REPUBLIC OF THE PHILIPPINES

URBAN TRANSPORT STUDY IN MANILA METROPOLITAN AREA

SEPTEMBER, 1973

OVERSEAS TECHNICAL COOPERATION AGENCY
GOVERNMENT OF JAPAN

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PREFACE

In compliance with the request of the Government of the Republic of the Philippines, the Government of Japan undertook an urban transport study covering the Metropolitan Manila Area and entrusted the Overseas Technical Cooperation Agency with the execution of the study.

Noting that the Metropolitan Manila Area Transport Plan has a vital bearing on the future socio-economic development of the republic, the Agency dispatched a preliminary survey team to the Philippines in March 1971 for planning and preparation of a detailed study, and further sent, in July 1971, a 12-member survey team headed by Prof. Takashi Inouye, Department of Urban Engineering, Faculty of Engineering, Tokyo University. The urban transport study, undertaken by the said team, was carried out smoothly as scheduled for a period of about three months with the close and unlimited cooperation of the competent Philippine authorities. After its return to Japan, the team engaged in related studies and analyses, of which the results are compiled into this report.

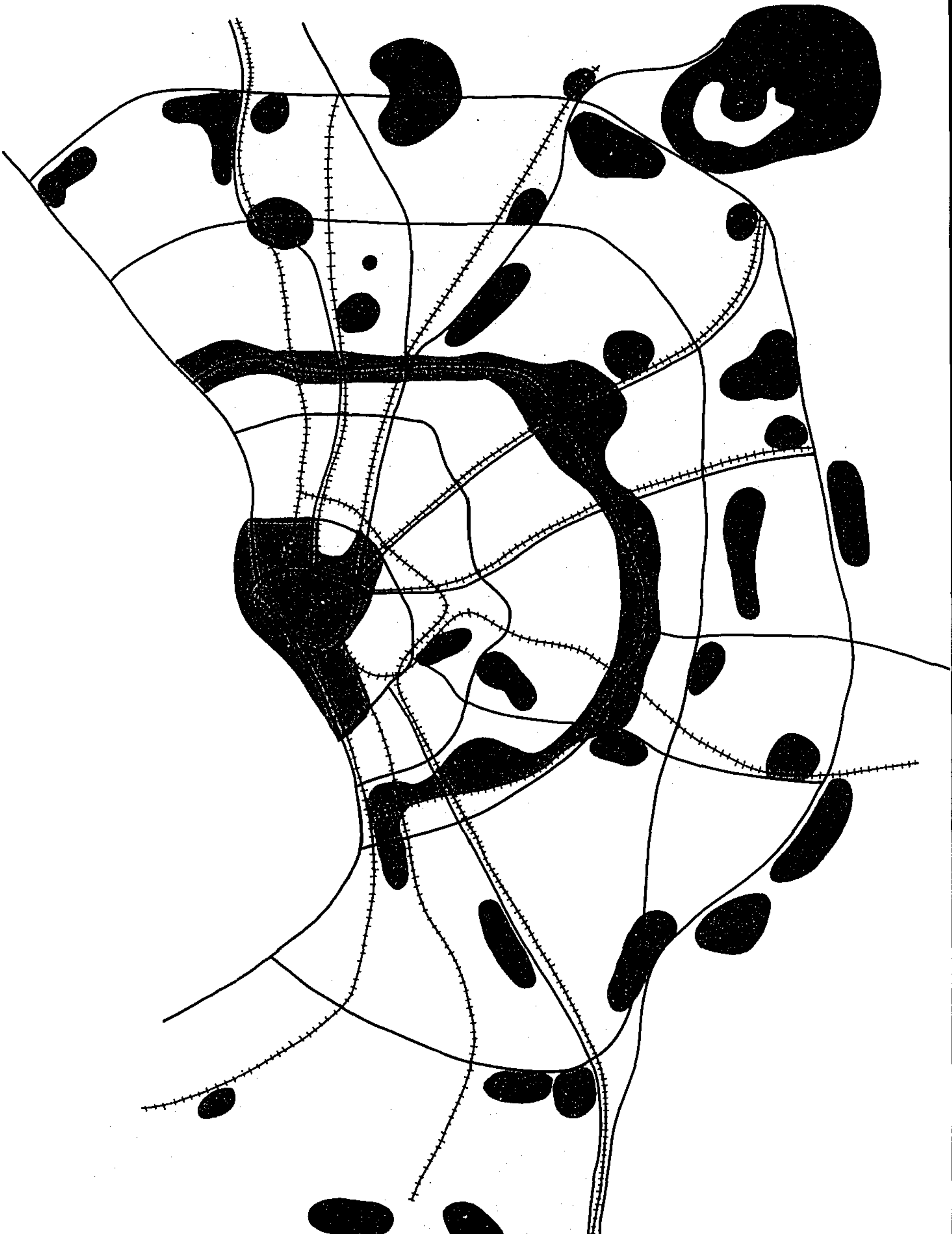
In this report, studies and analyses in the Metropolitan Manila Area are made on its development pattern, transportation system, distribution of traffic demand and modal split on the basis of land use and population distribution plans and a future comprehensive transportation system is proposed for the Area, to cope with the marked expansion of urbanization and its increasing density as well as to bring solution for the resultant acute traffic congestion;

I sincerely hope that this study would contribute to the development of the Metropolitan Manila Area and at the same time serve for enhancement of the friendly relations now existing between our two countries.

I avail myself of this opportunity to express my heartfelt appreciation to the competent Philippine authorities and other parties concerned for the valuable assistance offered to the team throughout the survey period.

June 1973

Keiichi Tatsuke
Director-General
Overseas Technical Cooperation Agency



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SUMMARY AND RECOMMENDATION

SUMMARY AND RECOMMENDATION

1 Purpose of Study

The report describes the Manila Metropolitan Area Transportation Plan under the Terms of Reference prepared on July 13, 1971 by the Philippine Government.

The plan prepared covers the whole of the Manila Metropolitan Area approximately within twenty kilometers from the center of Manila. The target year of the plan is 1987.

2 Development of Manila Metropolitan Area and Growth of Traffic Demand

2.1 The population of the Manila Metropolitan Area has been growing with outstanding speed. Population will increase to 7.5 million in 1987, compared with 3.9 million in 1970. The annual rate of population growth in future, however, will be 3.7% which is significantly lower than the rate in the decade from 1960 to 1970, which was 4.1%. The area to be urbanized will expand beyond the present fifteen kilometer radius and will cover a twenty kilometer radial area in 1987.

2.2 The development of the Metropolitan Area means the growth of traffice demand within it. The number of person trips in the Area is predicated to be 13.9 million in 1987, which is 1.9 times larger than the present level of 7.2 million in 1971.

3 Development Pattern of Manila Metropolitan Area

3.1 The development pattern that is to constitute the foundation of the land use plan and the transportation plan of the Metropolitan Manila Area should be based on the conception of the Manilà Bay Development Plan (as its prerequisite) which has been suggested by the Manila Bay Development Team and at the same time should consider and investigate the present urban structure of the Metropolitan Manila Area as well as the characteristics of the rapidly expanding big cities.

3.2 The six alternative patterns as the objects of the present investigation are as follows (Refer to Fig. 5.2-1).

The Metropolitan Manila Area is devided by Highway No. 54 into two, the inner and the outer areas. For the inner area, two patterns are conceived, first, assuming that the present trend of development will continue in future and secondly, the pattern that restricts the further development of the urban center and positively promotes the formation of new urban centers along the Highway No. 54 in order to alleviate the increase of the traffic volume being to be concentrated upon the urban center. For the outer area, the following three patterns are presumed. The first pattern is the one that assumes that the outer area will be sprawling in future as it is at present. The second pattern restricts that sprawling and also breeds large-scale semi-independent·cities along the fringe of the Metropolitan Manila Area. The third pattern extends mass transit from the existing CBD to the outer area and thereby forms coaxial built-up areas in a planned way.

3.3 As a result of the comparative investigation of these six patterns from various angles, it is concluded that the development pattern to be adopted by the future Metropolitan Manila Area is most desirably organized by "three kinds of axes"

In the first place, it is necessary to strengthen the existing urban axis along the Highway No. 54 in order to alleviate the increase of the traffic demand otherwise concentrated on the present urban center. In the second place, to realize a mass transit system, the introduction of which will be indispensable in the future Metropolitan Manila Area, it is necessary to create the urban structure where the mass transit can easily be established, that is, a radial built-up area with the axis of the mass transit stretching from the existing CBD to the surrounding area and integrating the transportation means and the land use plan.

Thirdly, it is quite significant to the future Metropolitan Manila Area to build the functional circumferential roads along the fringe of the present Metropolitan Manila Area and thereby th encourage according to a plan the establishment of the factories, circulation centers and other facilities with a higher use of automobiles which may otherwise be scattered at random in future around this area.

3.4 The issue of how to distribute weight between the existing urban center and the new axial cities to be formed along the Highway No. 54, awaits mainly the result of the estimate of the future traffic demand. Accordingly the traffic demand is estimated for the two cases of the inner area of the Highway No. 54, i.e. the case where the development of the present urban center will continue in future and the case where the axis of the urban center along the Highway No. 54 is to be strengthened. Both have in common the development of the radial axis cities in the outer area.

In the future Metropolitan Manila Area as mentioned above the dispersal of the traffic demand otherwise concentrated upon the existing urban center is an indispensable task. Therefore the latter of the preceding two cases is adopted and is made as the prerequisite of the final land use plan and the transportation facility plan.

4 Integrated Transportation System

4.1 The increase of the traffic demand in future, even if the urban functions have been partly scattered in the surrounding area, far exceeds the maximum capacity that can be achieved by the improvement of a part of the existing transportation facilities. Therefore it becomes necessary to radically innovate the existing transportation system of the Metropolitan Manila Area so that the development pattern of the Metropolitan Manila Area can be organized by the above-mentioned "three kinds of axes". This also necessitates the adjustment of the transportation system according to such a concept.

4.2 Even when the urban functions have partly been dispersed around the outer area and the rapid transit has been positively introduced, the demand for automobile transportation will greatly expand. This implies that the adjustment of the arterial road network is an indispensable task for the Metropolitan Manila Area and therefore that the radial and the circumferential systems have to be organized on the foundation of the arterial road network whose planning is already established as well as on the conclusion that congestion has to be eliminated by innovation. Besides, in the area outer to the Highway No. 54 where new urbanization can be predicted, the plan of the arterial road network must immediately be determined. Especially the construction of the circumferential roads of larger width along the fringe of the present Metropolitan Manila Area plays a significant role to the future Metropolitan Manila Area structure as the existing Highway No. 54 does to the urban structure and to the transportation pattern of the Metropolitan Manila Area.

4.3 The urban expressway plays an important role for the automobile traffic of big cities.

However the adoption of the urban expressway in the Metropolitan Manila Area cannot but be restricted to the specific routes if such probable outcomes are considered as the destruction of landscape, the new traffic congestion occurring in the area around the ramps, etc. From these viewpoints, it is to be presumed that the urban expressway routes in the Metropolitan Manila Area will be limited, to the existing south and north routes, main circumferential route on the Highway No. 54 and radial routes outside, and inside Highway No. 54.

Highway No. 54 functions as a by-pass connecting the south and the north expressways and also plays the role as a spine combining the new commercial and business district centers along this route. It is important to further strengthen this route to assist in the dispersement of urban functions, as is underlined in the suggested development patterns of the Metropolitan Manila Area.

4.4 The planning of the mass transit in the Metropolitan Manila Area is to be an absolutely necessary task for the realization of the radially stretching urban corridors as are mentioned above and also of the urban axes on formed Highway No. 54.

Various kinds of mass transit such as bus, jeepney, monorail and new transportation systems are urgently promoted these days, but the main routes of mass transit cannot but be restricted to the railway (in the form of subway in the inner area) judging from the size of the traffic demand predicted for the Metropolitan Manila Area.

The selection of the routes rests on various concepts. However, great importance should be attached to the simultaneous development of the residential areas and the establishment of railways extending the routes to the suburban areas beyond the Highway No. 54. Because the Metropolitan Manila Area will further rapidly develop in years to come, it is important to deliver a large amount of residential area to the ordinary citizens but the introduction of the mass transit will be difficult in the areas which have been developed at a low density.

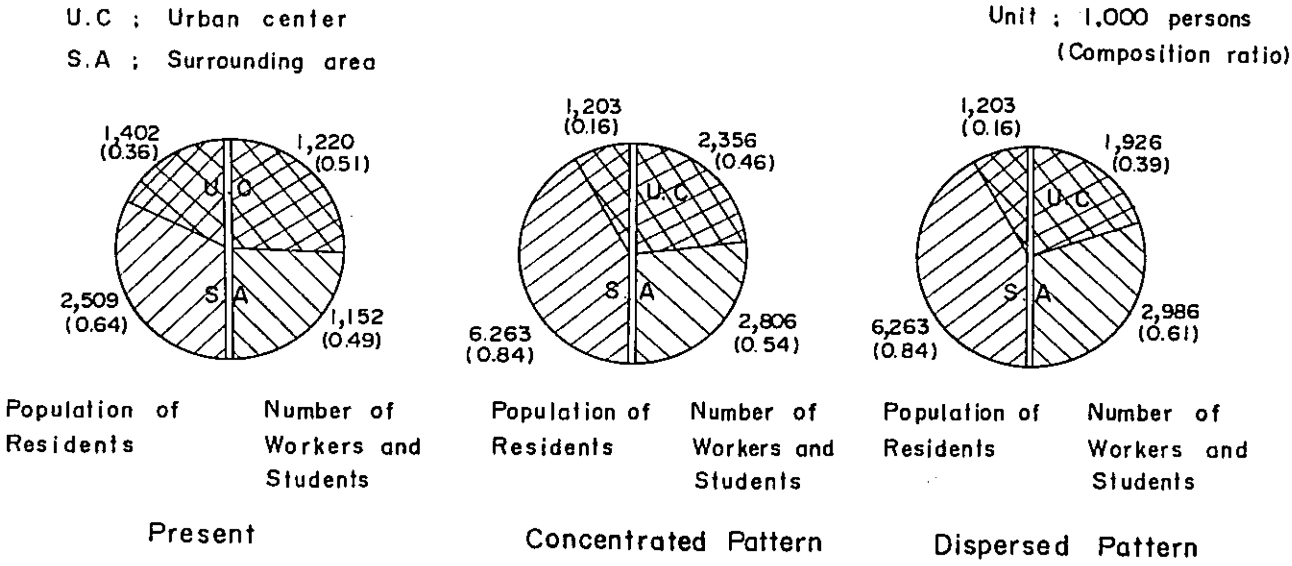
4.5 The bus and the jeepney play very important roles in the traffic in the present Metropolitan Manila Area. It should be admitted that this will remain in future, though it is predicated that when the subway is completed, the railway serve longer trips and the bus and the jeepney will be the transportation means for the feeder services.

From these viewpoints, an integrated management of the railway as the arterial route and the bus or the jeepney as the feeder service will be related to the organization of the ordinary road network.

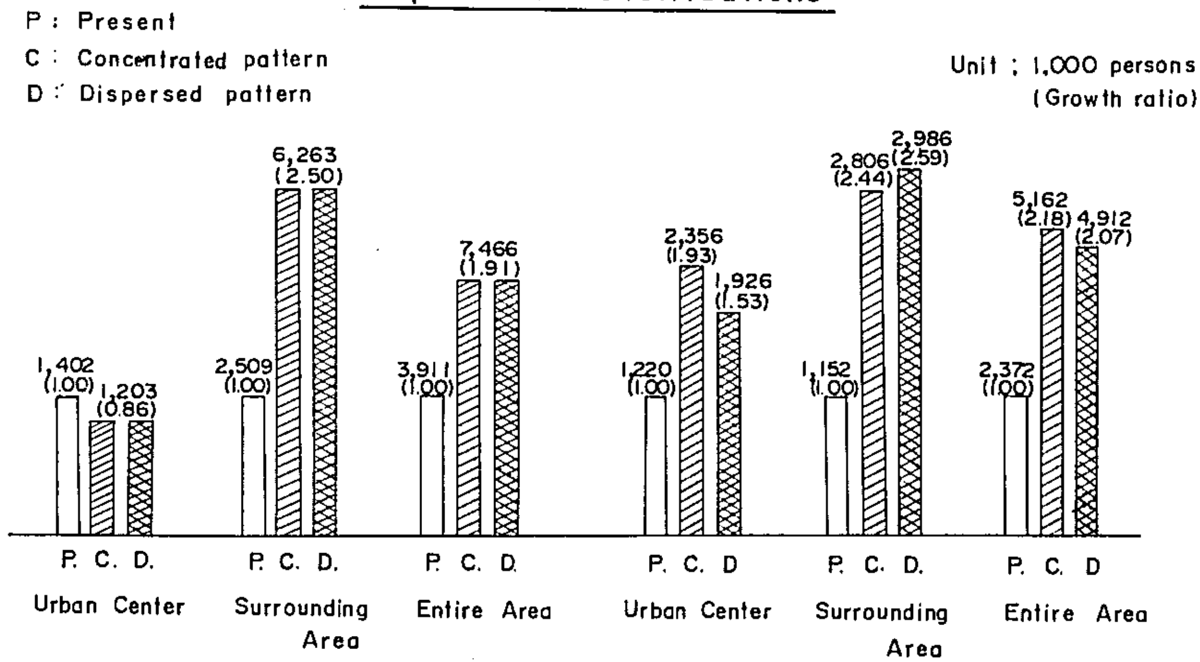
The introduction of the monorail or the new transportation system may be feasible of the feeder routes of lower transportation density. However further investigation would have to be undertaken in specific cases.

5 Distribution of Traffic Demand and Modal Split

5.1 Two alternative future land-use patterns, concentrated urban center pattern and dispersed surrounding area pattern, were considered as the basis for traffic demand forecast. The percent distributions of population in the study area for each alternative pattern and shown below in comparison with the present.

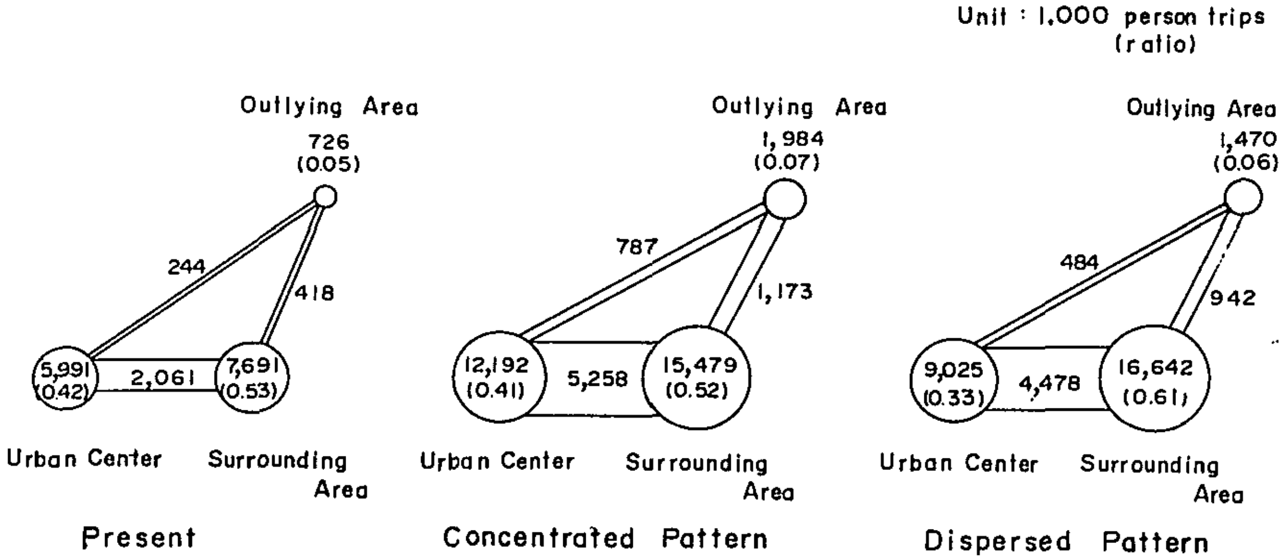


Population Distributions

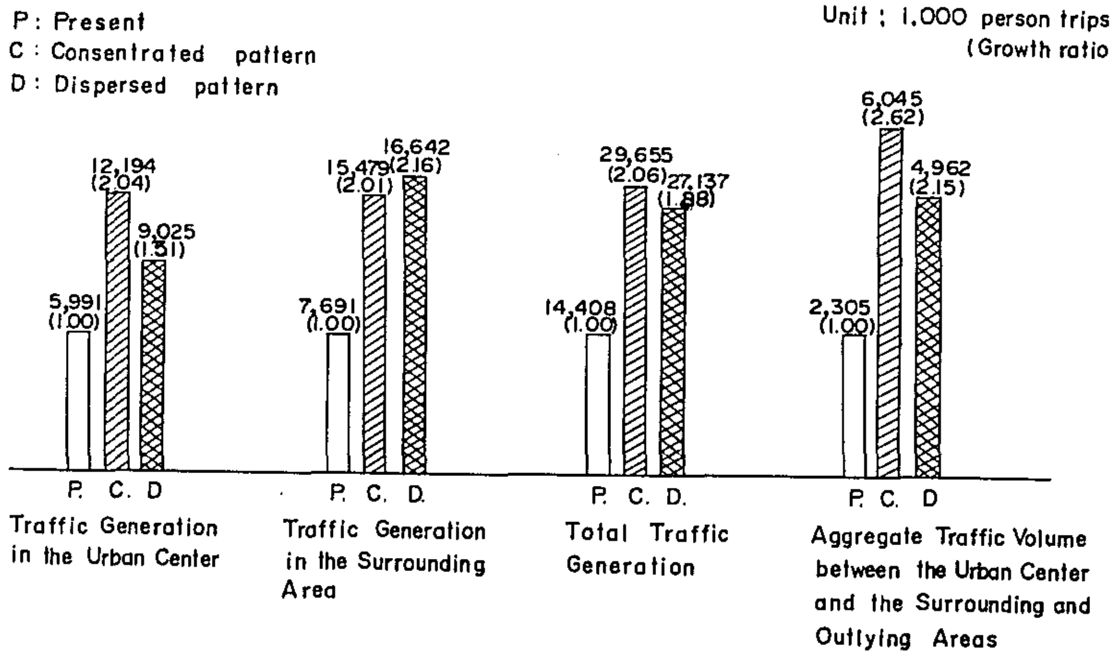


Population Growth

5.2 Future patterns of traffic demand in the study area predicted on the basis of each alternative future land-use pattern are shown below in comparison with the present pattern of traffic demand.



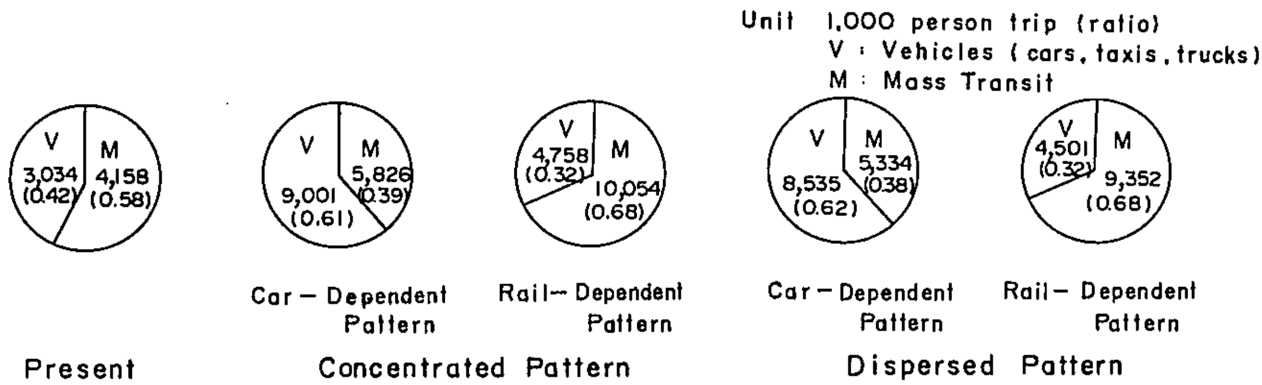
Traffic Generation and Traffic Volume among Areas



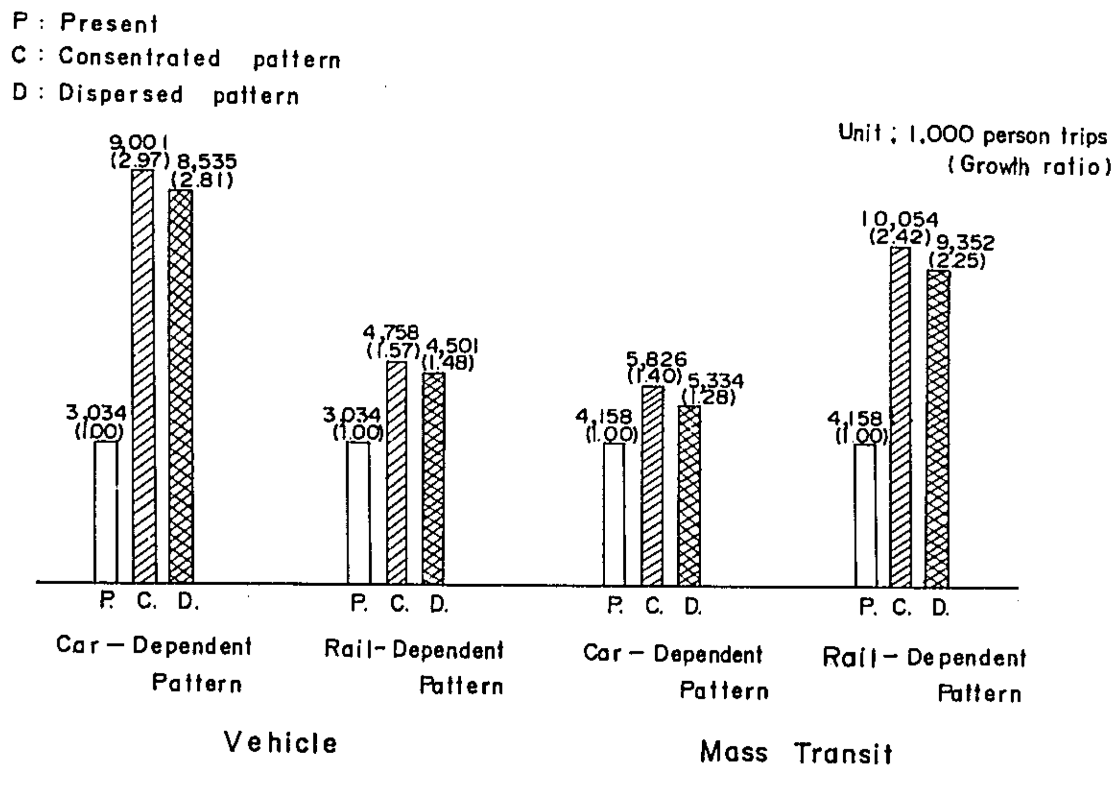
Growth of the Traffic Volume

5.3 The number of trips by travel mode in the area may vary following the development pattern of transportation system in the area. Two basic development patterns worth consideration would be car-dependent pattern and rail-dependent pattern. The former means the extraporation of the present tendency and the latter requires the introduction of rail transit system.

The number of person trips by vehicles and mass transit for each alternative land-use pattern in the future as shown below in comparison with that of present.



Trips by Travel Mode



Traffic Growth by Travel Mode

5.4 Here we have two future alternative land-use patterns and the two future alternative development patterns of transportation system. Among the four alternative land-use/transport patterns, the rail-dependent pattern with the dispersed surrounding area requires the least development of transportation facilities to meet the predicted traffic demand in the area. It follows that the rail-dependent pattern with the despersed surrounding area should be adopted as a basis of transportation facility plan.

a) The relative difficulty of new transportation facility development in the central area is commonly accepted. Trip generation in the urban center and the trip distribution between the urban center and the surrounding area for the dispersed pattern is three forths of those for the concentrated pattern. Trip generation in the surrounding area for the dispersed pattern, however, is less than ten percent increase of that for the concentrated pattern.

b) For either land-use pattern, the number of trips by vehicles for the car-dependent pattern will be ten times larger than that for the rail-dependent pattern. It is not too much to say that trippling the present road network capacity would be impossible considering the difficulty of right of way acquisition especially in the urban center.

The traffic demand by vehicles for the rail-dependent pattern will be about fifty percent larger than that of present for either land-use pattern. Extensive development of the rail transit system required for the alternative pattern will cost very much. A relatively smaller requirement of land acquisition in this case, however, implies relatively higher feasibility. In addition, total amount of money required for the rail-dependent pattern is estimated to be lower than that for the car-dependent pattern.

c) The above consideration leads the recommendation of the dispersed/rail-dependent pattern as basic policy for transportation facility plan. To materialize the recommendation, further and careful consideration will be indispensable on effective connection between the land use and transportation system plan.

6 Urban Road Network

6.1 Traffic demand by vehicles is predicted to increase rapidly from now on, even though a certain amount of traffic demand could be satisfied by rail transit newly introduced. It follows that urban road network should be developed both extensively and rapidly.

6.2 Among radial and circumferential roads which form the trunk road network in the area, circumferential roads should be developed urgently, because the milage of ring roads is relatively small now and traffic demand along circumferential roads will significantly increase in future, following the prediction based on the land-use pattern.

6.3 Among many circumferential roads in the area, C-2 located within the five kilometer radius has a relatively small milage of incompletion. The five kilometer unpenetrated section should be completed urgently so that C-2 could function fully as a major circumferential road in the area.

6.4 The construction of C-3 located within nine kilometer radius should urgently be started in order to satisfy existing traffic demand along the planned circumferential road. The road should have six lanes in general. Almost all the nineteen kilometer section should be newly constructed, because the length of its completed section is almost negligible.

6.5 C-4 located within twelve kilometer radius has now two incompleted sections, the total length of which is about five kilometers out of C-4's total twenty five kilometer length. These two sections should be completed as early as possible.

The northern incompleted section, however, should be opened simultaneously with the radial road R-10 mentioned below.

6.6 Most radial roads within C-4 require partial improvement only. R-10 extending north along the Manila Bay, however, does not exist at all, despite of its highly rated necessity. It is recommended to complete the seven kilometer section from the southern bank of the Pasig to C-4 urgently.

6.7 As for the two circumferential roads, C-5 and C-6, located within fifteen and twenty kilometer radii respectively, land acquisition at the earliest possible time is recommended. The former should have six lanes, while the latter should have four or six lanes with additional right-of-way for an access-limited expressway. Thus, the width of C-6 may vary depending on the type of the expressway. It is needless to say that rampway sections require wider right of way. The reasons why C-6 should have many lanes with potential for an expressway are as follows. First, land acquisition is relatively easy now when the area around is not fully developed yet. Secondly, C-6 should provide enough high service level as an outer circumferential road in order not to introduce through traffic within the Manila Metropolitan Area. Thirdly, C-6 should serve many development centers in the outer area.

6.8 The radial routes which necessitate large-scale construction are R-1, R-4, R-10 and so on.

6.9 The major thoroughfare network does not provide satisfactory service for the future traffic demand in the area. Therefore, many secondary roads with four lanes and more should be constructed throughout the Manila Metropolitan Area.

6.10 To solve the present conditions of congestion in accordance with the above mentioned road network, the following works have to be completed urgently, that is, within five years to come:

Improvement of main intersections inside C-4
Construction of the missing 5 kilometer section of C-2
Construction of 19 kilometer C-3
Construction of the missing 2 kilometer section of R-6
Construction of the extention of R-1 beyond C-4
Construction of R-4 inside C-4
Construction of R-10
Construction of missing sections of C-4

As regards C-5 and C-6, it is necessary, for the time being, to acquire enough right of way over the entire routes.

Of course, the other major thoroughfares, together with the secondary roads, proposed in this study should be completed within fifteen years to come. Their priority should be studied further, based upon the yearly plan of development of the Area.

7 Urban Expressways

7.1 Urban expressway network

An urban expressway network in the Manila Metropolitan Area is proposed below on the basis of the dispersed pattern of urban activities in the Area.

The trunk expressway Route No. 1 should be planned along Highway No. 54 (C-4) which serves developing sub-centers such as Cubao and Makati. The expressway is a rough half circle, about twelve kilometers from Manila downtown. The trunk expressway should be supplemented by three inner branches (Route No. 2 No. 3 and No. 4) bound for Manila downtown and two outer branches (Route No. 5 and No. 6) bound for suburbs. These trunk and branch expressways should function in conjunction with existing southern and northern expressways which are completed up to Highway No. 54.

Total length of the expressway network described above is about 54.4 kilometers.

7.2 Structure type

The proposed Manila Metropolitan Urban Expressway network should be basically elevated expressways planned over existing surface roads, except for short sections on reclaimed land and on embankment. It follows that its structure type should be selected carefully in order not to disturb traffic on surface roads during construction periods and to enable easier maintenance.

Based on the above consideration, it is desirable to adopt P.C. beams, except for interchange and ramp sections where steel beams should be adopted on structural consideration. Concrete structure should basically adopted for lower structures except for complicated piers and abutments. Concrete structures cost relatively less and require relatively easy maintenance. Moreover, it is easy to procure most material needed for them within the nation.

As for foundations, cast-in-place concrete piles, steel piles and prestressed concrete piles should be adopted in the parts along the Manila Bay west to the lines of P.N.R. running north and south, considering the general geological characteristics of the Manila Metropolitan Area. In the remaining area, however, the footing foundation is considered to be enough without piles because of volcanic tuff being near to the ground surface.

7.3 Cost and benefit

The total amount required for the construction of the total expressway network and for its maintenance and administration over thirty years from its completion is estimated to be 2,472 million pesos (2,037 million construction, 306 million for maintenance and 129 million for administration). The total amount of benefits over the same period is estimated to be 11,370 million pesos (10,530 million for time saving and 840 million for running cost reduction). The conclusion is that the expressway network could generate about 3,800 million pesos net social benefit over the period.

7.4 Construction priority

It will be impossible to complete the whole network of the proposed urban expressway at one time. Therefore, it is desirable to construct one section after another at the same time considering the effect of each section, the growth of the traffic demand, the tendency of the urban development and the progress of related development projects. From this point of view, Expressway Route No. 2 which runs north from C-2 along the Manila Bay should receive the top priority of the urban expressway construction program. The construction of northern part of Expressway Route No. 1, which runs along the Manila Bay should be given the second priority. Inner branches Route No. 3 and No. 4 should be completed next. Suburban extension of the expressway should be completed simultaneously with the completion of C-5 and C-6.

It is necessary to study in more details the year when each route of the proposed expressway should be opened for traffic. Roughly speaking, however, Route No. 2 on R-10 should be constructed within five years to come from the viewpoint of the present traffic congestion, and successively Route No. 1 on C-4 should be completed at the early stage of the second five year period to come in orders to guide development. The other sections will be opened before the target year, i.e. within fifteen years to come. The study should be commenced immediately to follow the above time schedule.

7.5 Operation

The proposed urban expressways should be planned as a toll road in order to enable earlier completion. Administrative body of the expressway should be a public corporation so that the government could control the basic policy. According to our estimation, the construction cost of the proposed urban expressway system can be repaid over twenty nine years under the condition of two pesos per vehicle toll and four percent interest rate.

8 Urban Rapid Transit Railways

8.1 Urban rail transit network

An urban rail transit network in the Manila Metropolitan Area is proposed below on the basis of the dispersed pattern of urban activities in the Area.

Subway (135.1 km)

Line No. 1 (27.1 km)	From Construction Hill to Talon via centeral Quezon Blvd., Manila downtown and the International Airport
Line No. 2 (36.0 km)	From Novaliches to Cainta via Manila downtown and Pasig
Line No. 3 (24.3 km)	Along Highway No. 54 (C-4): a half circle route about twelve kilometers from Manila downtown
Line No. 4 (30.1 km)	From Marikina to Zapote via Cubao, Manila downtown and the Manila Bay area
Line No. 5 (17.6 km)	From Meycauayan to Manila downtown running between Line No. 2 and P.N.R.
P.N.R. improvement (56.4 km)	From Bocaue to Muntinglupa via Tutuban Station

To improve the existing lines of the Philippine National Railway (P.N.R.) and stations in order to facilitate commuter service.

The proposed urban rail transit lines described above are connected with each other in the CBD in order to provide easier and convenient transfer.

8.2 Structure type

In general, the structure type of the proposed urban rail transit should be underground in built-up area and elevated type in suburban area. P.N.R. improvement should basically be planned on surface except for elevated or depressed section in the inner area where crossing streets are dense. Transit route selection below existing roads enables the usage of cut and cover construction method in built-up area. The structure type of the subway should be reinforced concrete box culvert. Shield and sunk tunnel may be used where they are necessary. Through tunnel sections various equipments such as drainage, ventilation, air conditioning and fire prevention should be installed in addition to electric facilities.

The proposed subway in the Manila Metropolitan Area is considered to be feasible enough with the provision of various modern equipments to overcome hot and humid climate.

8.3 Cost and benefit

The total amount required for the construction of the total rail transit network and for its operation and administration over thirty years from its completion is estimated to be 26,110 million pesos (14,070 million for construction, 5,118 million for purchasing cars and 6,922 million for administration). The total amount of benefits over the same period is estimated to be 63,702 million pesos (36,347 million for time saving, 4,770 million for road investment saving, 15,265 million for bus system investment saving and 7,320 million for increase in land-use potential). The balance of the rail transit network is estimated to be 37,592 million pesos social benefit.

8.4 Construction priority

It will be impossible to complete the whole network of the proposed rapid transit at one time. It follows that stage construction is necessary. The first construction work should be started both in 14 kilometer section of Line No. 1 between Quezon and Manila downtown (four year construction period) and in 5.7 kilometer section of P.N.R. from Tutuban station to the north (two and half year construction period). The latter should be completed at least a year and half earlier than the completion of the former. During the time lag of a year and half, operators and personnel required for the subway operation should be trained and educated utilizing the P.N.R. facilities and organization. Thus, Line No. 1 can be immediately in full operation after the construction.

Completion of the above two sections of railways will establish the construction method, the operational organization, the use by people.

All railway lines proposed in this report should be opened for transportation as early as possible, judging from the existing traffic demand for the mass transit system.

The improved sections of the above 5.7 kms. of PNR and Subway Line No. 1 are desired to be open for the transportation within five years to come. The remaining sections and lines should be completed within fifteen years to come.

8.5 Operation

The fare system of the proposed rail transit should be determined on the basis of route sections. The operational body of the system should be a public corporation or governmental organization. The existing organization of the P.N.R. could be expanded to operate the improved lines. Accounting should be pooled within general P.N.R. accounting.

According to our estimation, the construction cost of the proposed rail transit system can be repaid over sixty years under the condition of fifty centavos (fourty centavos on the average, considering the discount of commutation tickets) per person fare and four percent interest rate.

9 Flexibility of Transportation Systems

9.1 Rights of way

Early acquisition of necessary rights of way is desirable to avoid problems of rising costs. Also, whenever possible, opportunities should be taken to ensure that R's. O.W. have more than adequate capacity to provide for possible unforseen expansion or development in the Metropolitan Area.

9.2 Operational review

As sections of the transport system are constructed and placed in operation, the performance of the system should be reviewed and modifications or adjustments considered where necessary for the system as a whole.

ACKNOWLEDGEMENT

It is solely through the kind cooperation of two counterpart teams in the Government of the Philippines and other agencies in various fields that this report on the Urban Transport Study in the Manila Metropolitan Area has been prepared smoothly and fruitfully. This report is a fruit of collaboration with the two counterpart teams. The Japanese Survey Team expresses its hearty gratitude to the participating agencies, especially the said two counterpart teams, by mentioning their collaboration in details.

During the initial stage, government participation in the study was coordinated by a special counterpart committee of officials from the Office of the Secretary of the Department of Public Works and Communications (DPWC) and the Bureau of Public Highways (BPH). Created by former Secretary of Public Works and Communications, Manuel B. Syquio and Commissioner of Public Highway, Baltazar Aquino, the committee was composed of Mr. Leoncio Limjuco, Administrative Engineer, BPH, as Chairman, Mr. Remee Geyenechea, Chief of the Programming and Planning Division, DPWC, as Vice-Chairman, and Messrs. Irenee Ramos, Chief of the Programming and Planning Division, BPH, Teadore T. Encarnacion, Assistant Chief of Planning and Project Development Office, DPWC, Antonio Goco, Chief of the Limited Access Section, Designing Division, BPH, Prudencio Baranda, Traffic Engineer, Programming and Planning Division, BPH, and Ricardo Cortes, Structural Engineer, Designing Division, BPH, as members.

As the work progressed, it became necessary to organize the counterpart services into two units: traffic and non-traffic elements.

Administering the traffic component of the study was the BPH team composed of Messrs. Limjuco, Goco, Baranda, and Cortes. Under the guidance of the Japanese team, the group carried out the origin-destination surveys and traffic counts. It also supplied data and services on road conditions, highway plans, road and structure design standards, vehicle fleet statistics and related informations.

The non-traffic elements of the study were handled by the Manila Bay Metropolitan Region Strategic Planning Team, one of three joint on-going projects of the DPWC and the Institute of Planning of the University of the Philippines (IPUP). The team provided the basic land use plan and associated information on population and economic activities. Providing overall guidance and supervision of the three projects was an Executive Staff composed of Messrs. Leandro Viloria, Dean of the IPUP, Prospero C. Moreles,

Chief of the Planning and Project Development Office, DPWC, and Walter Faithfull, UNDP Manager for IPUP projects. Key officials of the Manila Bay Project Planning Team include Messrs. Jose R. Valdecanas and Cesar Marques, Study Coordinators from the IPUP, Messrs. Teodoro Encarnacion and Jose Virtucio, DPWC Coordinators, and Rosauro Paderon, Regional Planner from the National Planning Commission. Expert advice to the team was provided by Messrs. Hermund Skholberg,Regional Planner and Sigurd Grava, Transport System Planner, both from the UNDP.

In the conduct of their work, the two counterpart teams received various forms of assistance from other agencies, among which are the following:

1. Local governments of Manila, Quezon City, Pasay City, Caloocan City, Las Pinas, Paranaque, Makati, Muntinglupa, for the conduct of the traffic surveys and provisions of development plans.

2. Land Transportation Commission for vehicle fleet data.
3. Bureau of the Census and Statistics for population data.
4. National Planning Commission for land-use information.
5. Board of Technical Surveys and Maps for aerial photographs and maps.
6. Bureau of Public Works for data on flood control and drainage.

7. Philippine National Railways for data on railroad conditions and development plans.

8. Laguna Lake Development Authority for agro-industrial and water resources data in the area surrounding the lake.

9. Highway Division Engineer of the Sixth Engineering Division (covering Metropolitan Manila and adjacent provinces), District Engineers or Rizal, Laguna, Bulacan and Cavite, and City Engineers of Manila, Quezon City, Pasay City and Caloocan City, for assistance in the traffic surveys.

The Japanese Survey Team would like to show its sincere appreciation to present Secretary of the Department of Public Works, Transportations and Communications for the kind cooperation made constantly for a long time and again to the two counterpart teams for the fruitful result of this study and the opportunity to collaborate with them.

MEMBERS OF SURVEY TEAM

Preliminary Survey (March 1971)

Kazuo Tsuno	(Asst. Director of Kanagawa Construction Bureau, Tokyo Expressway Public Corporation)
Kazuo Yoda	(Deputy Chief, City Planning Section, City Bureau, Ministry of Construction)
Masaya Tokumaru	(Development Survey Department, Overseas Technical Cooperation Agency)

Detailed Survey (July - October 1971)

Leader: Takashi Inouye	(Professor, Urban Engineering, Faculty of Engineering, University of Tokyo)
Vice-leader: Shintaro Suzuki	(Director of Facilities Planning Department, Capital Development Bureau, Tokyo Metropolitan Government)
Member: Moriyuki Hirose	(Associate Professor at Meisei University)
Kazuo Yoda	(Deputy Chief of City Planning Section, City Bureau, Ministry of Construction)
Kazuhiro Matsuno	(Chief of First Planning Section, Road Department, Kanto Regional Construction Bureau, Ministry of Construction)
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Koichi Kadoya	(Nikken Consultants, Inc.)
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Akira Asahi	(Japan Overseas Consultants Corporation)
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Fumio Higai	(Development Survey Department, Overseas Technical Cooperation Agency - subsequent to March 1972).

