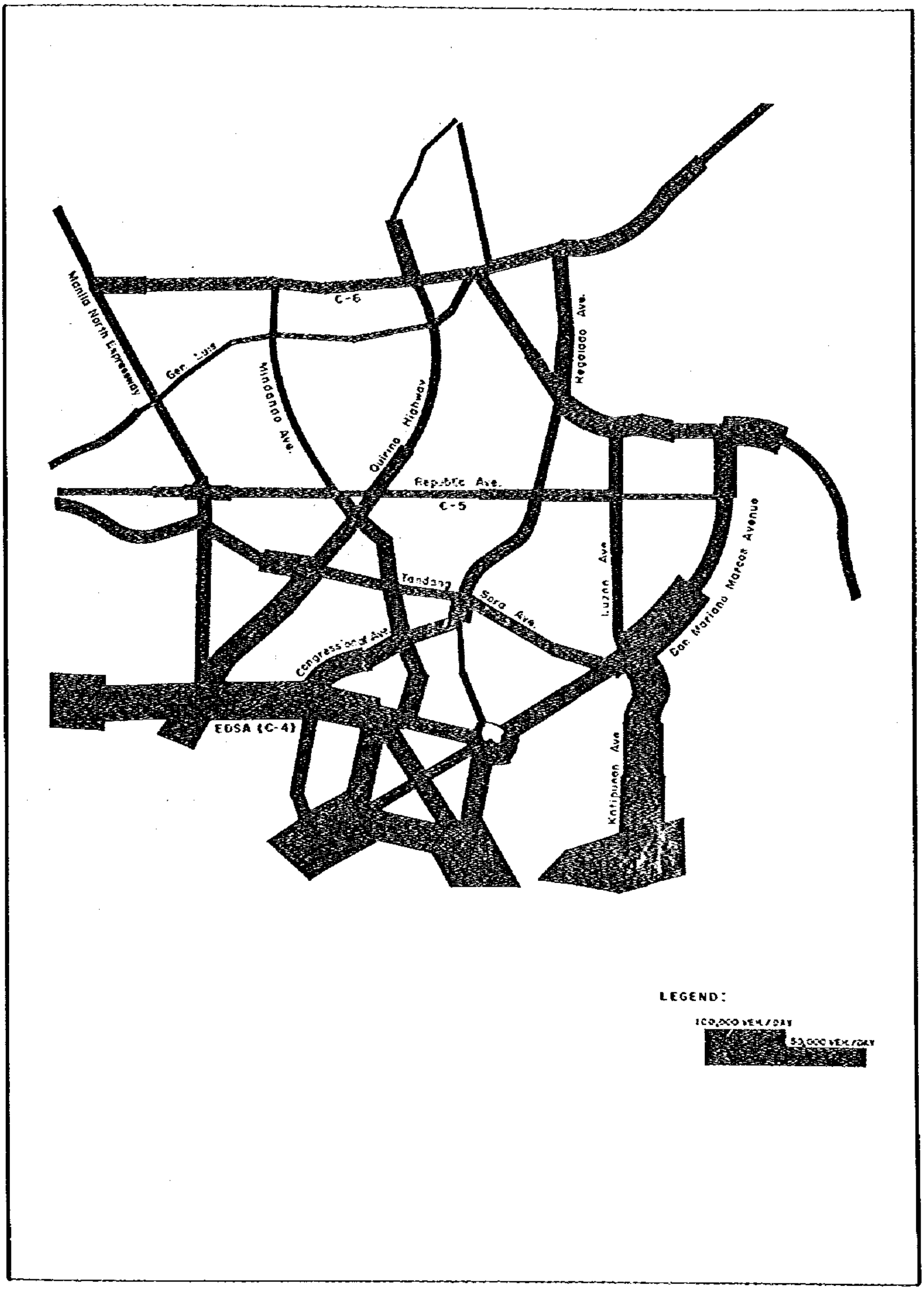
4) The urbanization of the DIZ, especially within the Capitol Hills Urban Land Reform, would generate traffic which will congest the Don Mariano Marcos and Katipunan Avenues. Both roads should be widened to accommodate the expected traffic.

6.6.3 Number of Lanes

To determine the required number of lanes for the project roads, the DIZ was subdivided into several screen lines.

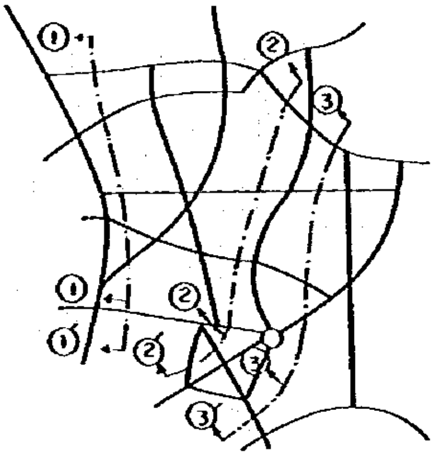
Three (3) screen lines were for the east-west direction and four (4) for the north-south direction. Based on the non-capacity constraint traffic assignment, the total traffic volume on each screen line was estimated to have an indication on the required number of lanes by screen lines. The number of lanes necessary to accommodate the expected traffic demand by screen lines includes the present and future widening of other related roads excluding the project roads. The traffic capacity per lane was assumed at 11,000 vehicles per day which is a little higher than the present capacity of EDSA of about 9,000 to 10,000 veh/day/lane. The remaining traffic demand will then be served

FIGURE 6.6–1 RESULT OF NON-CAPACITY CONSTRAINT TRAFFIC ASSIGNMENT (2000)



by the project roads. The required number of lanes and the estimated traffic volume by screen lines for years 1980, 1990 and 2000 are presented in Tables 6.6–1 and Table 6.6–2.

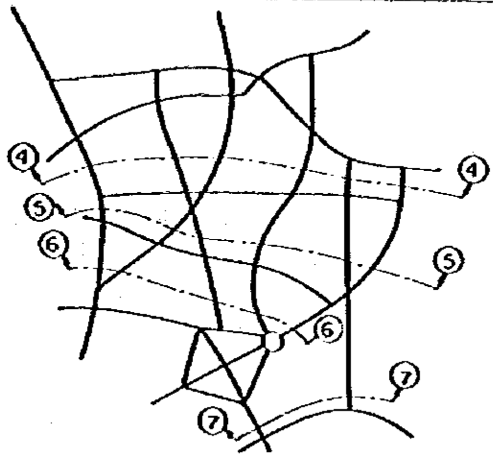
TABLE 6.6–1 TRAFFIC VOLUME AND NUMBER OF LANES REQUIRED BY SCREEN LINE



Cross-Section	Traffic Volume (100 veh/day) 1980	1990	2000	No. of Lanes Required 1980	1990	2000	No. of Lanes of Each Road: Name of Road	1980	1990	2000
							o C–6	–	S–2 (1.5)	D–2 (4)
							o G. Luis	S–2 (1.5)	S–2	S–2 (1.5)
							o Republic (C–5)	–	D–2 (4)	D–3 (6)
							o Tandang Sora	S–2 (1.5)	S–2 (1.5)	S–2 (1.5)
①–①	91	136	215	9	13	20	o Quirino Highway	S–4 (3)	S–4 (3)	S–4 (3)
							Sub-total 1 – 1	8 (6)	14(11.5)	18 (16)
(①–①́)	(162)	(206)	(325)	(15)	(19)	(30)	o EDSA	D–3 (6)	D–4 (8)	D–5 (10)
							TOTAL 1 – 1	14 (12)	22(19.5)	28 (26)
							o C–6	D–2 (4)	D–2 (4)	D–3 (6)
							o Republic (C–5)	–	D–2 (4)	D–3 (6)
							o Tandang Sora	S–2 (1.5)	S–2 (1.5)	S–2 (1.5)
							o Ext. Congressional	–	–	D–2 (4)
②–②	36	87	171	4	8	16	o North Ave.	S–2 (1.5)	D–2 (4)	D–2 (4)
(②–②́)	(101)	(175)	(291)	(10)	(16)	(27)	Sub-Total 2 – 2	8 (7)	14(13.5)	22(21.5)
							o EDSA	D–3 (6)	D–4 (8)	D–5 (10)
							o West Ave.	S–4 (3)	S–6 (5)	S–6 (5)
							Total 2 – 2	18 (16)	28(26.5)	33(36.5)
							o C–6	–	D–2 (4)	D–3 (6)
							o Republic (C–5)	–	D–2 (4)	D–3 (6)
							o Tandang Sora	S–2 (1.5)	S–2 (1.5)	S–2 (1.5)
							o Don Mariano	D–2 (4)	D–3 (6)	D–4 (8)
③–③	60	112	181	6	11	17	Sub-total 3 – 3	6 (5.5)	16 (15.5)	22 (21.5)
(③–③́)	(143)	(227)	(356)	(13)	(21)	(33)	o EDSA	D–4 (8)	D–5 (10)	D–5 (10)
							Total 3 – 3	14 (13.5)	26 (25.5)	32 (31.5)