CHAPTER 1 INTRODUCTION

CHAPTER 1 INTRODUCTION

§ 1.1 Foreword

The city of Manila, the largest city in the Republic of the Philippines, together with its neighboring cities and municipalities including the capital city of Quezon, forms a metropolitan area which has expanded rapidly in recent years. The expansion of urban areas and high densities of building in the Manila Metropolitan Area are causing considerable traffic congestion in the entire area.

The Government of the Republic of the Philippines, in the face of such a serious traffic problem, made a request to the Government of Japan for technical cooperation on February 26, 1971 and further presented the terms of reference to the Government of Japan on March 30, 1971.

In response to this request, representatives of the Japanese survey team were sent to Manila in March 1971 for a preliminary survey as a prelude to this survey project. The period of April to June of the same year was devoted mainly to the programming and preparations for a detailed survey with the participation of the visiting Philippine counterparts. During the period of July to October, the survey team remained in the Philippines for consultations with the Philippine Government and for collection of data and conduct of traffic surveys.

The counterpart agency in the Philippines was the Bureau of Public Highways initially but was changed later to the Department of Public Works and Communications as the scope of the survey expanded.

An interim report of the survey was presented to the Philippine Government in December 1971 and representative Philippine counterparts were invited to Tokyo during the February-March period of the following year to exchange and coordinate views mainly on land-use planning and basic traffic system. On the basis of this discussion the Philippine Government completed a draft land use plan in May and the Philippine counterparts were again invited to Tokyo in June to participate in the study and plan the optimum traffic network plan.

In the following half year, traffic facilities plans including alternative land-use plan were drawn up. Although the completion of the report of this study was delayed, it is now ready for presentation.

This report consists of eleven chapters. Chapter 2 to 3 describe the scope and background of the survey. Chapter 4 deals with the present traffic conditions of the Metropolitan Area based on the large scale traffic surveys specially conducted for this study. Chapter 5 illustrates the fundamental city structure of the future Metropolitan Area and Chapter 6 forecasts traffic demands in four different forms in line with the planned city structures. Chapter 7 makes comprehensive recommendations on the traffic system on the basis of the conclusions reached in the preceding two chapters. Chapter 8 through 10 propose a basic plan for urban traffic system discussed in Chapter 7, which include major thoroughfare network, urban expressways and urban rapid railways. Chapter 11 explains various problems related to urban traffic systems.

§ 1.2 Terminology

Definitions are given in this section to the words expressing various areas in the study area and the classification of the trip purposes in this report.

1.2.1 Study area

Refer to Figs. 1.2-1 and 4.3-2.

(a) Study area

This area consists of the city of Manila and a part of Rizal and Bulacan Provinces around there. It is roughly inside of C-6 with an approximately 20 km. radius and has an area of 600 kms^2. It is called Manila Metropolitan Area or briefly Metropolitan Area.

(b) CBD (Central Business District)

This area corresponds to the area within C-1 of an about 2 km. radius. It consists of zone Nos. 1, 2, 12, 17 and 19, that is Sector CBD. It includes Districts of Binond, Quiapo, Ermita and so on and has dense urban activities within it.

(c) Urban center

This area corresponds to the area encircled by C-3 of an approximately 7 km. radius. It is roughly the city area of Manila. It consists of zone Nos.1 to 19 and 24, that is Sectors CBD and A. It is densely urbanized except for slight open lands.

(d) This area is the study area excluding the above mentioned urban center. It consists of Sectors B and C. It is roughly the study area outside of the city of Manila.

(e) Inner area

This area is the area inside of C-4 located at about 10 kms. from the center. It consists of zone Nos. 1 to 37, but excluding zone Nos. 27, 28, 30, 32 and 36 as a whole and zone Nos. 21, 23 and 25 partly. It is already urbanized entirely now.

(f) Outer area

This area excludes the above mentioned inner area from the study area. It is the area between C-4 and C-6. It is urbanized only locally and to

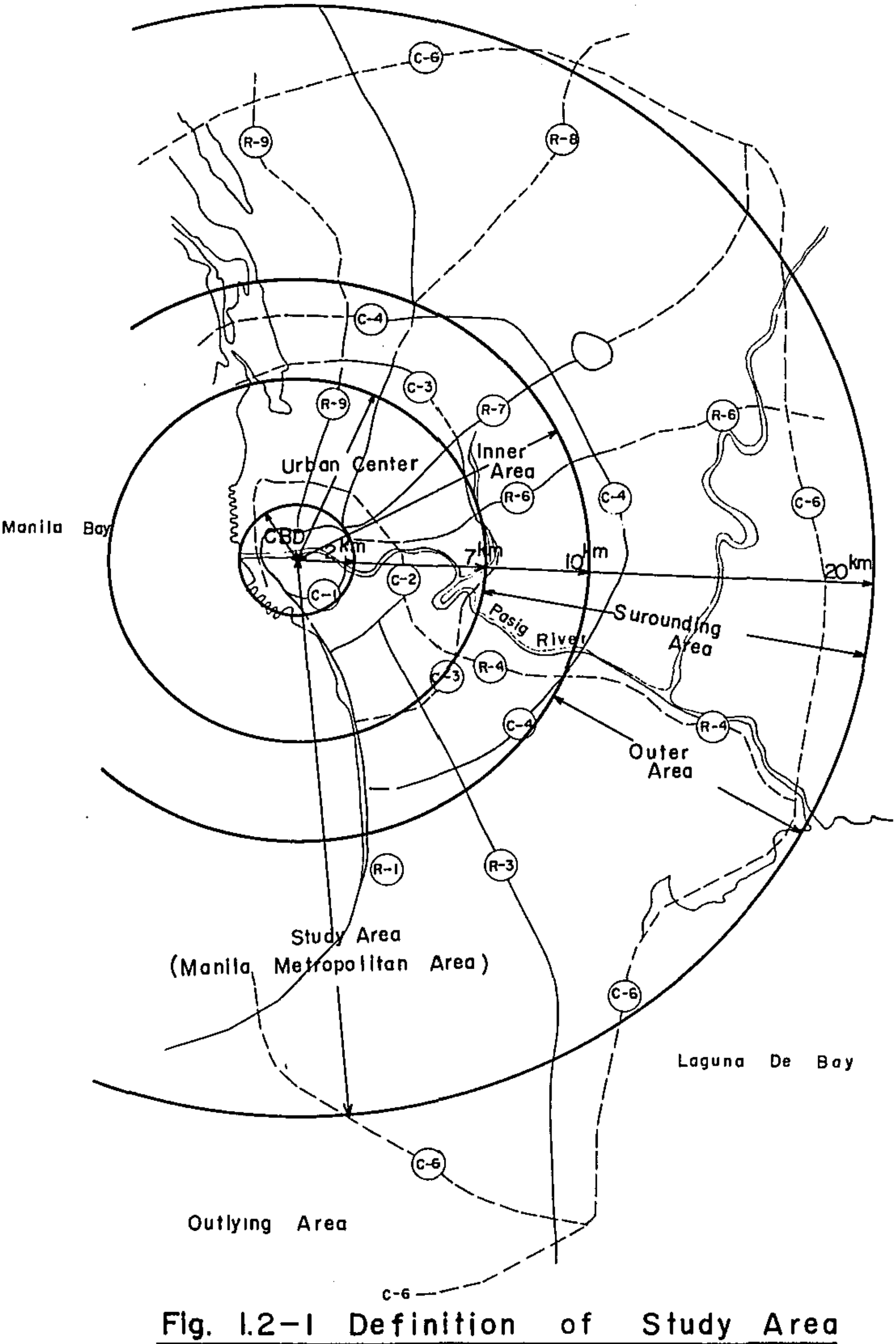

Fig. 1.2-1 Definition of Study Area

be developed much in future.

(g) Outlying area

This area is the area outside of the study area.

1.2.2 Trip purposes

(a) Commuting to work

This refers to trips made from a place where the person stays for a night or spends his private time, such as his own home, his friend's home or a hotel to the location of his place of employment, such as a factory, a store, a shop or an office in order to perform a normal day's work.

(b) Going to school

This applies to trips made from the above-mentioned place to the location of a school by students who are actually attending school. Teachers and employees at schools would be reported as "Commuting to Work".

(c) Private

These trips are understood as personal trips. The examples are given as follows:

Under this category classed in a trip made to a store for shopping or just looking.

This category includes cultural trips made to church, civic meetings, lectures, and concerts, as well as trips to attend parties or to visit friends. This category also includes trips made for golfing, fishing, movies, bowling, pleasure riding, gambling, and so on.

Under this category fall trips made for eating meal, taking refreshments, consultation about health with doctors and dentists and serving passengers. A trip for eating meal at home is considered as a trip "To Home". If a man's wife took the car and drove him to a station or his office or drove the children to school, the trip purpose of this wife was to serve passenger. Trips made for repairs to automobiles, radios, or other items, and for personal service such as haircuts, beauty treatments, cleaning and pressing clothes, etc., also should be recorded under this category.

(d) Work

This includes all kinds of trips to carry out the duties of a job. Trips made by a doctor in making his calls, by a salesman calling on prospective customers and by a real estate man going to a bank for depositting his sales are classed as "Work", as far as they are necessitated to conduct some official business. Trips falling within this category and code 1 are made by working persons only, but not by housewives, students or persons not engaged in a job.

(e) To home

This refers specifically to the address of one's own household.

CHAPTER 2 SCOPE OF STUDY

CHAPTER 2 SCOPE OF STUDY

§ 2.1 Purpose of Study

This survey has as its purpose the formulation of a plan of urban transportation facilities in the Metropolitan Manila Area.

As to the land use plan, according to the views exchanged between the Philippine government and the Japanese survey team, an original plan has been settled by the hands of the Manila Bay Development Planning Team, an original plan with the urban activities relatively centralized on the existing urban centres. However, the Japanese survey team presumes the probable state where the urban activities are further scattered around, and thus makes the alternative land use plan on the basis of that presumption. As the land use plan is to be derived from two different ideas, i.e. the concentrated pattern and the dispersed pattern, the concept of the transportation system as well as the forecast of the transportation demand has to be treated in two different ways corresponding to those two ideas.

As a result, the team came to the judgment that the land use plan is of higher validity when it depends on the dispersed pattern. Accordingly, the team is to formulate the basic plan of transportation facilities from the viewpoint of the dispersed pattern.

The transportation facilities, as the object of the survey, ranges over all the transportation means inside the Metropolitan Manila Area, and therefore the team is to make a comprehensive investigation of the ordinary streets, the urban expressways and the rapid mass transit means.

The team is to draw a more specific plan for each of these means of transportation. These plans will be those which cover the questions such as the estimation of traffic volume, the plan of designing, the location of routes, the location of ramps or stations, the total amount of working expenses, the estimation of benefit, economy and the investigation of payability, the approximate order of undertaking the work, the organization of the administrative body, etc. Since the present report gives only a fundamental outline of these plans, it will be necessary to continue the survey in future for further detailed investigation.

§ 2.2 Study Area

Needless to say the Republic of the Philippines belongs to the tropics and is an island country surrounded by the Pacific Ocean and the South China Sea. The Republic comprises islands, large and small, inhabited and uninhabited, which amount to more than 7,000 in number, about 300,000 km^2 in area and approximately 37,000,000 in population (as of 1970).

The land is roughly divided into three regions, Luzon, Visayas and Mindanao from north to south. The city of Manila is located almost in the centre of the Luzon island and is the largest city of the Republic.

The survey area is the Manila Metropolitan Area centering around the city of Manila. A metropolitan area can be considered as a sphere of the inhabitants' everyday life, in other words, a commuting sphere, though its specific border line is not always clear. Therefore, considering the scope of area that is and will be urbanized, the team puts the object of the study as the area within a radius of 20 kms. from the present centre of the city of Manila, namely, the area consisting of the city of Manila, Rizal Province and a part of Bulacan Province.

Accordingly, Bacod of Cavite Province and Muntinlupa of Laguna Province are excluded from the study area, though both of them are adjacent to the object area and their built-up areas can well be estimated to join the Metropolitan Manila area in future.

The following are the names of the cities and municipalities to be included in the study area. There are 19 of them, covering the area of 600 km^2 and accommodating the population of approximately 3,900,000 at present.

Cities:	Manila, Caloocan, Quezon, Pasay
Municipalities (of Rizal Province) :	Navotas, Malabon, Mandaluyong, San Juan, Makati, Pasig, Pateros, Marikina, Taguig, Parañaque, Las Piñas
Municipalities (of Bulacan Province) :	Obando, Marilao, Meycauayan, Valenzuela

CHAPTER 3 BACKGROUND OF STUDY

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§ 3.1 General Outline

The capital of the Philippines is Quezon city which is located about 8 km north-east of the city of Manila. Although a new government listrict is being developed in this new capital city, the vast space of land contains only scattered government offices and school buildings and the remaining parts are still unoccupied.

Due to the fact that most of the main government offices including the presidential residence and many banks, business centers, entertainment facilities such as movie theaters and educational and cultural functions such as schools are still located in Manila, there is a chronic traffic jam on radial roads and circumferential roads centering on the city of Manila. In particular, the area in and around Quiapo, which is a transfer point for jeepneys and buses and also a business district, is confused with a surging crowd of people all the year round. Accounting for nearly 30% of the gross national product, Manila is a city of thriving economic activities.

Because of the small gradient of river bed and insufficient flow capacity of the Pasig river which divides the city of Manila in two, floods occur frequently during the rainly season from May through December and the city section of Manila is often inundated.

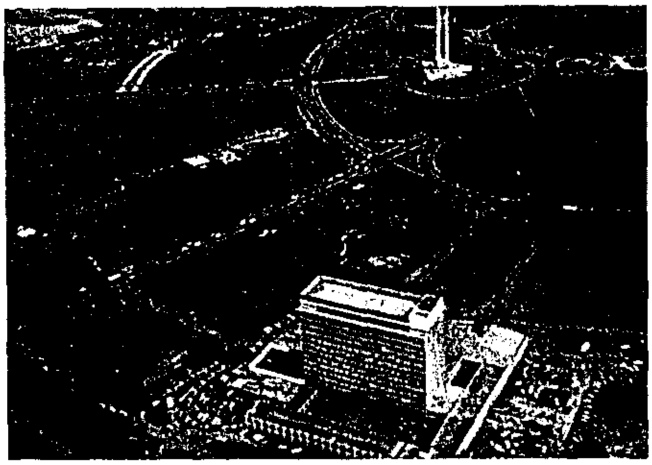
Photo 3.1-1

Roxas Bloulevard, Manila Bay
on the right side.

Photo 3.1-2

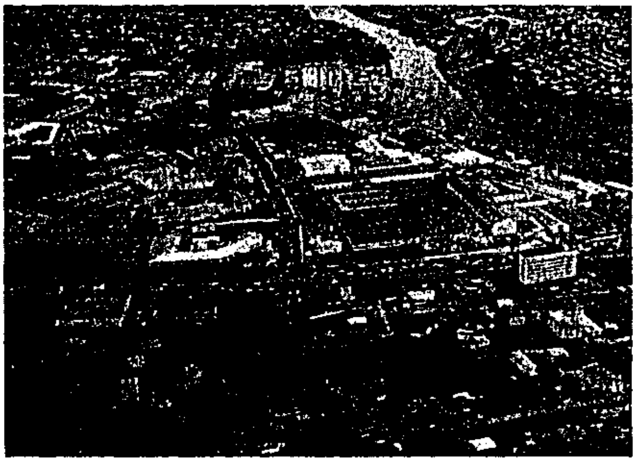
Near Sta Cruz in CBD area

Photo 3.1-3



Near Memorial Circle East Ave. in Quezon city. Although a new government district is being developed in this new capital city, the vast space of land contains only scattered government offices and school buildings and the remaining parts are still unoccupied. Taken in August 1971.

Photo 3.1-4



Near the intersection of Highway No. 54 and Pianear Street.
Upper side is the Pasig river. This intersection is an obstacle to traffic on Highway No. 54.
Picture taken in the late afternoon of August, 1971.

Photo 3.1-5

Near the intersection of the extension of South Diversian Road and Highway No. 54.
To be noted is the congestion of traffic toward the CBD for going to school and commuting to work trips in the morning.

§ 3.2 Land Area and Population

The population of Manila Metropolitan Area, extending over approximately 600 km^2, the area under study, was about 3.9 million as of 1970.

Since the population of the Philippines was about 36.7 million in 1970, it means that nearly 10% of the total population is concentrated in Manila Metropolitan Area. Population density in the Manila Metropolitan Area is 6,550 persons/km^2, about 54 times the average national density of 122 persons/km^2, and there is an increasing tendency toward further concentration of population in the Metropolitan Area annually. The density is highest in Zone 7 near the boundary of Manila city and Caloocan city where it stands at 48,300 persons/km^2. Table 3.2-1 shows populations, land area and population density of regions, provinces and municipalities included in the Manila Metropolitan Area, (This includes all regions, provinces and municipalities by administrative division and is therefore somewhat greater in scope than the Manila Metropolitan Area under study), and of the Philippines in 1939, 1948, 1960 and 1970. According to the Table, the annual population growth in Manila Metropolitan Area during the period from 1960 through 1970 was 4.8% and youths under 20 years of age account of about 75% of the total population. Judging from this trend, sharp growth of population is also imagined in the future.

This growth of population is believed to be supported by natural increase resulting from a sharp decrease of mortality rate and high birth rate.

When compared with most other countries, the population increase of the Philippines is remarkably higher.

Table 3.2 - 1 a) Comparative Table on Population, Land Area and Density of the Philippines by Region, Province and Municipality : 1970, 1960, 1948 and 1939.

Region, Province and Municipality	Population				Area (km²)	Density in Km²				Population percent change			
	1970	1960	1948	1939		1970	1960	1948	1939	1990 -1960	1960 -1968	1948 -1939	1970 -1939
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
RIZAL													
Quezon City	754,412	397,990	107,977	39,013	166.15	4,540.8	2,395.4	649.9	234.8	6.6	11.5	12.0	10.0
Pasay City	206,283	132,673	88,728	55,161	13.97	14,766.1	9,496.9	6,351.3	2,938.4	4.5	3.4	5.4	4.3
Caloocan City	274,453	145,523	58,208	38,820	55.81	4,917.6	2,607.5	1,042.9	695.6	6.5	7.9	5.2	2.5
Navotas	83,245	49,262	28,889	20,861	2.60	32,017.3	8,946.7	1,111.2	8,023.5	5.4	4.5	3.7	4.6
Malabon	141,514	76,438	46,455	33,285	23.37	6,055.4	3,270.8	1,987.8	1,424.3	6.3	4.2	3.8	4.8
Mandaluyong	149,407	71,619	26,309	18,200	25.96	5,755.3	2,758.8	1,013.4	701.1	7.6	8.7	4.2	7.0
San Juan	104,559	56,861	31,493	18,870	10.38	10,073.1	5,477.9	3,034.0	1,817.9	6.3	5.0	5.8	5.7
Makati	264,918	114,540	41,335	33,530	29.86	8,872.0	3,835.9	1,384.3	1,122.9	8.7	8.9	2.3	6.9
Pasig	156,492	62,130	35,407	27,541	12.97	12,065.7	4,790.3	2,729.9	2,123.4	9.7	4.8	2.8	5.8
Pateros	25,468	13,173	8,380	7,160	10.38	2,453.6	1,269.1	807.3	689.8	6.8	3.8	1.8	4.2
Marikina	113,400	40,445	23,353	15,166	38.94	2,912.2	1,038.6	599.7	389.5	10.9	4.7	4.9	6.7
Taguig	55,257	21,856	15,340	12,087	33.71	1,639.2	648.4	455.1	358.6	9.7	3.0	2.7	5.0
Parañaque	97,214	61,898	28,884	21,125	38.32	2,536.9	1,615.3	753.8	551.3	4.6	6.6	3.5	5.0
Las Piñas	45,732	16,093	9,280	6,822	41.54	1,100.9	387.4	223.4	164.2	11.0	4.7	3.5	6.3
MANILA	1,330,768	1,138,611	983,906	623,492	38.3	34,764.6	29,744.3	25,702.9	16,287.7	1.6	1.2	5.2	2.5

Table 3. 2 - 1 b) Comparative Table on Population, Land Area and Density of the Philippines by Region, Province and Municipality : 1970, 1960, 1948 and 1939

Region, Province and Municipality	Population				Area (km²)	Density in Km²				Population percent change			
	1970	1960	1948	1939		1970	1960	1948	1939	1970 -1960	1960 -1948	1948 -1939	1970 -1939
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Obando	27, 176	18, 733	11, 957	10, 026	52. 09	521. 7	359. 6	229. 5	192. 5	3. 8	3. 8	2. 0	3. 3
Marilao	16, 128	9, 206	6, 206	5, 682	36. 50	441. 9	252. 2	170. 0	155. 7	5. 8	3. 3	1. 0	3. 4
Meycauayan	50, 977	32, 234	21, 695	16, 082	21. 50	2, 371. 0	1, 499. 3	1, 009. 1	748. 0	4. 7	3. 4	3. 4	3. 8
Valenzuela (Polo)	98, 456	41, 473	16, 740	13, 468	47. 00	2, 094. 8	882. 4	356. 2	286. 6	9. 0	7. 8	2. 4	6. 6
Manila Metropolitan Area	3, 995, 879	2, 500, 758	1, 590, 542	1, 016, 391	699. 35	5, 713. 7	3, 575. 8	2, 274. 3	1, 453. 3	4. 8	3. 8	5. 1	4. 5
Philippines	36, 684, 486	27, 087, 685	19, 234, 182	16, 000, 303	300, 000. 00	122. 3	90. 3	64. 1	53. 3	3. 1	2. 9	2. 1	2. 7

§ 3.3 Climate *

Generally, the climate is tropical with two pronounced seasons, namely, dry and rainy and with corresponding seasonal wind pattern.

Winds. The prevailing northeasterly winds over Manila between November and February are caused by the high pressure area that prevails over continental Asia. Local topography causes the northeast trade winds to come from the southwest in the Manila area during March, April, and May, and these hot rainless months form the summer season. Rain and brisk westerly winds prevail with the southwest monsoon from June to October.

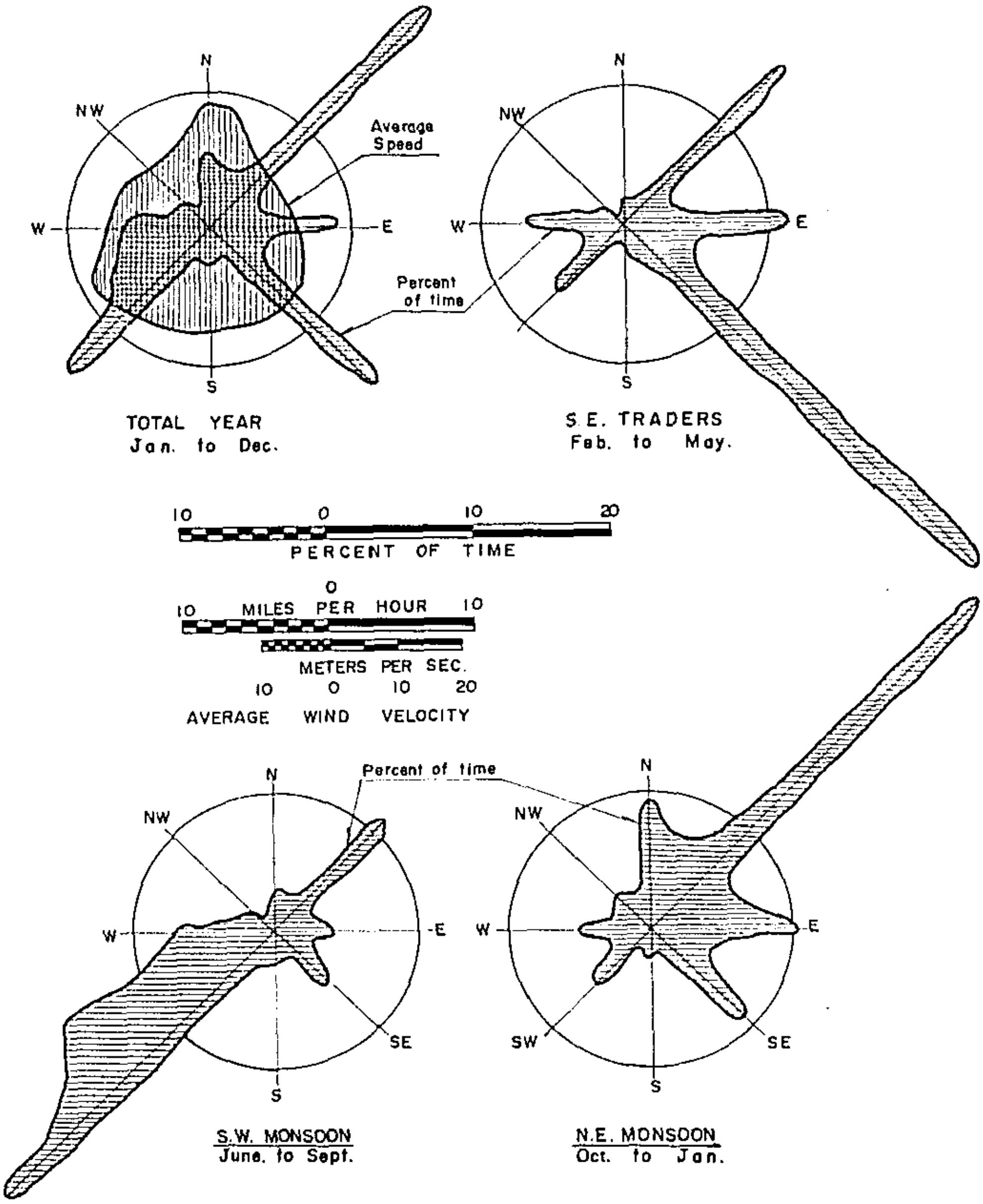
Wind roses compiled from the last 15 years average daily records of the Weather Bureau, Manila Central Office (MCO, See Figure 3.3-1), show the "total year" rose indicating the three major wind directions, and the seasonal diagrams show how wind from a particular direction predominates.

Over 50% of the rainfall in the Philippines is associated with typhoons and tropical storms. Out of the 123 major typhoons that visited the country over a period of 32 years, the eye of 20 (or 16%) passed within 120 kms. (75 mi.) of Manila, Half of these typhoons occurred between October and December.

Rainfall. The most rainy months are from June to September, the months of the southwest monsoon. The northeast monsoon brings much less precipitation, while the easterly trade winds are virtually rainless. Precipitation increases uniformly from an annual average of about 1,600 mm. (65 in.) in the south at Sangley Point to 2,700 (106 in.) in the north at Montalban. Thunderstorms are also caused by the damp equatorial air of the southeast monsoon. Ninety percent of thunderstorms occur between May and October at an average of 8 days of thunderstorms per month.

Flood Exceptionally damaging floods are caused by torrential rains due to passing typhoons. Other causes are inadequate flood control system, poorly maintained drainage system and poor public services such as garbage collection and road maintenance.

Extent of major floods that have occurred in the Marikina-Pasig basin cover a considerable area. In spite of the floods, considerable commercial and industrial land development has been taking place lately in many flood areas, particularly those bordering the Marikina and Pasig Rivers.



Sketches were based on 15 years of average daily wind records taken at the Manila Central Office to the Weather Bureau.

Fig 3.3-1 WIND ROSES

Temperature The easterly trades bring warm dry air. May has the highest average mean monthly temperature. The maximum temperature ever recorded at was 38.6°C (101.3°F) in April, 1948 and the minimum was 14.5°C (58.1°F) in January, 1914. January is usually the coolest month.

Humidity. The average relative humidity is lowest in April (69% at MCO) and the highest in September, at 84%.

Evaporation Evaporation is dependent on wind, temperature and humidity. Mean monthly evaporation result for Laguna de Bay is probably the most representative for the study area and is given at 1,150 mm. (45.2 in.) or approximately half the annual rainfall.

Sunlight. At the latitude of Manila, the sum is above the horizon a maximum of 53 percent of the time in June and a minimum of 47 percent of time in December.

* Source: Black & Vearch, Master Plan for a Sewerage System for Metro Manila.

§ 3.4 Industry and Economy

In the Republic of Philippines nearly half of the national land is covered with forests and approximately 40% is under cultivation as agricultural land. A little over 10% is level land including marshes.

Under the glaring sunshine and with abundant rainfall, the country enjoys fast growing agricultural products and forest resources. Besides, the numerous islands totalling more than 7,100 are situated in excellent fishing grounds.

Mineral resources are also abundant and copper, iron and chrome are major export items. However, the Philippines is slow in the development of its national land and has not yet attained the stage in which its rich natural resources may be fully utilized. For example, the country still has to import part of the supply of the staple food of rice despite the very favorable conditions for agriculture. While new high-yielding varieties of rice such as IR-8 have been developed in the country, the rice supply is still inadequate. For reference, the index numbers of agricultural production in the Philippines with 1963 as the base year of 100 are shown below.

Table 3.4-1 Index Numbers of Agricultural Production in Philippines

Agricultural Production \ Year	1962	1966	1967	1968	1969
Food products	96	107	105	108	118
Other products	96	106	104	107	116

Note: The food index relates to the production of crops and livestock products for human consumption. The all commodities index includes in addition, fibers, tobacco, industrial oilseeds, rubber, tea and coffee.

Annual increase of the food index during of 1962-1969 was 3.3% which was lower than that of population which stood at 3.5%. As the supply of staple food per capita is increasing at an annual rate of 3.4%, food shortage is one of the important questions for the government to solve.

The Philippines has a coast line of 183,000 km, territorial waters extending over 1,826,000 km^2 (about 6 times the total land area) and 505,000 hectars of irrigated puddy fields, lakes and rivers. Because of the lag in the development of its rich marine resources, part of the fish supply has to be imported.

The fishing industry in the Philippines is employing obsolute techniques and operating inefficient, old style fishing boats. There is very little capital investment in the fishing industry. Inefficient transport framework is a great obstacle to the transportation of hauls and coordination of shipments to the market. There has been little improvement of fishing techniques because of lack of statistical and biological data and inadequate oceanographic surveys and reserach. Fish canning industry is relatively new to the Philippines and only a few packing plants are in operation. For this reason, the fishing industry is still far from the ideal stage where the rich marine resources can be fully utilized for domestic and export purpose.

CHAPTER 4 PRESENT STATE OF URBAN TRAFFIC

CHAPTER 4 PRESENT STATE OF URBAN TRAFFIC

§4.1 General Outline

Traffic congestion in the Philippines' major cities is exceptional. This is especially true in the Manila Metropolitan Area which has a population of about 3.9 million (in 1971) where it takes about an hour and half to travel over a distance of 9 km by car during the morning and evening peak hours on major roads.
Besides, it is often necessary to take a route which is about twice as long as the regular route to avoid congestion.

The annual growth rate of population in the Manila Metropolitan Area is as high as 4.1% and youths under 20 years of age account for 75% of the total population. This means that the traffic condition of the Manila Metropolitan Area which is in state of confusion even today will be further deteriorated. When the future traffic entering and existing from the Manila Metropolitan Area is taken into consideration, the problem shows a very serious aspect. This traffic congestion is believed to be caused mainly by the following.

4.1.1 Jeepney and bus

The jeepney, which accounts for nearly 50% of the total number of unlinked trips (See Fig. 4.4-1) is a very convenient means of transportation for the general public. On the other hand, however, it picks up customers any place when motioned or called on and therefore has to make frequent starts and stops. As a result, it runs very slowly and follows a zigzag course, thereby interfering the traffic of other vehicles behind it. This practice coupled with frequent on-street parking considerably reduces traffic capacity of the road.

Another factor in the worsening traffic situation is the bus which accounts for about 16% of the total unlinked trips. (See Fig. 4.4-1) The bus has a character very similar to that of the jeepney and makes a stop any place in addition to the designated bus stops when motioned by a passenger as in the case of buses in the provinces of Japan.

The traffic congestion on roads may well be alleviated when the traffic by bus and jeepney, which carries so many people and on the other hand is a great factor of traffic congestion, could be substituded by other traffic modes, for example by subway.

The fact that the majority of major roads in Manila Metropolitan Area are designated for jeepney and bus routes also contributes to the concentration of traffic on the major roads.

Still another contributing factor to the traffic confusion in Manila Metropolitan Area is the lack of coordination between the operating organizations of jeepneys and buses. As a result, operation of jeepneys and buses is loose and disorderly with no controlled management making use of the supplemental and complementary nature of the jeepneys and buses.

4.1.2 Management and maintenance of roads

The roads in the Manila Metropolitan Area are so poorly maintained that cracks and damages are observed at numerous locations on the paved roads.

In the Philippines there is often havey rainfall during the rainy season in May through December. Because of the insufficient capacity of sewerage systems and poor drainage systems, a rainfall for only about twenty minutes in duration causes inundation of many roads. The downpour which occurred in July 1970 inundated approximately 65% of the city area of Manila, submerging some sections of Pandacan in the vicinity of the Pasig river 2.0 m under water. Roads suffer severe damage at such times.

This fact, coupled with the peculiar traffic patterns is the main cause of slow traffic which moves at a snail's pace immediately after a rainfall.

Even the South Diversion Road, which has high speed traffic up to 100 km/hr and is 15 km in total length, linking Alabang south of Manila Metropolitan Area to Manila city, is often crossed by pedestrians or carabao entering the road sections through broken fences because of the lack of crossing facilities. The road losses its function as a superhighway to some extent.

4.1.3 Parking facilities

As the parking facilities are too scarce to meet the demand especially during the daytime in and around Quiapo, Binondo and San Nicolas on the right bank of the Pasig river in the Central Business District where buildings stand side by side, vehicles are frequently parked on both sides of narrow streets in defiance of the traffic regulations. This practice lowers traffic efficiency greatly in the downtown area where traffic capacity is limited and is causing a great confusion and obstacles to the north-south traffic flow of jeepneys and buses which use Quiapo or Plaza Lawton on the left bank of the Pasig river as a transfer point and to the eastward traffic flow to Quezon Boulevard via downtown Manila. Traffic congestion in the heart of the city not only disrupts overall functions of the city but also expand ill effects to outer area.

4.1.4 Traffic signals

In addition to the inadequate parking facilities in the Central Business District, the number of traffic signals are definitely too few totalling only 64 in the entire Manila city which extends over 38.3 km^2. In addition, these signals are often improperly installed and many intersections have only a small four-direction signal hung at the center. Adoption of the progressive system signal is not yet a reality for economic and other reasons and the lack of an improved signal system is greatly reducing the traffic capacity.

4.1.5 Intersections

Because of the heavy traffic volume in both directions, (for instance, at Guadalupe bridge on Highway No. 54: 91,500 vehicles/day, Near Cubao on Aurora Boulevard: 36,500 vehicles/day. Near Roxas District on Quezon Boulevard: 68,700 vehicles/day ... All these date obtained from the traffic survey of September in 1971) coupled with inefficiency of signal system and inappropriate channelization at the intersections, particularly at the junctions of main circumferential roads and radial roads, traffic flow at the intersections is greatly obstructed. Traffic delays at the intersections often extend even to clear sections of main circumferential roads and radial roads that have important functions, thereby lowering the efficiency of the entire traffic system considerably and inviting serious traffic congestions in the Manila Metropolitan Area.

In the Manila Metropolitan Area there are many grade intersections of the rotary type with a monument erected at the center. Since the traffic volume is great at these intersections, traffic is often held up and through traffic is seriously disrupted.

4.1.6 Traffic behaviour

In general, traffic behaviour leaves much to be desired on the part of drivers who often drive across the median strip to opposite lanes, make a U-turn at the intersections and take zigzag driving for granted. Most drivers take no heed of such traffic rules as keeping to the lane and stopping, U-turn and parking restrictions. There is a causal relation in that traffic congestion invites the lowering of traffic behaviour which in turn worsens traffic congestions.

Besides the peculiarity of the jeepney that it makes a stop any place to pick up passengers, it is operated on a driver commission basis which spurs competition and invites sudden stops and suddan changing lanes. This further spurs deterioration of traffic behaviour.

§ 4. 2 Road Network and Traffic Volume

4. 2. 1 Traffic volume and traffic congestion

The major road network of the Manila Metropolitan Area consists mainly of four circumferential roads (C-1, C-2, C-3 and C-4) centering around the CBD and the following nine radial roads extending from CBD to the outer areas.

1.	Quirino Avenue - Roxas Boulevard	R-1
2.	South Diversion Road	R-3
3.	J.P. Rizal	R-4
4.	Shaw Boulevard	R-5
5.	Aurora Boulevard	R-6
6.	Quezon Boulevard	R-7
7.	A. Bonifacio - Novaliches Road	R-8
8.	Rizal Avenue - Macarthur Highway	R-9
9.	Juan Luna - A. Mabini	-
10.	Roxas Blvd. North Extension	R-10

While the majority of major roads are six-lane or four-lane roads, A Bonifacio, the suburban section of Macarthur Highway and A. Mabini are two-lane roads and are causing bottlenecks in the smooth traffic in those direction. For example, A. Bonifacio which the four-lane North Diversion Road, is two-lane road linked to the four-lane Dimasalang that extends to the CBD. Therefore, the traffic to and from CBD using the North Diversion Road as a radial axis has to make a detour at times, and this extra roundabout traffic is one of the contributing factors to the worsening traffic congestion.

Besides, some sections of circumferential roads C-2 and C-3 are not constructed yet and for this reason, the traffic capacity of circumferential roads is greatly reduced. As a result, traffic is concentrated on C-4 (Highway No. 54 also called Epifanio De Los Santos Avenue) which is a comparatively well maintained six-lane (four-lane in part) road.

At present there are only nine bridges spanning the Pasig river which halves the city of Manila. This deficiency of bridges is a cause of traffic congestion between the two sections of the city is also lower overall traffic capacity of circumferential roads.

Traffic congestion calculated on the basis of a traffic capacity of 10, 000 (vehicles/lane. day) regardless of the width of a lane, is shown in Table 4. 2-1.

Routes that have high traffic congestion in the Manila Metropolitan Area are stations along screen line, radial roads, Highway No. 54 and cordon line in that order.

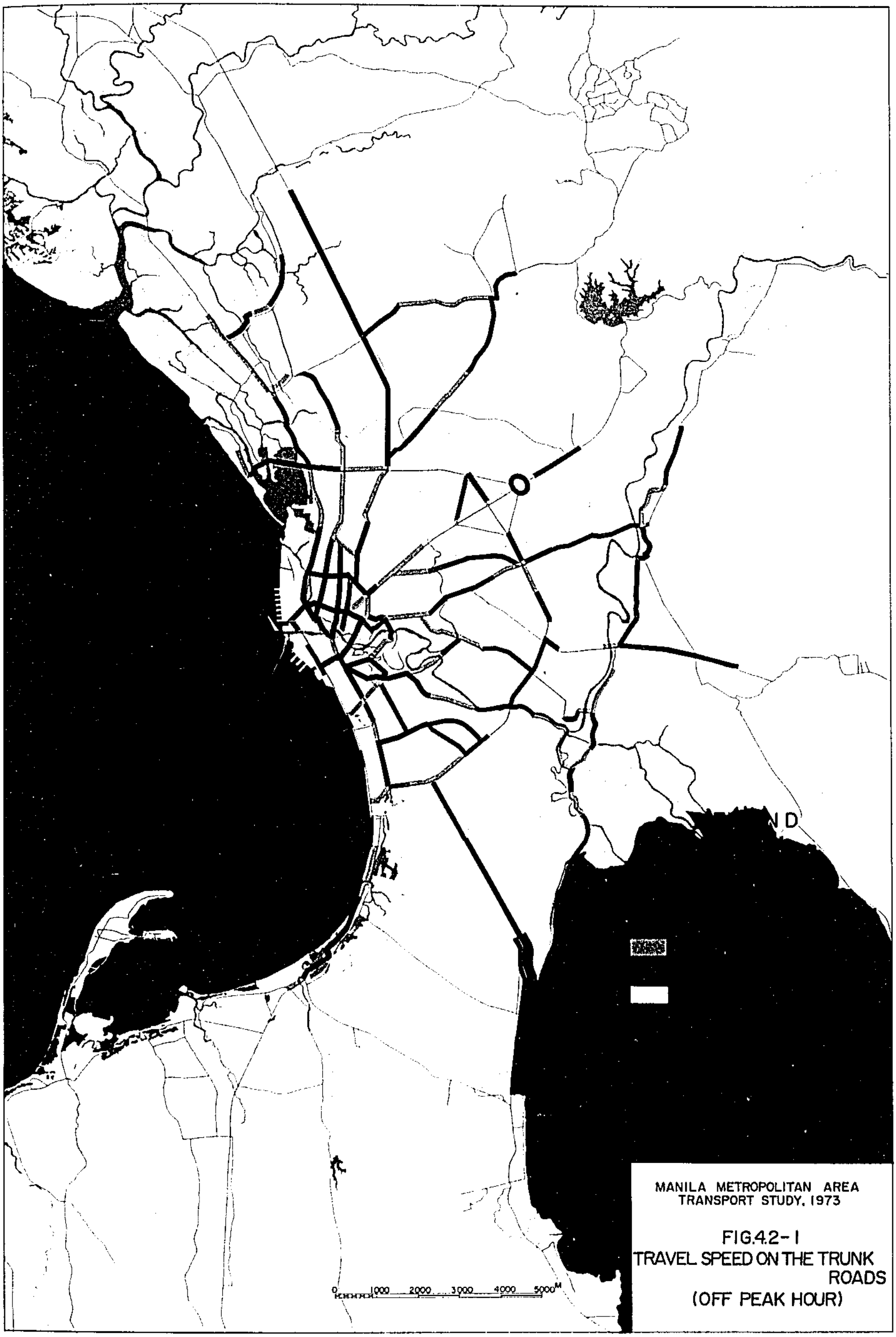
According to Table 4.2-1, the most congested points are Quezon Bridge (congestion level being 1.9) and Guadalupe Bridge (congestion level being 1.5) on the Pasig river. It is evident that the inadequate number of bridges across the Pasig river is sumbling block to the smooth traffic flow in the vicinity, thereby hampering social and economic activities in CBD.

As Calle Rosario is used for one-way traffic to the north connecting Jones Bridge, the north-bound traffic is 2.3 times heavier than the south-bound traffic at the bridge for any time zone.

Traffic congestion is also frequent on Roxas Boulevard, Aurora Boulevard, Quezon Boulevard, Rizal Avenue Extension and A. Bonifacio, all of which are important radial roads, and this fact indicates inadequate traffic capacity of radial roads, particularly in the north-south and north-east directions.

As the cordon station, traffic congestion is most serious in the vicinity of Zapote which occupies an important position in the traffic system between Manila Metropolitan Area and the southern district.

Traffic congestion in this district is mostly due to the fact that roads are too narrow (2 or 3 lanes), that dwellings and shops stand closely along the road with many stopped and parked cars on the street and many pedestrians crossing the road. The areas of intersections are small and channelization is not suitable, that traffic to and from the southern district is relatively large (22,600 vehicles/day), and that the road network in the southern district is not adequate. Only two routes -- Zapote-Quirino Avenue route and South Diversion Road (including service roads) -- are available for the traffic between Manila Metropolitan Area and the southern district.