o Traffic Capacity of one lane is assumed to be 11,000 veh/day

TABLE 6.6–2 TRAFFIC VOLUME AND NUMBER OF LANES REQUIRED BY SCREEN LINE



Cross–Section	Traffic Volume (1000 veh/day) 1980	1990	2000	No. of Lanes Required 1980	1990	2000	No. of Lanes of Each Road: Name of Road	1980	1990	2000
④–④	73	142	193	7	13	18	o North Expressway	D–2 (4)	D–2 (4)	D–3 (6)
							o Mindanao Ave.	–	S–2 (1.5)	D–2 (4)
							o Quirino Highway	S–4 (3)	S–4 (3)	S–4 (3)
							o Visayas Ave.	–	D–2 (4)	D–2 (4)
							o New Link	–	–	D–2 (4)
							o Don Mariano	D–2 (4)	D–2 (4)	D–3 (6)
							Total 4 – 4	12 (11)	16 (15.5)	28 (27)
⑤–⑤	119	214	299	11	20	28	o North Expressway	D–2 (4)	D–2 (4)	D–3 (6)
							o Quirino Highway	S–4 (3)	S–4 (3)	S–4 (3)
							o Mindanao Ave.	–	D–2 (4)	D–3 (4)
							o Visayas Ave.	–	D–2 (4)	D–2 (4)
							o C–5 (Luzon)	–	D–2 (4)	D–3 (6)
							o Don Mariano	D–2 (4)	D–3 (6)	D–4 (8)
							Total 5 – 5	12 (11)	26 (25)	34 (33)
⑥–⑥	191	217	292	18	20	27	o North Expressway	D–2 (4)	D–2 (4)	D–3 (6)
							o Quirino Highway	S–4 (3)	S–4 (3)	S–4 (3)
							o Congressional Ave.	D–2 (4)	D–2 (4)	D–2 (4)
							o Mindanao Ave.	D–2 (4)	D–2 (4)	D–3 (6)
							o Visayas Ave.	D–2 (4)	D–2 (4)	D–2 (4)
							o Don Mariano	D–2 (4)	D–3 (6)	D–4 (8)
							Total 6 – 6	24 (23)	26 (25)	32 (31)
⑦–⑦	100	210	295	10	19	27	o Katipunan	S–2 (1.5)	D–3 (6)	D–4 (8)
							o Mayala Ave. Ext.	D–2 (4)	D–2 (4)	D–2 (4)
							o EDSA	D–5 (10)	D–5 (10)	D–5 (10)
							Total 7 – 7	16 (15.5)	20 (20)	22 (22)

Figures 6.6–2 to 6.6–4 show the traffic volume and capacity of roads by screen lines from 1980 to 2005. In the Figures, the solid line indicates the estimated traffic volume and the broken line shows the capacity of the roads at the different stages of implementation. The assumed opening year of Phases 1 and 2 of Stage 1 will be in 1989 and 1991, respectively, while Stage 2 will be in 1996 or later.

The screen line analysis indicates that the current traffic demand along Screen Line 1–1 near the Manila North Expressway, which is presently being served by Quirino Highway, Tandang Sora Avenue and Gen. Luis Road, is not enough having only five (5) effective lanes compared to the required nine (9) lanes. With the present pace of development in the area, the traffic demand in 1990 would require at least 13 lanes along this screen line which would worsen the present traffic condition unless the first stage of the project roads are constructed. The necessity of the project roads is also reflected along Screen Line 5–5. The roads presently servicing this north-south traffic demand are the MNE, Quirino Highway and Don Mariano Marcos Avenue, having only 9 effective lanes which is 2 lanes short of the required. The traffic demand in 1990 would necessitate a total of 20 lanes along this screen line.

Aside from the construction of the project roads to complement the existing road network in the DIZ, the following existing roads should be improved/widened to service the future traffic demand:

a) EDSA (from Balintawak to West Avenue) to 10 lanes to conform with its normal section

b) North Avenue to at least 4 lanes

c) Don Mariano Marcos Avenue to 6 lanes

6.6.4 Formulation of Alternative Plans

Based on the previously discussed policy, the road network analysis, and the required number of lanes on each screen line, four alternative plans: Alternatives–1 (A), – 1 (B), – 2 (A), and – 2 (B) have been formulated from two basic plans (Plans–1 and –2) with different number of lanes and two modifications (Plans – A and – B) as Phase 1 of Stage 1 with different priority emphasis. The basic plans are described as follows (see Figure 6.6–6).

Plan – 1

It aims at the least investment by providing the minimum number of lanes for the project roads, just enough to meet the traffic demand.

Plan – 2

It aims at the achievement of a higher level of service than Plan 1 to attract more traffic from highly congested roads.