MANILA METROPOLITAN AREA
TRANSPORT STUDY, 1973

FIG.4.2-1
TRAVEL SPEED ON THE TRUNK ROADS
(OFF PEAK HOUR)

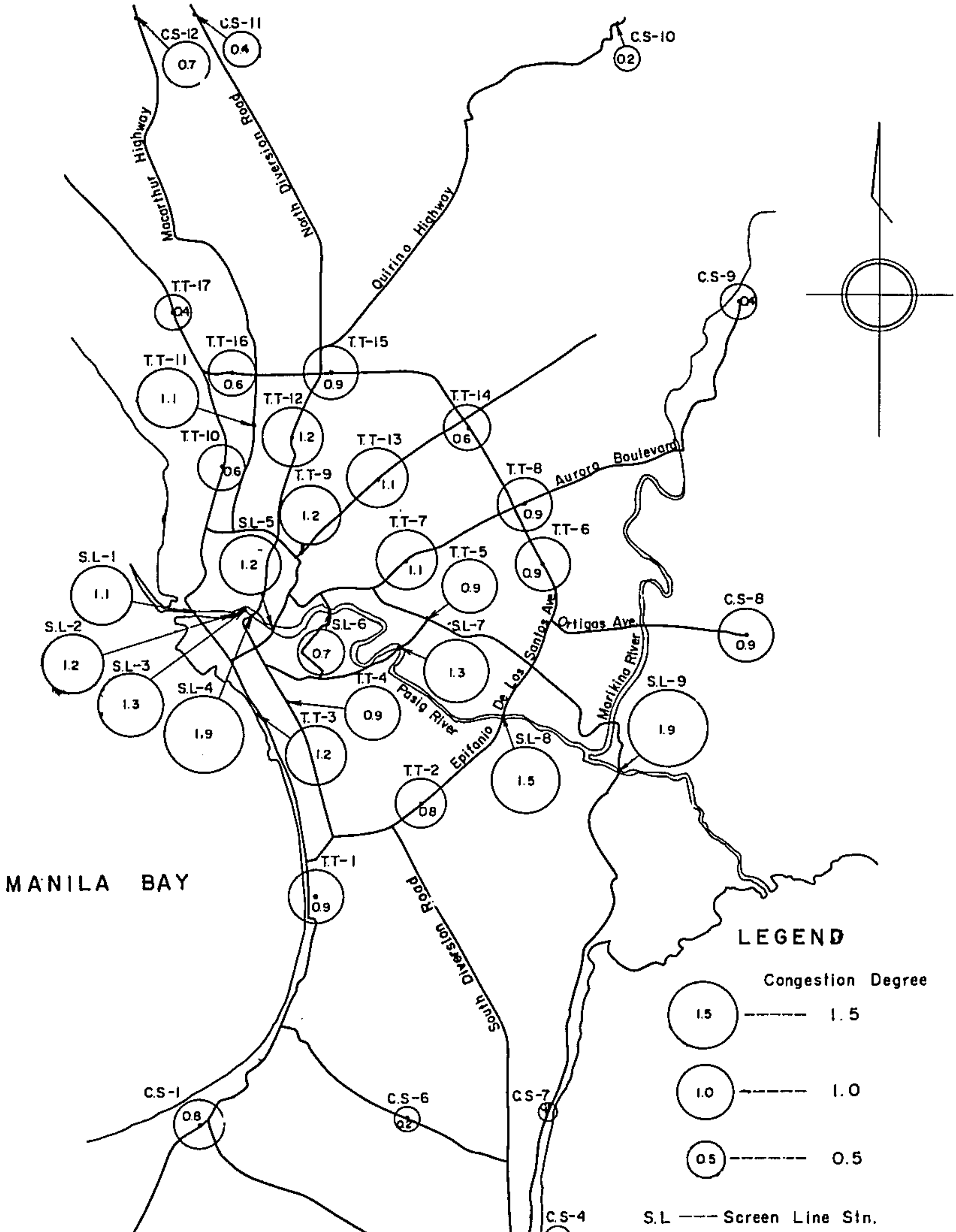


Fig 4.2-2 Traffic Congestion of Major Roads In 1971

Table 4. 2 - 1 Daily Traffic Volume of Main Points of Manila Metropolitan Area (Vehicles/day)

	Traffic Count Stn. No.	Location	Traffic Volume (Vehicles/day) 2 Direction	1 Direction	Direction	No. of Lanes	Width of one Lane (m)	Traffic Congestion	Remarks
Screen Line	S. L. 1	M. Roxas Bridge	42,400	20,300 22,100	S ⟶ N N ⟶ S	4	3.5	1.1	With Medial Strip
	S. L. 2	Jones Bridge	49,200	34,100 15,100	S ⟶ N N ⟶ S	4	3.5	1.2	"
	S. L. 3	MacArthur Bridge	53,100	22,900 30,200	S ⟶ N N ⟶ S	4	3.5	1.3	"
	S. L. 4	Quezon Bridge	74,300	35,900 38,400	S ⟶ N N ⟶ S	4	3.5	1.9	"
	S. L. 5	Ayala Bridge	49,000	22,700 26,300	S ⟶ N N ⟶ S	4	4.0	1.2	"
	S. L. 6	Nagtahan Bridge	41,200	20,300 20,900	S ⟶ N N ⟶ S	6	3.5	0.7	"
	S. L. 7	Panaderos Bridge	26,400			2	3.0	1.3	
	S. L. 8	Guadalupe Bridge	91,500	44,900 46,600	S ⟶ N N ⟶ S	6	3.5	1.5	With Medial Strip
	S. L. 9	Bambang Bridge	21,200			2	3.5	1.9	
Radial Road	T. T. 1	Quirino Avenue (Jose Abad Santos - Clipper Avenue)	25,700			3	3.3	0.9	
	T. T. 3	Roxas Boulevard Malate	73,000	36,800 36,200	S ⟶ N N ⟶ S	6	3.0	1.2	With Medial Strip
	T. T. 4	Taft Avenue Malate	54,800	28,400 26,400	S ⟶ N N ⟶ S	6	3.5	0.9	"
	T. T. 5	Shaw Boulevard, San Juan River Crossing	28,300	14,600 13,700	E ⟶ W W ⟶ E	3	3.0	0.9	"
	T. T. 7	Aurora Boulevard, San Juan River	45,900	22,300 23,600	E ⟶ W W ⟶ E	4	3.5	1.1	"
	T. T. 8	Aurora Boulevard, Cubao	36,500			4	3.0	0.9	
	T. T. 9	Espana Avenue, Balic	73,300	36,900 36,400	SW ⟶ NE NE ⟶ SW	6	3.5	1.2	With Medial Strip
	T. T. 10	Juan Luna Avenue (Manila-Caloocan boundary)	24,900			4	2.85	0.6	
	T. T. 11	Rizal Avenue Extension	64,100	31,000 33,100	S ⟶ N N ⟶ S	6	3.0	1.1	With Medial Strip
	T. T. 12	A. Banifacio	24,900			2	3.5	1.2	
	T. T. 13	Quezon Boulevard	68,700	35,600 33,100	SW ⟶ NE NE ⟶ SW	6	3.5	1.1	With Medial Strip
	T. T. 17	A. Mabini, Acacia	7,900			2	3.5	0.4	

Notes: Traffic Congestion; Daily Traffic Volume/No. of Lanes x 10,000 (Vehicles/day lane)

	Traffic Count Stn. No.	Location	Traffic Volume (Vehicles/day)			No. of Lanes	Width of One Lane (m)	Traffic Conge-stion	Remarks
			2 Direction	1 Direction	Direction				
Highway 54	T. T. 2	San Lorengo	50,000	23,500 26,500	SW ⟶ NE NE ⟶ SW	6	3.0 3.5	0.8	With Medial Strip
	T. T. 6	Camp Crame	55,300	29,400 25,900	S ⟶ N N ⟶ S	6	3.0 3.5	0.9	"
	T. T. 14	Quadrangle	38,400	20,300 18,100	S ⟶ N N ⟶ S	6	3.0 3.5	0.6	"
	T. T. 15	Balintawak	51,600	24,200 27,400	E ⟶ W W ⟶ E	6	3.0 3.5	0.9	"
	T. T. 16	Samson Road	23,400			4	3.0	0.6	
Cordon Station	C. S. 1	Zapote	22,600	11,000 11,600	inbound outbound	3	2-3.50 1-4.00	0.8	
	C. S. 2	Old MSR.	4,800		inbound outbound	2	3.00	0.2	
	C. S. 3	West Service Road	4,300		inbound outbound	2	3.25	0.2	
	C. S. 4	South Diversion Road	8,000	4,300 3,700	inbound outbound	4	3.50	0.2	With Medial Strip
	C. S. 5	East Service Road	4,600	1,300 3,300	inbound outbound	2	3.25	0.2	
	C. S. 6	Paranaque-Sukat Road	4,000	1,900 2,100	inbound outbound	2	3.00	0.2	
	C. S. 7	Alabang-Taguig Road	2,700	1,400 1,300	inbound outbound	2	2.50	0.1	
	C. S. 8	Rosario-Antiporo Road	18,300	9,000 9,300	inbound outbound	2	3.05	0.9	
	C. S. 9	Marikina-San Mateo	8,000	4,100 3,900	inbound outbound	2	3.00	0.4	
	C. S. 10	Novaliches-Tala Road	3,400	1,700 1,700	inbound outbound	2	3.00	0.2	
	C. S. 11	North Diversion Road	16,900	8,900 8,000	inbound outbound	4	3.65	0.4	With Medial Strip
	C. S. 12	MacArthur-Highway	14,500	7,300 7,200	inbound outbound	2	3.05	0.7	

Congestion is relatively high at cordon station No. 8 on Ortigas Avenue and cordon station No. 12 on Macarthur Highway. Traffic congestion in these places is caused because the roads of the standard (number of lanes and condition of roads) just sufficient for local traffic but are being utilized as major roads with relatively heavy traffic and also because the traffic capacity of roads has been reduced by many dwellings and shops standing closely all along the road with many stopped and parked vehicles and pedestrians crossing the road as in the case of Zapote.

4.2.2 Hourly change of traffic volume

The hourly fluctuation of traffic volume show rather even conditions in urban center and in its adjacent areas due to remarkable traffic congestion caused by each of road capacity.

This can be considered as a result of excessive traffic concentration in time zone in the morning and evening which is for commuting to work or going to school purpose and is therefore left over in time zones before or after them.

In the vicinity of Cubao, outside Highway No. 54, for example, there is no sharp change of traffic volume in the time zone of 6:00 a. m. - 10:00 p. m. except during the off peak hours in early morning, and a similar tendency is noted in the vicinity of San Juan river along Aurora Boulevard in Sampaloc along Espana hours from morning till night.

Quite a noticeable difference is observed between the traffic volume at peak hour and that at off-peak hour when they are compared as to arterial road in the radial direction. Traffic volume is the smallest both on radial roads and circumferential roads in the time zone of 1:00 a.m. - 5:00 a.m.

Increase of traffic volume during peak hours is particularly remarkable on radial roads in the time zone of 7:00 a.m. - 9:00 a.m. for commuting to work and going to school and in the time zone of 4:00 p.m. - 6:00 p.m. for going home and going to and from school. This pattern is very similar to the time distribution pattern of trips obtained by a person trip survey. Although the ratio of entrance/exist is different in various places, this average value at cordon stations in the time zone of 6:00 a.m. - 8:00 a.m. for commuting to work and going to school is 1.8 but the ratio of entrance/exit in the time zone of 4:00 p. m. - 6:00 p.m. for going home and going to and from school is about 0.8. This figure is truly descriptive of the trip pattern of vehicles registered in the external area which return from work and school and of the entering vehicles registered in the internal area which return from work in the external area.

In case of cordon station, the traffic volume is least between 11:00 a.m. and 13:00 p.m. against 12:00 and 14:00 of the time zone with the least traffic volume in the urban center. This shows that the traffic volume starts decreasing earlier in cordon station than in the urban center.

4.2.3 Travel speed

Distribution of travel speed in the time zone except the peak hours shows in general that there are many sections with low travel speeds of 5 km/hr -12 km/hr in and around CBD - 1 and CBD - 2. Although travel speed increases toward the outlying area, it decreases to 0 km/hr - 12 km/hr, the same level in CBD, even in the suburban area where such towns as Pasig and Marikina are located and where road conditions (width, number of lanes, conditions of road surface and intersections, etc.) are not favorable. The drop of travel speed is notable especially in the section where Jones Bridge, MacArthur Bridge and Quezon Bridge are concentrated, on Quezon Boulevard near Sta. Cruz and in Jose Abad Santos in the vicinity of Tondo, where travel speed is 0 - 5 km/hr on the average.

Although travel speed is generally high on Highway No. 54, it drops to about 12 km/hr - 20 km/hr on the highway near intersections where it crosses such main radial roads as South Diversion Road, Aurora Boulevard, North Diversion Road, MacArthur Highway and A. Mabini. In the section where Quezon Boulevard meets Highway No. 54, the road network is well developed in the entire area and there is less possibility of traffic concentration in a specific point. Therefore, travel speed in this section is maintained at 45 km/hr - 60 km/hr on the average, which is high compared with that in other sections.

Sections in which the ratio of stopping time to travel time is greater than 1.0, in other words, the stopping time is longer than the travel time, are seen in most of C - 1 (Claro M. Recto, P. Casal, Ayala Boulevard) on Rizal Avenue, Gov. Forbes, M. Earnshaw and Kalentong in CBD -1 and on Ramon Magsaysay Boulevard of sector A - 3. In the outlying area such a tendency is seen in the sections of Highway No. 54 and major radial roads (South Diversion Road, Shaw Boulevard, Ortigas Avenue and Aurora Boulevard) near intersections where Highway No. 54 meets these radial roads.

In the sections where the ratio of stopping time to travel time is greater than 1.0, the main causes of traffic jams are inefficient channelization and improper traffic control by signal system as well as a large traffic volume.

The highest travel speed is attainable on South Diversion Road and North Diversion Road where the speed exceeds 80 km/hr. As the South Diversion Road has a two-lane service road for both directions on both sides, the travel speed exceeds 80 km/hr in its entire length, but North Diversion Road has some sections where the speed limit is over 70 km/hr. Among other radial roads, Quezon Boulevard outside of San Juan River allows a high travel speed of about 45 km/hr - 70 km/hr. The remainder of the radial roads show no specific characteristics as far as travel speed is concerned.

The above is an outline of travel speeds in the time zone other than peak times. A comparison of travel speeds between the peak time zone and off-peak time zone on the same road shows a wide difference in the section nearer to CBD. While there is little difference in travel speed between the peak time zone and off-peak time zone in the suburbs, travel speed in the peak time zone drops to 0 km/hr - 5 km/hr near CBD due to traffic delays during the morning and evening rush hours.

Travel speeds in Manila Metropolitan Area in the off-peak time zone are shown in Fig. 4.2-1..

4.2.4 Composition of vehicle types

Results of screen line surveys and cordon line surveys show the following composition of vehicle types.

While the ratio of taxis about 11% - 16% at Del Pan Br., Jones Br., MacArthur Br. and Quezon Br., near CBD, taxis are seldom utilized at cordon stations in the suburbs and the rate of taxis at all cordon stations is only 0.3%.

As in the case of taxis, passenger cars are highly utilized in the section nearest to CBD where there is a concentration of social and economic activities and the rate is about 50% - 70%. The utilization rate of passenger cars decreases in the suburbs and the rate of jeepneys and trucks increases in place of passenger cars.

On such roads as South and North Diversion Roads, passenger cars account for nearly 50% - 60% of all vehicle types which is almost the same rate as in CBD.

Table 4. 2 - 2 Composition of Vehicle Types of Screen Line Station (%)

Station No.	Location	Di rection	Vehicle Types						Total(%)
			Car	Taxi	Jeepney	Bus	Truck	Others	
1	Del Pan Bridge	Southbound	49. 8	12. 5	12. 5	3. 2	19. 7	2. 3	100 %
1	do.	Northbound	48. 2	14. 3	13. 0	2. 3	19. 8	2. 4	"
2	Jones Bridge	Southbound	43. 6	10. 9	37. 2	0. 4	5. 0	2. 9	"
2	do.	Southbound	53. 5	16. 3	19. 8	0. 1	7. 5	2. 8	"
3	MacArthur Bridge	Southbound	46. 1	15. 0	29. 2	3. 5	3. 9	2. 3	"
3	do.	Southbound	25. 9	10. 7	39. 3	17. 5	4. 4	2. 2	"
4	Quezon Bridge	Bothbound	45. 8	11. 0	27. 1	9. 1	5. 5	1. 5	"
4	do.	Southbound	53. 1	10. 7	25. 8	5. 3	3. 8	1. 3	"
5	Ayala Bridge	Southbound	60. 0	15. 4	0. 9	15. 6	6. 4	1. 7	"
5	do.	Northbound	61. 2	17. 7	0. 8	3. 5	14. 3	2. 5	"
6	Nagtahan Bridge	Northbound	55. 5	15. 4	11. 2	0. 7	13. 8	3. 4	"
6	do.	Northbound	53. 2	15. 7	11. 7	0. 2	15. 7	3. 5	"
7	Panaderos Bridge	Bothbound	43. 8	14. 1	26. 6	0. 1	11. 3	4. 1	"
7	do.	Southbound	48. 4	13. 8	25. 8	0. 2	8. 6	3. 2	"
8	Guadalupe Bridge	Northbound	63. 7	7. 6	3. 4	5. 0	18. 3	2. 0	"
8	do.	Southbound	69. 8	7. 2	3. 0	4. 4	13. 9	1. 7	"
9	Bambang Bridge	Southbound	12. 6	0. 6	39. 8	5. 1	5. 6	36. 3	"
9	do.	Northbound	11. 6	0. 4	39. 4	4. 7	6. 5	37. 4	"

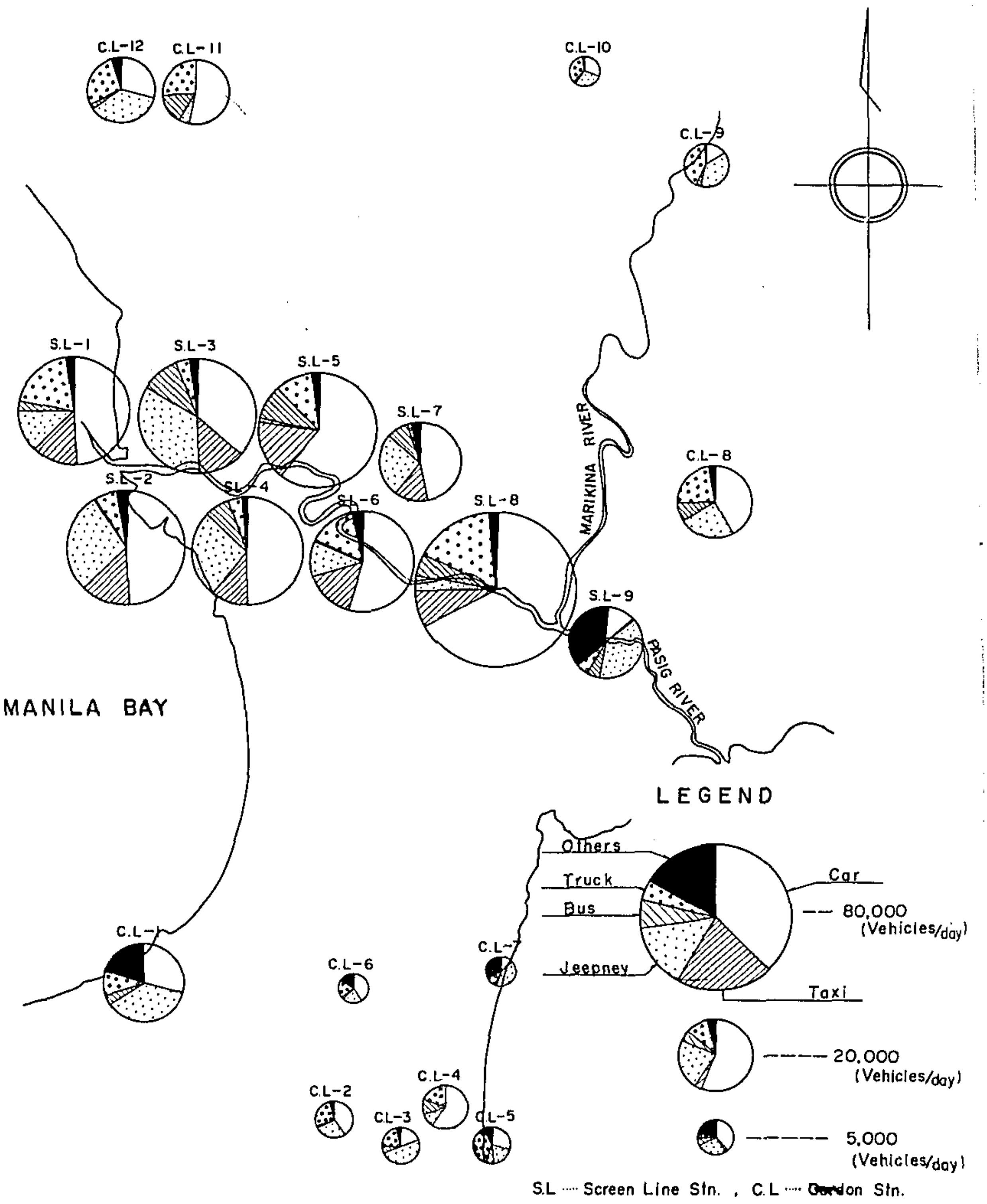


Fig 4.2-3 Composition of Vehicle Types at the Cordon Stn. and the Screen Line Stn.

Partly due to the suspension of daytime traffic of trucks on some of the roads in Manila city, the rate of trucks in the section between Jones Br. and Ayala Br. is as low as 4% - 8%.

Composition of vehicle types in the suburbs varies depending on land use and whether the road is designated as jeepney or bus route or whether the road is an expressway or an ordinary road.

4.2.5 Jeepneys and buses

Jeepneys and buses, which account for nearly 66% of the total number of unlinked trips, (50% for jeepney and 16% for bus) play an important role as a means of transportation for the general public.

The jeepney is a small bus with a legal capacity of 6 - 12 passengers, remodeled usually from a jeep released by the Army, and its operating route must be approved by the Government as in the case of bus.

Jeepney routes inside Highway No. 54 are densely distributed like a cabweb not only along the major roads but along the small roads as well. Because of the unique features of the jeepney that the fare is very cheap (15 centavos: for 6 km and 20 centavos for a distance of over 6 km), that it has a high operating frequency, that it operates 24 hours a day and that it makes a stop at any place when called out, it is used more widely than bus as a public transport system. Bus routes are provided mainly along major roads such as Highway No. 54, Quezon Blvd., and Aurora Blvd. The fare of bus is the same as that of jeepney.

Jeepney routes are almost identical to the bus routes, but in some sections in the suburbs and city area where traffic demand is relatively small and where the width of the road is narrow, jeepney routes predominate. Both jeepney routes and bus routes cover most major roads.

The registered number of jeepneys in Manila city as of 1970 was 12,536, about 6.3 times greater than that of buses which was 1,988.

Table 4.2-3 shows the trip frequency of buses entering and existing Metropolitan Manila Area on major routes.

Table 4.2 - 3 Bus Survey Data (Nov. 19 - 26, 1971)

Point of Entry	No. of Bus Co.	Trip Frequency (24 Hrs.)			Traveling Time		
		in coming	out going	Total	in coming	out going	Dist. Km.
1. North Diversion Road	30	1,191	1,227	2,418	30.5 min.	29.25 min.	15 km
					Destination-Divisoria		
2. MacArthur Highway	4	102	95	197	-	-	-
3. Aurora Boulevard	8	349	349	698	51 min.	56 min.	12 km
					Destination-Quiapo		
4. Ortigas Avenue	3	184	174	358	-	-	-
5. Pasig Road	10	710	592	1,302	34.4 min.	33.6 min.	15 km
					Destination-Quiapo		
6. Guadalupe Bridge	1	118	121	239	-	-	-
7. South Diversion Road	12	706	696	1,402	32 min.	33 min.	14 km
					Destination-Divisoria		
8. Quirino Avenue	6	425	421	846	33 min.	25.5 min.	13 km
					Destination-Lawton		
Total	74	3,785	3,675	7,460			

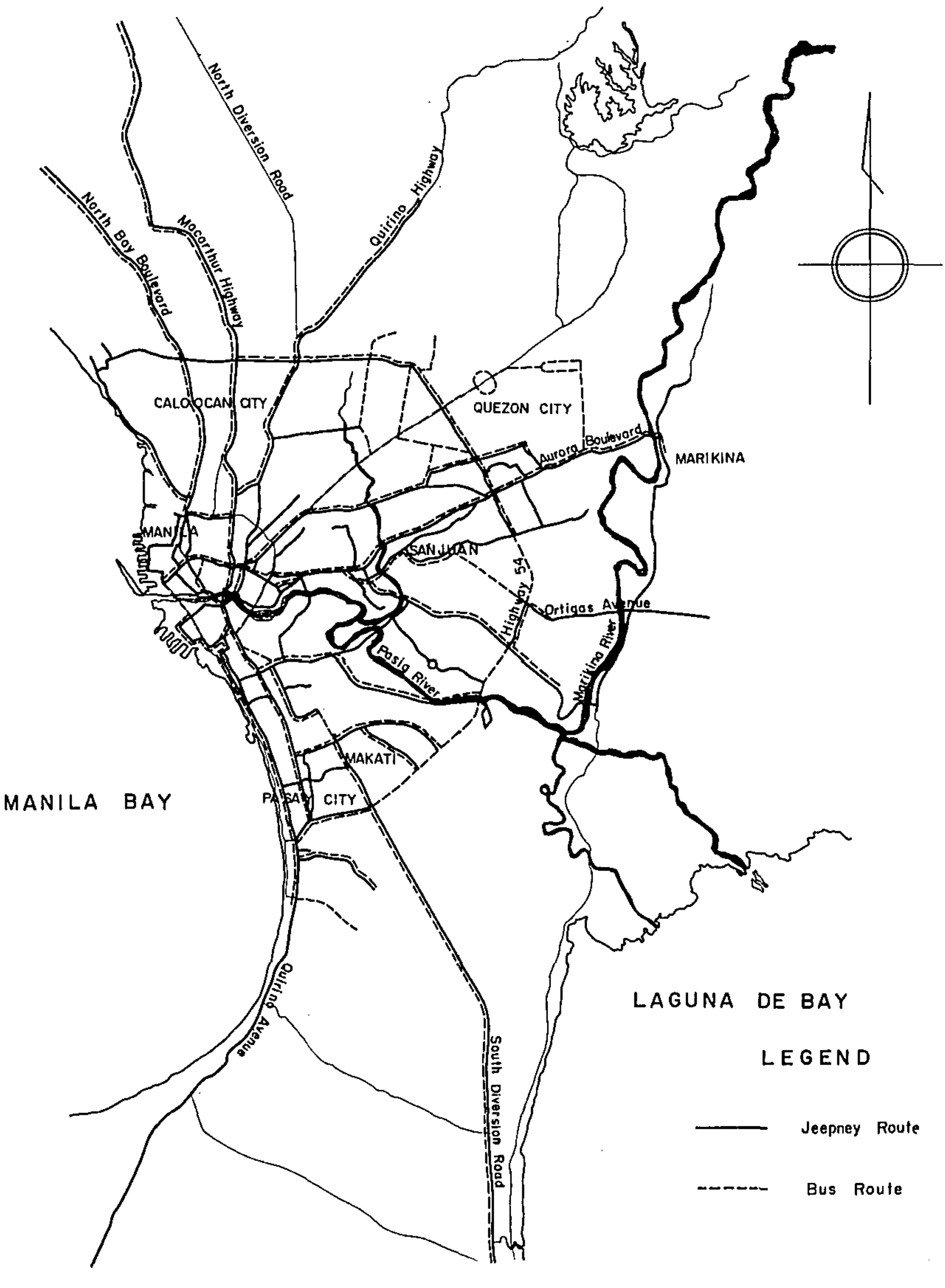


Fig. 4.2-4 Jeepney and Bus Routes of Manila Metropolitan Area

The Table shows that the trip frequency of bus entering from North Diversion Road in the North is highest accounting for about 32.4% of the total, followed by that from South Diversion Road which accounts for 18.8%. This means that better bus service is provided for the north-south direction that for the east direction. Travel speed is relatively high at 30 km/hr on the route to and from Divisoria via North Diversion Road and is lowest at 14 km/hr on the route to and from Quiapo via Aurora Boulevard.

4.2.6 Traffic to and from outlying areas

A person trip survey and a cordon line survey show the following pattern of traffic to outlying areas.

The largest traffic volume between the inner area and outer area is 11,200 vehicles/day for all vehicle types in the (E-1) - (C-1) section, followed by 10,200 vehicles/day in the (E-2) - (C-3) section and 8,000 vehicles/day in the (B-2) - (E-3) section. Sectors E-1 and C-1 and sectors E-2 and C-3 are in close proximity to each other and each sector seems to supplement another's function to a large extent.

Sector B-5, including Makati, is a district of business and commercial activities and a large number of trips by commuters to and from work, school and home in sector E-3.

In general, traffic volume between zones tend to increase as the distance becomes shorter. Between sector (E-1) and sector (C-2), however, traffic volumes is only about 500 vehicles/day despite the short distance between them, which is partly due to small generation and attraction in sector C-2. Lack of a sufficient number of roads between zones, poor road conditions and the existence of such topographic obstacles as hilly areas, rivers and lakes obstructing traffic may be pointed out as the main reason for a small traffic volume.

Traffic volume between the outer area and CBD-1 and between the outer area and CBD-2 is unexpectedly small being 6,300 vehicles/day and 2,800 vehicles/day respectively, for all vehicle types. Traffic volume between sector E-1 and CBD-1 is equivalent to 54% of the traffic volume between the entire outer area and CBD-1 and that between E-3 and CBD-2 is equivalent to 53% of traffic volume between the entire outer area and CBD-2. In each case, the traffic volume is larger in the OD pair of a short distance.

The pattern of traffic to the outlying area varies with each cordon station. The largest traffic volume is 22,700 vehicles/day near Zapote in the south, followed by 16,100 vehicles/day on MacArthur Highway in the north of Manila and 16,900 vehicles/day on North Diversion Road. Traffic volume on South Diversion Road and Service Road in the south are 8,000 vehicles/day and 8,900 vehicles/day respectively, each corresponding to about half of the traffic volume on MacArthur Highway and North Diversion Road in the north. As a whole, traffic volumes crossing cordon lines in the north and south of Manila are 33,000 vehicles/day and 50,100 vehicles/day. Although the extrazonal traffic crossing the cordon stations is light, there is an extrazonal traffic of about 1,500 vehicles/day for all vehicle types between Zone 52 and Zone 53 influenced by the shape of cordon lines at cordon stations 1, 2 and 6 in the south, which is the largest of all extrazonal traffic, followed by 950 vehicles/day in Zone 57 where origin and destination are within the same zone.

Through traffic is heaviest between Zone 53 and Zone 56 with a traffic volume of 340 vehicles/day, followed by 160 vehicles/day between Zone 53 and Zone 57.

Traffic volume within Zone 56 is 620 vehicles/day which represents traffic between Cainta, Antipolo and San Mateo crossing the cordon line because of the projection of Zone 48 which halves Zone 56.

Table 4.2-4 shows average daily traffic volume at cordon stations by vehicle types and directions.

Table 4.2 - 4 Average Daily Traffic Volume of Cordon Station by Vehicle Types Direction

Aug. - Sept. 1971

(Vehicles/day)

No.	Station	Direction	Car	Taxi	Truck	Jeepney	Bus	Others	Total
1	Zapote	Inbound	3,475	11	963	3,830	542	2,247	11,068
1	Zapote	Outbound	3,134	12	1,238	4,406	555	2,221	11,566
2	Old MSR	Inbound	816	4	621	678	27	71	2,217
2	Old MSR	Outbound	1,106	5	708	694	23	55	2,591
3	West Service Road	Inbound	599	3	790	1,398	188	108	3,086
3	West Service Road	Outbound	202	0	123	800	47	58	1,230
4	Manila South Expressway	Inbound	2,581	0	819	401	465	0	4,266
4	Manila South Expressway	Outbound	2,211	7	715	397	412	0	3,742
5	East Service Road	Inbound	533	0	444	147	14	171	1,309
5	East Service Road	Outbound	959	10	1,291	584	265	209	1,318
6	Paranaque-Sukat Road	Inbound	701	13	406	445	56	311	1,932
6	Paranaque-Sukat Road	Outbound	897	18	389	379	44	325	2,052
7	Alabang-Taguig Road	Inbound	177	3	120	610	34	451	1,395
7	Alabang-Taguig Road	Outbound	177	4	135	520	26	446	1,308
8	Rosario-Antiporo Road	Inbound	3,741	72	1,925	2,241	768	289	9,036
8	Rosario-Antiporo Road	Outbound	3,829	74	2,137	2,250	799	204	9,293
9	Marikina-San Mateo	Inbound	629	8	1,771	1,512	127	62	4,109
9	Marikina-San Mateo	Outbound	599	8	1,571	1,512	145	82	3,917
10	Novaliches-Tala Road	Inbound	515	0	612	503	39	37	1,706
10	Novaliches-Tala Road	Outbound	507	3	618	492	35	31	1,686
11	Balitawak-Terminal	Inbound	4,830	27	2,156	517	1,381	0	8,911
11	Balitawak-Terminal	Outbound	4,086	40	2,235	303	1,301	16	7,981
12	MacArthur Highway	Inbound	2,238	21	1,838	2,594	152	428	7,271
12	MacArthur Highway	Outbound	1,931	7	2,205	2,601	136	304	7,184
	Total (Stn. 1 - 12)	Inbound	20,835	162	12,465	14,876	3,793	4,175	56,306
		Outbound	19,638	188	13,365	14,938	3,788	3,951	55,868
		Inbound + Outbound	40,473	350	25,830	29,814	7,581	8,126	112,174

§4.3 General Outline of Traffic Survey

4.3.1 General outline

In order to forecast the future transport demand from the present movement of peoples and vehicles and to obtain basic data for the determination of optimum means of transport, traffic routes, operating frequency and traffic capacity for the future while giving due consideration to metropolitan and city planning the following traffic surveys were conducted in the study area.

1. Person trip survey
2. Cordon line survey
3. Screen line survey
4. Travel speed survey
5. Vehicular traffic volume survey

In the person trip survey, daily movement of the people residing in Manila Metropolitan Area was surveyed through interviews at households sampled at random from the 1970 national census. As the study area under this survey is limited to Manila Metropolitan Area, traffic of vehicles entering or passing through Metropolitan Area from other areas cannot be determined. For this reason, cordon lines were established at the outer edges of the study area covered by person trip survey and cordon stations were set up at the points where the traffic entering and existing Manila Metropolitan Area could be determined. Road with a small volume were excluded from the establishment of cordon stations.

In order to verify the results of the person trip survey, a traffic volume survey was conducted at nine bridges spanning the Pasig river which halves Manila Metropolitan Area into north and south sections and can be used as a screen line.

Since the number of vehicles can be determined by dividing the number of unlinked trips obtained from the person trip survey by the average number of passengers for each type of vehicles, the reliability of the person trip survey may be verified through a comparison of traffic volume between the north and south sections of the zone bordered by the Pasig river obtained by a traffic volume survey and the result of person trip survey.

Since there were no data available on vehicular traffic in recent years except for the findings of a traffic volume survey conducted in Manila city by the Bureau of

Public Highways during the period 1963 - 1969, a traffic volume survey was conducted on major roads and at screen lines, cordon stations and on the travel speed observation roads.

The surveys were aimed specifically at the roads with chronic traffic delays which were confirmed by a travel speed survey in order to consider them as the object of a road improvement program and to determine the optimum travel time for the purpose of forecasting future transport demand on the basis of the findings of travel speed survey under existing road conditions.

Fig. 4.3-1 shows traffic survey points and routes.

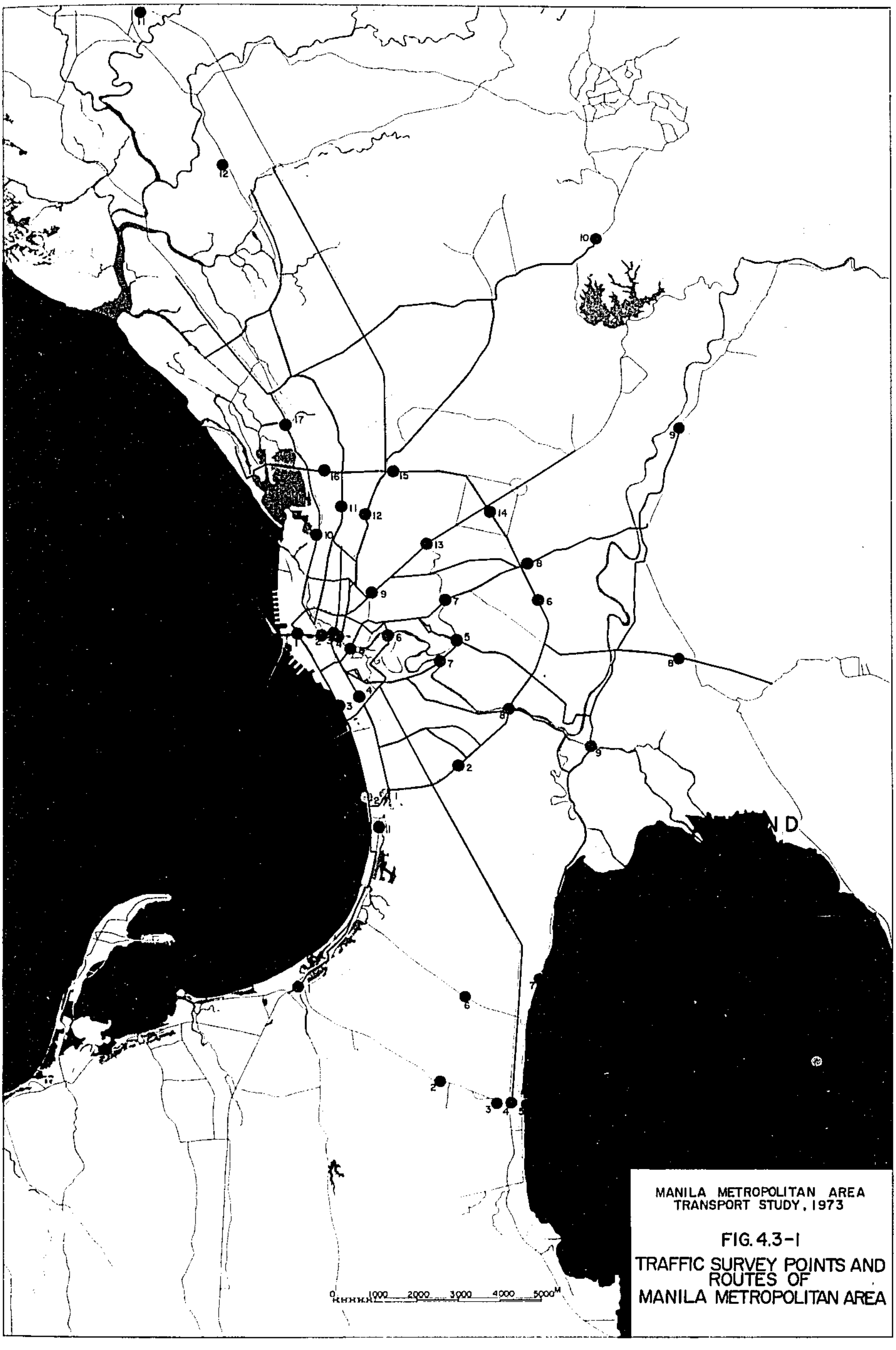
4.3.2 Study area and zoning

The study area was Manila Metropolitan Area with a population of about 3.9 million (as of 1970) and an area of about 600 km^2, which was divided into 51 internal zones. Luzon Island excluding the foregoing internal zones was then divided into nine external zones.

The 51 zones were grouped in 15 sectors for convenience and adaptability to transport planning and analysis.

The division of 15 sectors was made by dividing CBD near the mouth of the Pasig river in two with the river as a border line, and by assuming that three rings surround CBD and dividing each of the rings into sections of four radial directions. Relationship between the 51 zones and 15 sectors is shown in Table 4.3-1.

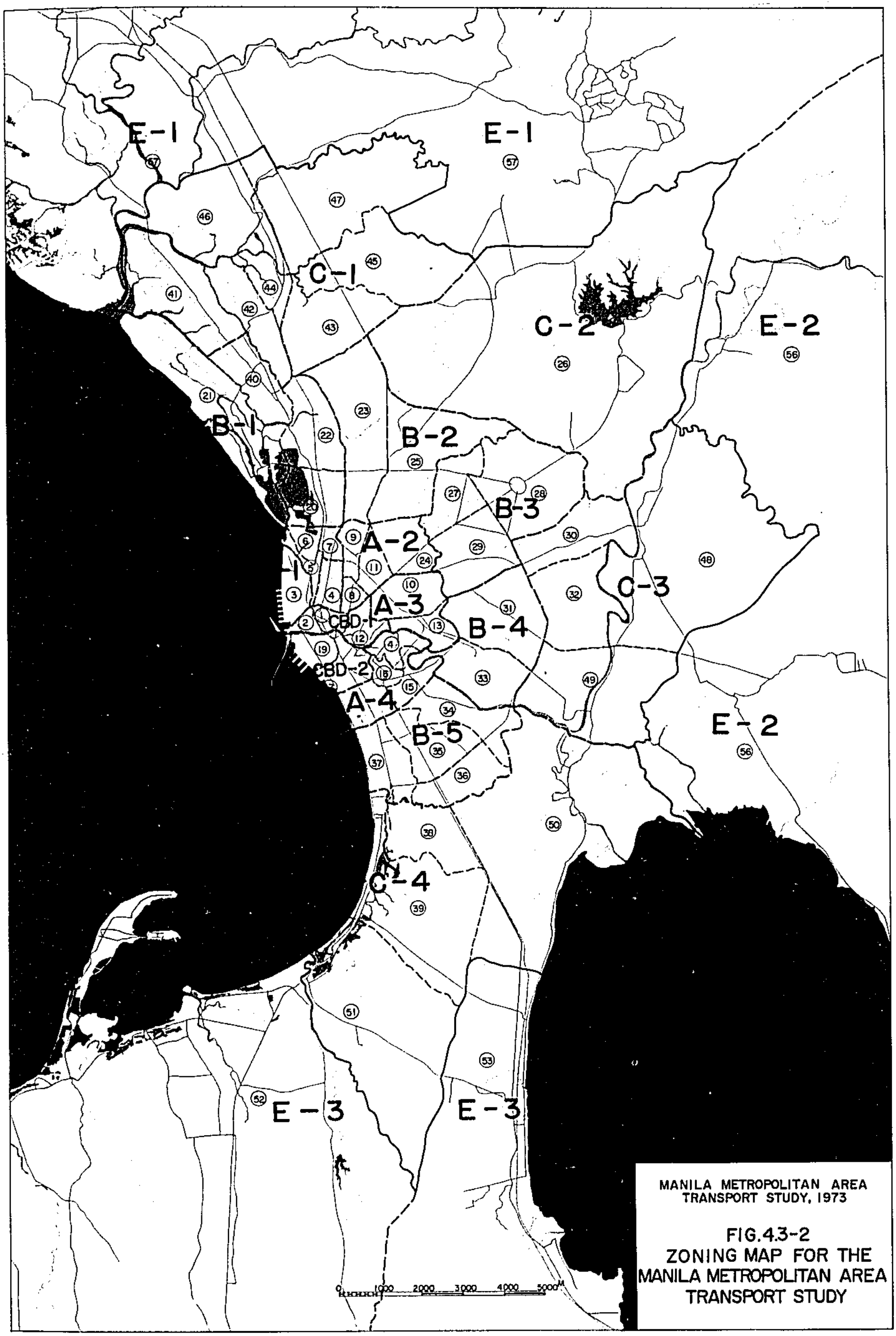
Table 4.3-2 shows technical descriptions of 51 internal zones and 9 external zones. Fig. 4.3-2 shows 51 zones grouped in 15 sectors.



MANILA METROPOLITAN AREA
TRANSPORT STUDY, 1973

FIG. 4.3-1

TRAFFIC SURVEY POINTS AND ROUTES OF MANILA METROPOLITAN AREA



MANILA METROPOLITAN AREA TRANSPORT STUDY, 1973

FIG.4.3-2 ZONING MAP FOR THE MANILA METROPOLITAN AREA TRANSPORT STUDY

Table 4. 3 - 1 Zoning List

	Ring	Sector	Zone No.
1	C B D	C B D -1	1, 2, 12,
2		C B D -2	17, 19
3	First Ring	A - 1	3, 4, 5, 6, 7,
4		A - 2	8, 9, 11, 24,
5		A - 3	10, 13,
6		A - 4	14, 15, 16, 18
7	Second Ring	B - 1	20, 21, 22, 40
8		B - 2	23, 25
9		B - 3	27, 28, 29
10		B - 4	31, 33
11		B - 5	34, 35, 36, 37
12	Third Ring	C - 1	41, 42, 43, 44, 45, 46, 47
13		C - 2	26
14		C - 3	30, 32, 48, 49
15		C - 4	38, 39, 50, 51
	External	E - 1	57, 58, 59, 60
		E - 2	56
		E - 3	52, 53, 54, 55

Table 4.3-2 Technical Descriptions of Internal and External Zones

Internal Zone (51 Zones)	
Zone No.	Technical Descriptions
1	Central Business District (CBD); covers the area of Binondo and a portion of Quiapo; bounded on the North by C.M. Recto Avenue, on the East by Quezon Blvd., on the South by Pasig River, and on the West by Estero de Binondo.
2	Covers the area of San Nicolas; bounded on the North by railroad track, on the East by Estero de Binondo, on the South by Pasig River, and on the West by the Manila Bay Shoreline.
3	Covers a portion of Tondo; bounded on the North by Estero de Vitas, on the East by Estero dela Reina, on the South by the railroad track, and on the West by Manila Bay Shoreline.
4	Bounded on the North by the railroad track, on the East by Rizal Avenue, on the South by C.M. Recto Avenue, and on the West by Calle Dagupan.
5	Bounded on the North by Solis-Juan Luna-North Bay Blvd., on the East by Calle Dagupan and railroad track on the South, by C.M. Recto Avenue, and on the West by Estero de Vitas and Estero dela Reina.
6	Bounded on the North by the Manila-Caloocan City Boundary, on the East by Juan Luna St., on the South by North Bay Blvd., and on the West, by North Bay Blvd.
7	Bounded on the North by Manila-Caloocan City Bdry., on the East by Rizal Avenue Extension, on the South by railroad track and on the West by Juan Luna Street.

Zone No.	Technical Descriptions
8	Bounded on the North by Tayuman, on the East by Espana-Gov. Forbes St., on the South by C. M. Recto Avenue, and on the West by Rizal Avenue.
9	Bounded on the North by Manila-Caloocan Boundary, on the East by Dimasalang and Manila-Quezon City Bdry., on the South by Tayuman-Gov. Forbes Street, and on the West by Rizal Avenue Extension.
10	Bounded on the North by Espana St., on the East by San Juan River, on the South by Legarda-R. Magsaysay Blvd.-Aurora Blvd. and on the West by Earnshaw Street.
11	Bounded on the North by A. Bonifacio St. and Manila-Quezon City Bdry., on the East by Mayon Street, on the South by Espana St., and on the West by Gov. Forbes Street and Dimasalang Street.
12	Bounded on the North by Espana St., on the East by Earnshaw-Legarda-Nagtahan Street, on the South by Pasig River, and on the West by Quezon Boulevard.
13	Bounded on the North by R. Magsaysay Blvd., on the East by San Juan River, on the South by Pasig River, and on the West by Nagtahan Street.
14	Bounded on the North and East by Pasig River, and on the South and West by creeks (Estero de Pandacan and Estero de Concordia).
15	Bounded on the North by Estero de Pandacan, on the East by Pasig River, on the South by Zobel Roxas Avenue, and on the West by a railroad track and Estero Tripa de Gallina.

Zone No.	Technical Descriptions
16	Within Paco; bounded on the North by Estero de Concordia, on the East by Estero de Pandacan and Estero Tripa de Gallina, on the South by Estero de Paco and Estero de Gallina, and on the West by Estero de Paco.
17	Within Ermita, bounded on the North by Pasig River on the East by Estero de Paco, on the South by Calle Herran, and on the West by Manila Bay Shoreline.
18	Within Malate; bounded on the North by Calle Herran and Estero de Paco, on the East by the railroad track, on the South by Vito Cruz Street, and on the West by Manila Bay Shoreline.
19	Within Intramuros; bounded on the North by Pasig River, on the East by Taft Avenue - Plaza Lawton-MacArthur Bridge, on the South by Burgos Street, and on the West by Manila Bay Shoreline.
20	Within Caloocan City; bounded on the North by Gen. San Miguel and Samson Road, on the East by Rizal Avenue Ext., on the South by Caloocan-Manila Boundary, and on the West by Caloocan-Malabon Boundary.
21	Covers a portion of Navotas and Malabon Rizal Prov.; bounded on the North by Obando River and Malabon River, on the East by a creek & Sanciangco Street, on the South by Caloocan-Malabon Boundary, and on the West by Malabon Bay Shoreline.
22	Bounded on the North by Malinta-Panghulo Road, on the East by Manila North Road (MacArthur Highway), on the South by Samson Road and Gen. San Miguel, and on the West by a creek and Sanciangco Street.

Zone No.	Technical Descriptions
23	Bounded on the North by Malinta-Novaliches Road, on the East by A. Bonifacio St. and Manila North Diversion Road, on the South by Caloocan-Manila Boundary, and on the West by Rizal Avenue Ext. and Manila North Road (MacArthur Highway)
24	Covers a portion of Sta. Mesa Heights and San Francisco del Monte; bounded on the North by Del Monte Avenue, on the East by San Francisco River, on the South by Espana Extension, and on the West by Mayon Street.
25	Covers a portion of San Francisco Del Monte, San Jose and Bahay Toro; bounded on the North by Tandang Sora Avenue, on the East by Culiat creek and Roosevelt Ave., on the South by Del Monte Avenue, and on the West by A. Bonifacio and Manila North Diversion Road.
26	Covers the town of Novaliches; bounded on the North by Malinta-Novaliches Road and Quezon City-Caloocan Bdry. on the East by Quezon City-Montalban Boundary and Pasig River, on the South by Tandang Sora, Katipunan Avenue, and the road between Maryknoll College and Ateneo University; and on the West by Manila North Diversion Road.
27	Bounded on the North by Culiat creek, on the East by Mindanao Avenue-North Avenue-E. de Los Santos Avenue, on the South by Quezon Blvd., and on the West by San Francisco Del Monte creek - Del Monte Avenue - Roosevelt Avenue.
28	Within Dilimar; bounded on the North by Tandang Sora Avenue, on the East by Katipunan Avenue, on the South by underground pipeline and Kamias Road, and on the West by E. de Los Santos Avenue-North Avenue-Mindanao Ave.

Zone No.	Technical Descriptions
29	Bounded on the North by Quezon Blvd. Extension, on the East by E. de Los Santos Avenue, on the South by Aurora Blvd., and on the West by San Juan River.
30	Bounded on the North by Kamias Road, underground pipeline, and a road towards Marikina River located between Maryknoll College and Ateneo University; on the East by Marikina River, on the South by Central Blvd., and on the West by E. de Los Santos Avenue.
31	Bounded on the North by Aurora Blvd., on the East by E. de Los Santos Ave., on the South by Shaw Blvd., and on the West by San Juan River.
32	Bounded on the North by Central Blvd., on the East by Marikina River, on the South by Ortigas Avenue, and on the West E. de Los Santos Avenue.
33	Bounded on the Norty by Shaw Blvd., on the East by E. de Los Santos Avenue, on the South by Pasing River, and on the West by Pasig River and San Juan River.
34	Bounded on the North by Pasig River; on the East by Makati-Fort Bonifacio Boundary, on the South by Buendia Avenue-Pasong Tamo Avenue and Vito Cruz Ext., and on the West by Zobel Roxas St.
35	Bounded on the North by Vito Cruz Extension, Pasong Tamo Avenue and Buendia Avenue; on the East by E. de Los Santos Avenue, on the South by Makati-Pasay City Boundary, and on the West by Vito Cruz St. and Makati-Pasay City Boundary.
36	Bounded on the North by E. delos Santos Avenue, on the East by Buendia Avenue, on the South by Makati-Fort Bonifacio Boundary and on the West by Makati-Pasay City Boundary.

Zone No.	Technical Descriptions
37	Bounded on the North by Vito Cruz Street, on the East by Pasay-Makati Boundary, on the South by Pasay Parañaque Boundary and a creek, and on the West by Manila Bay Shoreline.
38	Covers the area of Nichols Field, MIA and Manila Domestic Airport; bounded on the North by Pasay-Makati Boundary and a creek, on the East by railroad track, on the South by Pasay-Parañaque Boundary, and on the West by Pasay-Parañaque Boundary.
39	Covers the Municipalities of Parañaque; bounded on the North by Pasay-Parañaque Boundary, on the East by Parañaque-Taguig and on the South by Parañaque-Las Piñas Boundary.
40	Covers a portion of Valenzuela; bounded on the North by Meycauayan-Polo-Obando Road, on the East by Polo River, on the South by Malabon River, and on the West by Obando River.
41	Bounded on the North by Meycauayan River, on the East by Polo River, on the South by Obando-Polo-Meycauayan Road and on the West by Obando River.
42	Covers a portion of Valenzuela, bounded on the North by Meycauayan River, on the East by a creek and Manila North Road, on the South by Panghulo-Malinta Road, and on the West by Polo River.
43	Within Valenzuela; bounded on the North by a creek, on the East by the same creek and Malinta-Novaliches Road, on the South also by Malinta-Novaliches Road, and on the West by Manila North Road and railroad track.
44	Covers a portion of Valenzuela; bounded on the North by Meycauayan River, on the South-east by railroad track;

Zone No.	Technical Descriptions
	and on the West by Manila North Road, Polo-Meycauayan Road and a creek.
45	Covers a portion of Valenzuela and a portion of Caloocan City; bounded on the North by Meycauayan River, on the East by Caloocan-Quezon City Boundary, on the South by a creek, and on the West by a creek.
46	Covers a portion of Marilao; bounded on the North by Bulacan River, Bucaue River and Marilao-Bucaue Boundary, on the East by railroad track, and on the South by Meycauayan River, and on the West by Meycauayan River and Bulacan River.
47	Covers a portion of Marilao and Meycauayan; bounded on the North by Marilao-Bucaue Boundary, on the East by Marilao River and Meycauayan-San Jose del Monte Boundary, on the South by Meycauayan-Caloocan City Boundary and Meycauayan River, and on the West by railroad track.
48	Within Marikina and a portion of Pasig; bounded on the North by Marikina-San Mateo boundary, on the East by Marikina-Antipolo boundary, on the South by Ortigas Avenue, and on the West by Marikina River.
49	Within Pasig; bounded on the North by Ortigas Avenue, on the East by Pasig-Cainta boundary, on the South by Pasig River, on the West by E. de Los Santos Avenue (Highway 54).
50	Covers the Area of Pateros and Taguig; bounded on the North by Pasig River, on the East by Pasig River and Laguna de Bay Shoreline, on the South by Taguig-Muntinlupa boundary, and on the West by Taguig-Paranaque boundary and railroad track.

Zone No.	Technical Descriptions
51	Covers the municipality of Las Piñas; bounded on the North by Las Piñas-Parañaque boundary, on the East by Las Piñas-Muntinlupa boundary, on the South by Las Piñas-Gavite boundary, and on the West by Manila Bay.

External Zone (9 zones)

Zone No.	Technical Descriptions
52	Covers the province of Cavite.
53	Covers the province of Laguna.
54	Covers the province of Batangas.
55	Covers the province of Quezon and the southern part of Luzon Island which includes Camarines Norts, Camarines Sur and Sorsogon.
56	Covers other municipalities of Rizal province which is not included in the internal area.
57	Covers the province of Bulacan.
58	Covers the province of Pampanga.
59	Covers the province of Bataan and Zambales.
60	Covers the province of Tarlac, Nueva Ecija, Pangasinan, Nueva Vizcaya, Benguet, La Union and other part of northern Luzon.

4.3.3 Person trip survey

A person trip survey was conducted in four cities and 15 municipalities within Manila Metropolitan Area during the period from August to October 1971 for the purpose of estimating future traffic demand. Surveyed persons were residents of this area 7 years of age and over. The sample rate was 1%.

Prior to the interview, an advance notice was sent to each household (6, 185 families) sampled from resident registration of the 1970 census informing of the scheduled visit and the purpose of the visit. Such time zones as early morning were avoided for a visit. Family composition described in the sampling card was confirmed and questions were asked on the items listed in the questionnaire. If the family was not home or the interview was declined, another visit was made or another family was selected.

The survey was conducted over a period of 40 days from August 24 to October 2.

Questions asked at the interview included the following:

a) Household (Address, Number of family members, number and type of vehicles owned by family members)

b) Family members (Sex, age, occupation of family members, location of factory, office or school to which family members are commuting)

c) Trips made by family members excluding trips made on foot (Origin, destination, time of departure or arrival, purpose of trip, type of transport facilities used and transfer points)

(Note)For details of questions, please refer to Sampling Card and the questionnaire.

The following formula was used to determine the expansion factor required for obtaining actual figures.

$$Fi = \frac{Pi}{Si}$$

where: Fi = Expansion factor of i zone

Pi = Population of i zone under study determined by the 1970 census

Si = Number of residents of the study area sampled

IBM 360 - 75 was used for tabulation, listing, verification and computation of the findings of person trip survey.

The size of population and the number of samples are shown in the following table.

Table 4.3-3 The Size of the Population and the Sample

Item	Population	Sample	Sample Rate
No. of Persons	3,911,421	35,084	0.9%
No. of Households	686,441	6,184	1.0%

4.3.4 Cordon line survey

A cordon line survey was conducted by establishing 12 cordon stations (see Fig. 4.3-1) on the borderline of the inner zone and the outer zone for the purpose of determining the movement of vehicles registered in the outer zone and the traffic characteristics near the cordon line.

There are 12 roads that have important functions for the traffic between the inner zone and the outer zone. In the case of South Diversion Road which has two-lane service roads for both directions it was considered that the OD pattern of one service road would also apply to the other and for this reason, roadside interviews were conducted on only one service road.

Cordon stations at which roadside interviews were held totalled 8 excluding the ones in the suburbs where traffic volume was too small to be included in the interview (Station No. 1, 2, 4, 5, 8, 9, 11 and 12). Vehicle types interviewed included passenger car, taxi and truck, and questions were asked about the type of vehicle, origin, destination, purpose of trip, number of passengers, type and approximate weight of cargo (only for truck), whether the vehicle is registered in the inner zone or outer zone and so on. Interviewers on their part entered cordon station number, and date and hours of interview. No interview was held for buses and jeepneys and only the number of passengers aborad was recorded. As they operate on the fixed routes, their origins and destinations were determined from the sign boards displayed on the vehicles.

The traffic volume survey covered all the 12 cordon stations.

While one tends to consider it relatively easy to discriminate inbound vehicles from outbound vehicles by combining the location of cordon station with the origin and destination of vehicles, there are many vehicles whose movement is very complicated and therefore the distinction between the inbound vehicles and outbound vehicles must be clearly indicated.

4.3.5 Screen line survey

A traffic volume survey using an automatic traffic counter and a manual counter was conducted at nine bridges (1 - M. Roxas, 2 - Jones, 3 - MacArthur, 4 - Quezon 5 - Ayala, 6 - Nagtahan, 7 - Panaderos, 8 - Guadalupe, 9 - Bambang) spanning the Pasig river while using the river as a screen line.

The survey with a traffic counter was conducted for a duration of 48 hours, and where there was a median strip, traffic on both directions was surveyed.

The survey with a manual counter was conducted from 7 o'clock in the morning till 5:30 o'clock in the evening and covered traffic volume for each type of vehicles (car, taxi, jeepney, bus, truck and others). For the car, taxi, jeepney and bus, approximate number of passengers was counted on the basis of classifications shown in Table 4.3-4 and the pedestrians on the bridges were also counted for both directions.

4.3.6 Travel speed survey

Travel speed was measured with a Toyota jeep which was driven on main circumferential roads and radial roads in Manila Metropolitan Area both during the peak hours and the off-peak hours. For such major roads as Highway 54, special care was taken to ensure accuracy of observation, Depending on the importance of road the number of test runs was increased.

For the peak hours, a travel speed survey was conducted in the time zones in which the heavier for specific direction. As the test car did not make frequent starts and stops to load an unload passengers, the travel speed obtained directly from the data supplied by the test car tends to show a higher figure than that of transport facilities actually in use. For this reason, various conditions were taken into account to reduce travel speed provided directly by the test car. In order to determine practical travel time between zones, it is necessary to allow for some reduction of travel speed by considering the walking distance to the nearest transport facilities, waiting time for the arrival of jeepney or bus, and reduction of travel speed depending on operating routes according to the size of zone and population distribution.

Table 4.3. - 4 Type of Vehicles Classified by the Number of Passenger at the Screen Line Stations

No.	Type of Vehicles	Number of Passengers			Remarks
		(1)	(2)	(3)	
1	Car	-	1, 2, 3	4, 5, ----- (more than 3)	Including the driver
2	Taxi	0	1, 2, 3	4, 5, ----- (more than 3)	Excluding the driver
3	Jeepney	0	1, 2, 3, 4, 5	6, 7, 8, --- (more than 5)	- do. -
4	Bus	0	1 - 25	26 -------- (more than 25)	- do. -
5	Truck				
6	Others				

A traffic volume survey using a traffic counter was conducted on major roads to determine correlation between travel speed and traffic volume.

4.3.7 Vehicular traffic volume survey

Traffic volume surveys were conducted in Manila Metropolitan Area during the period from August to September 1971 at 40 points with the breakdown as follows:

Bridges spanning the Pasig river (Screen line)	9 points
Cordon Station	12 points
Travel speed observation road (major roads)	17 points
Roads near the churches	2 points

Traffic volume surveys were conducted at all screen line stations (9 points) and cordon stations (Station No. 1,2, 4, 5, 8, 9, 11 and 12 for a total of 8 stations) by using a traffic counter and a manual counter. Traffic volume surveys were conducted at the remaining cordon stations (Station No. 3, 6, 7, and 10), on travel speed observation roads and on the road near the churches using only a traffic counter. On the road near Baclaran Church, a traffic survey was conducted for a week to observe functuations of traffic volume affected by days of church service.

Traffic jams on the bridges near CBD is remarkable and a vehicle often stops and remains on the rubber hose of traffic counter for a while. The latent traffic demand over the bridges spanning the Pasig river seems to be greater than the traffic volume actually observed by the survey.

§ 4.4 Results of Person Trip Survey

4.4.1 Number of trips by purpose and travel mode

As shown in Fig. 4.4-1, the total number of linked trips by trip purpose is 6.34 million with a breakdown of 42%, nearly half of the total number, for returning home, 16% for going to school and 16% for commuting to work. Trips for going to school number almost one million in the total number of trips of 6.34 million and the ratio is high compared with other cities.

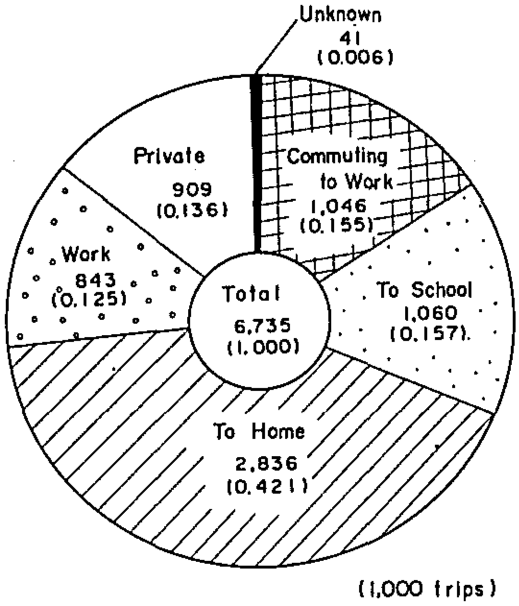
This is probably due to a very high ratio of younger generation to the total population, as well as to a high ratio of students seeking higher education and to the concentration of major academic institutions in Manila Metropolitan Area.

The rates of 16% for commuting to work and 13% for work purposes are similar to those in other cities.

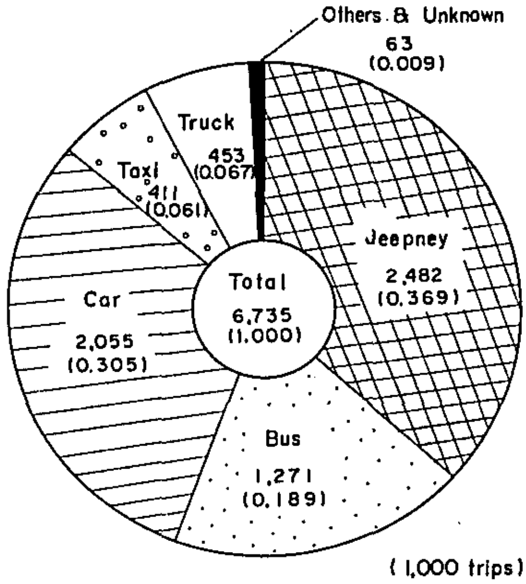
The rate of 14% for private purpose is considered exceptionally low. As reasons for this, a low income level which is about 180 dollars (in 1969) per capita per annum may be pointed out first. Secondly, most of families except those in low income brackets employ a maid and therefore there is no need for housewives to go shopping. Trips for shopping purpose total 210,000 accounting for only 3% of the total number of trips. In this survey, trips for shopping purpose by maids are defined as business purpose, unless they make purchases of their own.

A breakdown of the total number of linked trips (6.34 million) by typical travel mode is shown in Fig. 4.4-1 (c) and (d) respectively. Figures show that both jeepney and bus, popular transport facilities for the general public, account for 3.75 million trips corresponding to 56% of the total number of trips and that jeepneys in particular, account for 2.48 million corresponding to nearly 37% of the total number of trips. This means that the number of trips by jeepney is nearly twice the number of trips by bus. Trips by passenger car number 2.06 million corresponding to 30% and those by truck and taxi are 450,000 and 410,000 respectively accounting for nearly 6% of the total number of trips, showing that it does not greatly differ from the trend in other cities. Constituent ratio of trucks is relatively low as compared with the figure obtained in Japan.

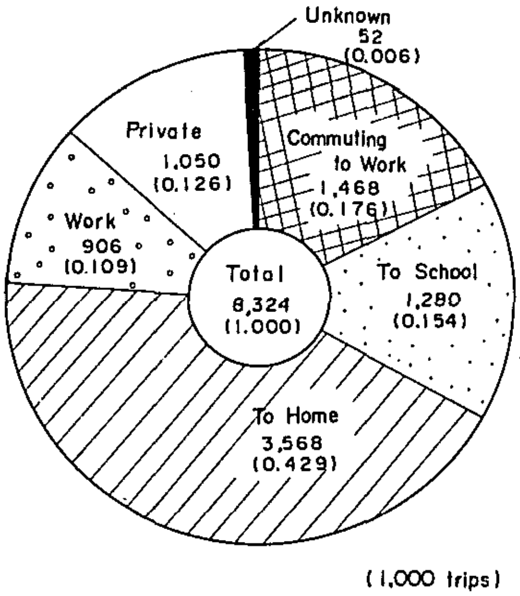
This reflects the small share of trucks in Manila Metropolitan Area which accounts for 40,000 or only 1/4 of a total of 240,000 vehicles, while trucks account for nearly half of the total number of vehicles in Japan.



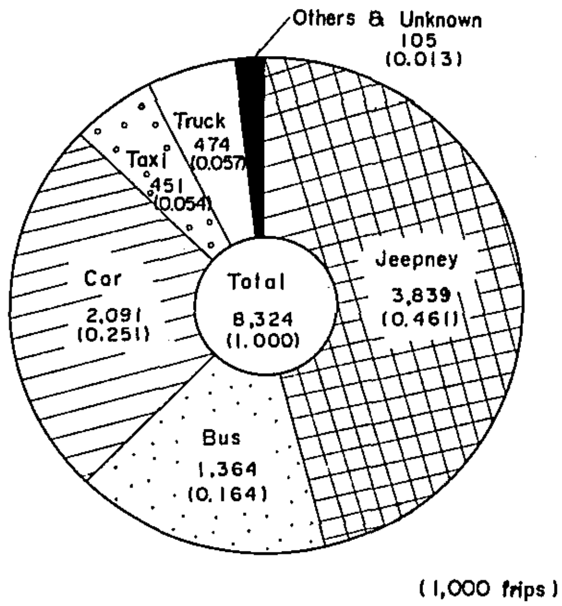
a) NO. of Linked Trips by Trip Purpose



b) NO. of Linked Trips by Travel Mode



c) NO. of Unlinked Trips by Trip Purpose



d) NO. of Unlinked Trips by Travel Mode

Fig. 4.4-1 Composition of NO. of Linked Trips and Unlinked Trips
(Trip Purpose and Travel Mode)

As the ratio of the total number of unlinked trips by travel mode (8.32 million) to the total number of linked trips by travel mode (6.74 million) is 1.23, the average number of transfers per trip is 1.23.

The shares of jeepney and bus in the total number of linked trips by travel mode are 37% and 19% respectively. The percentages in terms of unlinked trips are 46% and 16% respectively and the share of jeepney increases from 37% to 46% and that of bus decreases from 19% to 16%.

This means that there are a comparatively large number of trips by a combination of bus and jeepney and that jeepney in particular is used more frequently for transfer than bus and that it is also used frequently for short trips.

As for passenger car, the ratio of unlinked trips to linked trips is almost 1.0 showing a very small number of passengers transferring from car to other transport facilities.

4.4.2 Number of trips per capita and ratio of trip makers

(1) Number of trips per capita

As shown in Table 4.4-1, the number of trips per capita for all trip purposes, and occupations and for both car owners and non-car owners is 1.73 trips/person, which is very close to the result of other person trip surveys and, therefore, is considered reasonable.

The number of trips per car owner is 2.32 trips/person and that of trips per non-owner is 1.57 trips/person. It is natural that the number of trips by car owners is greater than that of non-owners because of the difference in income between the two classes. Exceptions to this are sales, agriculture, manufacturing and service industries in which the number of trips by non-owners (1.88 trips/person) is greater than that of trips by car owners (1.68 trips/person). This is probably due to the fact that the income level of car owners is generally higher than that of non-owners and that there are many shop owners and business men who own a small factory and whose place of work happens to be in the same location as their residences, with the resultant smaller number of trips for commuting to and from work than that for trips by non-owners.

By occupation, the number of trips by employed people is the largest at 2.32 trips/person, followed by that of students at 1.75 trips/person. The smallest number of trips is for unemployed and housewives with 0.81 trips/person.

The largest number of trips for all occupations and trip purposes is 4.52 trips/person for workers in the transport industry, comprising 3.60 trips/person for making the round on business and 1.68 trips/person for returning home. There is a great difference in the number of works related trips between car owners and non-owners among the transport firms. The number of works related trips by car owners is about 3.6 times greater than that of trips by non-owners.

The next largest number of trips is for P.A.C. workers who own a car with 3.60 trips/person comprising 1.34 trips/person for returning home and 1.12 trips/person for commuting to work. The smallest number of trips is 0.5 trips/person for the unemployed without a car, consisting of trips only for returning home and private purpose.

As for private purpose, the number of trips by car owners with high income level is larger than that of trips by non-owners. By occupation, the largest number of trips is 0.96 trips/person for housewives with a car and the smallest number is 0.02 trips/person for students (under 14 years of age) without a car.

As for going to school, the number of trips by students under 14 years of age is smaller than that of trips by students over 15 years of age. This is probably due to the fact that most of the students under 14 years of age go to school on foot.

(2) Ratio of trip makers

As shown in Table 4.4-2, the ratio of trip makers is 50% to the total population excluding children under 7 years of age, a relatively small figure even though trips on foot and by bicycle are not included.

The proportion of trip makers varies with occupation, and the highest proportion is 64% of workers, followed by 54% of students and 24% of housewives and the unemployed. A further breakdown shows that the highest

Table 4.4 - 1 Number of Linked Trips per Head (Trip Purpose/Occupation/Car Ownership)

Car Ownership	Occupation \ Trip Purpose	1 Commuting to Work	2 To School	3 To Home	4 Work	5 Private	6 Unknown	Total
Owner	1 Professional, Administrative, Clerical Workers	1.12	0.05	1.34	0.57	0.68	0.00	3.60
	2 Sales Workers, Farmers, Craftsmen, Service Workers	0.32	0.01	0.61	0.73	0.29	0.00	1.68
	3 Workers in Transport	0.40	0.01	1.68	3.60	0.27	0.00	4.52
	Average 1, 2, 3	0.62	0.03	0.94	0.83	0.44	0.00	2.56
	4 School Children	0	0.80	0.88	0	0.06	0.02	1.99
	5 Students	0	1.13	1.30	0	0.20	0.03	2.95
	Average 4, 5	0	0.99	1.12	0	0.14	0.02	2.53
	6 Housewives	0	0.01	0.62	0	0.96	0.02	1.58
	7 Jobleses	0	0.00	0.38	0	0.58	0.00	0.95
	Average 6, 7	0	0.00	0.51	0	0.77	0.01	1.27
	Average 1, 2, 3, 4, 5, 6, 7	0.29	0.36	0.93	0.39	0.39	0.01	2.32

Car Ownership	Occupation \ Trip Purpose	Commuting to Work	To School	To Home	Work	Private	Unknown	Total
Non Owner	1 Professional, Administrative, Clerical Workers	1.12	0.06	1.21	0.36	0.21	0.00	2.93
	2 Sales Workers, Farmers, Craftsmen, Service Workers	0.57	0.02	0.78	0.49	0.17	0.00	1.88
	3 Workers in Transport	0.90	0.02	0.96	1.01	0.14	0.00	2.69
	Average 1, 2, 3	0.75	0.03	0.91	0.49	0.17	0.00	2.24
	4 School Children	0	0.33	0.36	0	0.02	0.00	0.81
	5 Students	0	0.96	1.08	0	0.09	0.02	2.38
	Average 4, 5	0	0.63	0.71	0	0.05	0.01	1.56
	6 Housewives	0	0.00	0.40	0	0.50	0.00	0.91
	7 Jobleses	0	0.00	0.23	0	0.33	0.00	0.56
	Average 6, 7	0	0.00	0.32	0	0.41	0.00	0.73
	Average 1, 2, 3, 4, 5, 6, 7	0.26	0.25	0.67	0.17	0.19	0.01	1.57

Car Ownership	Occupation \ Trip Purpose	Commuting to Work	To School	To Home	Work	Private	Unknown	Total
Total	1 Professional, Administrative, Clerical Workers	1.10	0.06	1.25	0.47	0.36	0.00	3.02
	2 Sales Workers, Farmers, Craftsmen, Service Workers	0.49	0.02	0.75	0.54	0.20	0.00	1.83
	3 Workers in Transport	0.84	0.01	1.11	1.50	0.15	0.00	3.04
	Average 1, 2, 3	0.72	0.03	0.92	0.58	0.24	0.00	2.32
	4 School Children	0	0.41	0.47	0	0.02	0.00	1.01
	5 Students	0	0.99	1.13	0	0.11	0.02	2.51
	Average 4, 5	0	0.70	0.79	0	0.07	0.01	1.75
	6 Housewives	0	0.00	0.44	0	0.58	0.00	1.01
	7 Jobleses	0	0.00	0.26	0	0.36	0.00	0.62
	Average 6, 7	0	0.00	0.34	0	0.46	0.00	0.81
	Average 1, 2, 3, 4, 5, 6, 7	0.27	0.27	0.73	0.22	0.23	0.01	1.73

Table 4.4 - 2 Ratio of Trip Makers by Occupation

Occupation		Ratio of	
		Trip Makers	Non Trip Makers
1.	Professional, Administrative, Clerical Workers	0.857	0.143
2.	Sales Workers, Farmers, Craftsmen, Service Workers	0.529	0.471
3.	Workers in Transport	0.727	0.273
2 - 3.	Average	0.551	0.449
1 - 3.	Average	0.644	0.356
4.	School Children	0.318	0.682
5.	Students	0.756	0.244
4 - 5.	Average	0.535	0.465
6.	Housewives	0.305	0.695
7.	Joblesses	0.187	0.813
6 - 7.	Average	0.243	0.757
1 - 7.	Average	0.503	0.497

ratio is 86% for white-collar workers whose income level is considered to be relatively high, followed by 76% of students (over 15 years of age). The ratio of trip makers for students under 14 years of age of the same student group is low at 32%. This probably due to the fact that lower grade students commute to nearby schools on foot. The lower ratios of trip makers are for housewives with 31% and for the unemployed with 19%. As far as trip makers are concerned, there is no remarkable difference in the average number of trips between occupations.

4.4.3 Number of generated and attracted trips

The number of generated and attracted trips by sector is greatest at 1.5 million trips in CBD - 1, the center of social and economic activities in Metropolitan Manila Area, as expected, followed by 1.47 million trips in B - 5, 1.43 million trips in C-3, 1.08 million trips in A-1 and a million trips in B-3.

The number of generated and attracted trips in CBD-2 is a small figure of 820,000 despite its location adjacent to CBD-1. One of the reasons for this is that CBD-2 has lower density of development.

By trip purpose, however, there is another aspect of generated and attracted trips. For example, the number of attracted trips for commuting to work is greatest in CBD-2 where many government offices and public facilities are located with 160,000 trips, followed by B-5 with 150,000 trips, CBD-1 with 140,000 trips and C-3 with 130,000 trips. This shows that the place of work is concentrated mainly in three districts, namely, CBD, B-5 where Makati is located and C-3.

The number of generated trips for commuting to work is greatest in B-5 with 120,000 trips, followed by C-3 with 115,000 trips and A-1 and A-4 each with 90,000 trips. While the number of both generated and attracted trips is great in B-5 and C-3, generation in CBD accounts for only 13% of generation-attraction, indicating that the residential districts are distributed in outlying areas and not in CBD.

The largest number of attracted trips for going to school is obtained in CBD-1 where many schools are located with 300,000 trips, followed by A-2 with 90,000 trips and C-3 with 80,000 trips. The largest number of generated trips for going to school is obtained in B-5, C-3 and A-1 where there is a large population of residents with 120,000 trips, 110,000 trips and 100,000 trips respectively.

The largest number of attracted trips for going home is obtained in B-5 with 340,000 trips, followed by C-3 with 300,000 trips, A-1 with 270,000 trips and A-4 and B-1 each with 230,000 trips, all of which are residential districts in and around Metropolitan Area.

An overwhelmingly large number of generated trips for returning home is obtained in CBD-1, the center of business activities, with 560,000 trips, followed by C-3 and CBD-2 each with 300,000 trips and B-5 with 270,000 trips.

The number of attracted trips for work is greatest in CBD-1 with 120,000 trips, followed by B-5 with 90,000 trips, A-1 with 80,000 trips and C-3 with 70,000 trips. The largest number of generated trips is obtained in B-5 with 100,000 trips, followed by A-1 with 90,000 trips and C-3 with 70,000 trips. It is evident that CBD, B-5, C-3 and A-1 are the center of business activities.

The number of attracted trips for private purpose is greatest in CBD-1 with 150,000 trips, followed by C-3 with 110,000 trips and B-5 with 100,000 trips. For generated trips, B-5 is outstanding with 120,000 trips, followed by C-3 with 100,000 trips.

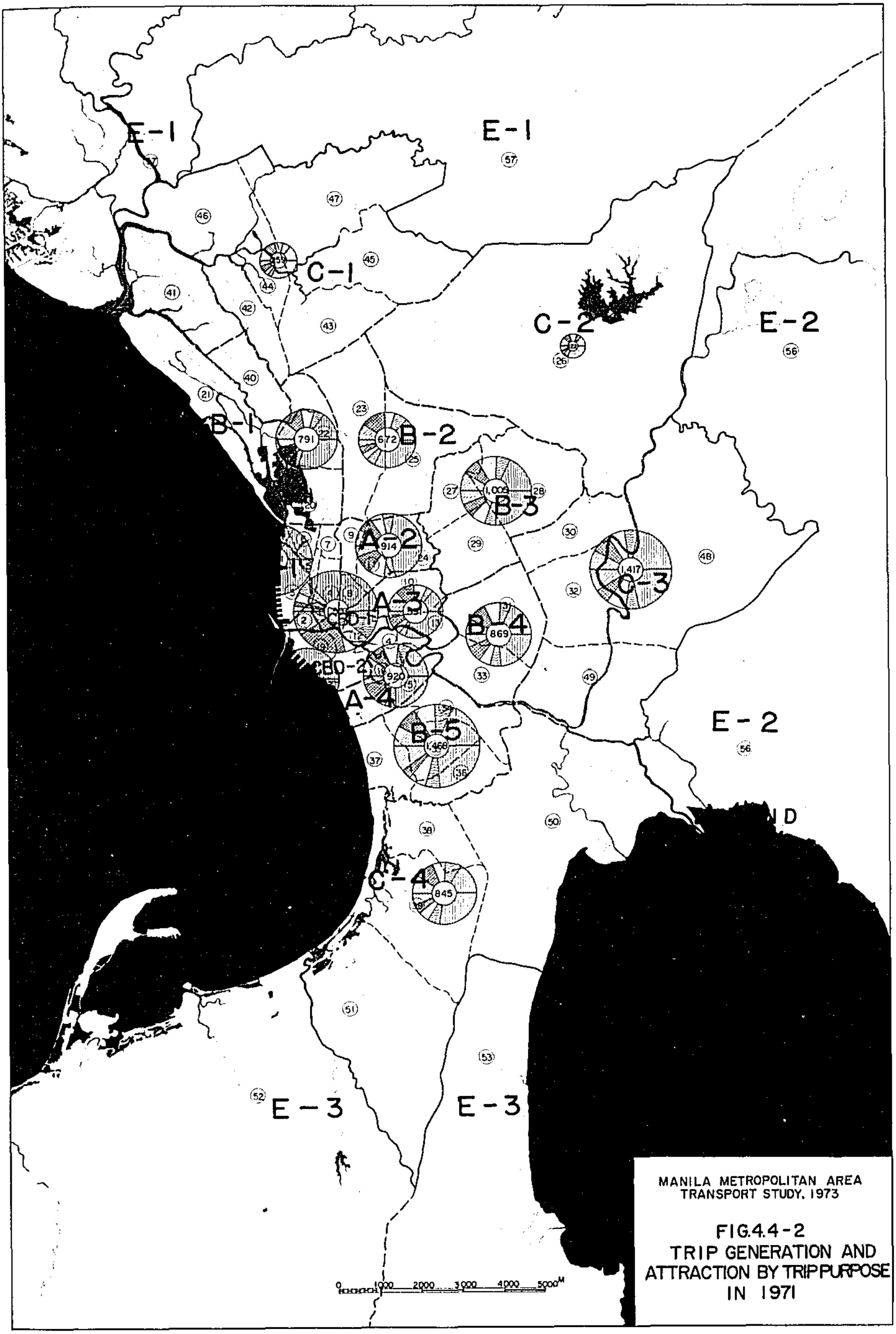
An analysis of trips for commuting to work and going to school in each of the 51 zones shows that the generation is almost proportional to the resident population and that the attraction is almost proportional to the number of day time workers and day time students.

As for trips for private purpose, the generation is almost proportional to the resident population and the attraction is almost proportional to the number of employees in the tertiary industry.

4.4.4 OD distribution

OD distribution in Manila Metropolitan Area as a whole shows a centripetal pattern centering around CBD with a larger traffic volume in north-south direction and in eastern direction. Traffic is particularly heavy to north-south direction connecting with A-1, CBD, A-4 and B-5 as the axis.

Of the total number of trips for all purposes, the areas with a greater OD pair, excluding intrasectoral trips, are as follows:



MANILA METROPOLITAN AREA TRANSPORT STUDY, 1973

FIG.4.4-2 TRIP GENERATION AND ATTRACTION BY TRIPPURPOSE IN 1971

(CBD-1) - (A-1)	230,000 trips
(B-5) - (A-4)	170,000 trips
(CBD-2) - (A-4)	150,000 trips
(B-3) - (C-3)	150,000 trips
(CBD-1) - (A-3)	150,000 trips

CBD-1 and B-1 form an economic block of the similar nature in their respective zones and this is the reason for a large number of trips shown above. Trips of jeepney account for 57% of the total vehicular trips, followed by truck for 19%. Trips of bus, a popular transport system, show a very small share of 5% and trips of truck and jeepneys are outstanding. Cars and others account for 10%.

A breakdown of OD distribution in these sectors by trip purpose shows that work accounts for 23% of all trip purposes, exceeding the average rate of 13% for work trips in Manila Metropolitan Area and shows that (CBD-1) and (A-1) are high concentration of social and economic activities.

As for the balance of OD for all trip purposes, there is no great difference between the going trip and the return trip. A breakdown by trip purpose, however, shows a clear difference between the going trip and the return trip. For example, return trips account for 37% of trips for all purposes and the return trip from (CBD-1) to (A-1) totals 80,000 while that from (A-1) to (CBD-1) numbers only 4,000. Similarly, the number of trips from(A-1) to (CBD-1) for the purpose of going to school and commuting to work is 16 times and 10 times greater respectively than that of trips from (CBD-1) to (A-1) for the same purpose. These figures indicate that there are many people, who reside in A-1 which is close to CBD and is convenient for transportation, make trips to CBD-1 for the purpose of going to school and commuting to work.

As for the trip on work, there is no great difference in the number of trips by direction.

The number of trips between (B-5) and (A-4) is relatively large with 170,000 trips, which consists mainly of 27,000 trips or 16% for taxi and 24,000 trips or 14% for truck. Compared with the rate of taxi at cordon stations accounting for only about 0.3% of all vehicles, the utilization rate of taxi between (B-5) and (A-4) is high.

Since B-5 zone includes Makati which is a high-class business district and residential district, it appears that the stratum of a relatively high income level makes a trip to A-4 by taxi for commuting to work, going to school and work.

For commuting to work, the trips from A-4 to B-5 which includes Makati numbers 15, 000 while these from B-5 to A-4 numbers only 9, 000. This shows that there is a function of business sub-center in B-5.

For going to school, on the contrary, the trip from B-5 to A-4 total 30, 000 while those from A-4 to B-5 number only 2, 000. Consequently, the OD pattern of trips between A-4 and B-5 is quite opposite between trips for going to school and trips for commuting to work.

For trips for private purpose, the trips from B-5 to A-4 number 30, 000 corresponding to 93% of the total number of round trips, indicating that most of the trip makers for private purpose go to A-4 where shopping centers and other facilities are located.

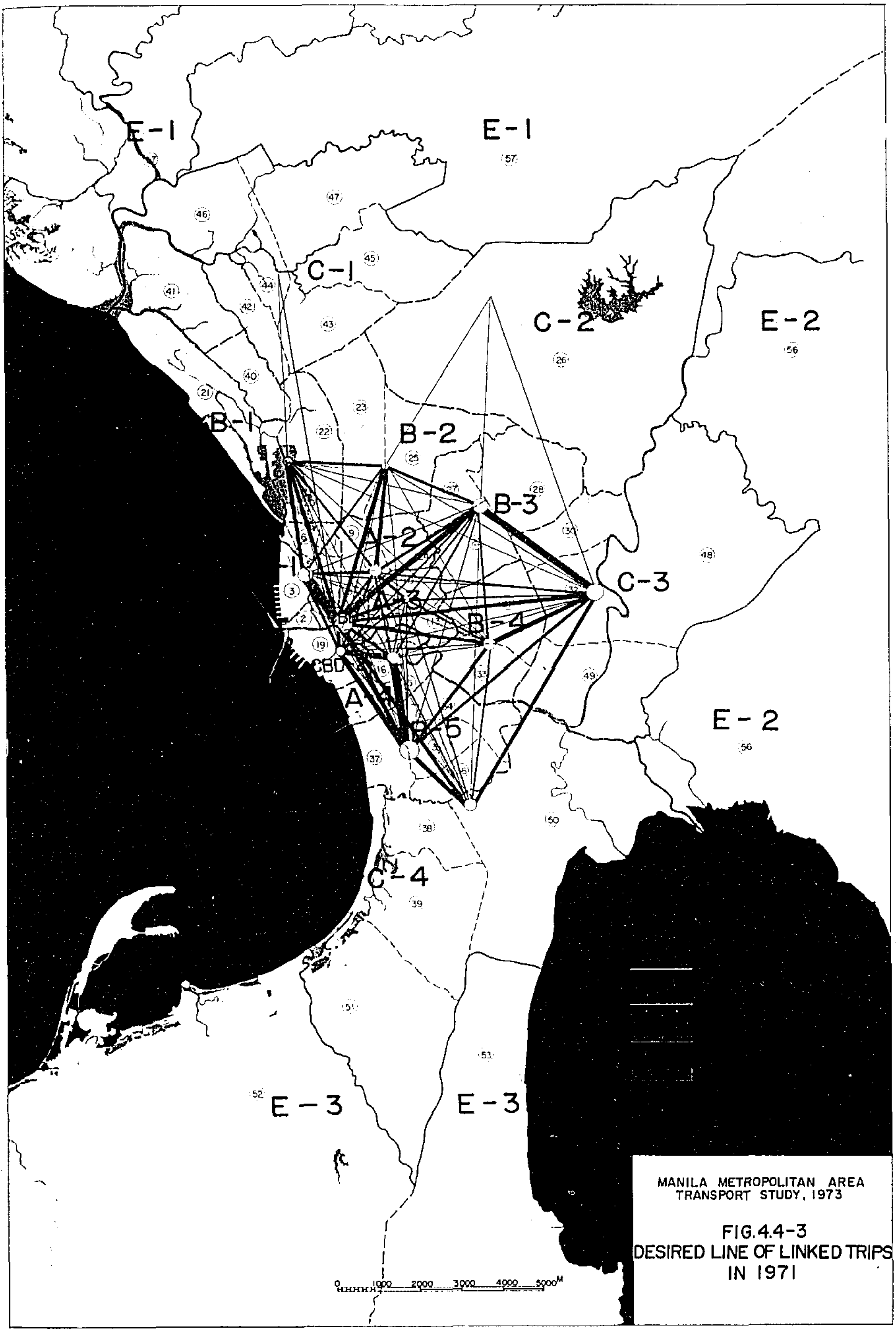
An analysis of OD distribution by travel mode shows that there is no great difference in the rate of utilization of transport facilities between the going and returning trip. For trips by taxi and truck, however, 60% and 64% of all round trips respectively are from B-5 to A-4.