FIGURE 6.6-2 TRAFFIC VOLUME AND CAPACITY

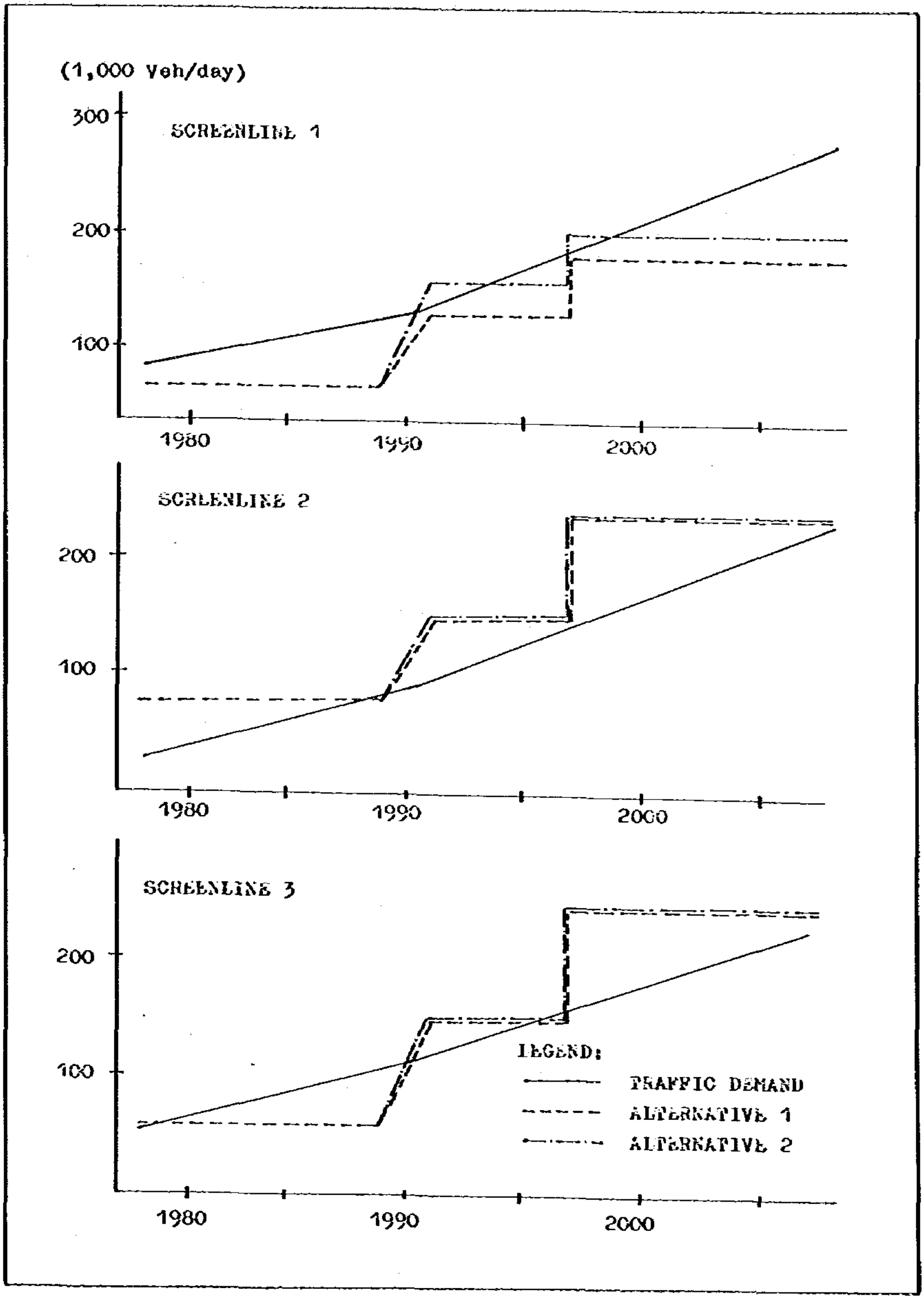


FIGURE 6.6-3 TRAFFIC VOLUME AND CAPACITY

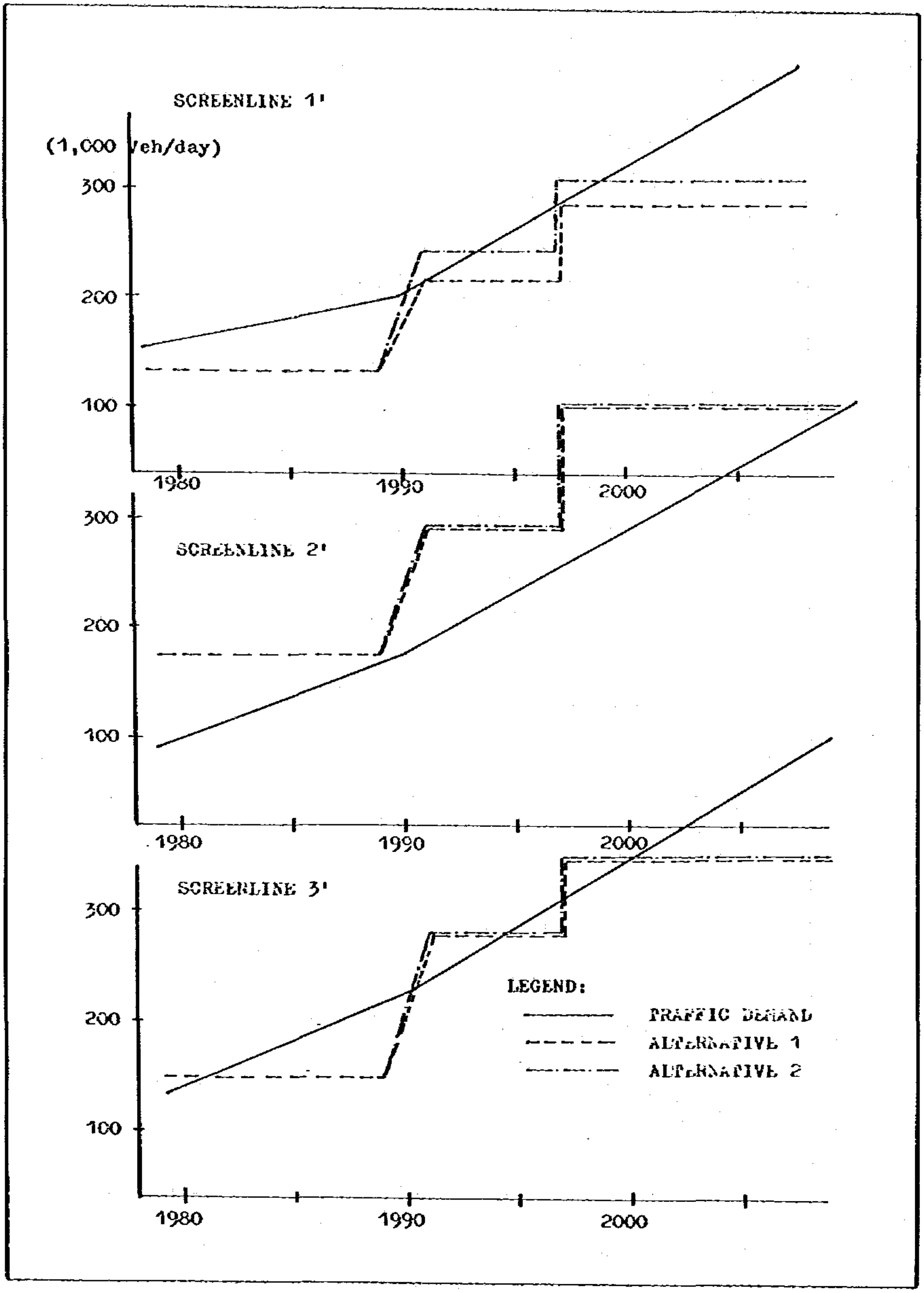
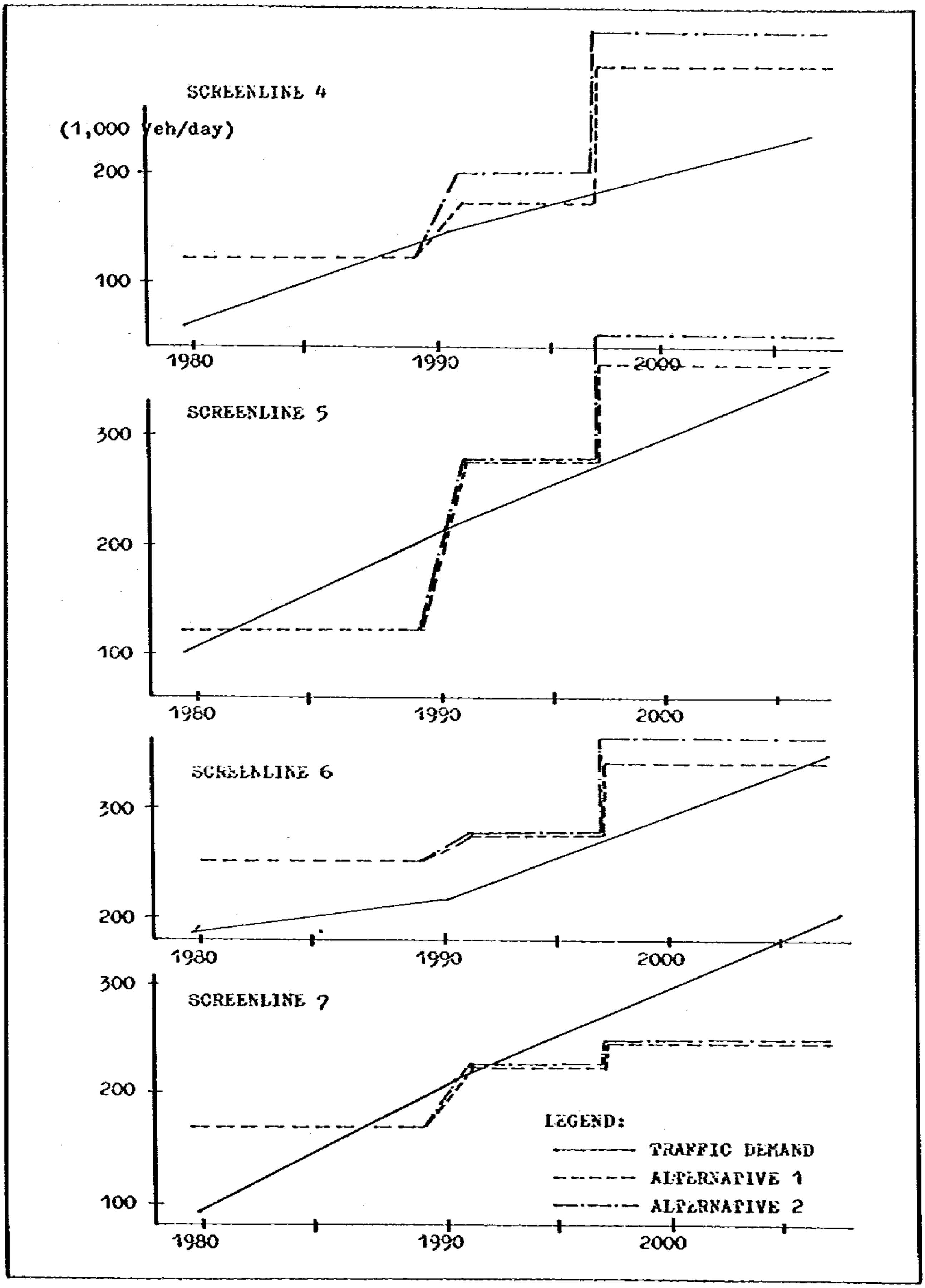


FIGURE 6.6-4 TRAFFIC VOLUME AND CAPACITY



Plans–A and –B on the other hand, were established giving different priority emphasis on the implementation of Stage 1. Plans–A and –B are described as follows (See Figure 6.6–7):

Plan–A (Priority Emphasis: Circumferential Roads)

The plan aims at the strengthening of circumferential road functions in the DIZ and the urbanization of areas along Republic and Luzon Avenues. Included as Phase I of this plan are:

C–5: Whole section from MNE to Aurora Blvd.

C–6: Section from Quirino Highway to connect with the Don Mariano Marcos Avenue

Mindanao Avenue: Section from North Avenue to C–5

Visayas Avenue: Whole section from Elliptical Road to C–6

C–5, when completed, will attract a big portion of the traffic from the presently heavily traveled C–4 and from the east-west direction Tandang Sora Road and to distribute traffic from Quirino Highway to Manila North Expressway, Mindanao Avenue, and Visayas Avenue, and vice versa. Fairview Avenue, which will form part of C–6, presently extends westward from Don Mariano Marcos Avenue but not connected with the Quirino Highway and the completion of C–6 under this Plan will complete the important link between the two major roads.

Plan–B (Priority Emphasis: Radial Roads)

The plan aims at the strengthening of radial road functions and the urbanization of areas along Mindanao Avenue and Visayas Avenue. Included as Phase I of this Plan are:

C–5: Katipunan Avenue from Aurora Boulevard to Don Mariano Marcos Avenue

C–6: Section from Quirino Highway to Don Mariano Marcos Avenue

Mindanao Avenue: Section from North Avenue to General Luis Road

Visayas Avenue: Whole section from Elliptical Road to C–6.

Under this Plan, traffic will be diverted from Quirino Highway to Visayas or Don Mariano Marcos Avenue via C–6, from Tandang Sora Avenue to Mindanao and Visayas Avenues, and from Don Mariano Marcos Avenue to Katipunan Avenue. Also, the traffic presently generated in and around Fairview Park Subdivision and flowing into Don Mariano Marcos Avenue will partly be absorbed by Visayas Avenue.