The trips between CBD-2 and A-4 show a fairly large number of 150, 000. Characteristic with this sector pair is that the share of bus traffic is large accounting for nearly 34% of all vehicular traffic and that the traffic of passenger car is reduced by that much.

A study of trips between CBD-2 and A-4 for trip purpose shows that there are to outstanding characteristics in the composition of trip purpose which is similar to the average composition of trip purpose in Manila Metropolitan Area.

A study of OD distribution for each trip purpose, however, shows a definite feature. For example, trips for going to school, commuting to work and for private purpose account for 94%, 93% and 75% respectively of all round trips from A-4 to CBD-2 while returning trips from A-4 to CBD-2 account for only 3% of all round trips, indicating that A-4 is a residential district and CBD-2 is a business district. There is no great difference in the utilization rate of transport facilities between the going and the return trip.

The trips between B-3 and C-3 total 150, 000 and show a fairly high utilization rate of 17% for taxi. There is no great difference in the OD distribution of transport facilities utilized between the going and the returning trip.



MANILA METROPOLITAN AREA TRANSPORT STUDY, 1973

FIG. 4.4-3 DESIRED LINE OF LINKED TRIPS IN 1971

A study of trips between B-3 and C-3 for each trip purpose shows that trips from B-3 to C-3 for private purpose account for 66% of all round trips, indicating a fairly large number of people making a trip to the Cubao district for shopping.

4.4.5 Hourly distribution of trips

As shown in Fig. 4.4-4, there is a definite pattern of hourly distribution of trips, in which the peak appears in the time zone of 7:00 - 9:00 a.m. (1.26 million trips) and again in the time zone of 5:00 - 7:00 p.m. (1.14 million trips) and the number of trips drops to the lowest level temporarily in the time zone of 12:00 noon until 1:00 p.m.

The morning peak hours are mainly due to trips for commuting to work, going to school and outing for private purpose, and the peak hours for going to school appear 1 - 2 hours earlier than the peak hours for commuting to work. The morning peak hours are more intensive than the evening peak hours. Probably because of more time on hand, the trip pattern in the evening is more sporadic than that in the morning except the trip for returning home.

The temporary drop in the number of trips in the time zone of 12:00 noon until 1:00 p.m. apparently results from the stoppage of the movement of people for lunch and rest.

The peak hour for morning home trips occurs twice, once in the time zone of 10:00 - 11:00 a.m. and again in the time zone of 5:00 - 7:00 p.m. with the former occurring because of return trips of people going out for private purpose and school children going to school early in the morning.

The evening peak hours occurs because of return trips of commuters, students and people who have been out for private purpose, and the return trips account for 80% of all trips in the time zone of 5:00 p.m. - 7:00 p.m.

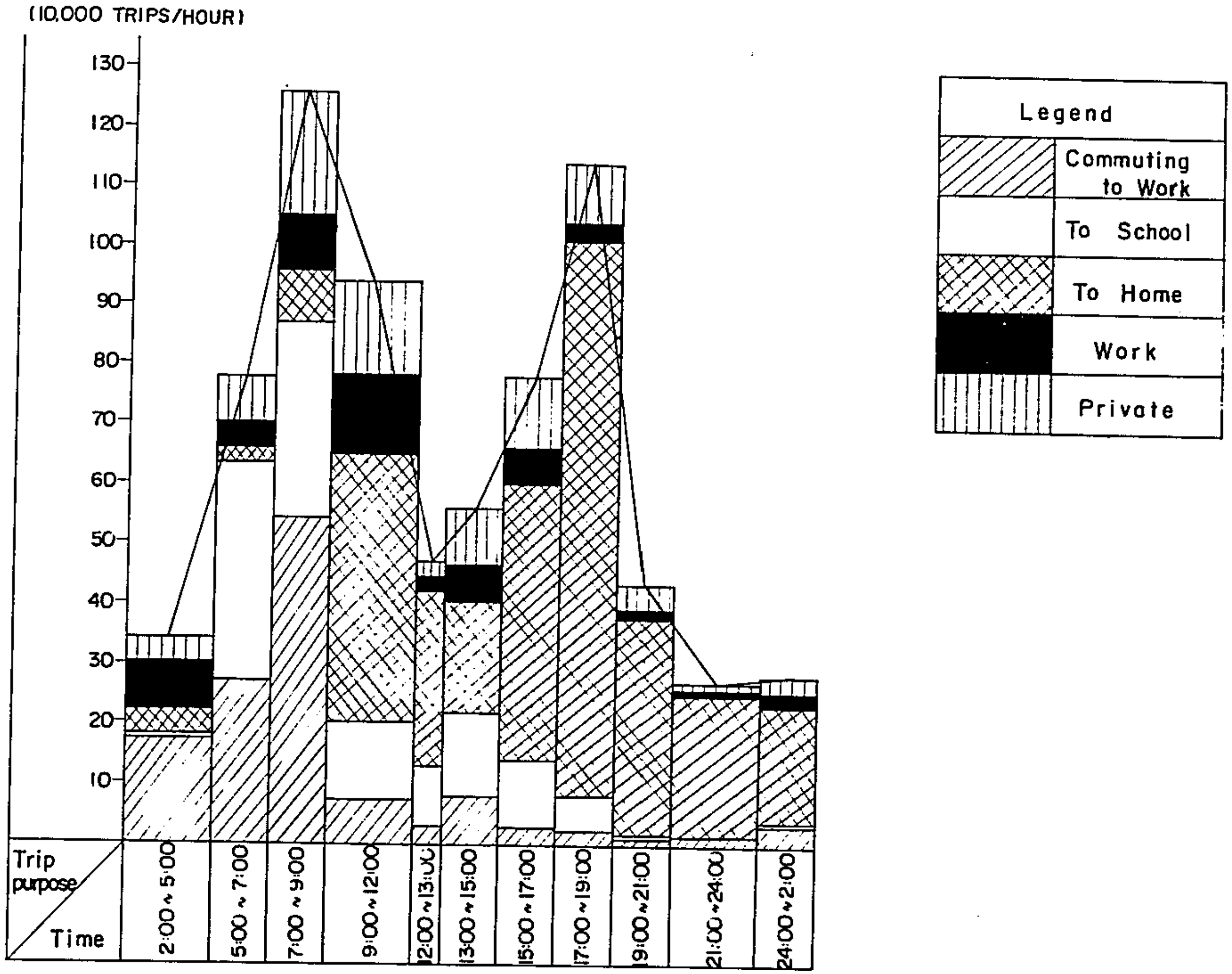


Fig.4.4-4 Proportion of Each Trip Purpose for the Total Trip Purpose by Hour

CHAPTER 5 STRUCTURE OF METROPOLITAN MANILA AREA

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§ 5.1 Premise of Planning

5.1.1 Characteristics of development in the Manila Metropolitan Area

It is estimated that the population of the Manila Metropolitan Area will increase from 3.9 million of 1970 to arrive at 7.5 million of 1987 during the 17 years as is shown by table 5.1-1. This implies that the growth of the cities in the Manila Metropolitan Area will be accelerated even faster in years to come.

In big cities following the trend of development, in order to lead a planned urbanization in the surrounding areas of big cities, proper means and a pattern of development bases on them have to be explored.

Table 5.1-1 Trend of Population Growth

(1,000 persons)

Years	1970	1987
Manila Metropolitan Area	3,911	7,466
Manila Bay Metro Region	8,584	15,114

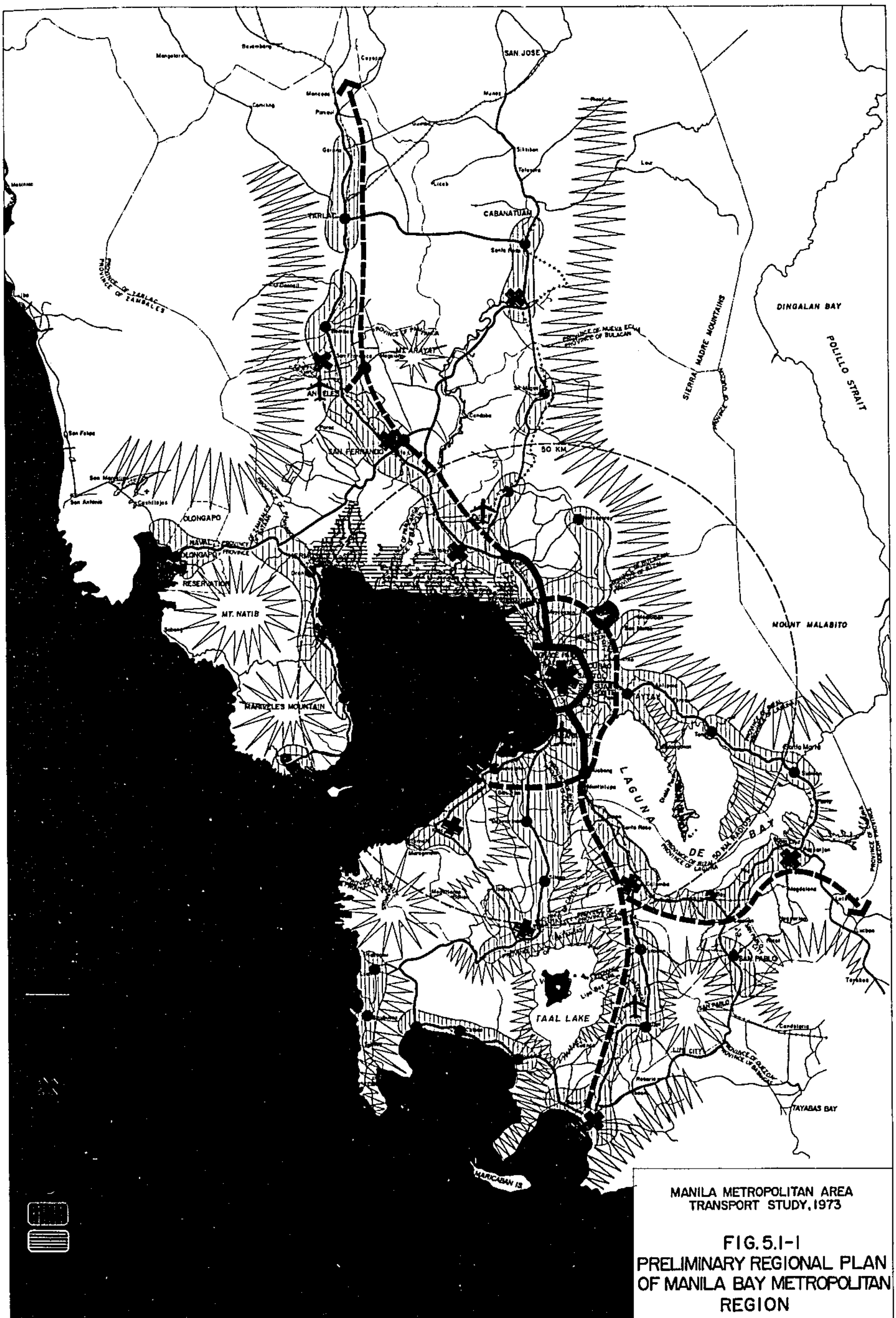
Source: Population Census and estimated by Manila Bay Development Plan Team

5.1.2 Suggestions for the Manila Bay Metro Region

The conception of the master plan for the Manila Bay Metro Region including the Manila Metropolitan Area has already been suggested by the Manila Bay Development Plan Team as illustrated in Fig. 5.1-1. This conception, which is based on the scale of a national planning of the Republic as a whole, is the one that should constitute the premise of the planning for the Manila Metroplitan Area.

5.1.3 Urban form and traffic characteristics in the Manila Metroplítan Area

In investigating the development pattern of the Manila Metropolitan Area, it is necessary to pay due consideration to the following characteristics observed in the present urban structure, in the trend of development and in the pattern of urban transportation.



MANILA METROPOLITAN AREA
TRANSPORT STUDY, 1973

FIG. 5.1-1
PRELIMINARY REGIONAL PLAN
OF MANILA BAY METROPOLITAN
REGION

1) The organization of the present Manila Metropolitan Area, which has been following a concentrated pattern of development centered around the Point area, Quipo and Malate, is undergoing a great change in recent years due to the rise of new urban centers such as Makati, Cubao, Green Hills and others that are being formed along the surrounding Highway No. 54.

2) The New built-up areas show a tendency to expand rapidly over the surrounding areas as a result of the excessive concentration in the existing built-up areas inside the Highway No. 54 and of the spread of cars. However, under the present conditions, there is yet no land use plan legally established that can guide a planned expansion of built-up areas.

3) According to the person trip survey conducted in the Manila Metroplitan Area, the shares of transportation means are shown in Fig. 5.1-2. By comparing the shares of Manila with those of Tokyo or London, we notice that the shares of Manila are marked by an extremely low dependence on railways and a great importance attached to the roles played by jeepneys for the urban transportation.

Though this characteristic deserves respect, it has to be accepted that the combined increase in traffic demand will definitely far exceed the limit of capacity which the existing transportation means can manage to achieve.

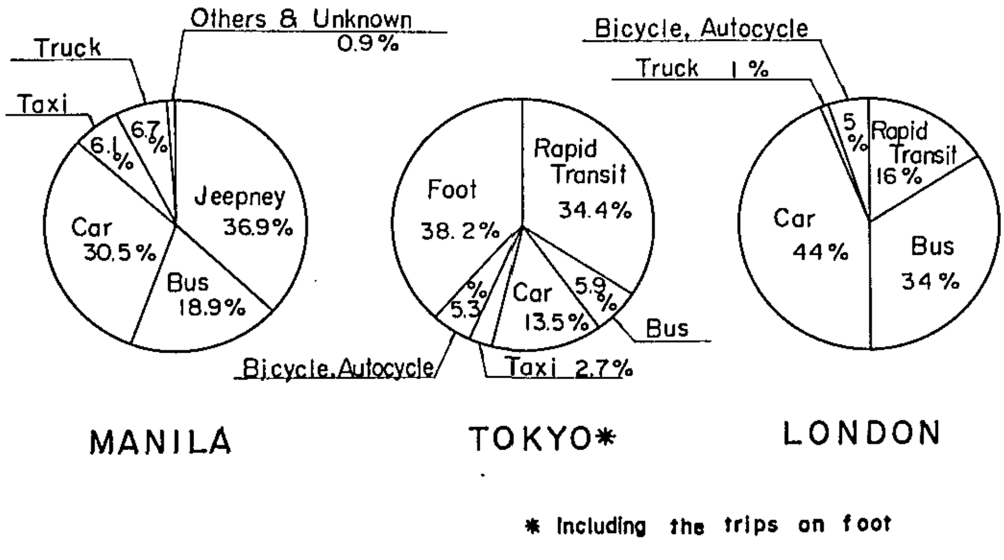


Fig 5.1-2 **Percentage of Linked Trips by Travel Modes**

§ 5.2 Investigation of Development Patterns

5.2.1 Probable development patterns

On the basis of the above-mentioned conditions of planning, the following alternative patterns can be presumed for the future Manila Metropolitan Area.

In the first place, dividing the Manila Metropolitan Area into two, the inner and the outer areas with the Highway No. 54 as the line of division, the following two types of patterns can be presumed as the alternatives for the inner area of the Manila Metropolitan Area.

The first alternative pattern supposes a state where the present trend of development continues toward the future, accompanying a further development of the existing main urban center (CBD) and where a part of the urban functions is dispersed along the Highway No. 54. The second type supposes restraint on further development of the CBD by administrative measures and promotion of the formation of new axial urban centers along the Highway No. 54.

Next, for the outer area of the Manila Metropolitan Area, three fundamental types of alternative plans are to be presumed as follows.

The first alternative plan rests on the estimate that the present trend of development will continue in future and built-up areas will be formed in the outer area by a natural sprawl of employment and housing on a relatively small unit.

The second alternative plan for the outer area emphasizes decentralization where large-scale independent cities are nurtured on the fringe of a big city sphere mainly through industrial development.

The third pattern is the one adopted in the cities of Copenhagen, Stockholm and Hamburg, where new mass transit means are included in the planning, stretching radially from the urban centers, and thereby the area along this line is subjected to an intensive development in order to breed coaxial cities.

Combining the two patterns (A and B) for the inner area and the three types (1, 2 and 3) for the outer area as have been mentioned, we can presume six different patterns (A-1, A-2, A-3, B-1, B-2, B-3) as illustrated in Fig. 5.2-1.

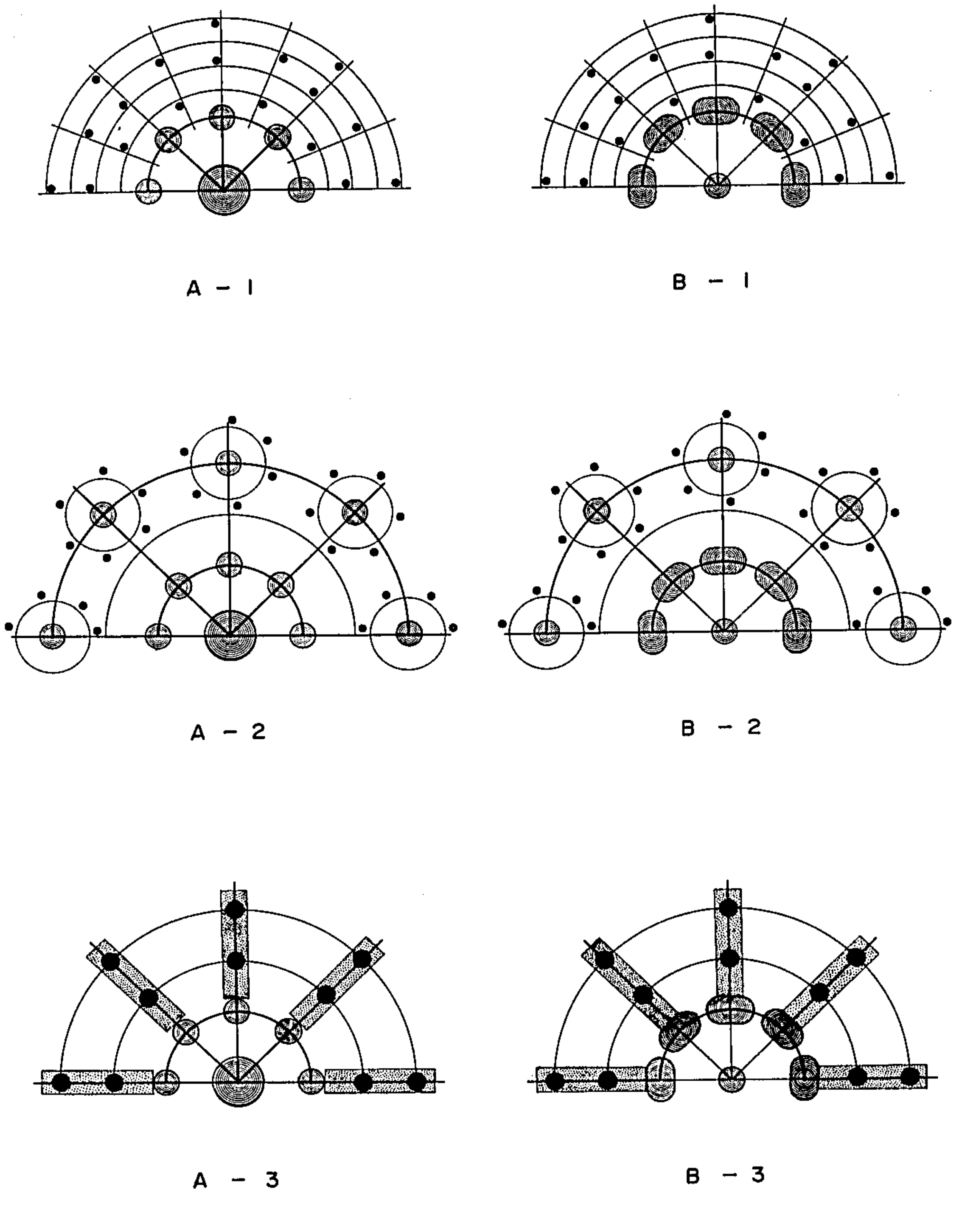


Fig: 5.2 - 1 DEVELOPMENT PATTERN OF METROPOLITAN MANILA AREA

5.2.2 Characteristics of each pattern

1) Pattern A-1 is most feasible, for it accepts the present trend of development in the existing cities.

However, in this case, as the outer area will most likely be developed at a relatively low density, we will be confronted with the difficulty of realizing the mass transit means in the outer area as is often the case in various cities of the United States.

Moreover it is predictable that there will be an extreme shortage of the capacity of transportation means in the existing urban centers.

2) Concerning Pattern A-2, it is quite desirable to adopt this pattern in order to form large-scale independent cities in the outer area and also to promote the decentralization of urban centers. However we cannot always expect from this pattern the effective decentralization over the entire Manila Metropolitan Area, since we do observe a too rapid development going on in the Manila Metropolitan Area.

3) Pattern A-3 rests on the assumption that new mass transit means will be introduced on a large scale into the Manila Metropolitan Area. It stresses the idea to connect closely the transportation planning and large-scale housing in order to produce an urban form in which mass transit means can easily be realized.

This pattern satisfies the conditions of realizing the mass transit means. Though it is of great merit in contributing to the solution of the housing problem of the Manila Metropolitan Area by its fostering the supply of a large residential area, it will inevitably impose an excessive burden on the CBD as Pattern A-1 will.

4) Patterns B-1, B-2 and B-3 have common characteristics to Patterns A-1, A-2 and A-3, respectively, as to the development patterns in the outer area. They intend to reinforce the rapidly emerging urban centers along the Highway No. 54 by administrative measures in order to restrain further development of the CBD.

5.2.3 Development patterns to be adopted

As a result of a comparative investigation of the above-mentioned patterns, we judge that Pattern A-3 or Pattern B-3 best suits the urban form of the Manila Metropolitan Area. The main reasons for this are as follows:

(1) Both Patterns A-3 and Pattern B-3 serve to satisfy the conditions of realizing the mass transit means, which is essential to cope with the increase of traffic demand.

(2) Both patterns facilitate the forming of large residential areas in the outer area.

(3) Both patterns improve the accessibility for commuters from the outer area to the urban centers.

§ 5.3 Conceptions of Transportation System and Land Use Plan

5.3.1 Urban form - Compromise between B-2 and B-3

According to the basic ideas mentioned above, the urban form of the Manila Metropolitan Area is most effectively a combination of Patterns B-2 and B-3 as shown in Fig. 5.3-1. In this case:

(1) 10 transportation corridors are stretching radially from the center of the Manila Metropolitan Area. These corridors are formed on the nucleus of the strip built-up areas where the building of railways and the development of residential areas are to be conducted simultaneously.

(2) Circumferential corridors are placed along the Highway No. 54. These corridors cover the strip built-up areas, consisting of office centers, commercial districts and residential areas, which are to be connected to each other by highly efficient transportation facilities.

(3) Along the main circumferential roads in the outer area, factories and institutional facilities such as colleges are allocated. These facilities, which show a tendency to sprawl over the outer area of Manila, should be distributed according to a definite plan along the circumferential roads.

(4) The existing urban center and the relatively new urban centers along the Highway No. 54 are closely connected to each other by the arterial roads so that an integrated development can be maintained.

(5) Sub centers are allocated in densely populated parts and at the nodes of transportation facilities on the radial corridors.

(6) Green tract of land is allocated at the fringe of the Manila Metropolitan Area, in the areas behind the corridors and on seashores, lakes or rivers.

5.3.2 Land use plan

The land use plan should be determined according to the basis concepts of the city structure mentioned in the preceding section, to the existing circumstances of land use and to the following policies:

1) Allocation of industrial districts

Industrial districts already distributed inside the existing built-up area which are relatively large-scale and do not create hazards to the heighboring residences are generally accepted as industrial area in future just as they are at present and some industrial expansion will be possible.

Industrial developments mixed with the residential areas may need to be restricted to some extent depending on their character.

As to the allocation of large-scale industrial districts, it would be proper to place them along the circumferential roads planned in the outer area of the Manila Metropolitan Area and along the Marikina River and on the Laguna De Bay. Industries to be established alongside the water should be free from any anticipation of pollution.

2) Allocation of commercial and business districts

Concerning the commercial and business districts, the areas immediately north and south of the Pasig River will expand as business, retail and commercial districts. The commercial districts along the radial transport routes should be nurtured as retail and commercial districts providing sub-regional services and some employment.

To cope with the predicted increase in the demand for commercial and business districts, it is desirable to allocate them mainly in the existing urban center and along the Highway No. 54.

In this case, the question of great importance is how to attribute weight between the commercial and business districts in the existing urban center and those along the Highway No. 54. It is predictable that the amount of expansion of the commercial and business districts in the existing urban center are restricted by the capacity of the future teansportation facilities there.

It is hoped that the centers of the commercial and business districts along the Highway No. 54 will be placed in Quezon, Caloocan and Makati districts in relation to the nodes of mass transit means.

In the outer residential areas where further development is to be fostered, retail commercial districts are allocated at the nodes of arterial roads and along the mass transit routes to provide sub-regional centers.

3) Allocation of goods circulation centers

Judging from the circumstances of land use in the areas behind the harbors which are all situated at a short distance to the CBD, it is not appropriate to treat the existing harbors as cores of goods circulation which is estimated to expand in the near future. Therefore, it is required that new goods circulation harbors should be somewhere else in addition to the existing harbors. The probable site of the new circulation harbors will be the area on the seashore around Cavite. Regarding the circulation business districts related to these harbors, it is hoped that they should be arranged and developed in the area directly behind each harbor and that the cores of circulation for regional services centering around wholesale markets should be prepared along the arterial road on the inland side (outside Highway No. 54).

4) Allocation of residential districts

Densely populated residential areas may call for the improvement of their environments and in some cases this may mean a reduction of population density. If so, any land left over should be utilized as a public open land, a public facility land, or a land for high and middle density residences.

For the residential areas to be developed newly (the whole suburban area may well accept development excluding the damp and low-altitude part), gradual development should be conducted in the districts where a harmonious connection can be achieved between the development plan of employment places and the adjustment plan at transportation facilities.

For these areas it becomes quite significant to lead development under a definite planning by conducting simultaneously the development of mass transit means and that of large-scale residential areas, for it can be predicted that in the outer area rapid urbanization will be accelerated by the increase in the population in years to come.

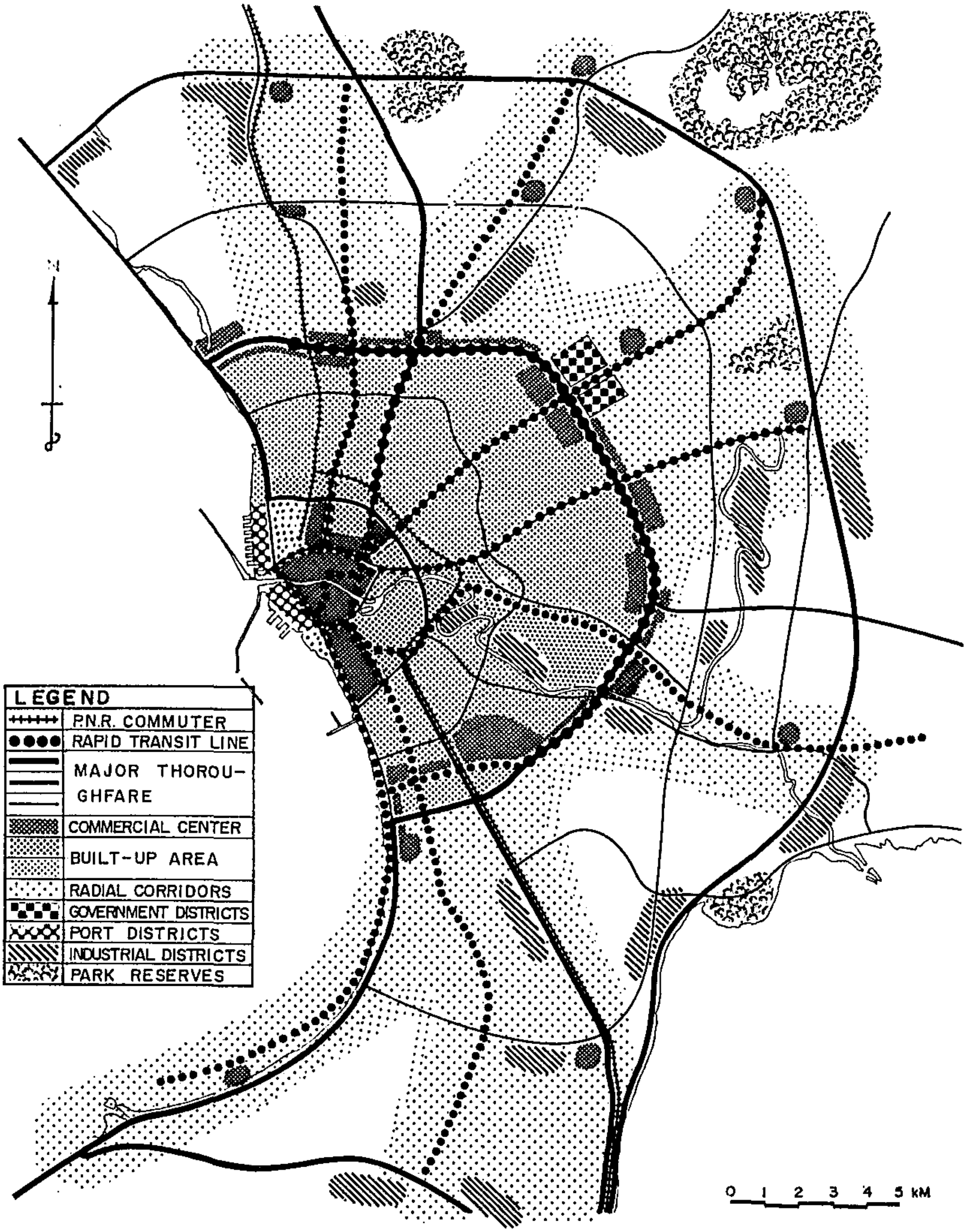


Fig 5.3-1 DEVELOPMENT PATTERNS OF METROPOLITAN MANILA

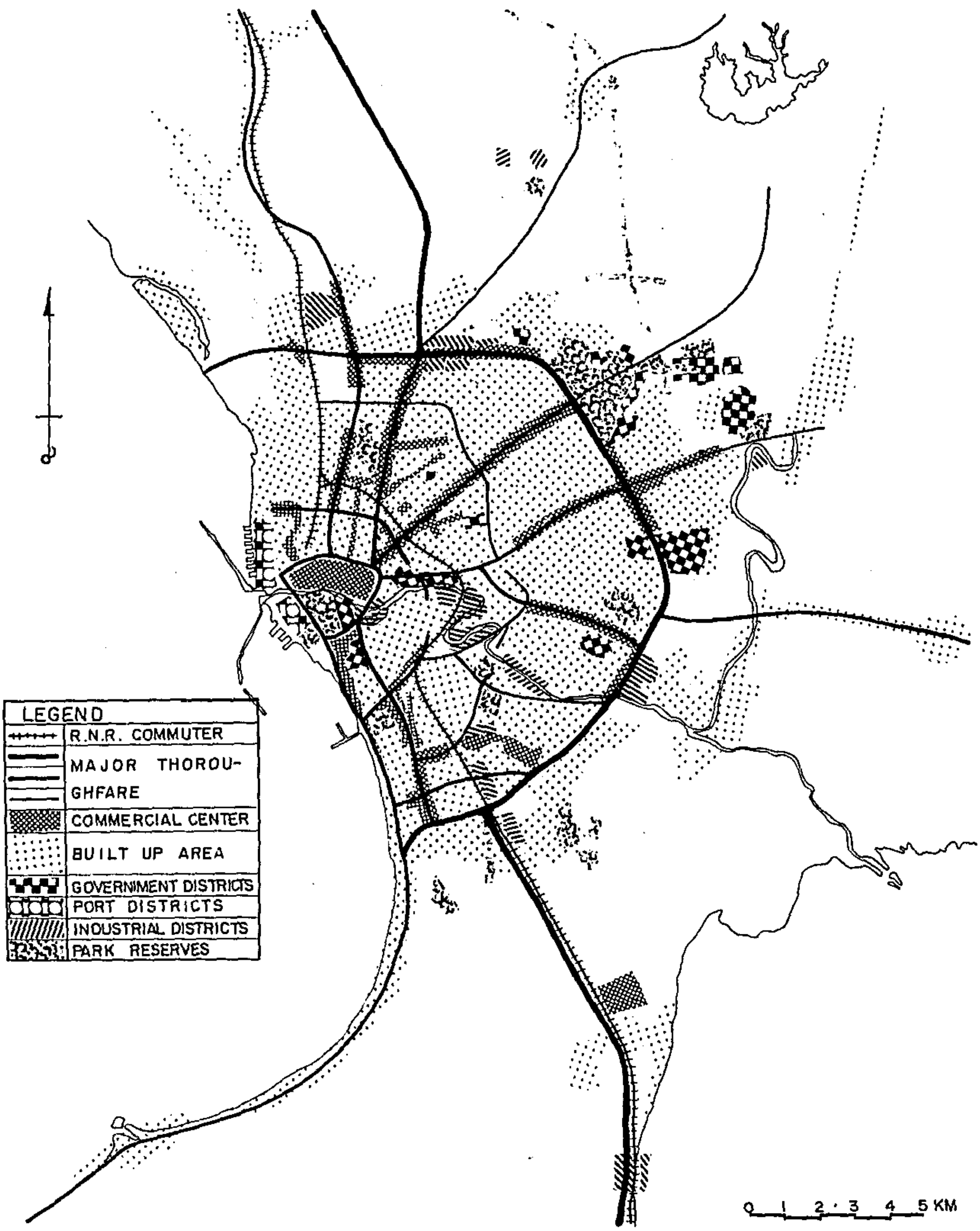


Fig 5.3-2 PRESENT PATTERNS OF METROPOLITAN MANILA

5) Allocation of public open land and others

The public vacant land which is under utilization or planning for its adjustment at present will be successively used or will be constructed in the near future. It is desirable to prepare all-purpose parks, each covering the area of more than 50 has., in different directions at several places in the area outside the Highway No. 54 where a new urbanization is predicted.

Moreover efforts must be made in placing green tracts of land along rivers, lakes and seashores as much as possible and also in restraining the development of the steepen slopes of the hills in the eastern part of the Manila Metropolitan Area in order to prepare for the future demand for recreation.

In order to accommodate the increased future population of students, due consideration has to be paid to the restriction of building colleges in the area inside the Highway No. 54 as well as the removal of the existing colleges concentrated on the periphery of the present CBD to locations in the outer sub-urban areas.

5.3.3 Transportation System

It is necessary to emphasize the following objective in investigating the future transportation system in the Manila Metropolitan Area.

(1) To solve the problems of transportation that have arisen or will arise in the near future.

(2) To greatly reinforce the capacity of transportation facilities in order to meet the increased demand for transportation in future. However, in the urban center and their periphery, where there is a limit to the reinforcement of the road capacity, the introduction of mass transit means should be positively conducted.

(3) To plan the transportation system that best suits the structure of the Manila Metropolitan Area and the conception of the land use plan as has been mentioned.

According to these basic objectives, we can presume the following components of the future transportation system to be adopted in the Manila Metropolitan Area as is shown in Fig. 5.3-2.

1) Rapid transit system

(1) The retention and improvement of the national railway route to function as an urban rapid transit service.

(2) Four new rapid transit routes that stretch radially from the urban centers to meet the increase in the traffic demand from the outer area to the CBD as well as to the new and expanded commercial and business districts to be formed along the Highway No. 54. The new rapid transit routes are located in the directions that have already attracted much traffic demand and where it is possible to form the urban corridors by the simultaneous construction of rapid transit and development of large-scale residential areas.

(3) A new circumferential route that will interconnect the commercial and business districts which are expected along the Highway No. 54. This circumferential route will connect with all the radial routes from the suburban area to the urban center.

(4) Organization of the network in the area inside the Highway No. 54 in such a way that routes pass any main commercial and business districts and so that traffic in any direction is possible by a single transfer in the CBD.

2) Arterial roads

(1) Basic concept

The existing circumstances of road traffic show that the capacity of road facilities has been exhausted in the CBD and in their peripheral areas, as is observed in the marked congestion especially at the peak hours in the morning and evening.

It can be forecast that the car ownership will further increase keeping pace with the economic development greatly increasing automobile traffic.

The estimated amount of increase in automobile traffic will far exceed the capacity which can be managed by the reinforcement of the existing automobile traffic facilities. This will necessitate some kind of means that can restrain the increase in the automobile traffic demand.

There are various means to restrict the increase of the demand for automobile traffic, among which the most effective and the most feasible will be the introduction of mass transit means and the dispersement of a part of the urban functions into the outer area by an appropriate land use planning.

The planning of automobile traffic facilities of the Manila Metropolitan Area rests on the premise that the increase in the demand for automobile traffic should be alleviated by the above-mentioned ways.

However even when we have adopted those ways, we would still have to expect that the demand for the essential automobile traffic as a prop of the urban activities is sure to expand beyond the present automobile traffic volume. The solution to this will be the drastic reinforcement of the arterial roads.

(2) Adjustment of network of arterial roads

The adjustment plan of arterial road network is based on different concepts of planning between the urban center and its peripheral area, i.e. the area inside the Highway No. 54 and the area outside it.

In the area inside the Highway No. 54, the immediate objective is to alleviate congestion by adding some improvements to the foundation made up by the network of the existing arterial roads and those whose planning is already established.

In the area outside the Highway No. 54, which still holds plenty of vacant land, it is possible to realize new wide arterial roads. Therefore, for this area, it can be said that a functional network should be composed in radial and circumferential forms.

It can be predicted that wide circumferential roads at the fringe of the Manila Metropolitan Area will play quite a significant role in future, just as the Highway No. 54 does at present to the existing urban structure and to the traffic flow in the Manila Metropolitan Area.

3) Urban expressways

It is obvious that the urban expressways, connecting the urban center with the outer area as well as with the commercial and business districts expected along the Highway No. 54, will play a very important role to the flow of automobile traffic in future.

However, it is not always profitable to introduce the urban expressways into the existing built-up area, because it is extremely difficult to construct elevated urban expressways in the existing built-up area and even if it may be possible it will certainly destroy the landscape of the city and naturally invite traffic congestion in places around the rampways in the CBD.

Judging from these points, it is advisable to improve a part of the arterial roads as has been mentioned by installing grade separations in order to let them function largely as urban expressways. And the true urban expressways can then be introduced over the Highway No. 54 and on the main radial routes situated to the outside of the Highway No. 54.

Highway No. 54 plays the role as a spine combining the expected commercial and business centers alongside. It also functions as a by-pass and a distributor connecting the existing South and North Diversion Roads. It is important to reinforce this highway and let is help the dispersement of urban functions, as has been stressed in the suggestions of the development patterns of the Manila Metropolitan Area.

In these viewpoints, it is to be desired that an urban expressway should be added to this route.

In other words, the network of expressways in the Manila Metropolitan Area will be constituted by the existing South and North Diversion Roads and the urban expressway on the Highway No. 54 as the main axes of the network including the new radial routes leading to the Highway No. 54 and the arterial routes branching out in the area outside the Highway No. 54.

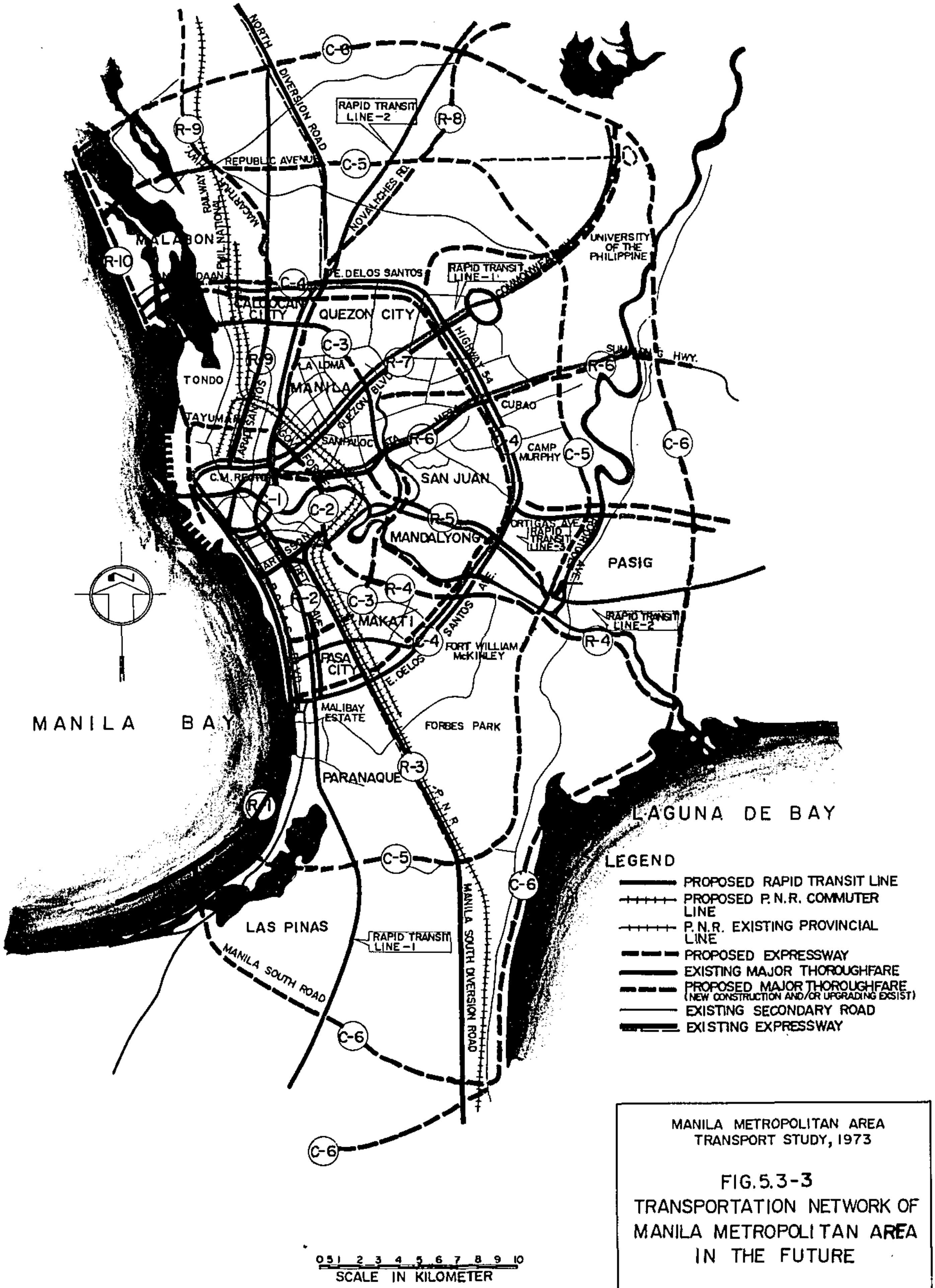


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FIG. 5.3-3
TRANSPORTATION NETWORK OF MANILA METROPOLITAN AREA IN THE FUTURE

§ 5.4 Site for Planning

The importance should be emphasized from the view point of characteristics of the development in the Metropolitan Area that acquisition of sites for public facilities and other land uses should be undertaken as early as possible in order to materialize the above-mentioned development plan. It is absolutely necessary to acquire especially the land with right of way wider than enough for transportation facilities, the open land for citizens' recreation and the land for residential areas to be developed along planned railways at the time when the land is still cheap.

CHAPTER 6 ESTIMATION OF FUTURE TRAFFIC DEMAND

CHAPTER 6 ESTIMATION OF FUTURE TRAFFIC DEMAND

In this chapter the traffic demand in 1987 is estimated according to the land use plans and the basic transportation network plan discussed in Chapter 5. This estimation is to be the basis for the proposal of the transportation system in Chapter 7.

The traffic volume is estimated of every traffic mode of urban transportation, for example, automobile and mass transit. Then the estimating method by a person trip analysis is adopted in order to clarify the intermodal relations.

This chapter first deals with the estimating method. Then the estimation of the future traffic demand is made in order as to trip production, trip generation and trip attraction, trip distribution, modal split, external traffic, and traffic assignment.

§ 6.1 Estimating Method

6.1.1 Estimating procedures

The estimation of the person trip must be made for every trip purpose, since trip characteristics are influenced by the trip purpose in every estimating process. This means that the estimation becomes easier when the traffic volume is estimated by purpose. Moreover, the intention of the planning of transportation facilities is made clear only when the planning is reflected against the trip purpose as its object. Here a brief explanation is made, exemplifying that the estimation by trip purpose is relatively easy and necessary as well. When it comes to commuting to work trip, single worker usually produces one trip. It is also understood that the trip generation is naturally related to the number of residents and that the trip attraction is related to the number of daytime workers. The main traffic mode in this case, commuting to work trips, would be mass transit in most cities. On the other hand, a work trip has its own characteristics of production as well as its own trip generation and attraction different from the other trip purposes. Besides, a work trip has a tendency to use personal transport mode such as automobile and taxi.

Thus, for the above reasons, the traffic demand is to be estimated by trip purpose. The trip purpose is classified into commuting to work trip, going to school trip, private trip and work trip. Then, the number of trip purposes is four, which is considered to be the minimum required for classifications.

In order to treat the trips as a chain of trips (a cycle), departing from some place (home, place of work, etc.) and returning to the same place, the purpose of the following trip is estimated based on the purpose of the previous trip (including the same purpose) using the probability analysis. Using this method (called the trip purpose correlation method), the purpose of the second trip and following trips would be automatically calculated based on the purpose of the first trip using this transition probabilities between trip purposes. As a result, the estimation of the trip generation and attraction is simplified and the estimation of the intermodal traffic demand becomes more valid (especially in the case of the automobile traffic).

Each stage of the traffic demand estimation is now briefly explained.

First the estimation is made as to the total trip generation in the area concerned to be used as a control total by multiplying the average number of trip production per person, calculated by occupation and by car ownership, by future population.

Then, the correspondence is clarified between trip purposes and the kinds of the population described in Chapter 5. The trip generation and attraction of each zone is estimated on the basis of the number of each classification of population of each zone. Using the above result, the distribution of the traffic demand is calculated, using the entropy method incorporating the gravity model. The time distance between zones is given by the basic transportation network plan described before, and the exponent of the time distance is obtained from the analysis the present distributing pattern of the traffic.

The estimation of the external traffic across the area boundary is to be made separately by the living place of the person, outside of the study area and inside of the study area, and by trip purposes. A perfect OD table is obtained by adding this external traffic to the OD table of the trips within the study area described drove.

Then, the OD tables by travel mode are estimated. The share of each mode is determined by trip purpose for the internal as well as external traffic. Nevertheless, another case is added for the estimation of the modal split, using actual capacity of proposed transportation facilities. The classification of travel modes used for the estimation of the modal split is: drivers of passenger cars and trucks, passengers of passenger cars and trucks, taxi passengers, and mass transit.

As two cases of land use plans and two kinds of modal split are analyzed in the estimating procedure mentioned above, four kinds of OD tables of vehicles and mass transit are obtained. However, the traffic assignment is made only for a single case in which every traffic demand of mass transit and vehicles is within the capacity after the careful examination of the capacity of the proposed transportation facilities.

The procedure of the traffic demand estimation is shown by Figure 6.1.1.

The target year of this estimation is 1987. The number of zones is 51 for inside and 6 for outside of the study area for the actual calculation work. Fifteen sectors inside and 3 sectors outside combined with these zones are also used for convenience of the explanation.

6.1.2 Preconditions for estimation

In advance to the estimation of traffic demand, the preconditions for the estimation should be made clear.

The preconditions for the estimation, in ordinary cases, are the frame and the land use of the study area, that is the Metropolitan Manila Area. In accordance with the method of estimation here described, the frame is specified by such data as the total population, the occupational organization of the total population and the car ownership by type of vehicles, while the land use is specified by such data as various kinds of distribution of the population.

Among the input data for the estimation of traffic demand, the total population and the vehicle fleet statistics were prepared by the Manila Bay Development Planning Team as illustrated in Tables 6.1-1 and 6.1-2.

Regarding the future land use in the study area, two plans have been proposed as the original by the Manila Bay Development Planning Team and as the alternative through amendments to the original by the Japanese Survey Team. It is necessary to estimate the traffic demand in each of both plans separately.

The land use of these two plans are given in Figs. 6.1-2 and 6.1-3, while the land area by use and the distribution of population are shown in Tables 6.1-3 and 6.1-4 respectively. The main differences between the two plans, the original and the alternative are as follows:

(1) According to the original plan, the number of workers at their residence is 2,838,000 out of the total resident population within the study area and the number of workers at their place of work is 3,333,000 within the study area,

which means that the inflow of workers into the study area must be more than the outflow by 495, 000 in their commuting traffic. On the oterhand, the alternative plan takes this difference between the inflow and the outflow to be 245, 000, almost half of the above figure, thus aiming at the dispersement of the daytime population out of the Metropolitan Manila Area. The reduction of the inflow by 250, 000 in the alternative plan is achieved by decreasing the incoming industrial workers to 2/3 (being totalized at 162, 000) and the commercial workers to 1/3 (totalized at 83, 000) of the number estimated in the original plan.

(2) In the original plan, the density of workers in the industrial area around the urban center is 250 persons/ha. and 200 persons/ha., which is reduced to 150 persons/ha.in the alternative plan. The density of 150 persons/ha. and 100 persons/ha. are not changed in the surrounding area. In so doing, as the alternative plan reduces the density in the urban center to a relatively lower level, it will be more dispersive than the original.

(3) Another difference is observed in the reduction of the area of industrial land which is equal to the area of commercial land in case commercial land is thought to be required in some zones. When the number of industrial workers is reduced by only 162, 000, the total area of the industrial land to be cut off will be 880 has.

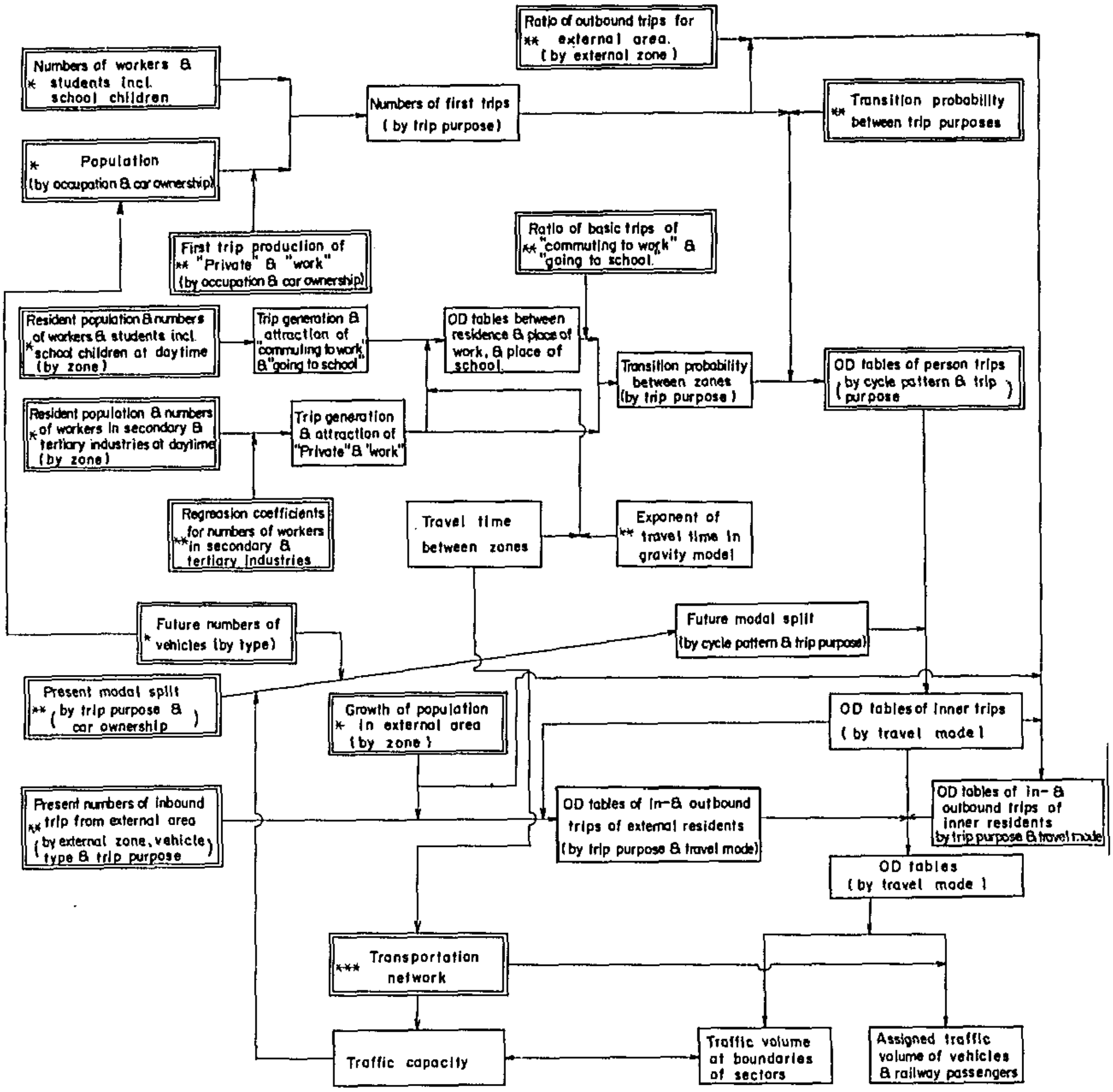
(4) The density of commercial workers in the CBD sector is 1, 500 persons/ha, in the original plan and is 1, 000 persons/ha. in the alternative plan. This results in the reduction of the commercial workers in the CBD sector by 274, 000 persons, from the 522, 000 persons of the original to the 348, 000 persons of the alternative.

(5) Among the 274, 000 persons as a reduction of commercial workers 191, 000 persons which is a remainder behind 83, 000 persons cancelled out of it due to the reduction of the inflow workers is to be accommodated half in sub centers on C-4 and half in regional centers in suburbs respectively. The increased commercial workers in B and C Sectors will be accommodated by the increase of the density in the Zone No. 35 from 500 persons/ha. to 1, 000 persons/ha. and by the expansion of the commercial area. The increase of the area for commercial land required is 650 has. From this viewpoint, the original plan is relatively more concentrated, whereas the alternative is dispersed.

(6) As a result of the above operations, the residential area in each zone will be slightly changed, and supposing the total residential population to be constant, a total of 40 has. of residential land will be required additionally in the alternative plan.

(7) Finally,as a result of the reduction of industrial area, the 880 has. is made available for other uses, 650 has. for commercial area and 40 has. for residential area. The residue of 190 has. is to be utilized as greens.

The above differences may well imply that the original plan of the future land use is the concentrated pattern in the urban center and that the alternative plan for it is the dispersed pattern in the surrounding area.



Remarks (classification)

1. trip purposes : commuting to work, going to school, private & work
2. travel modes : car & truck driver, car & truck passenger, taxi Passenger & mass transit (devided into bus & railway passengers at traffic assignment)
3. Input data : [double-framed box]
   * Decided by land use plan
   ** Given through analysis of traffic survey data
   *** Decided by future transportation system

Fig. 6.1-1 Flowdiagram for Traffic Projection

Table 6.1-1 Future Population by Occupation

(1,000 Persons)

Occupation	Population
Professional Workers	331
Administrative Workers	88
Clerical Workers	325
Sales Workers	297
Farmers	94
Workers in Transport	374
Craftsman	665
Service Workers	664
Sub-Totals	2,838
School Children	633
Students	1,000
Sub-Totals	1,633
Houswives	1,226
Joblesses	264
Sub-Totals	1,490
Children under 7 years old of Age	1,505
Grand Total	7,466

Source : Supplied by the Manila Bay Development Planning Team

Table 6.1-2 Present and Future Vehicle Registration

(Vehicles)

Vehicle Type \ Year		Present (1970 - 71)	Future (1987)
Passenger Cars (Incl. Jeeps & Vans)	Owned by Households	149,693	648,112
	A.C.	4,485	19,418
	Tourist Bus	29	126
	Sub-Totals	154,207	667,656
Passenger Cars (Incl. Jeeps & Vans)	Owned by Private Enterprises & Governmental Organization	6,246	12,367
	Taxis & Carriage	7,339	14,531
	Sub-Totals	13,585	26,898
Trucks	Trucks	54,551	169,598
	P. U. J.	12,983	40,364
	Busses	2,820	8,767
	Sub-Totals	70,354	218,729
Grand Totals		238,146	913,283

Source : Present : Supplied by Land Transport Commission.

Future : Estimated by the Manila Bay Development Planning Team and subclassified by the Japanese Team.

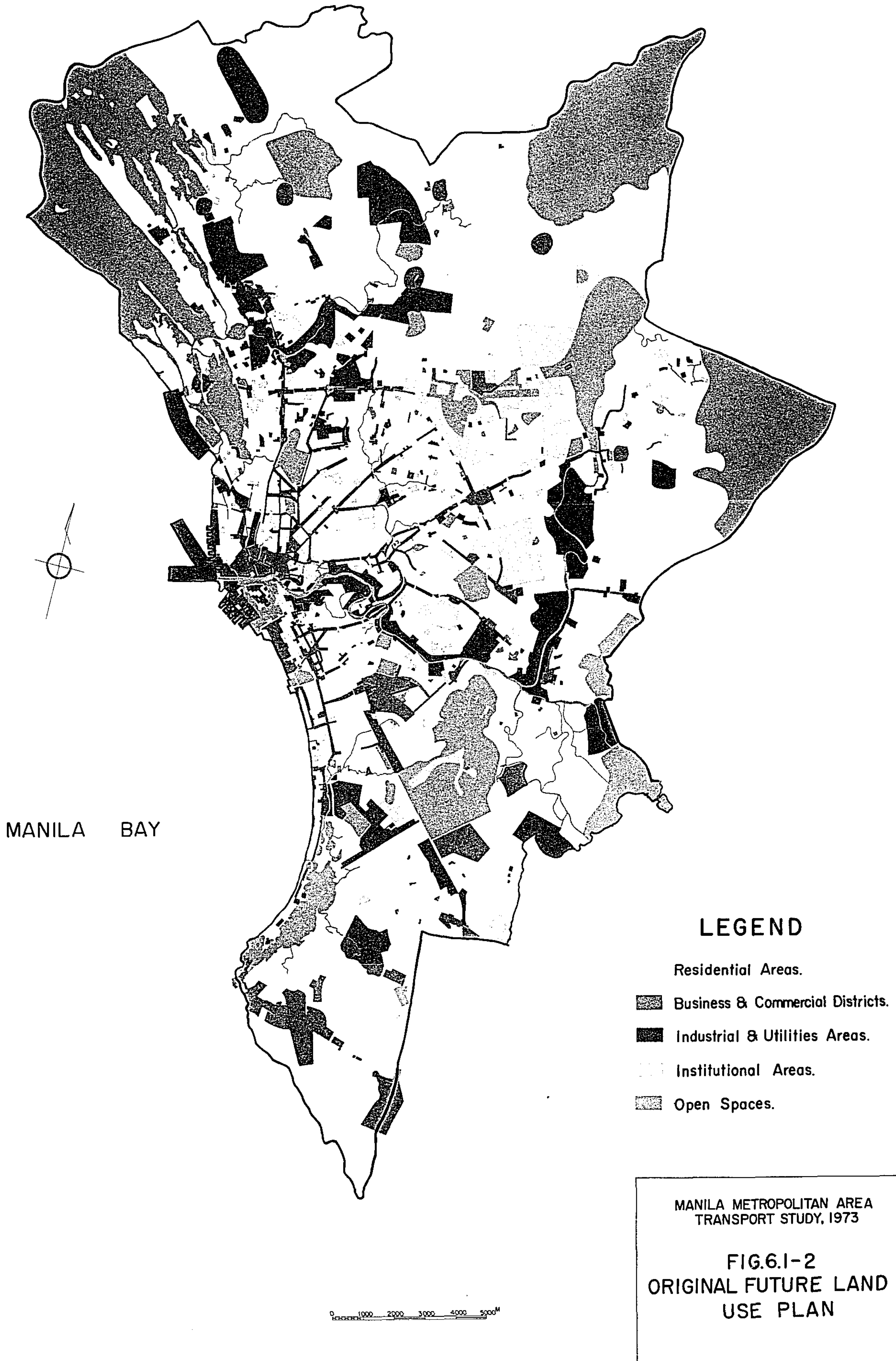


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FIG.6.1-2
ORIGINAL FUTURE LAND
USE PLAN

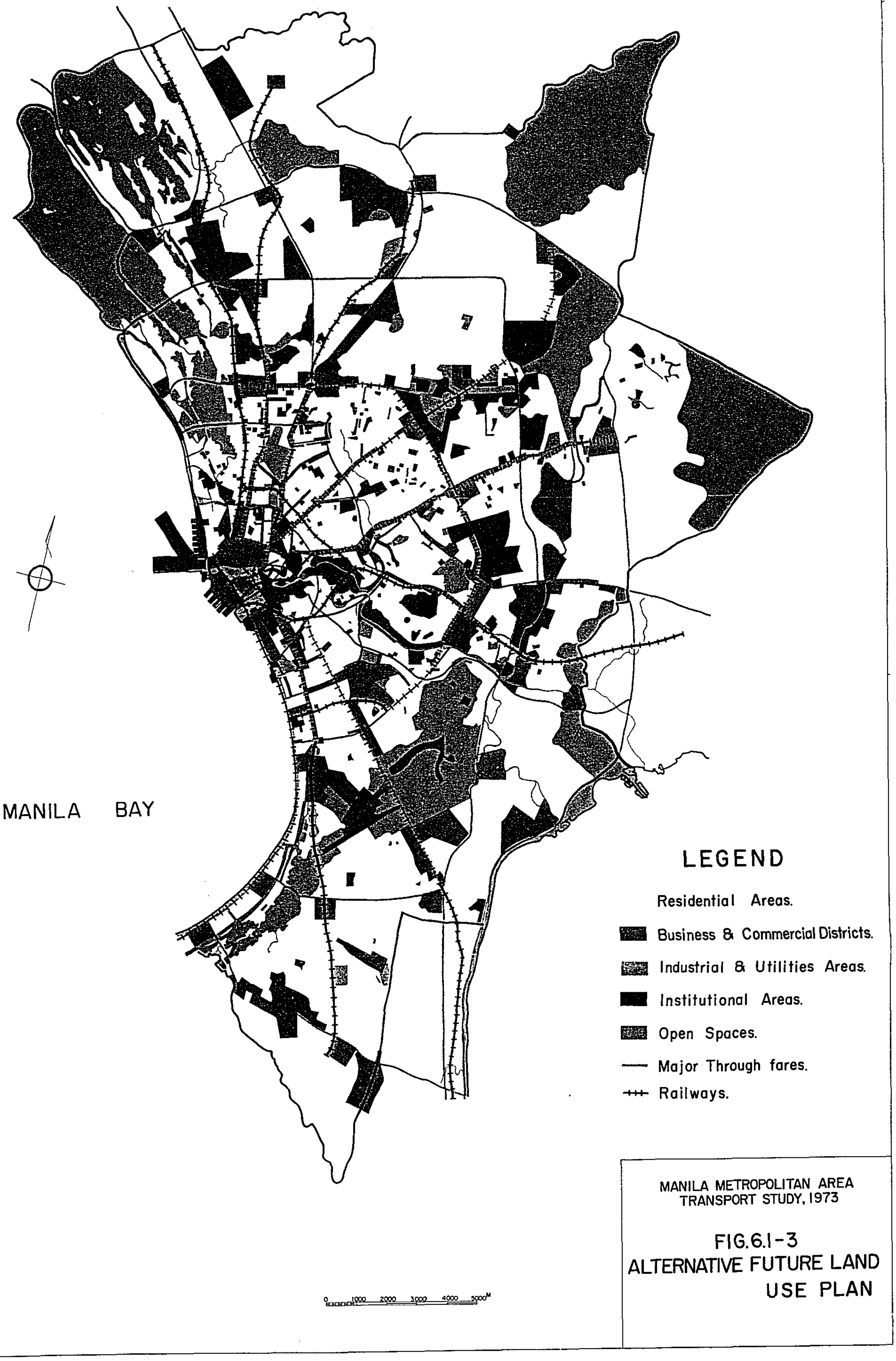

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FIG.6.1-3
ALTERNATIVE FUTURE LAND
USE PLAN

Table 6. 1-3 Future Land Use Plans

(ha.)

Plans	Land Use	Density (persons/ha)	1	2	3	4	5	6	7	8	9	10	11	12	13
Original	Residential Area	600	1		195	93	53	103	88	36	48	399	164	50	74
		450													
		300													
		250													
		200													
		150													
		Totals	1		195	93	53	103	88	36	48	399	164	50	74
	Industrial Area	250		30	41		35		2					23	102
		200													
		150													
		100													
		Totals		30	41		35		2					23	102
	Commercial Area	1,500	105	53	33	45	6	7	13	56	32	41	50	43	40
		500													
		400													
		300													
		Totals	105	53	33	45	6	7	13	56	32	41	50	45	40
	Institutional Area	500	5	6	14	42	5	10	10	19	5	34	4	88	32
	Open Space	-	6	23	8	3	3	11	0	0	120	5	0	27	22
	Totals	-	117	113	282	183	102	131	111	111	205	479	216	227	260
Alternative	Residential Area	600	1		195	93	53	103	88	36	48	399	164	50	74
		450													
		300													
		250													
		200													
		150													
			1		195	93	53	103	88	36	48	399	164	50	74
	Industrial Area	200													
		150		30	41		35		2					23	102
		100													
				30	41		35		2					23	102
	Commercial Area	1,000	105	53	23	45	6	7	13	56	32	41	50	45	40
		500													
		400													
		300													
		Totals	105	53	23	45	6	7	13	56	32	41	50	45	40
	Institutional Area	500	5	6	14	42	5	10	10	19	5	34	4	86	27
	Open Space	-	6	23	8	3	3	11	0	0	120	5	0	23	22
	Totals	-	117	112	282	183	102	131	111	111	205	479	218	227	263

Plans	Land Use	Density (persons/ha)	14	15	16	17	18	19	20	21	22	23	24	25	26
Original	Residential Area	600	73	135	83	11	106	26							
		450											358		
		300							263						
		250												1,113	
		200								231	415	794			
		150													4,535
		Totals	73	135	83	11	106	26	263	231	415	794	358	1,113	4,535
	Industrial Area	250	105	29	3	27		41	24						
		200													
		150												328	
		100								177	188	294			512
		Totals	105	29	3	27		41	24	177	188	294		328	512
	Commercial Area	1,500	15	30	16	88	100	59							
		500							31				50		
		400												25	
		300								52	31	150			158
		Totals	15	30	16	88	100	59	31	52	31	150	50	25	158
	Institutional Area	500	1	9	4	87	38	31	28	15	11	101	30	14	421
	Open Space	-	27	24	0	65	65	61	200	1,417	90	58	0	4	4,689
	Totals	-	221	227	106	276	307	218	544	1,832	733	1,397	438	1,484	10,375
Alternative	Residential Area	600	73	135	83	11	106	26							
		450											358		
		300							255						
		250												1,153	
		200								231	425	404			
		150													4,645
			73	135	83	11	106	26	253	231	425	404	358	1,153	4,643
	Industrial Area	200													
		150	105	29	3	27		41	14					258	
		100								177	136	244			412
			105	29	3	27		41	14	177	136	244		258	412
	Commercial Area	1,000	15	30	16	86	100	59					50		
		500							51						
		400												55	
		300								52	71	190			208
		Totals	15	30	16	86	100	59	51	53	71	190	50	55	208
	Institutional Area	500	1	9	4	87	38	31	28	15	11	101	30	14	421
	Open Space	-	27	24	0	65	65	61	200	1,417	90	44	0	4	4,689
	Totals	-	221	227	106	276	307	218	544	1,882	733	1,397	438	1,484	10,375

Plans	Land Use	Density (persons/ha)	27	28	29	30	31	32	33	34	35	36	37	38	39
Original	Residential Area	600													
		450													
		300	491		681		817		402	396	374		319		
		250													
		200		740		658		497				352		479	1,474
		150													
		Totals	491	740	681	658	817	497	402	396	374	352	319	479	1,474
	Industrial Area	250			22		27		137	48	29				
		200	35												
		150													
		100		1		3		104				41		5	206
		Totals	35	1	22	3	27	104	137	48	29	41		5	206
	Commercial Area	1,500													
		500			73		133		38	61	171		72		
		400	35												
		300		175		89		12				20		2	100
		Totals	35	175	73	89	133	12	38	61	171	20	72	2	100
	Institutional Area	500	42	530	41	116	88	343	161	35	7	3	35	34	18
	Open Space	-	10	44	0	35	151	38	34	114	8	112	8	360	449
	Totals	-	603	1,490	837	903	1,208	994	772	644	587	528	432	800	2,247
Alternative	Residential Area	600													
		450													
		300	481		871		807		402	396	374		299		
		250													
		200		740		628		497				352		489	1,594
		150													
			481	740	871	628	807	497	402	396	374	352	299	489	1,594
	Industrial Area	200													
		150	15		12		17		137	48	29				
		100		1		3		104				41		5	48
			15	1	12	3	17	104	137	48	29	41		5	46
	Commercial Area	1,000									171				
		500			103		143		38	61			92		
		400	55												
		300		175		119		12				20		13	140
		Totals	55	175	103	119	143	12	38	61	171	20	92	13	140
	Institutional Area	500	42	530	41	116	88	343	161	35	7	3	33	34	19
	Open Space	-	10	44	0	35	151	38	34	114	8	112	8	280	449
	Totals	-	603	1,490	837	903	1,206	994	772	644	587	528	432	800	2,247

Plans	Land Use	Density (persons/ha)	40	41	42	43	44	45	46	47	48	49	50	51	Totals
Original	Residential Area	600													1,736
		450													358
		300													3,753
		250													1,113
		200	272	1,094	270		287		1,674					3,115	12,363
		150				712		1,138		3,084	4,475	1,055	1,888		15,913
		Totals	272	1,094	270	712	287	1,138	1,674	3,084	4,475	1,055	1,888	3,115	35,255
	Industrial Area	250													725
		200													35
		150													328
		100	18		108	240	14	148	9	321	395	528	317	439	4,035
		Totals	18		108	240	14	148	9	321	395	528	317	439	5,103
	Commercial Area	1,500													832
		500													619
		400													80
		300	1	35	5	53	34		4	1	175	100	269	100	1,586
		Totals	1	35	5	53	34		4	1	175	100	269	100	3,067
	Institutional Area	500	4	4	5	3	14	1	2	1	49	43	161	11	3,789
	Open Space	-	292	260	293	105	0	390	0	305	793	437	2,388	135	13,504
	Totals	-	586	1,393	681	1,113	359	1,683	1,889	2,512	3,867	2,153	9,041	3,800	59,698
Alternative	Residential Area	600													1,736
		450													358
		300													3,483
		250													1,153
		200	282	1,094	290		287		1,444					3,045	12,372
		150				712		1,186		2,114	4,495	1,085	1,736		15,973
			262	1,094	290	712	287	1,186	1,644	2,114	4,495	1,085	1,736	3,045	35,275
	Industrial Area	200													
		150													968
		100	18		78	240	14	98	9	161	325	438	277	429	3,255
			19		78	240	14	98	9	161	325	438	277	428	4,223
	Commercial Area	1,000													1,045
		500													468
		400													110
		300	11	35	15	53	34	30	34	31	225	160	319	140	2,076
		Totals	11	35	15	53	34	30	34	31	225	160	319	140	3,717
	Institutional Area	500	4	4	5	3	14	1	2	1	49	43	161	11	2,769
	Open Space	-	292	260	293	105	0	390	0	205	793	437	2,388	175	13,884
	Totals	-	586	1,393	681	1,113	359	1,693	1,688	2,512	3,867	2,153	9,041	3,800	59,698

Table 6. 1-4 Future Population Distribution

(Persons)

Land Use Plans	Kinds of Population \ Zone Numbers	1	2	3	4	5	6	7	8	9	10	11	12	13
Original	Resident Population	600	0	117,000	55,800	31,800	61,600	31,600	31,600	28,800	239,400	98,400	30,000	44,400
	Number of Workers at Daytime: Totals	157,675	87,150	51,882	71,768	19,707	14,314	23,220	144,370	49,806	128,977	80,793	282,667	68,624
	Number of Workers at Daytime: Primary	0	0	0	0	0	0	0	0	0	0	0	0	0
	Number of Workers at Daytime: Secondary	0	7,500	10,250	0	8,750	0	500	0	0	0	0	5,750	25,500
	Number of Workers at Daytime: Tertiary	157,675	79,650	41,632	71,768	10,957	14,314	22,720	144,370	49,806	128,977	80,793	276,917	63,124
	Number of Students & School Children	163	0	31,829	15,180	8,651	16,812	14,037	84,477	7,635	104,436	26,767	57,288	13,079
Alternative	Resident Population	600	0	117,000	55,800	31,800	61,800	31,600	31,600	28,800	239,400	98,400	30,000	44,400
	Number of Workers at Daytime: Totals	105,175	57,650	38,382	49,268	13,207	10,814	16,520	118,370	33,806	106,477	55,783	157,867	58,424
	Number of Workers at Daytime: Primary	0	0	0	0	0	0	0	0	0	0	0	0	0
	Number of Workers at Daytime: Secondary	0	4,500	8,150	0	5,250	0	300	0	0	0	0	3,450	15,300
	Number of Workers at Daytime: Tertiary	105,175	53,150	30,132	49,268	7,957	10,814	16,220	118,370	33,806	106,477	55,783	154,417	43,123
	Number of Students & School Children	163	0	31,829	15,180	8,651	16,812	14,037	84,477	7,635	104,436	26,767	57,288	12,079

Land Use Plans	Kinds of Population \ Zone Numbers	14	15	16	17	18	19	20	21	22	23	24	25	26
Original	Resident Population	43,800	81,000	49,800	9,600	63,600	15,600	78,900	48,200	83,000	156,800	181,100	278,250	680,250
	Number of Workers at Daytime: Totals	51,300	57,178	27,721	138,321	154,563	100,418	27,678	51,933	30,327	82,370	35,056	75,638	151,750
	Number of Workers at Daytime: Primary	0	0	0	0	0	0	974	17,416	271	0	0	0	0
	Number of Workers at Daytime: Secondary	26,250	7,250	750	6,750	0	10,250	6,000	17,700	18,600	29,400	0	49,200	57,200
	Number of Workers at Daytime: Tertiary	25,050	49,928	26,971	131,571	154,563	90,168	20,704	16,817	11,456	52,970	35,056	26,438	94,555
	Number of Students & School Children	11,905	22,036	13,348	1,795	17,301	4,244	21,464	6,121	12,022	33,932	43,828	75,895	179,082
Alternative	Resident Population	43,800	81,000	49,800	9,600	63,600	15,800	75,900	48,200	85,000	160,680	181,100	288,250	696,750
	Number of Workers at Daytime: Totals	33,300	39,278	19,421	92,621	104,563	66,816	32,778	51,933	37,327	68,370	60,056	77,138	150,755
	Number of Workers at Daytime: Primary	0	0	0	0	0	0	974	17,416	271	0	0	0	0
	Number of Workers at Daytime: Secondary	15,750	4,350	450	4,050	0	6,150	2,100	17,700	13,600	24,400	0	38,700	41,200
	Number of Workers at Daytime: Tertiary	17,500	34,928	18,971	88,571	104,563	60,666	30,704	16,817	23,456	44,970	60,056	38,438	109,555
	Number of Students & School Children	11,905	22,036	13,348	1,795	17,301	4,244	21,464	6,121	12,022	33,932	43,828	75,895	179,082

Land Use Plans	Kinds of Population \ Zone Numbers	27	28	29	30	31	32	33	34	35	36	37	38	39
Original	Resident Population	147,300	148,000	207,300	131,600	245,100	99,400	120,600	118,800	112,200	70,400	55,700	95,800	294,800
	Number of Workers at Daytime: Totals	28,564	92,036	55,004	35,643	76,638	28,317	59,008	44,858	94,559	11,215	42,369	7,494	60,685
	Number of Workers at Daytime: Primary	0	0	0	0	0	0	0	0	0	0	0	0	5,378
	Number of Workers at Daytime: Secondary	5,000	100	5,500	300	6,750	10,400	34,250	12,000	7,250	4,100	0	500	20,600
	Number of Workers at Daytime: Tertiary	23,564	91,936	49,504	35,343	69,888	17,917	24,758	32,858	87,309	7,115	42,369	6,994	34,707
	Number of Students & School Children	40,071	69,947	58,394	27,888	33,519	27,041	11,054	10,889	10,285	6,453	26,035	28,061	27,022
Alternative	Resident Population	144,300	148,000	201,300	135,400	242,100	99,400	120,600	118,800	112,200	70,400	69,700	93,800	516,800
	Number of Workers at Daytime: Totals	33,814	92,036	86,304	44,643	82,438	28,317	45,308	40,058	177,159	11,215	52,369	10,494	56,685
	Number of Workers at Daytime: Primary	0	0	0	0	0	0	0	0	0	0	0	0	5,378
	Number of Workers at Daytime: Secondary	2,250	100	1,800	300	3,550	10,400	20,550	7,200	4,350	4,100	0	500	4,600
	Number of Workers at Daytime: Tertiary	31,564	91,936	84,504	44,343	78,888	17,917	24,758	32,858	172,809	7,115	52,369	9,994	46,707
	Number of Students & School Children	40,071	69,947	56,394	27,888	33,519	27,041	11,054	10,889	10,285	6,453	26,035	28,061	27,022

Land Use Plans	Kinds of Population \ Zone Numbers	40	41	42	43	44	45	46	47	48	49	50	51	Totals
Original	Resident Population	34,400	218,800	56,000	106,800	59,400	173,400	334,800	312,600	871,250	158,250	284,400	823,000	7,466,200
	Number of Workers at Daytime: Totals	4,750	39,135	17,157	42,599	14,883	18,882	34,195	30,096	102,977	86,153	128,600	91,711	3,332,939
	Number of Workers at Daytime: Primary	1,410	23,139	3,395	0	1,447	0	23,828	0	0	0	8,266	8,477	94,001
	Number of Workers at Daytime: Secondary	1,900	0	10,800	24,000	1,400	14,600	900	22,100	39,500	52,800	31,700	43,900	637,950
	Number of Workers at Daytime: Tertiary	1,440	15,996	2,962	18,599	12,035	4,282	9,467	7,996	63,477	33,353	88,634	39,334	2,600,988
	Number of Students & School Children	8,319	48,882	11,565	22,874	12,723	37,139	71,708	68,953	61,527	14,506	26,069	57,104	1,632,520
Alternative	Resident Population	53,400	218,800	58,000	106,800	59,400	177,900	328,800	317,100	674,250	162,750	280,400	608,000	7,168,200
	Number of Workers at Daytime: Totals	7,750	39,135	17,157	42,389	14,883	19,882	43,195	33,098	110,977	95,152	139,800	02,711	3,083,169
	Number of Workers at Daytime: Primary	1,410	23,139	5,395	0	1,447	0	23,828	0	0	0	8,266	8,477	94,001
	Number of Workers at Daytime: Secondary	1,900	0	7,800	24,000	1,400	9,600	900	16,100	32,500	43,800	27,700	42,900	470,700
	Number of Workers at Daytime: Tertiary	4,400	15,996	5,962	18,599	12,035	10,282	18,467	16,998	78,477	51,352	103,834	51,334	2,518,468
	Number of Students & School Children	8,319	48,862	11,565	23,874	12,723	37,139	71,708	68,953	61,527	14,506	26,069	57,104	1,632,520

§ 6.2 Total Number of First Trips

In this section, the total number of trips is estimated by purpose as a control total. The number of trips is that of first trips, since the estimating method is based upon the concept of the trip purpose correlation mentioned above. For that purpose the unit number of producted trips must be decided for each kind of population. This unit number of trips is multiplied by the population by kinds. As far as work trips and going to school trips are concerned, every worker and student makes one trip for his own purpose. Therefore, it is not necessary to estimate the unit trip production for these purposes, because the only necessary treatment is to subtract the number of persons who just walk to their working places or studying places from the total workers or students. This calculation is made in the process of estimating the trip distribution.

6.2.1 Number of first trips per person producted for private and work purposes.

It is well-known that the trip production is influenced by the occupation and the car ownership. According to the person trip survey, the relations between the production of the first trip for the private and work purposes and the occupation and car ownership is to be considered as shown by Table 6. 2-1. This table indicates the following facts.

There are not found the relations between the private trips and work trips by occupation, because even if some occupations produce a lot of private trips, they do not necessarily produce so many work trips. As far as private trips are concerned, housewives show the largest value and the school children show the smallest. Administrative workers show larger values among workers. Trip production being considered by car ownership, car owners show larger values with few exceptions. Car owners produce more trips by about 50% and non-owners do less by about 20% than the average of both. On the other hand, in the case of work trips, car owners show 50% larger values of trip production and non-owners show 20% smaller values with the large amount of the variance. It is conspicuous that in workers in the transport industry, the ratio between car owners and non-owners is 16:1.

The reason is explained as follows why the difference between car owners and non-owners of workers in the transport industry amounts to such a large value. A part of workers in the transport industry have to make far more trips than workers in other industries and have to own cars for their occupational requirements. A "car" means a passenger car privately owned. But this kind of private automobile is also used for work purpose in Manila, and it is popular to hold such a car privately for the work purpose. Then, there is very close relations between the production of work trips and the car ownership.

As mentioned above, the result of this survey is very reasonable and agrees very well to the facts which we know from our experiences. Nevertheless, the multivariate analysis is made for the purpose of eliminating the deviations and exceptions in the survey results.

The Quantitative Model Type I is reasonable to be applied as one of the multivariate analysis, judging from the nature of data.

In this analysis are treated the number of the first trip productions as an external standard (dependent variable) and occupation and car ownership as factors (items). As there are few relations between private trips and work trips, they are calculated independently. The trip production of workers in the transport industry is excluded from the data, because there is an interaction between trip production and car ownership in the workers. Therefore, car ownership is enough to have two categories in every case, while occupation has twelve categories for private trips and seven categories for work trips. Since car ownership does not have a linear effect but a multiplicative effect on the trip production, the data are transformed into logarithmic terms.

The computation result is shown in Table 6.2.2. Both items, occupation and car ownership have strong effects on trip production. And the former is a little stronger than the latter judging from the partial correlation coefficient. This result is used for the future estimation, because the multiple correlation coefficient is large enough. Work trip production of workers in the transport is left as surveyed in the estination.

6.2.2 Population by occupation and car ownership

Since the unit trip production has been settled by occupation and by car ownership, and the occupation of the resident population in the study area is the population given in the future plan by the Philippine Government, it is necessary to break down each occupation by the car ownership.

According to the person trip survey, the number of the households owning cars is 125,000, 24.8% of which possess two or more cars. This result suggests the total number of vehicles of 156,000, and this is slightly more than the number of registered vehicles, 150,000, as shown in Table 6.1-2. The car ownership by occupation is adjusted as shown in Table 6.2-3 in order to get the total number of vehicles of 150,000 in accordance with the number of registered vehicles.

Table 6.2-3 estimates that the number of passenger cars which is now 150,000 will be 648,000 in future. This means the number of passenger cars in future will be 4.33 times as much as at present. The population over six years old is now 3,086,000 and will be 5,961,000 in future. This means the future population will be 1.93 times as much as that of today. Therefore, the car ownership rate will be 2.24 times as much (4.33 ÷ 1.93 = 2.24). On the assumption that the number of households which possess two cars or more will increase by the same rate, the proportion of the households owning one car to the total number of households will change from 1.51% to 19.4% and the proportion of households with two vehicles or more will change from 5% to 12.8% and the proportion of car owning households to the total will change from 20.1% to 32.2%. Then the car ownership rate increases 1.60 times as much (32.2 ÷ 20.1 = 1.60). Assuming that the car ownership of every occupation will increase proportionately to this increasing rate, and adjusting the average rate of car ownership to 32.2%, the car ownership of each occupation is obtained as shown in Table 6.2-3.

Table 6.2-4, obtained by applying this car ownership rate to the forecasted number of population by occupation, shows the number of population by occupation and car ownership.

6.2.3 Total number of trips within study area

Through the unit first trip production in Table 6.2-2 and the population by occupation and car ownership in Table 6.2-4, 1,494,000 and 1,148,000 trips are obtained as the numbers of first trips of private purpose and work purpose respectively. In this case, the number of trips was calculated based on the number of people living inside the study area and there would be no problem as far as the private trips are concerned. But the number of work trips will increase proportionately to the number of workers in the area, neglecting the difference of the occupational constitution and car ownership ratio between resident people and workers in the area. The number of workers living in the area is 2,838,000 according to Table 6.2-4. The number of workers working in the area are different by land use plan. The number of workers of the original land use plan is 3,333,000 and that of the alternative plan 3,083,000, respectively. Then the number of first trips of work purpose would be 1,348,000 in the case of the original plan and 1,246,000 in the alternative plan.

Those trips include not only internal trips but also outbound trips which go beyond the boundary of the study area. The number of internal trips and outbound trips can be obtained, applying to the total number of first trips the same ratio between the number of internal trips and outbound trips as given in the present OD table. The result is shown in Table 6.2-5, together with the number of resident workers and students (including school children) shown in Table 6.2-4. The number of internal trips and outbound trips are used as control totals of the trip distribution, the former for internal OD table and the latter for outbound and then inbound OD table of trips made by the people living inside respectively.

Table 6.2-1 First Trip Production as Surveyed

(Trips/Person)

Occupation \ Car Ownership \ Trip Purposes		Private			Work		
		Car Owners	Non Owners	Average	Car Owners	Non Owners	Average
1	Professional Workers	0.435	0.128	0.233	0.249	0.107	0.155
2	Administrative Workers	0.645	0.260	0.437	0.369	0.415	0.392
3	Clerical Workers	0.301	0.074	0.122	0.120	0.084	0.091
4	Sales Workers	0.526	0.216	0.289	0.742	0.742	0.742
5	Farmers	0.495	0.229	0.260	1.671	0.301	0.460
6	Workers in Transport	0.212	0.084	0.107	2.879	0.181	0.687
7	Craftsmen	0.315	0.128	0.146	0.398	0.188	0.207
8	Service Workers	0.107	0.117	0.115	0.405	0.279	0.324
1-8	Average	0.320	0.136	0.184	0.541	0.279	0.340
9	School Children	0.031	0.014	0.016	-	-	-
10	Students	0.115	0.060	0.076	-	-	-
9-10	Average	0.084	0.037	0.047	-	-	-
11	Housewives	0.905	0.585	0.635	-	-	-
12	Joblesses	0.550	0.352	0.379	-	-	-
11-12	Average	0.728	0.462	0.501	-	-	-
1-12	Average	0.311	0.188	0.214	-	-	-

Table 6.2-2 First Trip Production as Analysed

(Trips/Person)

Occupation \ Car Ownership \ Trip Purposes	Private		Work	
	Car Owners	Non Owners	Car Owners	Non Owners
1. Professional Workers	0.330	0.159	0.217	0.123
2. Administrative Workers	0.592	0.283	0.518	0.295
3. Clerical Workers	0.215	0.103	0.133	0.074
4. Sales Workers	0.486	0.233	0.981	0.560
5. Farmers	0.486	0.233	0.939	0.534
6. Workers in Transport	0.191	0.091	2.879*	0.181*
7. Craftsmen	0.289	0.138	0.363	0.207
8. Service Workers	0.161	0.078	0.444	0.253
9. School Children	0.024	0.011	-	-
10. Students	0.120	0.059	-	-
11. Housewives	1.047	0.502	-	-
12. Joblesses	0.634	0.304	-	-
Correlation coefficient — Partial	Occu-pation	Car Ownership	Occu-pation	Car Ownership
	0.98	0.89	0.92	0.70
Correlation coefficient — Multiple	0.98		0.93	

* As Surveyed

Table 6.2-3 Present and Future Ratio of Car Owners by Occupation

Occupation \ Year	Present (1970-71)	Future (1987)
Professional Workers	0.329	0.528
Administrative Workers	0.438	0.703
Clerical Workers	0.212	0.341
Sales Workers	0.231	0.371
Farmers	0.110	0.176
Workers in Transport	0.180	0.288
Craftsmen	0.086	0.138
Service Workers	0.356	0.571
School Children	0.167	0.268
Students	0.215	0.345
Housewives	0.150	0.240
Joblesses	0.136	0.218
Average	0.201	0.322

Table 6.2-4 Future Population by Occupation and Car-Ownership

(1,000 Persons)

Car Ownership / Occupation	Owners	Non-Owners	Totals
Professional Workers	175	156	331
Administrative Workers	62	26	88
Clerical Workers	111	214	325
Sales Workers	110	187	297
Farmers	17	77	94
Workers in Transport	108	266	374
Craftsmen	92	573	665
Service Workers	379	285	664
Sub-Totals	1,054	1,784	2,838
School Children	170	463	633
Students	344	656	1,000
Sub-Totals	514	1,119	1,633
Houswives	295	931	1,226
Joblesses	58	206	264
Sub-Totals	353	1,137	1,490
Grand Totals	1,921	4,040	5,961

Source: Estimated by Occupation by Manila Team and broken down by car ownership by Japanese Team.