FIGURE 6.6–5 ALTERNATIVE PLANS

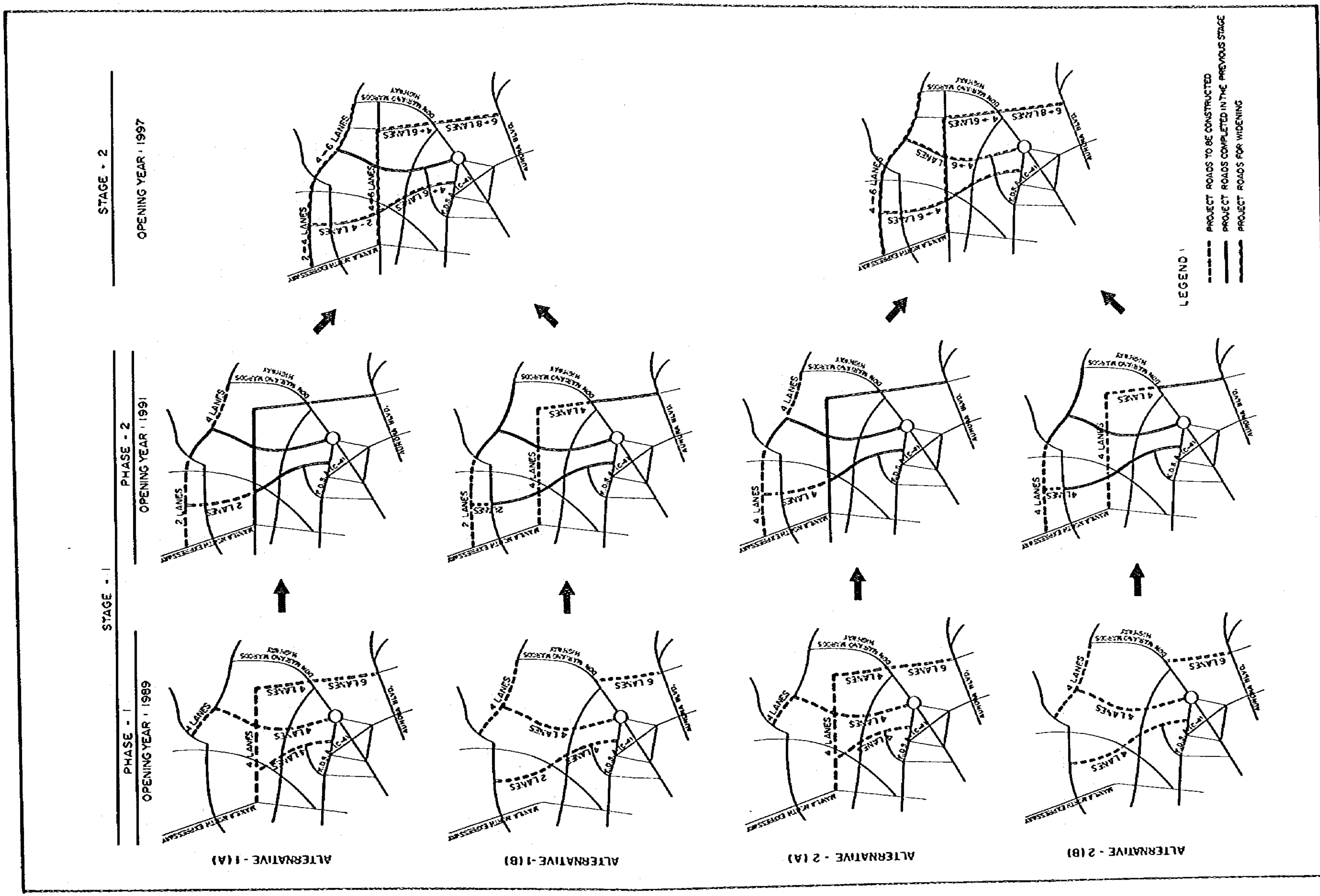


FIGURE 6.6–6 PLANS 1 AND 2

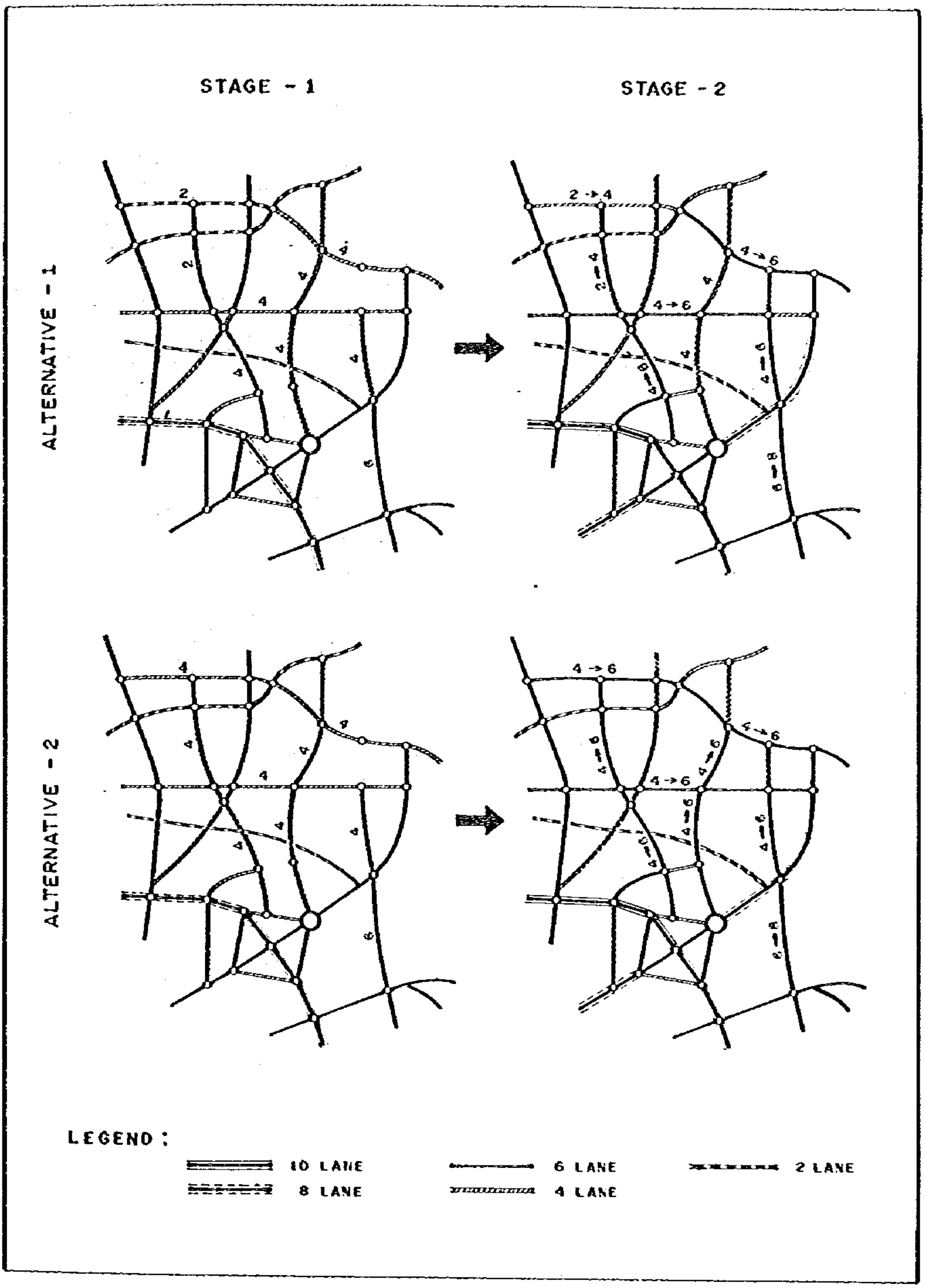
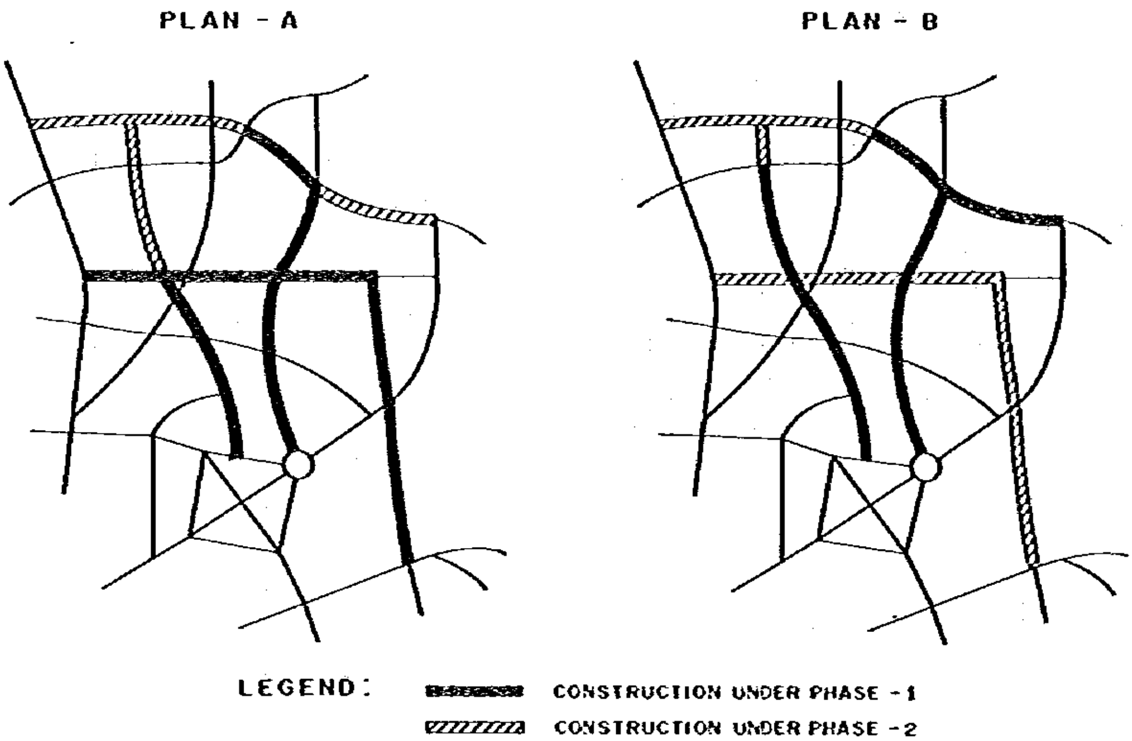