Table 6.2-5 Total Number of Persons and First Trips by Area

(1,000 Persons or trips)

Trip Purposes \ Ratio or Number \ Land Use Plans \ Area			Internal	External	Totals
Workers	Ratio 1)	-	0.985	0.015	1.000
	Number 2)	-	2,796	42	2,838
Students Incl. School Children	Ratio 1)	-	0.998	0.002	1.000
	Number 2)	-	1,630	3	1,633
Private Trips	Ratio 1)	-	0.975	0.025	1.000
	Number	-	1,457	37	1,494
Works Trips	Ratio 1)	-	0.938	0.062	1.000
	Number	Original	1,264	84	1,348
		Alternative	1,169	77	1,246

Remarks: 1) Calculated from the present OD tables of the person trip survey.

2) Based upon Table 6.2-4, Refer to Table 6.4-5 regarding to the number of first trips.

§ 6.3 Trip Generation and Attraction

When the trip generation and attraction are classified according to trip purposes it is easier to settle factors used for the estimation. Especially the factors used to estimate the trip generation are limited to the factors related to the generation of first trips, since the trip purpose correlation method is adopted. The number of the second and thereafter trips can be automatically calculated in the process of calculating the trip distribution.

Trip generation and attraction are used only for the purpose of deciding the relative weight among zones, because there have been estimated the total trip generation and attraction, as control total in the preceding section 6.2 in this chapter.

The relation in each trip purpose between the trip generation and attraction and factors given by Table 6.3-1 is obvious and would not need any explanation.
The trip generation of commuting to work and going to school purposes are proportional to resident population, and the trip attraction of these purposes are proportional to the numbers of workers at work place and students at study place respectively. And the trip generation of private purpose would be proportional to the number of resident population and the attraction to the number of the workers in the tertiary industry.

As far as work trips are concerned, the trip generation and attraction would be equal. Since the workers in each industry seem to influence differently the trip generation and attraction, the multiple correlation analysis is made in several times to find the most suitable result. Through the person trip survey are obtained all data necessary for this multiple correlation analysis, the trip generation and attraction and the number of workers at work place by industry.

According to the basic concept mentioned above, the relative generation and attraction of first trips by purpose are estimated for the two land use plans respectively, based upon the population distribution in Table 6.1-4.

Table 6.3-1 Factors Estimating Trip Generation and Attraction of First Trips

Factors \ Trip Purposes / Generation or Attraction		Commuting to Work		Going to School		Private		Work	
		Generation	Attraction	Generation	Attraction	Generation	Attraction	Generation	Attraction
Resident Population		o		o		o			
Number of Workers at Work Place	Totals		o						
	Primary								
	Secondary							o*	o*
	Tertiary						o	o*	o*
Number of Students & School children at Daytime					o				

* The equation of estimate generation and attraction of the work trip is given as follows based upon the multiple regression analysis.

$$Y = 1050 + 0.185 X_1 + 0.486 X_2$$

$$R = 0.93$$

Y : Generation and Attraction of Work Trips
X_1 : Number of workers of Secondary Industry at Daytime
X_2 : " Tertiary "
R : Multiple correlation coefficient

§6.4 Trip Distribution

In this section, the future trip distribution is estimated using the production of first trips, the transition probability between trip purposes, and trip generation and attraction of each zone. As the gravity model is incorporated in the estimating process, the time distance between zones and its exponent are to be decided beforehand. The former is obtained based on the future transportation network and the latter by applying the gravity model to the present trip distribution.

The estimation will be made by trip purpose naturally. Private and work trips are estimated directly based upon the data mentioned above. On the other hand, only the resident population, daytime workers and daytime students, are given as far as it concerns commuting to work trips and going to school trips. Accordingly, comparison is made at first between the present OD table of commuting to work trip and the table showing the present relation of residence and work place and between two similar tables concerning going to school trips. Then can be found ratios of those workers and students in each zone pairs who walk from their home to the place of work and school for commuting, including the workers who do not make any trip, since they have their home and the place of work in the same buildings. The future OD tables of commuting to work trips and going to school trips are estimated by excluding walking trips from the tables showing the future relation of residence and working and studying zone pairs using the ratios estimated above.

6.4.1 Time distance between zones and its exponent in gravity model

The exponent of the time distance between zones in the gravity model is estimated by trip purpose through the least square method applied to the relation between the present OD tables and the present travel time of zone pairs. This calculation is made based upon 15 sectors instead of 51 zones.

The time distance between sectors is decided under the following principles.

(1) The zone center is settled at the gravity center considering the density of the trip generation.

(2) The travel speed and distance depends on the speed and route of bus and jeepney services, since both carry the most part of the person trips. This speed is decided according to the travel time survey as follows: 8 km/hr. in the CBD, 10 km/hr. in the inner area and 15 km/hr. in the outer area.

(3) Factors considered are the waiting time (5 - 15 min.) based on the service frequency of buses and jeepneys, transferring time (3 - 15 min.) decided by the operating route and the walking time (3 min.) decided by the density of the service route.

Table 6.4-1 shows the exponents derived from the above data. The results are considered to be reasonable because of the following reasons.

(1) The correlation coefficient is large enough for this kind of computation.

(2) The value of the exponent of travel time is almost included in the normal range.

(3) The exponent has the relation with trip length. The larger the exponent is the more strongly trips are influenced by the travel time and the shorter the trip length is and vice versa. The exponent of the relations between residence zone and working or studying zones shows large values. This is natural since it includes short trips on foot and persons working in the same buildings as they live.

(4) These exponents are arranged according to the value from the smallest as follows: work, private, relation between residence and working zone and relation between residence and studying zones. This result agrees with our experience.

When these exponents are applied for the estimation in 51 zones, the value of each exponent is multiplied by 1.23 based on the change of travel time, because these exponents are obtained by analyzing the traffic distribution between 15 sectors. The time distance between zones in future is estimated by the same method as used for the present. But since the rapid mass transit is introduced in future, the following principles are added.

(1) Comparison is made in the travel time between two routes of buses or jeepneys and the rapid mass transit. The faster route and travel time are adopted for a zone pair.

(2) The terminal travel time from the zone center to the station is added to the travel time by the rapid mass transit. The terminal travel time consists of the faster way from the two, i.e. walking at the speed of 4 km/hr. and taking a bus or jeepney. Waiting time, transferring time and walking time are

Table 6.4-1 Exponent of Travel Time

Items \ Trip Purposes		Residence & Place of Work	Residence & Place of School	Private	Work
Result of Multiple Regression Analysis	Multiple Regression Coefficient	0.88	0.80	0.82	0.74
	Exponent of Travel Time between Zones in Gravity Model	1.63	2.15	1.35	1.27
For Estimation		2.00	2.64	1.66	1.56

The Gravity Model is as follows:

$$Xij = \alpha w_i w_j t_{ij}^{-\gamma}$$

Xij : Number of Trips between Zones i and j

wi : Sum of Trip Generation and Attraction in Zone i

tij : Travel Time between Zones i and j

α : Constant of Proportion

γ : Exponent of Travel Time

and γ are estimated in the Model by the Least Square Method, and is eisted in the Table.

considered in every mode of travel.

(3) The intrazonal travel time is estimated by calculation using the gravity model and data, i.e. the exponents in Table 6.4-1, the present number of intrazonal trips and the present trip generation in order to get coincidence with the present pattern at least.

6.4.2 Ratio of basic trips of commuting to work and going to school purposes

In the above estimation are included those persons who need just walking to commute to work and to go to school or who do not need to make any trips, because their living place and working place is the same. Therefore, the OD table obtained first is not that of commuting to work trips nor going to school trips but the OD table showing the relations between residence zone and working or studying zone. In order to get the ratio of basic trips (trips using transportation means and excluding the number of persons walking and making no trip), the present OD tables and the tables showing relations between residence zones and working and studying zones are analyzed according to the following principles.

(1) Persons who walk and do not make trips are found only in the persons having the residence and the place of working (studying) in the same zone or the adjacent zones.

(2) The ratio of the basic trips of commuting to work (going to school) trips in the same zone is as follows:

$$\frac{\text{The number of intrazonal commuting to work (going to school) trips}}{\text{The number of persons working (studying) in the same zone as they live}}$$

This ratio shows the characteristics of each zone. The average value of all zones belonging to the same sector is applied for all zones in the sector, neglecting the small variation among these zones.

(3) The ratio of the basic trips of each zone in future would be the same as present except the sector C.

(4) In the sector C, the following characteristics is considered:

(a) The area of the zone is very large.

(b) This sector experiences the rapid increase of the population and the traffic pattern will be changed drastically.

The ratio of the basic trip will increase proportionally to the following:

$$\frac{\text{The average ratio calculated in the whole sector belonging to the sector B of basic trips of commuting to work (going to school) trips}}{\text{The average ratio calculated by zone belonging to the sector C of basic trips of commuting to work(going to school) trips}}$$

The area of each zone in the sector C is almost the same as the area of each zone belonging to the sector B, and the urbanization of the sector C in future would be almost the same as that of the sector B at present.

(5) The ratio of the basic trips between adjacent zones is expressed by the following:

$$\frac{\text{The number of basic trips of commuting to work (going to school) between adjacent zones}}{\text{The number of workers (students) living and working (studying) in adjacent zones.}}$$

After a careful consideration, this ratio is set at 1 in the sectors B and C, since it is almost 1 at present and furthermore becomes near to 1 as the trip generation increases in future. In the sectors CBD and A can not be found a big difference of the ratio of the basic trips among zone-pairs except a few pairs showing an abnormal ratio. Accordingly, the average ratio is applied to the almost all zone pairs.

Based on these principles, the basic trip ratios of commuting to work and going to school are converted from the surveyed value to the analyzed value as shown in Table 6.4-2. The OD tables are derived from the tables showing the distribution between residence zones and working and studying zones through the above analyzed ratio.

Table 6.4-2 Ratio of Basic Trips [1)] of Commuting to Work and Going to School

Within Zone

Sectors	S.A.	Zones	Commuting to Work: Surveyed	Commuting to Work: Analyzed	Going to School: Surveyed	Going to School: Analyzed
CBD	1	1, 2, 12		0.100		0.239
	2	17, 19		0.256	0.940 [1)]	0.451
		Averages	0.131		0.287	
A	1	3, 4, 5, 6, 7,		0.172		0.311
	2	8, 9, 11, 24		0.093		0.255
	3	10, 13		0.105		0.263
	4	14, 15, 16, 18		0.140		0.329
		Averages	0.135		0.297	
B	1	20, 21, 22, 40		0.260		0.375
	2	23, 25		0.093		0.308
	3	27, 28, 29		0.223		0.349
	4	31, 33		0.219		0.494
	5	34, 35, 36, 37		0.273		0.358
		Averages	0.222		0.374	
C	1	41, 42, 43, 44, 45, 46, 47	0.198	0.296	0.446	0.571
	2	26	0.267	0.399	0.179 [2)]	0.603
	3	30, 32, 48, 49	0.345	0.518	0.523	0.669
	4	38, 39, 50, 51	0.223	0.333	0.475	0.608
		Averages	0.289		0.475	
Averages			0.212		0.374	
CBD			0.412		0.507	
A			0.316		0.494	
B			0.432		0.608	
C			0.552		0.612	
Averages			0.432		0.568	

Between Adjacent Zones

Sectors	Zone Pairs	Commuting to Work: Surveyed	Commuting to Work: Analyzed	Going to School: Surveyed	Going to School: Analyzed
CBD1	1-2, 1-12	0.846	0.860	0.588	0.742
CBD2	17-19	3)	1.000	3)	1.000
A 1	3-5, 4-5, 4-7, 5-6, 5-7, 6-7	0.735		0.543	
A 2	8-9, 8-11, 9-11, 11-24	0.765	0.860	0.766	0.742
A 3	10-13	0.968		0.586	
A 4	14-15, 14-16, 15-16, 15-18, 16-18	0.782		0.349	
CBD1-CBD2	1-19, 2-19	3)		3)	
CBD1-A1	1-4, 1-5, 2-3	0.925			
CBD1-A2	1-8, 8-12	0.762	1.000	0.698	1.000
CBD1-A3	10-12, 12-13	0.909		3)	
CBD1-A4	12-14	3)			
CBD2-A4	14-17, 16-17, 17-18	0.657			
A1 - A2	4-8, 4-9, 7-9	0.512	0.860	0.485	0.742
A2 - A3	10-11, 10-24	0.669		0.619	
A3 - A4	13-14	3)		3)	
	Averages	0.860		0.742	

Remarks:

1) Ratio of basic trips = (The number of commuting to work (going to school) trips between the corresponding zones or sectors.) / (The number of workers (students) living in a zone or sector and working in a zone or sector.)

2) The ratio of commuting to work trips is used as the analyzed value after being multiplied by the ratio of the going to school basic trip ratio to the commuting to work basic trip ratio.

3) This value is excluded from the calculation.

6.4.3 Transition probability between trip purposes

The distribution of first trips are based on the principles mentioned up to here. The transition probability between trip purposes are necessary to estimate the trip distribution of the second trip and following trips. Table 6.4-3 shows the ratio between the purpose of the first trip and the purpose of the second trip and following trips.

The following 5 cycle patterns are neglected because the number of trips of those cycles are very few in this table: commuting to work ——► commuting to work, going to school ——► going to school, going to school ——► commuting to work, going to school ——► work, and work ——► going to school. The following 2 cycle patterns are treated as the cycle pattern of work ——► work, because a commuting to work trip in this cycle pattern resembles a work trip in its characteristics: commuting to work ——► work and work ——► commuting to work. The transition probability are obtained in Table 6.4-4 from Table 6.4-3 through calculation.

6.4.4 OD distribution of person trips

Now complete are all data required to estimate the transition probability by the entropy method incorporating the gravity model, i.e. the first trip generation and attraction, travel time of zone pairs, its exponent and the ratio of basic trips in commuting to work and going to school purposes. OD tables of person trips can be obtained by cycle pattern and trip purpose through the trip purpose correlation method based upon the transition probability between zones, the number of first trips and the transition probability between trip purposes.

A brief explanation is given about the method to estimate the trip distribution. The entropy method based upon the probability characteristics of traffic and calculates the trip distribution from the probability that a trip generating in a certain zone is attracted to a certain zone. This probability, i.e. the transition probability of pair zones is decided basically by the gravity model. The trip purpose carrelation method treats the trips made by a person as a chain of trips, i.e. a cycle having an attribute of the probability and calculates the distribution of the second and thereafter trips, when that of the first trips is given.

If computation is made for commuting to work trips or going to school trips based upon the above-mentioned input data, a kind of OD tables is obtained representing

Table 6.4-3 Relationship between Trip Purposes

(Ratio of 2nd & Thereafter Trips to 1st Trips)

1st Trips \ 2nd & Thereafter Trips	Commuting to work	Going to School	Private	Work
Commuting to Work	0.0000*	0.0343	0.0819	0.0000**
Going to School	0.0000*	0.0000*	0.0338	0.0000*
Private	0.0757	0.0389	0.4661	0.0893
Work	0.0000*	0.0000*	0.0782	0.3832

Remarks: * Relationship to be neglected.

** Relationship to be transferred to another relationship.

Table 6.4-4 Transition Probability between Trip Purposes

From \ To	Commuting to Work	Going to School	Private	Work
Commuting to Work	0.000	0.069*	0.056	0.000
Going to School	0.000	0.000	0.023	0.000
Private	0.052	0.019	0.312	0.044
Work	0.000	0.000	0.039	0.275

Remarks: * Calculated based upon the ratio of the future number of night students to that of workers instead of 0.033 calculated from the Table 6.4-3.

the relation between living zones and working or studying zones. After the ratio of basic trips is applied in Table 6.4-2 to the above table, an OD table of basic trips is obtained for commuting to work purpose or going to school purpose. Table 6.4-5 shows the total number of trips. If there cannot be found the difference of the total number of workers or students, but of their distribution between the two land use plans, the number of basic trips would be different. This is the reason why this table has two numbers of basic trips. The total numbers of commuting to work trips and going to school trips include the second trips made after trips of the other purposes. Then the number of commuting to work trips and going to school trips which is calculated as the first trip must be smaller by the number of the second trips than the total number of the trips of each purpose. The number of the second trips is computed by the number of the first trips of private purpose given by Table 6.2-5 and the transition probability in Table 6.4-3 from private purpose to commuting to work and going to school purposes. The above-mentioned input data give directly the transition probability of zone pairs for private and work purposes, since these data concern only basic trips from the first.

Now the trip purpose correlation method calculates the OD distribution based upon the transition probability between zones of the first trips of each purpose. In this calculation arises the combination of trip purposes. In the simple case of commuting to work only two OD tables are obtained of going trips and returning (to home) trips. But in the complex cycle pattern of commuting to work -- private, three OD tables are obtained of commuting to work, private and to home.
According to the transition probability between trip purposes shown in Table 6.4-4, twenty nine sheets of OD tables are required to be computed for eleven cycle patterns.

The computation amounts to a big volume. There are shown the total numbers by cycle pattern and trip purpose in Table 6.4-6, the trip generation and attraction by trip purpose in Tables 6.4-7 and 6.4-8 and the trip distribution of all purposes arranged in 15 sectors in Tables 6.4-9 and 6.4-10. Two alternative land use plans give two tables for the above all.

Table 6.4-5 Future Total Number of Basic Trips of Commuting to Work and Going to School

(1,000 Trips)

Land Use Plan / Trip Purpose / 1st, 2nd	Original		Alternative	
	Commuting to Work	Going to School	Commuting to Work	Going to School
1st	1,745	1,017	1,660	1,005
2nd	110	40 (160)	110	40 (155)
Totals	1,855	1,057 (1,177)	1,770	1,045 (1,160)

Remarks: ( ) includs the number of trips "Going to School" from "Commuting to Work", which is equal to the number of students at night.

Table 6.4-6 Future Numbers of Trips by Cycle Pattern and Trip Purpose

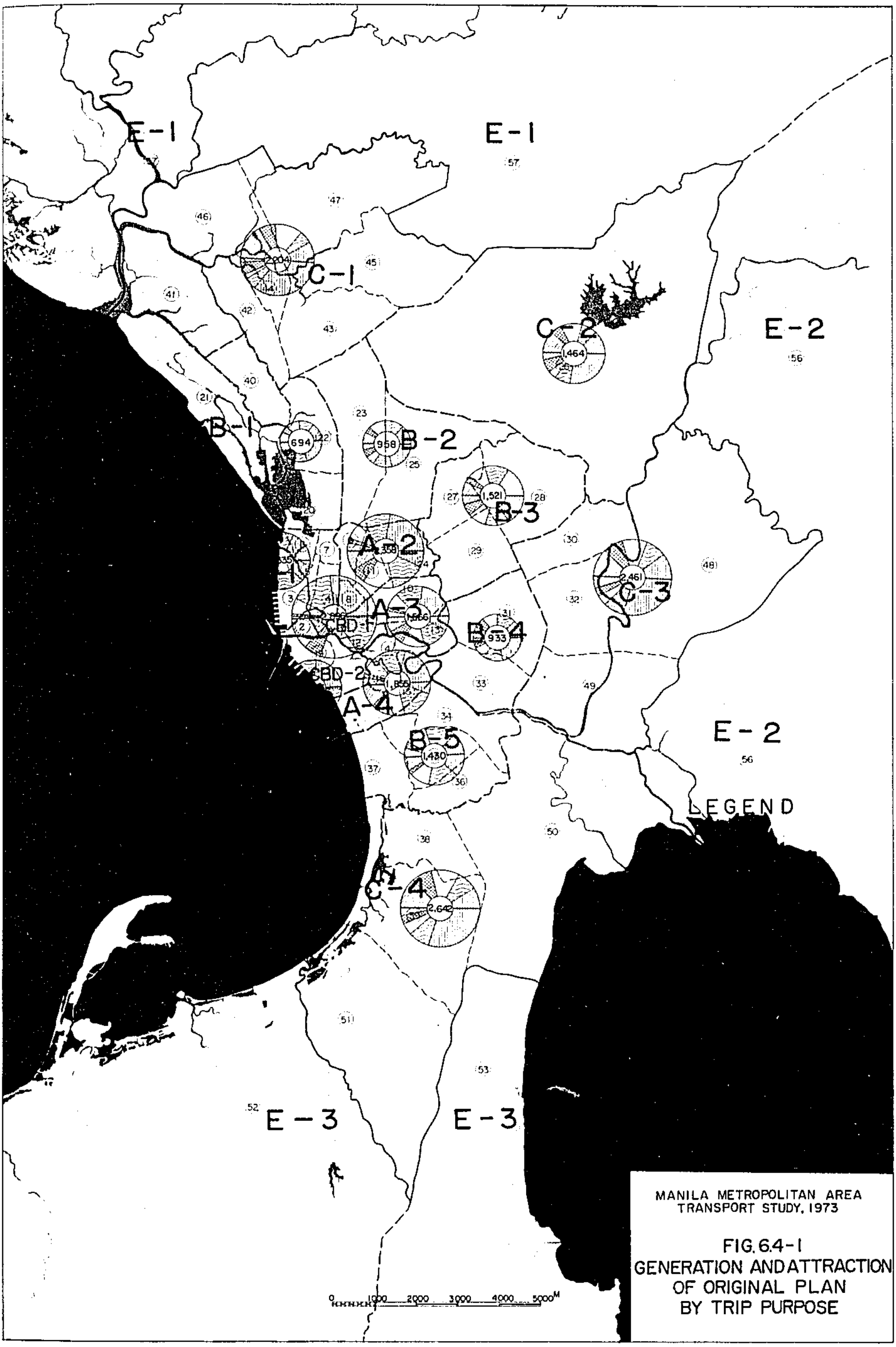
(1,000 Trips)

1st Trip Purposes \ 2nd Trip Purposes \ Land Use Plan	Original						Alternative					
	Commuting to Work	Going to School	Private	Work	Tables of 1st	Totals of 1st & 2nd	Commuting to Work	Going to School	Private	Work	Totals of 1st	Totals of 1st & 2nd
Commuting to Work	1,527 1,527	120 120 120	98 142 98	—	1,745 To Home 1,745	1,855	1,452 1,452	115 115 115	93 135 93	—	1,660 To Home 1,923	1,770
Going to School	—	994 994	23 34 23	—	1,017 To Home 1,017	1,177	—	982 982	23 34 23	—	1,005 To Home 1,105	1,160
Private	160 110 110	58 40 40	1,764 1,213	135 128 129	2,117 To Home 1,492	2,392	— 110 110	59 40 40	1,764 1,213	135 129 129	2,118 To Home 1,492	2,378
Work	—	—	— 99 99	— 1,650 1,196	1,744 1,295	3,167	—	—	87 91 91	1,526 1,106	1,613 1,197	2,938
Totals of 2nd	110	160	275	128	Totals of to Home 4,254	12,845	110	155	260	129	Totals of to Home 4,157	12,403

Remarks: The upper figure in a box indicates the number of trips of the 1st purpose of a cycle pattern.

The middle figure in a box indicates the number of trips of the 2nd purpose of a cycle pattern, but is omitted in case that this pattern does not have the 2nd purpose.

The lower figure in a box indicates the number of trips returning to the spot from which a cycle pattern starts.



MANILA METROPOLITAN AREA
TRANSPORT STUDY, 1973

FIG. 6.4-1
GENERATION AND ATTRACTION
OF ORIGINAL PLAN
BY TRIP PURPOSE

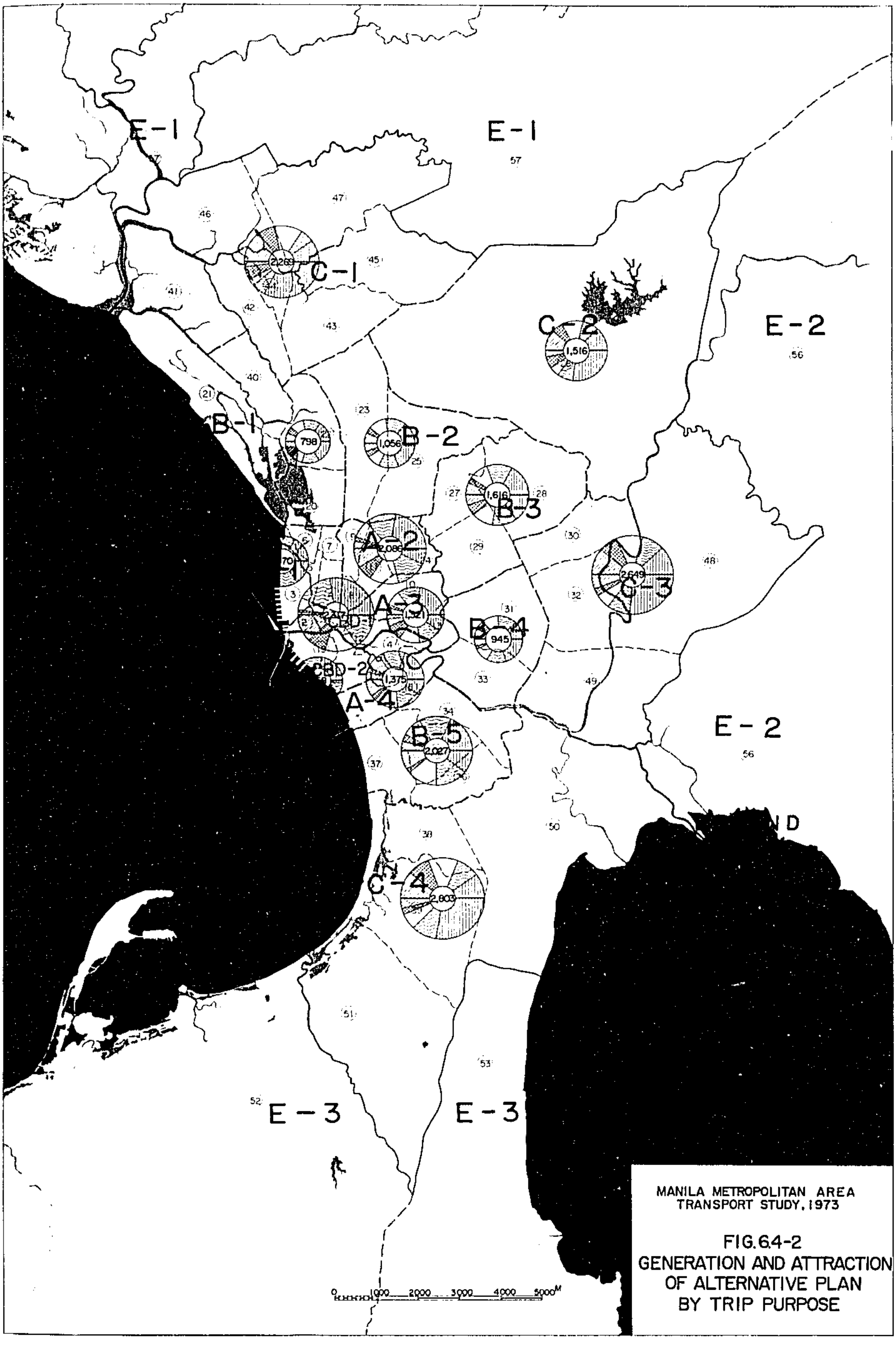


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FIG. 6.4-2
GENERATION AND ATTRACTION
OF ALTERNATIVE PLAN
BY TRIP PURPOSE

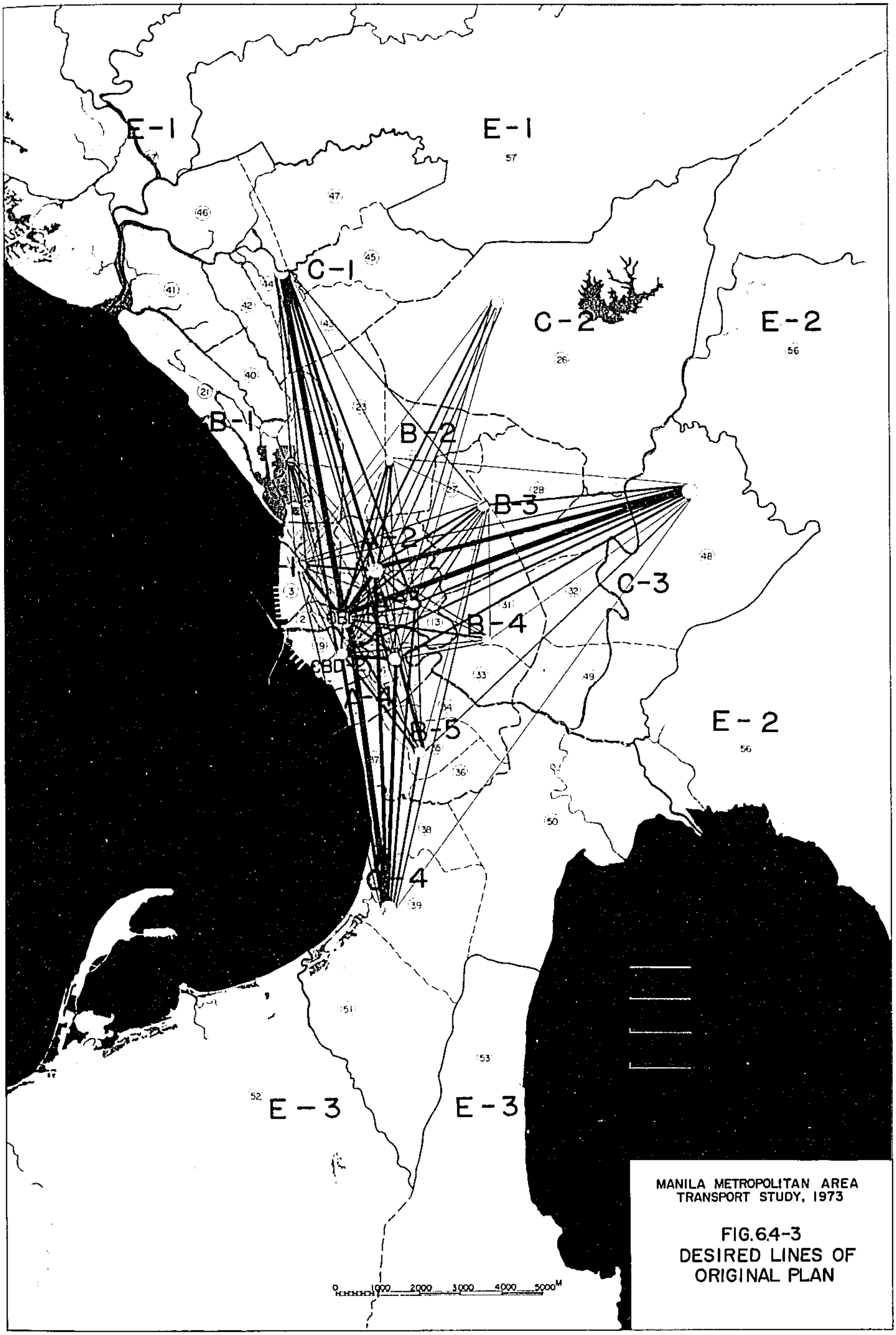

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FIG.6.4-3 DESIRED LINES OF ORIGINAL PLAN

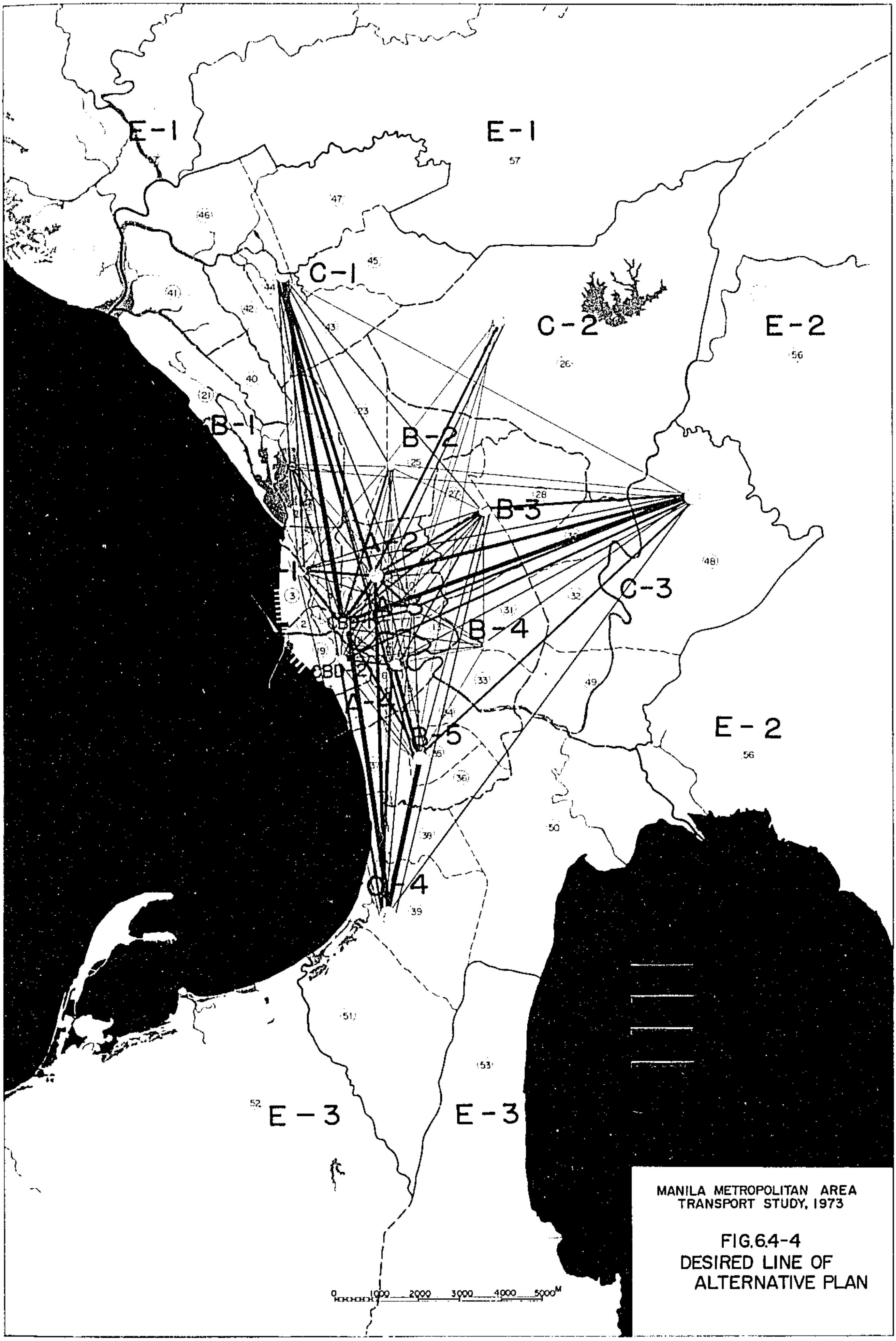

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FIG. 6.4-4
DESIRED LINE OF ALTERNATIVE PLAN

Table 6. 4-7 Future Trip Generation and Attraction of Original Plan by Trip Purpose

(,1000 Trips)

Trip Purpose	Generation or Attraction \ Zone Numbers	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Commuting to Work	Generation	7.3	3.8	24.0	14.6	7.5	16.2	12.6	11.1	8.0	45.8	25.9	15.0	7.0	6.3	13.9	14.5	7.9
	Attraction	133.0	73.6	23.6	51.9	12.8	5.6	12.8	117.6	37.1	61.6	54.8	151.0	62.2	32.0	30.5	19.3	117.1
	Sub Totals	140.3	77.4	47.6	66.5	20.3	21.8	25.3	128.7	45.1	107.4	80.7	166.0	69.2	38.3	44.4	33.8	125.0
Going to School	Generation	11.3	6.0	12.5	11.6	4.6	6.0	6.3	11.9	7.1	21.6	17.4	15.3	9.4	6.7	10.5	6.2	11.0
	Attraction	0.2	0	16.1	11.5	5.4	7.9	7.7	108.8	6.2	116.3	20.2	193.6	8.1	7.1	12.3	9.8	2.0
	Sub Totals	11.5	6.0	28.6	23.1	10.0	13.9	14.0	120.7	13.3	137.9	37.6	208.9	17.5	13.8	22.8	16.0	13.0
Private	Generation	60.1	30.4	37.6	38.7	10.5	16.7	17.8	62.3	24.1	94.0	48.3	78.4	34.8	18.6	34.1	19.8	50.0
	Attraction	158.2	78.9	38.9	74.6	10.2	13.1	20.3	149.4	48.9	124.6	76.8	182.4	67.3	23.8	48.8	26.2	120.5
	Sub Totals	218.3	109.3	76.5	113.3	20.7	29.8	38.1	211.7	73.0	218.6	125.1	260.8	102.1	42.4	82.9	46.0	170.5
Work	Generation	176.3	91.9	51.2	80.9	17.4	17.5	26.9	160.4	56.5	142.4	89.8	198.2	81.5	39.4	59.4	31.8	147.8
	Attraction	172.0	91.0	51.2	79.5	17.6	17.7	26.9	157.6	55.9	141.1	89.2	195.0	80.5	39.8	58.9	31.6	146.5
	Sub Totals	348.3	182.9	102.4	160.4	35.0	35.2	53.8	318.0	112.4	283.5	179.0	393.2	162.0	79.2	118.3	63.4	294.3
To Home	Generation	213.3	113.1	60.5	103.0	22.9	20.2	31.1	300.7	68.4	244.0	114.9	433.6	103.7	50.0	68.4	42.6	182.2
	Attraction	0.4	0	55.9	28.5	17.4	33.4	27.1	10.6	15.4	103.6	54.6	15.5	17.1	18.2	35.6	29.8	4.8
	Sub Totals	213.7	113.1	116.4	131.5	40.3	53.6	58.2	311.3	83.8	347.6	169.5	449.1	120.8	68.2	104.0	72.4	187.0
Totals	Generation	468.3	245.0	185.8	247.8	63.3	76.6	94.6	546.4	164.1	548.0	296.4	740.4	236.2	121.0	186.3	116.9	398.8
	Attraction	461.6	243.7	185.7	246.8	63.3	76.7	94.6	543.9	163.4	547.1	295.6	737.4	235.3	120.9	185.8	116.7	394.8
	Sub Totals	929.9	488.7	371.5	494.6	126.6	153.3	189.2	1090.3	327.5	1095.1	592.0	1477.8	471.5	241.9	372.1	233.6	793.6

Trip Purpose	Generation or Attraction \ Zone Numbers	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
Commuting to Work	Generation	18.1	9.0	20.4	5.7	17.4	20.6	37.7	58.4	171.5	38.3	21.6	53.8	39.9	47.9	26.8	22.1	24.1
	Attraction	118.0	84.3	14.4	31.4	12.2	29.0	8.6	20.1	49.4	8.4	41.6	23.4	21.3	20.4	13.7	26.9	17.2
	Sub Totals	136.1	93.3	34.8	37.1	29.6	49.6	46.3	78.5	220.9	46.7	63.2	77.2	61.2	68.3	40.5	49.0	41.3
Going to School	Generation	19.3	10.1	9.6	8.8	12.2	17.6	12.3	23.9	90.8	13.4	15.2	33.2	23.5	39.5	15.6	22.9	20.8
	Attraction	14.8	4.6	12.0	2.7	4.5	13.4	17.5	32.9	102.7	17.6	48.1	20.0	19.8	15.4	18.1	5.5	3.8
	Sub Totals	34.1	14.7	21.6	11.5	16.7	31.0	29.8	56.8	193.5	31.0	63.3	53.2	43.3	54.9	33.7	28.4	24.6
Private	Generation	74.8	36.0	22.4	16.0	20.1	48.1	42.0	63.2	160.5	35.7	67.6	56.5	37.5	68.8	25.3	32.6	33.5
	Attraction	168.4	84.2	17.5	15.1	6.6	44.1	28.7	19.5	64.5	17.7	81.4	41.7	30.1	57.3	13.6	21.5	27.1
	Sub Totals	243.2	120.2	39.9	31.1	26.7	92.2	70.7	82.7	225.0	53.4	154.0	98.2	67.6	126.1	38.9	53.8	60.6
Work	Generation	172.8	103.8	26.7	27.0	21.4	70.1	39.6	48.9	123.0	29.0	102.6	57.3	40.2	79.5	25.1	41.9	41.9
	Attraction	168.8	103.4	27.0	27.4	21.1	70.9	40.0	50.5	126.0	29.6	101.4	57.7	40.4	80.0	25.7	42.7	42.4
	Sub Totals	341.6	207.2	53.7	54.4	42.5	141.0	79.6	99.4	249.0	58.6	204.0	115.0	80.6	159.5	50.8	84.6	84.3
To Home	Generation	219.7	130.3	35.3	39.7	20.8	65.0	43.5	62.8	484.5	35.8	139.4	75.5	56.6	48.3	38.4	42.7	35.7
	Attraction	32.3	11.5	43.7	20.6	44.8	65.2	78.8	135.3	390.7	79.5	58.0	114.6	86.4	151.4	60.3	66.0	65.7
	Sub Totals	252.0	141.8	79.0	60.3	65.6	130.2	122.3	198.1	875.2	115.3	197.4	190.1	143.0	199.7	98.7	108.7	101.4
Totals	Generation	505.0	289.2	114.4	97.3	91.9	221.3	174.2	257.2	730.4	152.3	341.4	266.6	197.7	304.0	131.0	162.2	156.0
	Attraction	502.1	288.0	114.5	97.3	92.2	221.5	174.5	258.3	733.3	152.8	340.5	267.0	198.0	304.4	131.4	162.5	156.2
	Sub Totals	1007.1	577.2	228.9	194.6	184.1	442.8	348.7	515.5	1463.7	305.1	681.9	533.6	395.7	608.4	262.4	324.7	312.2