FIGURE 6.6-7 CONSTRUCTION PHASING OF STAGE 1



6.7 TRAFFIC ASSIGNMENT BY ALTERNATIVE PLANS

6.7.1 Methodology

1) PCU System

Traffic assignment was carried out in line with Passenger Car Unit (PCU) System, which was developed by the Planning and Project Development Office (PPDO) of the Ministry of Public Works and Highways. Under the PCU System, the indicators of related trips and traffic volume are expressed in terms of PCU unit. Future O–D trips of private car and PUV, which are estimated in terms of person trips, will be converted to PCU with the application of the average occupancy rates and passenger car equivalent factors (PCEF) listed below. The taxi and truck vehicle trips will be converted to PCU using the PCEF. At the same time, the road capacity on each link was defined by PCU.

TABLE 6.7–1 AVERAGE OCCUPANCY RATES AND PCEF BY TYPE OF VEHICLE

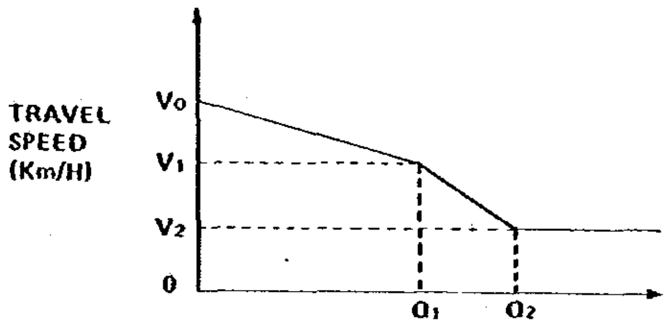
	Average[1/] Occupancy Rate	Passenger Car Equivalent Factor (PCEF)
Bus	29.0	2.0
Jeepney	9.0	1.5
Car, Taxi	2.3	1.0
Truck	2.4	2.0

[1/] Average Occupancy Rates from MMUTIP

2) Minimum Path Method

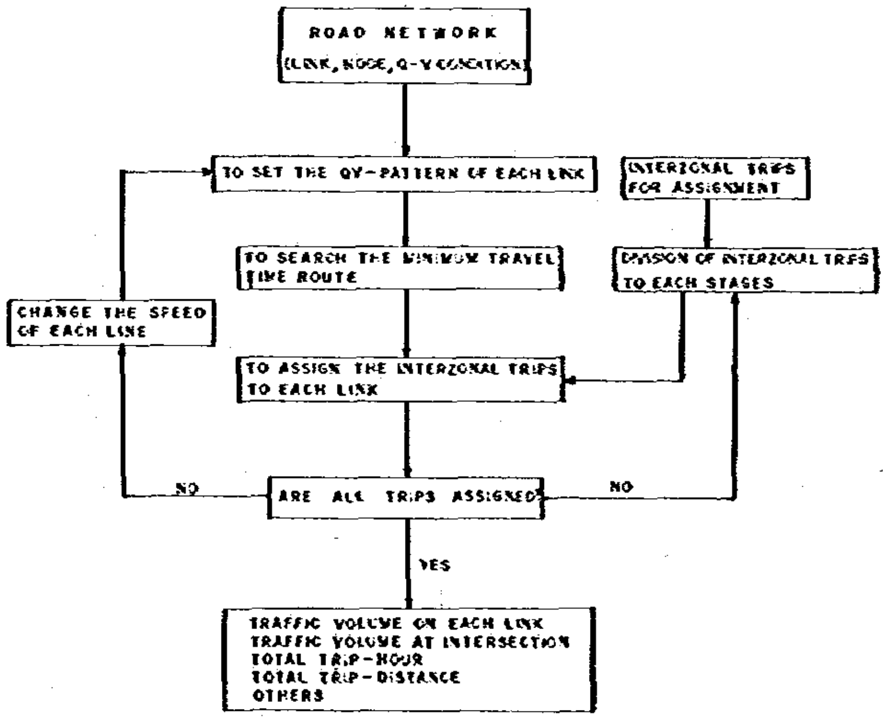
The assignment of car, taxi, and truck trips to the road network is accomplished with capacity constraint minimum path method, assuming the required travel time as the greatest factor for route selection. As for the capacity constraint, Q–V formula (equation to show correlation between traffic volume and vehicle speed, see Appendix 6.7–1) is prepared for each road classification, and the proper constraint is selected according to the road characteristics of the subject network. This is the method of assingment for vehicle trips in which route is not stipulated. Bus and jeepney trips are assigned to the minimum travel time route within the planned bus and jeepney network, without considering capacity constraint.

FIGURE 6.7–1 Q–V FORMULA PATTERN



WHEREIN: V_0 = INITIAL SPEED
V_1 = TRAVEL SPEED IN ROAD CAPACITY
V_2 = CRITICAL TRAVEL SPEED
Q_1 = ROAD CAPACITY
Q_2 = CRITICAL TRAFFIC VOLUME

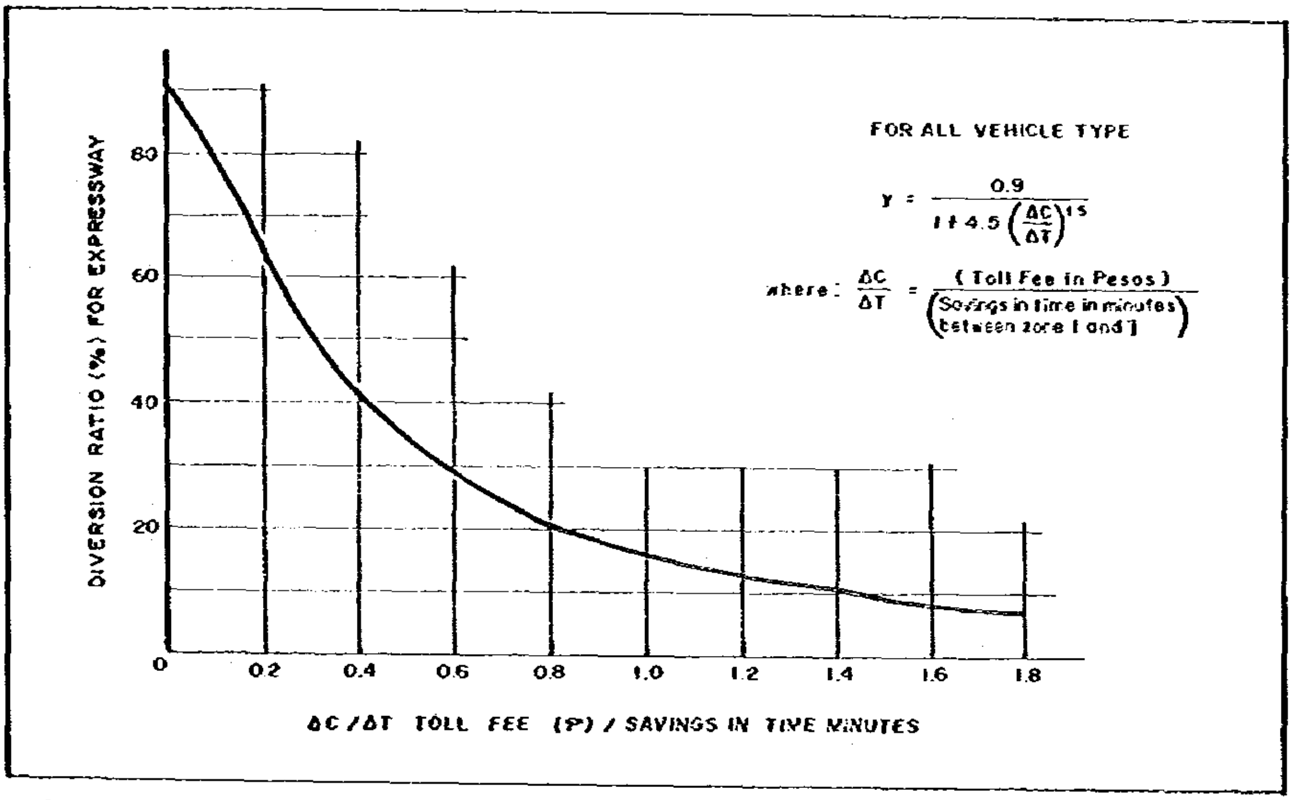
FIGURE 6.7–2 ASSIGNMENT TECHNIQUE WITH CAPACITY RESTRAINT



3) Expressway Traffic Forecast

The volume of traffic on an expressway is usually calculated as the function of time saved and extra cost spent as a result of using the expressway, rather than an ordinary road. The diversion curve (see Figure 6.7–3) sets forth, based on the traffic count on the Manila North Expressway in 1979, in the Feasibility Study for Manila-Bataan Coastal Roads and Its Related Roads (C–5 and C–6), has been adopted for the forecast of future expressway traffic in this Study after confirming its accuracy by comparing the result of traffic estimation on said Expressway in 1980 by said curve against actual count value.

FIGURE 6.7–3 DIVERSION CURVE



6.7.2 Road Capacity

The traffic capacity of roads at each cross-section has been calculated considering the following factors, and the calculation result is presented in Appendix 6.7–2:

- Basic capacity (PCU/hour)
- Three adjustment factors: lane width, lateral clearance, roadside friction
- Peak hour ratio (%)
- Heavy direction ratio (%)

$$RC = \frac{100 \times DC}{P} \times \frac{50}{H} \times n$$

$$DC = BC \times \gamma_1 \times \gamma_2 \times \gamma_3$$

Where,
- RC = Traffic capacity of road (PCU/day)
- DC = Design traffic capacity (PCU/hour/lane)
- BC = Basic traffic capacity (PCU/hour/lane)
- P = Peak hour ratio (%)
- H = Heavy direction ratio (%)
- n = *Number of lanes*
- γ_1 = Adjustment factor for lane width
- γ_2 = Adjustment factor for lateral clearance
- γ_3 = Adjustment factor for roadside friction

1) Basic Traffic Capacity and Peak Hour Ratio

Basic traffic capacity had been set at 2,400 PCU/hour/lane based on the Planning Manual of the PPDO. Peak hour ratio and heavy direction ratio have been set at 8.3% and 60%, respectively, based on the result of traffic counts conducted in 1982 as part of this study.

2) Adjustment Factors

Because no suitable data were found in the PPDO Planning Manual, the three adjustment factors have been determined as presented in the following Table, with the Japan Highway Manual as reference.

TABLE 6.7–2 ADJUSTMENT FACTOR OF LANE WIDTH

Lane Width (m)	Adjustment Factor
3.50	1.00
3.25	0.94
3.00	0.85
2.75	0.77

TABLE 6.7–3 ADJUSTMENT FACTOR OF LATERAL CLEARANCE

2–Lane 2–Direction Road

	Lateral Clearance						
	1.75	1.50	1.25	1.00	0.75	0.50	0.00
Lack of lateral clearance in one side	1.00	0.98	0.96	0.93	0.91	0.88	0.85
Lack of lateral clearance in both sides	1.00	0.96	0.92	0.86	0.81	0.75	0.70

Multiple–Lane Road

	Lateral Clearance						
	1.75	1.50	1.25	1.00	0.75	0.50	0.00
Lack of lateral clearance in one side	1.00	1.00	0.99	0.98	0.97	0.95	0.90
Lack of lateral clearance in both sides	1.00	0.99	0.98	0.97	0.94	0.90	0.81

TABLE 6.7–4 ADJUSTMENT FACTOR OF ROADSIDE FRICTION

Roadside Friction	Adjustment Factor
None	1.0 – 0.9
Light or Medium	0.9 – 0.8
Heavy	0.8 – 0.7

6.7.3 Traffic Volume

The figures indicate that the road network without the project roads are not functioning as a system but rather individually as shown by the uneven utilization of the road network, i.e. most sections are heavily congested while others are handling low traffic volume. With the project roads, the road network could function as a system having a more balanced distribution of traffic. Most of the related roads would experience reduction in traffic volume from as high as 46% reduction on the section of the Don Mariano Marcos Avenue near the Quezon Memorial Circle. Other roads that would be congested without the project are the MNE, EDSA, Quirino Highway, etc. The Katipunan Avenue is presently under utilized but when improved as part of C–5, its traffic volume is estimated to increase from an average of 27,300 PCU per day to about 80,700 PCU per day in 1989. The effect of the project roads could be felt more in year 2000.

6.7.4 PUV DEMAND

The number of PUV passengers on each road link in 1991 and 1997 are indicated in Figure 6.7-8. In 1991, when the stage-1 of the Project Roads will be completed and the entire network of the Project Roads will start to be operated, the busiest streets are EDSA and Aurora Blvd. as PUV corridor, where about 450,000 PUV passengers are observed at the specific sections near Cubao. Quezon Blvd., C-5 and Don Mariano Marcos Ave. will also handle large number of PUV passengers. 350,000 passengers are estimated on Quezon Blvd. and Katipunan section of C-5. C-5 has outstanding PUV passengers compared to other Project Roads (C-6, Mindanao Ave. and Visayas Ave.), where 100,000 passengers or less are observed except for specific sections, mainly due to only two lanes operation on approximate half parts of C-6 and Mindanao Ave..
In 1997, EDSA, Aurora Blvd., Quezon Blvd., C-5 and Don Mariano Marcos Ave. will handle large number of PUV passengers and be functioning as major route for PUV. The basic flowing pattern of PUV passengers is same in 1991. Meanwhile, the completion of stage-2 of the Project Roads leads to raise the function of C-6 and Mindanao Ave., at the same time, and number of PUV passengers. Especially outstanding growth of more than two times compared with that in 1991 is observed on C-6.

FIGURE 6.7–4 FUTURE TRAFFIC VOLUME IN 1989 ("WITHOUT" PROJECT)

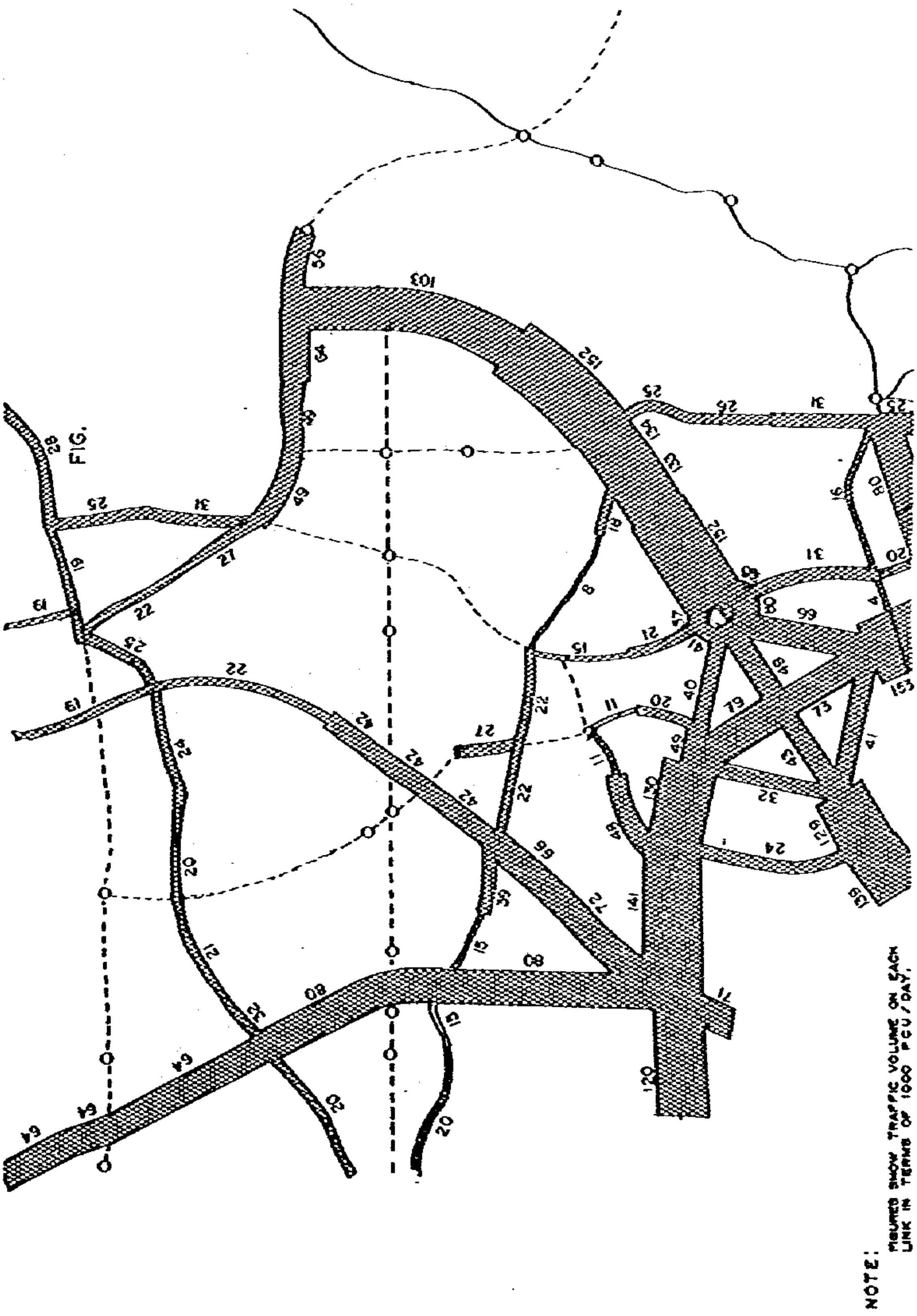


FIGURE 6.7-5 FUTURE TRAFFIC VOLUME IN 1989 (ALTERNATIVE 1 (B))

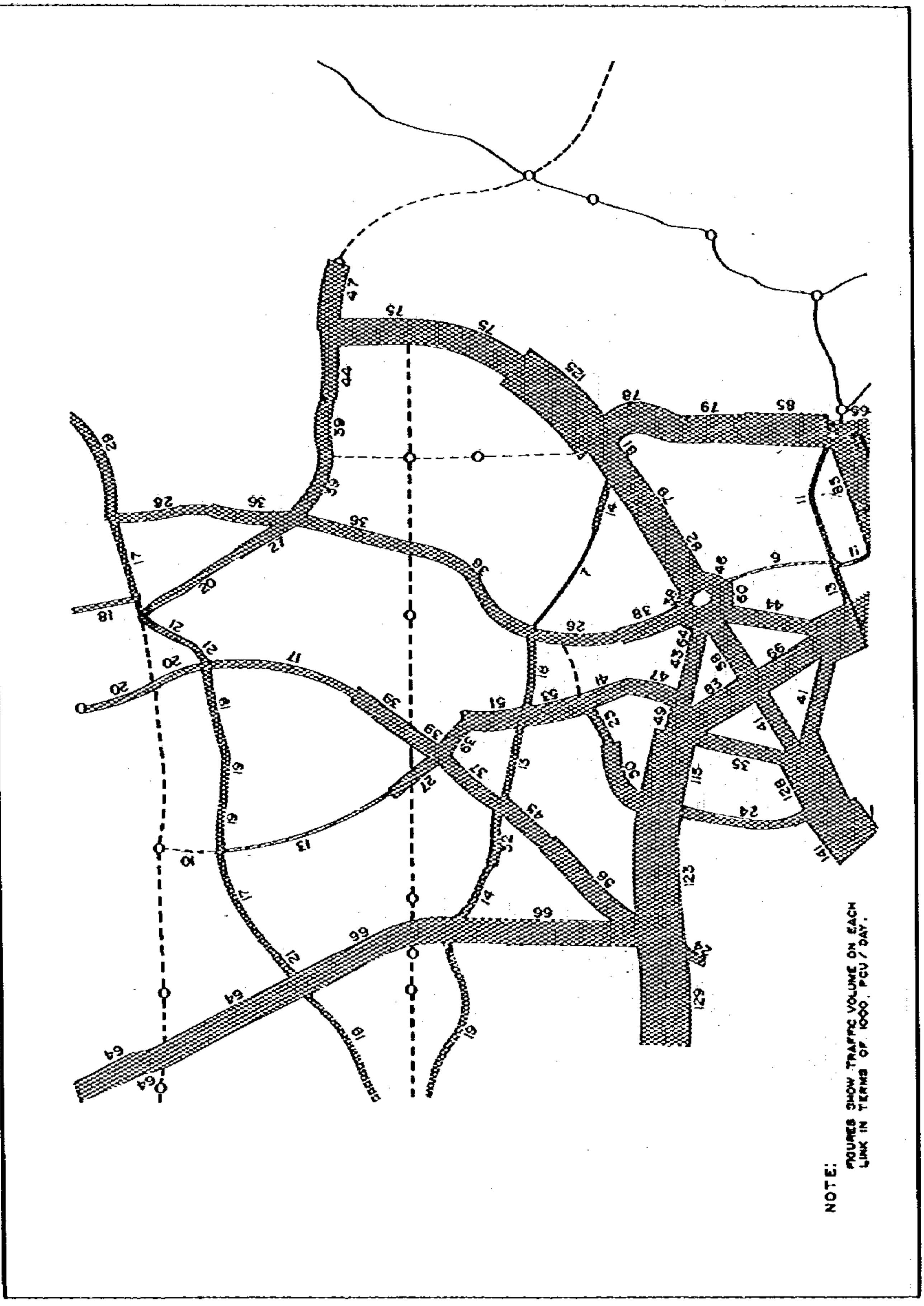


FIGURE 6.7-6 FUTURE TRAFFIC VOLUME IN 2000 ("WITHOUT" PROJECT)

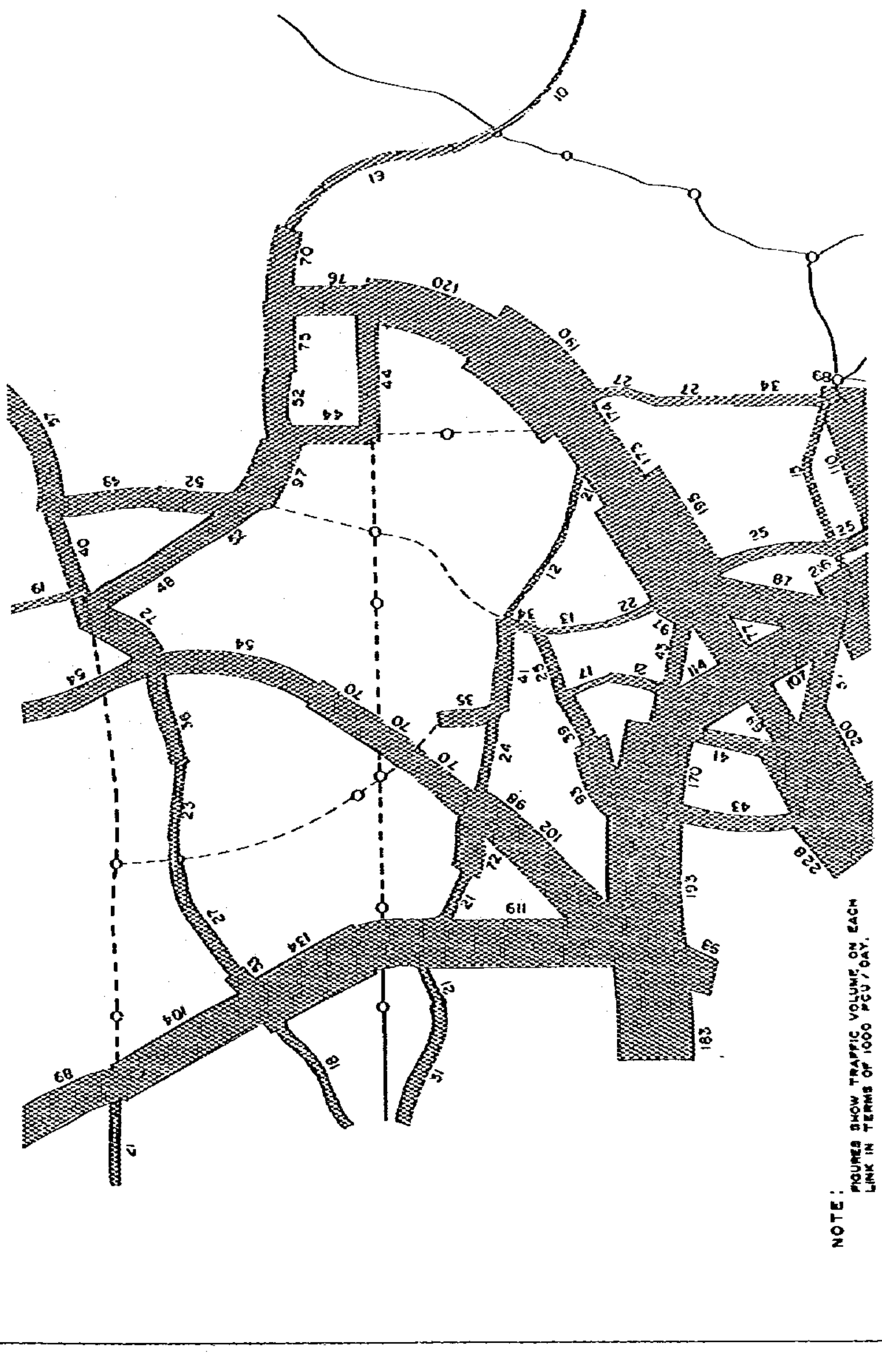


FIGURE 6.7–7 FUTURE TRAFFIC VOLUME IN 2000 (ALTERNATIVE 1)

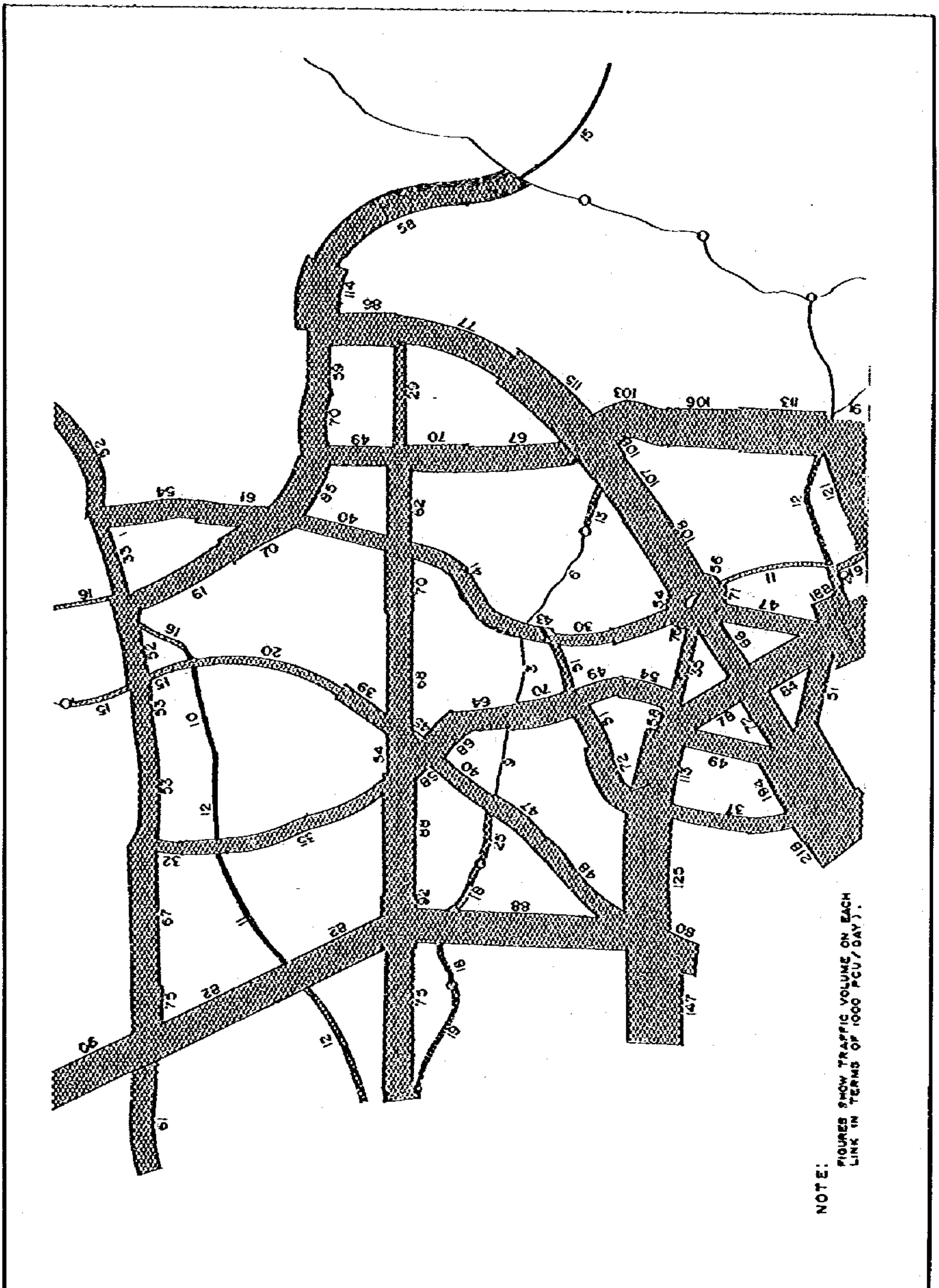
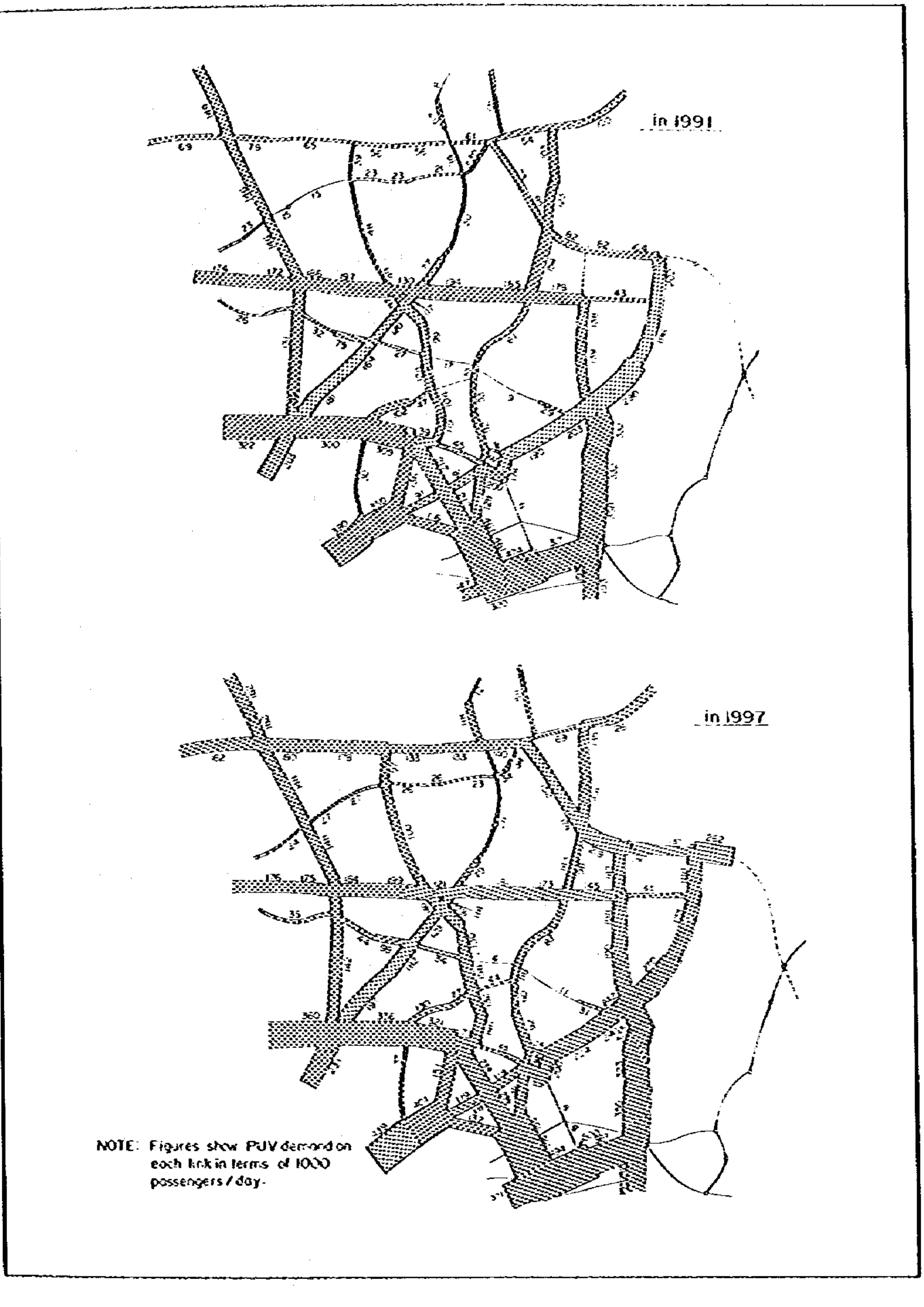


FIGURE 6.7–8 FUTURE PUV DEMAND



6.8 DEVELOPMENT OF THE RELATED ROADS

The present road network in the project area is composed of four (4) major trunk roads consisting of the MNE, EDSA (C–4), Aurora Boulevard (R–6) and the Don Mariano Marcos Avenue (R–7) and four (4) secondary major roads such as the Quirino Highway (R–8), Congressional Avenue, Tandang Sora Road and General Luis Road.

The traffic demand in year 2000 was estimated to increase at about 3.6 times of the present traffic demand in the project area compared to only about 2.0 times in the whole of Metro Manila. With the estimated average level of service of the road network of the project area in 1989, which is already approaching its capacity, the expected rapid increase in the traffic demand would heavily congest the road network.

The project roads will greatly improve the traffic condition in the project area by attracting a big portion of traffic from heavily travelled roads like MNE, EDSA, etc. The improvement/widening of other existing roads, however, is still necessary. Presented in Figure 6.8–1 is the comparison between the existing road capacity of these related roads and their future traffic demand with and without the project roads. It could clearly be seen in the Figure that these related roads will be congested unless the roads will be strengthened. Taking into consideration the existing physical condition, the following related roads are proposed for improvements:

1) EDSA

EDSA in some section has only eight (8) lanes of its ultimate section of 10 lanes, mostly located within the project area. With the present traffic demand on this road, it is necessary to widen the narrow sections to its ultimate section.

2) Tandang Sora and General Luis Roads

These two roads have narrow right-of-way and that further widening would be difficult and expensive. Tandang Sora Road, which is presently being improved to cement concrete, would increase its traffic capacity. Due to high traffic demand, their road spaces should be utilized effectively to the fullest extent through effective traffic management and installation of traffic lights at its major intersections.

3) Manila North Expressway

The section of the MNE from Balintawak to Malinta is close to its saturation capacity. To maintain the effectiveness of this access controlled highway, widening of its 4-lane divided to 6-lane is necessary by using the center island.

4) Quirino Highway

This highway also has narrow right-of-way and that widening to accommodate the future traffic demand would not be practical. The section of this road within the project area should be widened to its ultimate section (4-lane undivided) within the existing right-of-way and its existing pavement be improved.

5) Congressional Avenue

This Avenue should be widened to six (6) lanes within its existing right-of-way and extended at least up to Visayas Avenue.

6) Don Mariano Marcos Avenue

This radial road, which is strategically located between the Marikina River and the MNE, would be the major road directly linking the DIZ to the urban centers of NCR. For this reason, the traffic demand on this road will increase rapidly in the future and that its capacity should be improved to six (6) lanes in 1989 and eight (8) lanes in year 2000.

7) Aurora Boulevard

This road, which is the main access of the eastern towns of NCR to Cubao, is expected to be handling more traffic than its capacity. Due to the difficulty of widening, a feasibility study should be undertaken on the utilization of other parallel roads to complement this road.

FIGURE 6.8-1 FUTURE TRAFFIC VOLUME ON RELATED ROADS