Trip Purpose	Generation or Attraction \ Zone Numbers	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	Totals
Commuting to Work	Generation	25.1	19.7	24.6	30.4	75.7	16.4	55.9	9.7	15.4	13.3	50.7	99.4	93.7	200.1	35.5	42.5	172.5	1,855.0
	Attraction	60.2	3.6	24.1	3.4	19.0	1.0	9.2	4.2	11.5	3.8	4.4	8.2	7.1	43.3	49.0	43.2	24.3	1,855.0
	Sub Totals	85.3	23.3	48.7	33.8	94.7	17.4	65.1	13.9	26.9	17.1	55.1	107.6	100.8	243.4	84.5	85.7	196.8	3,710.0
Going to School	Generation	24.2	11.7	12.5	12.9	54.6	7.1	29.2	7.4	15.0	6.2	23.0	44.7	41.0	127.2	32.9	55.0	113.7	1,177.4
	Attraction	5.1	2.2	15.2	15.5	14.6	2.7	24.1	5.9	12.0	8.5	18.5	35.6	34.0	36.3	9.5	14.7	30.3	1,177.4
	Sub Totals	29.3	13.9	27.7	28.4	69.2	9.8	53.3	13.3	27.0	14.7	41.5	80.3	75.0	163.5	42.4	69.7	144.0	2,354.8
Private	Generation	53.6	15.8	33.9	20.9	47.4	11.1	47.3	11.7	26.6	15.0	35.6	68.6	64.1	149.0	43.6	83.7	132.4	2,392.4
	Attraction	84.3	5.1	40.5	4.8	33.9	0.8	9.9	1.8	13.4	8.7	2.5	5.6	4.7	41.4	27.9	74.6	26.0	2,392.4
	Sub Totals	137.9	20.9	74.4	25.7	81.3	11.9	57.2	13.5	40.0	23.7	38.1	74.2	68.8	190.4	71.5	158.3	158.4	4,784.8
Work	Generation	99.9	11.3	48.3	9.7	46.5	4.4	18.8	9.3	31.0	15.4	12.1	12.3	18.9	93.5	58.0	109.6	59.9	3,166.7
	Attraction	99.1	11.6	47.8	100.0	47.7	4.5	19.4	9.7	31.7	15.7	12.6	12.8	19.5	95.9	59.3	110.2	61.7	3,166.7
	Sub Totals	199.0	22.9	96.1	109.7	94.2	8.9	38.2	19.0	62.7	31.1	24.7	25.1	38.4	189.4	117.3	219.8	121.6	6,333.4
To Home	Generation	109.3	8.6	80.9	20.3	48.2	4.1	37.9	10.7	30.3	15.2	23.7	45.6	42.5	99.9	70.1	96.3	66.1	4,254.1
	Attraction	62.6	44.9	32.2	62.0	186.4	34.2	127.5	27.6	50.1	32.5	108.0	210.1	196.4	455.7	95.1	148.8	407.4	4,254.1
	Sub Totals	171.9	53.5	113.1	82.3	234.6	38.3	165.4	38.3	80.4	47.7	131.7	255.7	238.9	555.6	165.2	245.1	473.5	8,508.2
Totals	Generation	312.1	67.1	180.1	94.2	290.5	43.0	189.0	48.8	118.2	67.1	145.1	270.7	260.1	659.7	240.2	389.1	544.7	12,845.5
	Attraction	311.3	67.4	179.9	94.6	291.7	43.3	190.0	49.1	118.7	67.2	146.0	272.3	261.6	662.7	240.7	389.4	547.7	12,845.5
	Sub Totals	623.4	134.5	360.0	188.8	582.2	86.3	379.0	97.9	236.9	134.3	291.1	543.0	521.7	1322.4	480.9	778.5	1092.4	25,691.0

Table 6.4-8 Future Trip Generation and Attraction of Alternative Plan by Trip Purpose

(1,000 Trips)

Trip Purpose	Generation or Attraction \ Zone Numbers	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Commuting to Work	Generation	5.0	2.4	26.1	14.3	8.3	16.8	13.1	10.0	7.8	45.8	26.3	14.0	6.7	7.0	15.8	14.8	6.1
	Attraction	95.7	52.6	15.6	36.9	8.6	4.2	9.0	101.5	26.5	53.8	39.6	140.0	41.4	20.3	20.3	14.1	84.3
	Sub Totals	100.7	55.0	41.7	51.2	16.9	21.0	22.1	111.5	34.3	99.6	65.9	154.0	48.1	27.3	36.1	28.9	90.4
Going to School	Generation	8.0	4.3	11.7	10.2	4.2	5.8	5.9	10.4	6.1	20.7	15.9	14.3	7.6	5.6	9.5	7.7	8.2
	Attraction	0.2	0	15.3	10.9	5.2	7.7	7.4	105.3	5.9	114.0	19.7	188.2	7.4	6.8	11.6	9.5	1.9
	Sub Totals	8.2	4.3	27.0	21.1	9.4	13.5	13.3	115.7	12.0	134.7	35.6	202.5	15.0	12.4	21.1	17.2	10.1
Private	Generation	41.2	20.7	33.3	30.1	9.3	15.6	15.6	52.6	18.4	87.5	39.6	71.4	26.4	16.5	28.5	16.9	35.0
	Attraction	107.9	53.5	27.5	51.0	7.4	8.2	14.6	123.4	33.6	107.0	54.0	164.1	45.8	16.5	33.8	18.7	87.1
	Sub Totals	149.1	74.2	60.8	81.1	16.7	24.8	30.2	176.0	52.0	194.5	93.6	235.5	72.2	33.0	62.3	35.6	122.1
Work	Generation	114.0	60.2	36.1	54.6	12.4	13.4	18.2	126.4	38.0	117.0	61.1	168.4	54.0	26.5	40.7	22.4	97.5
	Attraction	112.6	59.8	36.3	54.0	12.7	13.6	18.4	124.4	37.7	116.1	60.8	165.7	53.6	26.8	40.6	22.3	96.8
	Sub Totals	226.6	120.0	72.4	108.6	25.1	27.0	36.6	250.8	75.7	233.1	121.9	334.1	107.6	53.3	81.3	44.7	194.3
To Home	Generation	150.2	78.1	45.8	74.3	17.4	17.0	24.2	267.7	48.7	217.7	87.3	407.7	71.8	34.8	50.3	35.3	129.5
	Attraction	0.4	0	58.4	30.2	17.9	34.1	27.9	10.8	16.8	104.2	55.9	15.2	17.8	19.2	37.8	30.3	4.8
	Sub Totals	150.6	78.1	104.2	104.5	35.3	51.1	52.1	278.5	65.5	321.9	143.2	422.9	89.6	54.0	88.1	65.6	134.3
Totals	Generation	318.5	168.7	153.0	183.5	51.7	68.5	78.2	467.1	120.0	494.7	230.4	675.9	166.5	89.5	144.5	95.1	276.3
	Attraction	316.7	165.9	153.2	183.9	51.7	68.7	78.2	465.1	119.6	494.1	230.0	673.3	165.8	89.5	144.4	95.0	274.9
	Sub Totals	635.2	332.6	306.2	366.4	103.4	137.2	156.4	932.3	239.6	988.8	460.4	1349.2	332.4	179.0	288.9	190.1	551.2

Trip Purpose	Generation or Attraction \ Zone Numbers	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
Commuting to Work	Generation	17.0	7.9	17.8	5.6	15.5	18.4	26.2	57.1	173.2	33.9	20.6	46.7	36.0	41.8	25.9	23.6	24.8
	Attraction	84.0	60.5	19.8	34.8	17.6	37.2	19.7	21.2	52.0	11.3	47.0	31.5	29.5	25.3	14.9	20.1	16.8
	Sub Totals	101.0	68.4	37.6	40.4	33.1	55.6	45.9	78.3	225.2	45.2	67.6	78.2	65.5	67.1	40.8	43.7	41.6
Going to School	Generation	16.2	8.1	9.6	8.9	13.0	18.3	13.3	25.1	92.5	13.2	15.5	23.3	22.8	39.0	15.5	22.2	20.5
	Attraction	13.9	4.4	12.4	2.8	4.6	12.8	18.0	31.3	100.0	18.0	48.1	30.2	20.3	15.5	18.0	5.4	3.8
	Sub Totals	30.1	12.5	22.0	11.7	17.6	31.1	31.3	56.4	192.5	31.2	63.6	53.5	43.1	54.5	33.5	27.6	24.3
Private	Generation	55.0	26.0	25.7	18.5	24.6	53.8	51.9	68.6	168.5	38.0	64.4	61.4	40.3	73.0	25.6	32.3	33.5
	Attraction	114.0	58.4	28.4	16.0	20.2	59.3	56.7	30.0	79.0	25.9	96.6	58.9	40.9	71.4	14.2	21.8	28.9
	Sub Totals	169.0	84.4	54.1	33.5	44.8	113.1	108.6	98.6	247.5	63.9	161.0	120.3	81.2	144.4	39.8	54.1	62.4
Work	Generation	114.3	68.5	35.2	26.4	31.7	79.5	65.5	56.2	129.6	35.7	100.4	70.5	48.8	86.9	24.5	35.7	39.2
	Attraction	112.1	68.3	35.3	26.7	32.1	79.8	65.3	57.7	132.4	36.2	99.0	70.6	48.9	87.0	25.0	38.3	39.5
	Sub Totals	226.4	136.8	70.5	53.1	63.8	159.3	130.8	113.9	262.0	71.9	199.4	141.1	97.7	173.9	49.5	73.0	78.7
To Home	Generation	156.8	93.5	47.0	43.3	33.4	81.8	69.8	68.6	193.9	43.7	147.4	93.6	71.0	81.2	39.8	36.7	34.2
	Attraction	33.5	11.5	39.5	20.5	43.2	62.6	66.9	136.5	395.1	73.5	56.7	104.5	79.4	123.0	59.4	67.3	68.1
	Sub Totals	190.3	105.0	86.5	63.8	73.8	144.4	136.7	205.1	589.0	117.2	204.1	198.1	150.4	204.2	99.2	104.0	102.3
Totals	Generation	359.3	204.0	135.4	100.7	117.5	251.8	226.7	275.8	757.7	164.5	348.3	295.6	218.9	322.0	131.3	150.5	154.5
	Attraction	357.5	203.1	135.3	100.7	117.6	251.7	226.6	276.7	758.5	164.9	347.3	295.7	218.9	322.1	131.6	150.6	154.7
	Sub Totals	716.8	407.1	270.7	201.4	235.1	503.5	453.3	552.5	1516.2	329.4	695.6	591.3	437.8	644.1	262.9	301.1	309.2

Trip Purpose	Generation or Attraction \ Zone Numbers	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	Totals
Commuting to Work	Generation	24.3	19.3	21.0	27.9	83.5	13.7	53.9	10.4	14.1	12.6	50.9	90.5	92.1	194.8	35.7	36.7	157.3	1,770.0
	Attraction	139.0	4.0	34.1	3.6	18.6	1.8	10.0	4.5	12.9	4.1	5.1	11.2	8.4	50.5	61.1	65.2	29.4	1,770.0
	Sub Totals	163.3	23.3	55.1	31.5	102.1	15.5	63.9	14.9	27.0	16.7	56.0	101.7	100.5	245.3	96.8	101.9	186.7	3,540.0
Going to School	Generation	30.7	11.6	12.5	12.6	59.2	6.6	28.9	8.2	15.0	8.1	23.9	43.3	41.9	127.2	34.6	51.2	110.1	1,159.5
	Attraction	8.0	2.1	16.1	15.6	14.5	2.7	23.8	5.9	11.9	6.5	18.3	35.5	33.5	36.2	9.6	15.1	30.1	1,159.5
	Sub Totals	38.7	13.7	28.6	28.2	73.7	9.3	52.7	14.1	26.9	14.6	42.2	78.8	75.4	163.4	44.2	66.3	140.2	2,319.0
Private	Generation	94.1	15.9	37.7	21.4	75.3	11.4	47.4	13.2	26.8	15.1	37.8	69.7	67.0	154.2	51.9	88.4	133.1	2,377.6
	Attraction	195.6	5.4	54.3	7.3	34.1	2.9	10.3	4.0	13.9	9.1	6.5	11.7	10.8	54.4	48.5	100.5	33.3	2,377.6
	Sub Totals	289.7	21.3	92.0	28.7	109.4	14.3	57.7	17.2	40.7	24.2	44.3	81.4	77.8	208.6	100.4	188.9	166.4	4,755.2
Work	Generation	190.3	11.0	58.0	12.6	51.8	7.3	18.3	11.1	30.2	15.0	16.1	21.1	25.3	94.2	72.6	122.5	70.3	2,938.4
	Attraction	186.0	11.3	57.3	12.9	52.9	7.5	18.8	11.4	30.8	15.3	16.6	21.8	26.1	96.7	73.2	121.1	72.3	2,938.4
	Sub Totals	376.3	22.3	115.3	25.5	104.7	14.8	37.1	22.5	61.0	30.3	32.7	42.9	51.4	190.9	145.8	243.6	142.6	5,876.8
To Home	Generation	246.1	9.1	79.0	23.1	51.9	8.0	38.5	12.5	31.8	15.6	26.5	52.1	46.6	114.1	93.5	134.0	76.3	4,157.0
	Attraction	56.6	44.4	45.8	58.5	202.9	30.5	125.2	28.6	48.6	31.7	109.6	197.9	196.1	449.6	95.8	129.5	384.9	4,157.0
	Sub Totals	302.7	53.5	124.8	81.6	254.8	38.5	163.7	41.9	80.4	47.3	136.1	250.0	242.7	563.7	189.3	263.5	461.2	8,314.0
Totals	Generation	585.4	66.9	208.1	97.6	321.7	45.1	187.1	55.2	117.8	66.5	155.1	276.7	273.1	684.5	288.2	432.9	547.1	12,402.6
	Attraction	582.2	67.2	207.6	97.9	322.9	45.4	188.1	55.4	118.2	66.7	156.0	278.2	274.7	687.4	288.2	432.5	550.0	12,402.6
	Sub Totals	1167.6	134.1	415.7	195.5	644.6	90.5	375.2	100.6	236.0	133.2	311.1	554.9	547.8	1371.9	576.4	865.4	1097.1	24,805.2

Table 6.4-9 Future OD Table of Original Plan

O \ D	CBD-1	CBD-2	A-1	A-2	A-3	A-4	B-1	B-2
CBD-1	279598.	54747.	88472.	126789.	72788.	58970.	35887.	51102.
CBD-2	60471.	86363.	25058.	43782.	19024.	87041.	15193.	25183.
A-1	88075.	23688.	212872.	65849.	27112.	21735.	18748.	18540.
A-2	123634.	40493.	65732.	310392.	72810.	42109.	29511.	44846.
A-3	68927..	16856.	27246.	70119.	252459.	21572.	17930.	18383.
A-4	59280.	82951.	22580.	43095.	22692.	276992.	16703.	24472.
B-1	35969.	15474.	18948.	29866.	17862.	16378.	124699.	13103.
B-2	50648.	25674.	18438.	45578.	17445.	23689.	13080.	180704.
B-3	63266.	29177.	25993.	51664.	32901.	29661.	11261.	18516.
B-4	48140.	22812.	12202.	27997.	32230.	24045.	4687.	6125.
B-5	56998.	47682.	16828.	35135.	25198.	78142.	7961.	11355.
C-1	143733.	56853.	40308.	90670.	49782.	58256.	23235.	19560.
C-2	64548.	30839.	17019.	44418.	19531.	28310.	6212.	12013.
C-3	146016.	62074.	42158.	104538.	73874.	57198.	12491.	16399.
C-4	155412.	89053.	33252.	87615.	46576.	101445.	9773.	13522.
TOTAL	1444724.	684736.	667106.	1177507.	782284.	925543.	347371.	479823.

O \ D	B-3	B-4	B-5	C-1	C-2	C-3	C-4	TOTAL
CBD-1	65306.	48502.	57838.	142600.	64305.	146615.	158153.	1451672.
CBD-2	30342.	22239.	47553.	54354.	29337.	59648.	82397.	687985.
A-1	25899.	12517.	16919.	40923.	17523.	42782.	34926.	668108.
A-2	52754.	28884.	35840.	92073.	44387.	105680.	91830.	1180975.
A-3	33426.	31877.	25055.	53126.	21185.	75467.	50578.	784206.
A-4	30959.	24382.	76447.	60253.	29254.	59081.	99962.	929112.
B-1	11120.	4714.	7814.	21938.	6191.	12578.	9999.	346653.
B-2	18285.	6118.	10871.	19404.	11681.	16723.	14181.	478519.
B-3	338165.	15494.	16656.	27793.	10236.	59925.	29527.	760235.
B-4	15326.	214899.	10174.	11077.	4481.	20508.	11501.	466204.
B-5	16910.	10479.	278264.	29486.	10001.	28254.	62648.	715341.
C-1	25663.	10898.	29293.	526677.	4751.	13823.	5480.	1098982.
C-2	9185.	4239.	9043.	5042.	406635.	7357.	6001.	730392.
C-3	59864.	20473.	27281.	14308.	7451.	564276.	20296.	1228697.
C-4	27131.	11180.	65690.	5898.	5899.	19976.	645982.	1318404.
TOTAL	760335.	466895.	714738.	1104952.	733317.	1232693.	1323461.	12845458.

Table 6.4-10 Future OD Table of Alternative Plan

O \ r	CBD-1	CBD-2	A-1	A-2	A-3	A-4	B-1	B-2
CBD-1	199998.	34747.	69081.	96161.	59355.	42758.	30639.	45171.
CBD-2	38374.	48690.	17181.	29902.	13104.	54536.	11601.	19623.
A-1	69660.	16607.	164972.	53964.	21645.	15817.	18278.	18388.
A-2	93716.	27609.	53653.	290746.	60776.	31737.	27460.	42566.
A-3	56339.	11717.	21973.	58824.	204988.	16417.	16622.	16836.
A-4	42622.	52744.	16305.	32040.	16936.	188958.	13425.	19498.
B-1	30866.	11767.	18354.	27872.	16829.	13393.	163873.	16653.
B-2	45097.	20165.	16438.	43318.	16208.	19303.	16639.	227955.
B-3	52115.	21806.	22845.	48687.	29898.	23857.	13649.	22493.
B-4	41524.	17014.	10163.	25628.	27217.	18625.	5448.	6808.
B-5	54926.	39731.	20648.	39430.	28550.	77011.	13041.	18240.
C-1	117555.	41735.	29322.	79373.	40958.	42326.	31063.	24875.
C-2	56389.	24082.	12957.	40236.	16696.	21856.	8498.	15411.
C-3	124909.	45966.	34826.	96943.	66589.	44432.	16423.	20264.
C-4	131764.	63635.	26016.	78229.	40289.	75500.	12381.	15572.
TOTAL	1155854.	478015.	534734.	1041353.	660047.	686526.	399040.	528353.

	B-3	B-4	B-5	C-1	C-2	C-3	C-4	TOTAL
CBD-1	54219.	41873.	56132.	116311.	55544.	125412.	133723.	1161124.
CBD-2	22822.	16522.	42541.	39469.	22743.	44394.	58997.	480229.
A-1	22558.	10289.	20109.	29493.	13131.	35051.	26876.	534928.
A-2	49738.	26392.	39746.	80562.	40085.	97863.	81565.	1044214.
A-3	30207.	27054.	27526.	43704.	18013.	67653.	43308.	661181.
A-4	24482.	18730.	78088.	43227.	22037.	45404.	73967.	688463.
B-1	13633.	5506.	12750.	29410.	8486.	16580.	12725.	398697.
B-2	22286.	6812.	17061.	24568.	14920.	20512.	16156.	527438.
B-3	381920.	16811.	23747.	34281.	13031.	70731.	32630.	808501.
B-4	16582.	235265.	14928.	11952.	4744.	23851.	12730.	472479.
B-5	24765.	15595.	445003.	60032.	19190.	48657.	110104.	1014932.
C-1	31876.	11650.	58321.	587025.	4675.	19406.	11344.	1131504.
C-2	11761.	4435.	17065.	4826.	506733.	9157.	6621.	756723.
C-3	70791.	23729.	46200	20220.	9536.	672419.	29540.	1322897.
C-4	30214.	12210.	112407.	12220.	6875.	28966.	752970.	1399248.
TOTAL	807964.	472873.	1011714.	1137300.	759473.	1326056.	1403256.	12402536.

§ 6.5 External Traffic

The external traffic consists of trips made by persons living inside the study area and those made by persons living outside the study area. Both are explained in contrast.

In the case of the external traffic, it is not necessary to think of the chain of trips, such as, a repetition of trips of the same purpose, or a trip of a certain purpose followed by a trip of another purpose, discussed in the estimation of trips within the study area. The external trips are treated as trips simply going outside from inside for a certain purpose and vice versa.

Therefore, the volume of the outbound and inbound traffic made by the persons living inside must be equal to each other. And also those made by the persons living outside must be equal. Besides, the outbound traffic made by the people living inside would have one of the purposes of commuting to work, going to school, private and work. When they come back to the study area from outside the trip purpose must be to home in case that the outbound trip belong to the former three, and work (returning) in case that the outbound trip has work (going) purpose. On the contrary, the inbound traffic made by the people living outside would have also one of the four purposes. When they are going back from the study area, the trip purpose must be to home or work (returning).

Therefore, in both cases, trips made by the people living inside and by the people living outside, the trip distribution is estimated for four purposes and then these OD tables are transposed into the OD tables of to home and work (returning) trips. The simplified entropy method is used for the computation of the trip distribution, neglecting the influence of travel time.

As far as through traffic is concerned, it is concluded after analyzing the results of the person trip survey and the cordon line survey that it is enough from the viewpoint of the traffic volume to estimate only the work trips made by outside residents. The total volume of the through traffic is obtained based upon the ratio of the inbound trips having the destination within the study area and the through trips having the destination outside the area to the total inbound trips in the cordon line survey.

Table 6.5-1 Procedures for Estimating External Trips

				OD Table to be Estimated First						
				Internal Sectors		External Sectors				
						Method of Estimation				
Residents of	Direction of Trips	Trip Purposes	Total Number of Trips	Gen. or Att.	Method of Estimation	Gen. or Att.	Present Volume	Multipliers for Future Volume	Direction of Trips	Trip Purposes
Internal Area	Outbound	Commuting to Work	Part of Trip Production of Residents of Internal Area by Trip Purpose as Control Table *	Trip Generation	Number of Working Residents Minus Internal Trip Generation of Commuting to Work	Trip Attraction	Number of External Trips in Present Person Trip OD Table by Trip Purpose and Sector	Population Growth of External Adjacent Area by Sector	Inbound	To Home
		Going to School			Number of Resident Students (incl. School Children)minus Internal Trip Generation of Going to School					
		Private			Internal Trip Generation of Private					
		Work			Internal Trip Generation of Work					Work (Returning)
External Area	Inbound	Commuting to Work	Table Sum of Trip Generation of External Sectors by Trip Purpose	Trip	Number of Workers minus Internal Trip Attraction of Commuting to Work	Trip Generation Incl. Attraction of Through Trips	Number of External Trips in Present OD Table of Cordon Line Survey by Trip Purpose and Sector	Population Growth of External Adjacent Area by Sector	Outbound	To Home
		Going to School			Number of Students (Incl. School Children)minus Internal Trip Attraction of Going to School					
		Private			Internal Trip Attraction of Private					
		Work			Internal Trip Attraction of Work					Work (Returning)

* Refer to Table 6.2-6

Table 6.5-2 Present Inbound Trips of External Residents

(1,000 Trips)

Trip Purposes \ Sector Numbers	E-1	E-2	E-3	Totals
Commuting to Work	21.0	14.7	26.4	62.1
Going to School	6.0	4.5	8.2	18.7
Private	26.1	18.8	37.0	81.9
Work	12.1	8.2	16.4	36.7
Total	65.2	46.2	88.0	199.4

Source: Cordon Line Survey

Table 6.5-3 Population of External Adjacent Area

(1,000 Persons)

Sector Numbers	Areas \ Population	Present (1971)	Future (1987)	Ratio
E - 1	Bulacan, St. Maria (1/2) Bacau, San Jose (1/8)	75.1	123.9	1.65
E - 2	San Mateo, Tanay, Angono, Cainta, Muntinlupa, Antiplo	102.9	315.8	3.07
E - 3	Kawit, Bacoor, Noveleta, Rosario, Imus,	196.5	492.7	2.51

Table 6.5-4 Generation and Attraction of External Trips of Original Plan

(1,000 Trips)

Trip Purpose	Generation or Attraction \ Sector Number	E - 1	E - 2	E - 3	Totals
Commuting to Work	Generation	127.4	165.5	244.1	537.0
	Attraction	7.8	24.8	9.4	42.0
	Sub-Totals	135.2	190.3	253.5	579.0
Going to School	Generation	0.7	0.9	1.4	3.0
	Attraction	1.9	0.6	0.5	3.0
	Sub-Totals	2.6	1.5	1.9	6.0
Private	Generation	43.0	57.9	93.1	194.0
	Attraction	13.1	10.2	13.7	37.0
	Sub-Totals	56.1	68.1	106.8	231.0
Work	Generation	44.8	62.3	56.9	164.0
	Attraction	44.8	62.3	56.9	164.0
	Sub-Totals	89.6	124.6	113.8	328.0
To Home	Generation	22.8	35.6	23.6	82.0
	Attraction	171.1	224.3	338.6	734.0
	Sub-Totals	193.9	259.9	362.2	816.0
Totals	Generation	238.7	322.2	419.1	980.0
	Attraction	238.7	322.2	419.1	980.0
	Totals	477.4	644.4	838.2	1960.0

Table 6.5-5 Generation and Attraction of External Trips of Alternative Plan

(1,000 Trips)

Trip Purpose	Generation or Attraction \ Sector Number	E - 1	E - 2	E - 3	Totals
Commuting to Work	Generation	68.1	88.5	130.4	287.0
	Attraction	7.8	24.8	9.4	42.0
	Sub Totals	75.9	113.3	139.8	329.0
Going to School	Generation	0.7	0.9	1.4	3.0
	Attraction	1.9	0.6	0.5	3.0
	Sub Totals	2.6	1.5	1.9	6.0
Private	Generation	43.0	57.9	93.1	194.0
	Attraction	13.1	10.2	13.7	37.0
	Sub Totals	56.1	68.1	106.8	231.0
Work	Generation	42.6	59.0	55.4	157.0
	Attraction	42.6	59.0	55.4	157.0
	Sub Totals	85.2	118.0	110.8	314.0
To Home	Generation	22.8	35.6	23.6	82.0
	Attraction	111.8	147.3	224.9	484.0
	Sub Totals	157.4	182.9	248.5	566.0
Totals	Generation	177.2	241.9	303.9	723.0
	Attraction	177.2	241.9	303.9	723.0
	Totals	354.4	483.8	607.8	1446.0

Table 6.5-6 Future OD Table of External Trips of Original Plan

O \ D	CBD-1	CBD-2	A-1	A-2	A-3	A-4	B-1	B-2
E-1	40980.	20896.	25780.	37810.	31038.	34322.	15270.	28186.
E-2	55068.	28100.	34866.	50986.	42246.	46590.	20638.	38476.
E-3	73372.	37212.	45284.	66876.	54990.	60886.	26710.	49506.
TOTAL	169420.	86208.	105930.	155672.	128274.	141798.	62618.	116168.

O \ D	B-3	B-4	B-5	C-1	C-2	C-3	C-4	E-1
E-1	31882.	24316.	28902.	38612.	27572.	37954.	53918.	
E-2	43152.	33334.	39218.	51204.	37050.	50476.	72914.	2212.
E-3	55894.	43018.	50952.	66020.	47708.	65508.	94258.	4252.
TOTAL	130928.	100668.	119072.	155836.	112330.	153938.	221150.	483902.

O \ D	E-2	E-3	TOTAL
E-1			
E-2			
E-3	5536.		
TOTAL	652126.	847982.	1972010.

Table 6.5-7 Future OD Table of External Trips of Alternative Plan

O \ D	CBD-1	CBD-2	A-1	A-2	A-3	A-4	B-1	B-2
E-1	24038.	11488.	15270.	27814.	19862.	19476.	13238	22246.
E-2	32592.	15542.	20700.	38010.	27330.	26636.	18218.	30846.
E-3	42470.	20248.	25994.	48460.	34374.	33772.	22658.	38034.
TOTAL	99100	47278.	61964.	114284.	81566.	79884.	54114.	91126.

O \ D	B-3	B-4	B-5	C-1	C-2	C-3	C-4	E-1
E-1	26594.	18218.	29240.	30854.	21986.	31902.	42214.	
E-2	36506.	25380.	40118.	41400.	29746.	42898.	57878.	2212.
E-3	45762.	31506.	50864.	51008.	37022.	53756.	71848.	4252.
TOTAL	108862.	75104.	120222.	123262.	88754.	128556.	171940.	360904.

O \ D	E-2	E-3	TOTAL
E-1			
E-2			
E-3	5536.		
TOTAL	491548.	617564.	1458016.

The results of the estimation of the external traffic is computed for two cases based on the two land use plans. The zoning consists of 15 sectors inside and 3 sectors outside.

Corresponding to these thinking process, the computing method and factors are shown in Table 6.5-1. It is not necessary to explain any more about this table. Table 6.5-2 shows the present volume of inbound trips made by the people living outside by trip purpose. Table 6.5-3 shows the population of adjacent outside areas.

As a result of the estimation, the trip generation and attraction by purpose is shown in Table 6.5-4 and OD tables of all trip purposes are shown in Table 6.5-6 and 6.5-7.

§ 6.6 Modal Split

6.6.1 Basic concept

The OD table by mode of travel is estimated in this section based upon the above estimated OD tables of person trips. The mode of travel is classified into four categories: drivers of cars and trucks (called drivers), passengers of cars and trucks (called passengers), taxi passengers (called taxis) and mass transit.

Indeed it brings about inaccuracy of the estimation to some extent to put together cars and trucks, but it is inevitable, since the truck traffic is not completely apprehended in the person trip survey and other informations are not available.

The first reason why drivers and passengers are separated is that the drivers have a tendency to remain in the same mode as a driver throughout the cycle. But the passengers do not have this tendency so much as the drivers. This prevailing way of thinking is assured by the person trip survey. And next the trip purpose of drivers is not necessarily the same as that of passengers. As shown in Table 6.6-2, the ratio of the drivers in going to school trips is only 0.02 and that of passengers is 0.21. This means passengers have a share ten times as much as drivers do. If the trip purpose of the drivers and passengers are the same, the total number of the persons in a vehicle for going to school purpose must be eleven but this is impossible. In this case, the trip purpose of passengers is going to school and the trip purposes of the drivers would be taking included in private purpose. Therefore, it is reasonable to distinguish the mode of drivers from that of the passengers.

Table 6.6-1 Priorities of Trip Purposes in Driver Mode by Cycle Pattern

1st Trip Purposes \ 2nd Trip Purposes	Commuting to Work	Going to School	Private	Work
Commuting to Work	C	G	P	-
Going to School	-	G	P	-
Private	P	P	P	P
Work	-	-	W	W

Remarks: C : Commuting to Work

G : Going to School

P : Private

W : Work

Mass transit is thought as a travel mode which is used by the people who do not use passenger cars or taxi. A mass transit passenger may be a bus passenger or a railway passenger, depending whether there exists a railway line between his origin and destination. Therefore, mass transit is treated as a single mode at this stage and is segregated into railways and buses at the later stage of the traffic assignment.

According to the above mentioned basic idea, the mode of drivers is estimated for the cycle pattern and the other modes of passengers, taxis and mass transit are estimated for the trip purpose. It is well known that the modal split is influenced by many factors such as car ownership, trip length, travel time and travel cost except trip purpose. But, since walking trips have been excluded already, the trip length does not seem to work so much. The travel time is partially influenced by the traffic capacity, which is discussed at the later stage. The travel cost is decided by the transportation policy, and is difficult as an object of the traffic forecast. Based upon these reasons, trip purpose and car ownership are adopted for the modal split at first, and then the restraint of the traffic capacity.

In order to determine the share of drivers in the modal split for every cycle pattern, a trip purpose is selected to be dominant to decide that share in a whole cycle which is applied to other trip purposes included in the cycle. Table 6.6-1 shows the priority of trip purposes in the driver mode by cycle pattern.

The shares of other modes than drivers, i.e. passengers, taxis and mass transit, in to home trips is equal to those in the purposes of trips made just before to home trips respectively. For example, the share in commuting to work purpose is applied to home trips made directly after commuting to work. The share in private purpose is dominant in to home trips in the cycle patterns of private ⟶ to home, commuting to work ⟶ private ⟶ to home and so on. Accordingly, it is enough to settle shares of all modes including drivers in other trip purposes than to home, i.e. commuting to work, going to school, private and work.

6.6.2 Future modal split

Table 6.6-2 shows the present modal split by the person trip survey and makes clear the following characteristics of the modal split.

(1) Car ownership affects naturally the share of drivers and passengers in the modal split strongly. The average share of owners for all trip purposes is 0.67, but that of non-owners is only 0.09. And the share of the driver mode

is 0.37 in owners and 0.03 in non-owners. The proportion is over ten times, which is bigger than that of cars.

(2) In the share of taxis, it is higher in non-owners than in owners. This means taxis are used as an alternative mode to cars.

(3) The difference of the share of the cars is obvious among trip purposes but not so large. The private purpose has in the average of owners and non-owners the share of 0.43, which is the largest among shares of all purposes. The work purpose is the second by a little difference. Then follow the commuting to work and the going to school purposes excluding the to home purpose. Even the share of the going to school purpose which is the lowest is half of that of the private purpose.

(4) The truck mode has the remarkably high share in the work purpose and the negligible share of 0.03 in the other purposes. This can be explained as natural, since trucks are usually used for the purposes of freight transportation.

(5) The share of the mass transit mode shows the opposite tendency to that of the car mode. It is conspicuous that the mass transit has the very low share and cars and trucks occupy a greater part of the share in work purpose.

Based on the above-mentioned characteristics, the following formula is assumed to estimate the future modal split.

Future share = (present share of owners) x (future car ownership)
+ (present share of non-owners) x (future car non-ownership)

The future share of every mode except trucks is estimated by trip purpose through this formula. As far as it concerns trucks, they are segregated into drivers and passengers (actually drivers' assistants) in order to coincide with the classification of travel modes for the estimation, using the proportion of both in cars. The shares of both are multiplied by the future increase of the trucks' rate to the workers. The driver mode and the passenger mode for the estimation are the totals of the former and of the latter of cars and trucks respectively. The share of the mass transit mode is the remaining of the other modes.

But, it is impossible to get the same share as present by the survey, if the value of the present ownership is applied to the above formula. Therefore, the final future modal split is estimated by the omega method used often for the statistical analysis, using three kinds of the modal split, i.e. the present modal split by the survey, the present one by the formula and the future one by the formula. Table 6.6-3 shows these three modal split.

The above-mentioned modal split is based on the principle that passenger cars would be the same in their use in future as today even if the number of passenger cars will increase greatly. Therefore, the increase of car ownership will bring about great increase of the automobile traffic accompanied by the increase of the population in the area. As explained later, the most of the person trips would be carried by passenger cars, and the total automobile traffic will increase to about three times as much as today.

Such a modal split is already seen in many cities in the world, and all of those are regarded to belong to automobile oriented type because railways show just the partial development and the most of the mass transit remain on the road surface. Moreover, not only the street network but also off street parking facilities is highly developed in these cities.

It is hard to say that the Manila Metropolitan Area does not have such a tendency as an automobile oriented development, but the Area has a very difficult problem to overcome. If the traffic demand grows to a volume of three times of today, the traffic capacity should be constructed in the size of three times of today so that the traffic congestion would be maintained at the same level as today. Moreover, irrespective of the land use plan, daytime workers are more concentrated in the downtown, the traffic demand generates more requiring the automobile mode and then the street capacity in the downtown is necessary to be over three times of today. However, it is quite difficult to construct additional streets in downtown Manila just as in other big cities.

If the capacity of the street does not increase enough to cover the demand and a mass transit system is introduced, the modal split would be different from either of the present one or the above estimated one. When the road system has a limited capacity, the travel time by cars is longer than that by mass transit, and the car mode has a relatively low share, even if cars are owned in a wider range.

It is probable enough for the Manila Metropolitan Area to follow a development such as this like big cities in Japan. When an urban rapid mass transit system is introduced in the Metropolitan Area, it can be assumed as a landmark that the car mode has a share of almost half as today. The share of the truck mode, however, remains at the same as today, considering the future industrial activities and freight transport. The modal split thus estimated is shown in the second case of the future in Table 6.6-3. Applying these two cases of the modal split, i.e. the car-dependent and mass transit-dependent patterns, to the future OD tables by cycle pattern in drivers and by trip purpose in passengers, taxis and mass transit, OD tables can be obtained by travel mode.

The above two cases of the future modal split concern the traffic within the study area. To the external traffic, the omega method is applied, using the values by the cordon line survey, those by the person trip survey and the future estimated values of the modal split of two cases. Different values are applied to the internal and external residents since both are different at present. The three modes, drivers, passengers and taxis are congregated into a single mode of vehicles, because taxis are as few as negligible in the external traffic and it is meaningless to segregate drivers and passengers owing to the fact that only the trip purpose of drivers is known by the cordon line survey. Therefore, the travel modes are classified into only two categories, mass transit and vehicles for the estimation. Table 6.6-4 shows the present and future modal split, which is used to estimate the external traffic of each mode by trip purpose.

The total numbers of trips are shown by travel mode and trip purpose in Table 6.6-5, based upon OD tables estimated according to the above procedures. The composition estimated as a case dependent on mass transit is located just half-way between Tokyo and Osaka (surveyed in 1968 and 1970 respectively), both of which depend especially slightly upon vehicles among Japanese big cities and do more slightly year by year.

Table 6.6-2 Present Modal Split by Trip Purpose and Car Ownership

(Total of each row = 1.00)

Car Ownership	Trip Purposes \ Travel Modes	Mass Transit: Jeepneys	Mass Transit: Busses	Mass Transit: Sub-Totals	Cars: Drivers	Cars: Passengers	Cars: Sub-Totals	Taxi Passengers	Trucks
Owners	Commuting to Work	0.10	0.09	0.19	0.46	0.29	0.75	0.04	0.02
	Going to School	0.26	0.17	0.43	0.06	0.48	0.54	0.02	0.01
	Private	0.09	0.04	0.13	0.50	0.28	0.78	0.06	0.03
	Work	0.05	0.02	0.07	0.54	0.17	0.71	0.02	0.20
	To Home	0.18	0.12	0.30	0.33	0.30	0.63	0.04	0.03
	Averages	0.15	0.09	0.24	0.37	0.30	0.67	0.04	0.05
Non-Owners	Commuting to Work	0.47	0.34	0.81	0.02	0.06	0.08	0.08	0.03
	Going to School	0.64	0.26	0.90	0.00	0.06	0.06	0.02	0.02
	Private	0.55	0.20	0.75	0.03	0.07	0.10	0.14	0.01
	Work	0.16	0.08	0.24	0.13	0.09	0.22	0.07	0.47
	To Home	0.55	0.27	0.82	0.01	0.06	0.07	0.08	0.03
	Averages	0.51	0.25	0.76	0.03	0.06	0.09	0.07	0.08
Averages	Commuting to Work	0.35	0.25	0.60	0.17	0.14	0.31	0.07	0.02
	Going to School	0.51	0.23	0.74	0.02	0.21	0.23	0.02	0.01
	Private	0.33	0.12	0.45	0.27	0.17	0.43	0.10	0.02
	Work	0.12	0.05	0.17	0.29	0.12	0.41	0.05	0.37
	To Home	0.42	0.21	0.63	0.13	0.14	0.27	0.07	0.03
	Average	0.38	0.19	0.57	0.15	0.15	0.30	0.06	0.07

Table 6.6-3 Estimated Modal Split

P. or F. / Case / Mode 1) / Trip Purposes	Present								Future							
	Surveyed				Calculated 2)				Dependent on Cars 3)				Dependent on Mass Transit 4)			
	Mass Transit	Driver	Passen-ger	Taxi	Mass Transit	Driver	Passen-ger	Taxi	Mass Transit	Driver	Passen-ger	Taxi	Mass Transit	Driver	Passen-ger	Taxi
Commuting to Work	0.60	0.18	0.15	0.07	0.69	0.12	0.12	0.07	0.49	0.25	0.19	0.07	0.78	0.10	0.08	0.04
Going to School	0.74	0.02	0.22	0.02	0.81	0.01	0.16	0.02	0.67	0.04	0.27	0.02	0.87	0.01	0.11	0.01
Private	0.45	0.27	0.18	0.10	0.62	0.14	0.12	0.12	0.31	0.37	0.23	0.09	0.71	0.15	0.09	0.05
Work	0.17	0.55	0.23	0.05	0.24	0.48	0.22	0.06	0.10	0.63	0.24	0.03	0.33	0.45	0.19	0.03

Remarks: 1) "Driver" and "Passenger" include those of trucks respectively.

2) The following equation is used:

Modal Split of Vehicles = Surveyed Car Owners Modal Split x Rate of Car Owners

+ Surveyed Non Owners Modal Split x Rate of Non Owners

$$+ \text{Truck Modal Split} \times \frac{\text{Auto Drivers (or Passengers) Modal Split}}{\text{Auto Drivers Modal Split} + \text{Auto Passengers Modal Split}}$$

$$\times \frac{\text{Ratio of Trucks to Population at Present (as Future)}}{\text{Present Ratio of Trucks to Population}}$$

Modal Split of Mass Transit = Remaining

(The last term is omitted in case of "Taxi")

3) The above equation is used and then adjusted through the Ω method.

4) The following equation is used:

Modal Split of Vehicles except "Taxi" = Present Surveyed Modal Split - (Future Estimated Modal Split under Remarks 3) - Present Surveyed Modal Split

Modal Split of Vehicles of "Taxi" = Present Surveyed Modal Split x 1/2

Modal Split of Mass Transit = Remaining.

Table 6.6-4 Modal Split for External Trips

Resident of	Trip Purposes (P. or F. / Case / Mode)	Present: Surveyed[1] Mass Transit	Present: Surveyed[1] Vehicle	Future: Dependent on Cars[2] Mass Transit	Future: Dependent on Cars[2] Vehicle	Future: Dependent on Mass Transit[2] Mass Transit	Future: Dependent on Mass Transit[2] Vehicle
Internal Area	Commuting to Work	0.58	0.42	0.47	0.53	0.77	0.23
	Going to School	0.73	0.27	0.66	0.34	0.86	0.14
	Private	0.34	0.66	0.22	0.78	0.61	0.39
	Work	0.08	0.92	0.05	0.95	0.17	0.83
External Area	Commuting to Work	0.80	0.20	0.72	0.28	0.91	0.09
	Going to School	0.86	0.14	0.81	0.19	0.94	0.06
	Private	0.67	0.33	0.53	0.47	0.86	0.14
	Work	0.23	0.77	0.14	0.86	0.42	0.58

Remarks: 1) The present figures regarding "Residents of Internal Area" are based upon the person trip survey and those regarding "Residents of External Area" upon the cordon line survey. The modal split of "Mass Transit" of "Residents of External Area" is estimated based upon that of "Residents of Internal Area".

2) Refer to Table 6.6-3.

Table 6.6-5 Future Number of Trips by Trip Purpose and Mode

(1,000 Trips)

Modal Split	Land Use Plan / Area / Mode / Trip Purposes	Original													Alternative												
		Internal					External			Totals			Internal					External			Totals		
		Driver	Passenger	Taxi	Mass Transit	Totals	Vehicle	Mass Transit	Totals	Vehicle	Mass Transit	Totals	Driver	Passenger	Taxi	Mass Transit	Totals	Vehicle	Mass Transit	Totals	Vehicle	Mass Transit	Totals
Dependent on Cars	Commuting to Work	463	353	130	909	1,855	173	406	579	1,119	1,315	2,434	443	336	124	867	1,770	103	226	329	1,006	1,093	2,099
	Going to School	67	318	23	789	1,197	2	4	6	410	793	1,203	67	313	23	777	1,180	2	4	6	405	781	1,186
	Private	911	550	215	742	2,418	120	111	231	1,796	853	2,649	903	547	214	737	2,401	120	111	231	1,784	848	2,632
	Work	1,962	760	95	316	3,133	307	33	340	3,124	349	3,473	1,818	705	88	294	2,905	294	32	326	2,905	326	3,231
	To Home	1,023	961	274	1,994	4,252	294	522	816	2,552	2,516	5,068	1,001	942	268	1,944	4,155	224	342	566	2,435	2,286	4,721
	Total	4,426	2,942	737	4,750	12,855	896	1,076	1,972	9,001	5,826	14,827	4,232	2,843	717	4,619	12,411	743	715	1,458	8,535	5,334	13,869
	Ratio	0.34	0.23	0.06	0.37	1.00	0.45	0.55	1.00	0.61	0.39	1.00	0.34	0.23	0.06	0.37	1.00	0.51	0.49	1.00	0.62	0.38	1.00
Dependent on Mass Transit	Commuting to Work	184	149	74	1,447	1,854	57	522	579	464	1,969	2,433	177	142	71	1,381	1,771	35	294	329	425	1,675	2,100
	Going to School	20	130	12	1,024	1,186	1	5	6	163	1,029	1,192	20	127	11	1,009	1,167	1	5	6	159	1,014	1,173
	Private	388	215	119	1,699	2,421	42	189	231	764	1,888	2,652	383	214	119	1,688	2,404	42	189	231	758	1,877	2,635
	Work	1,386	601	95	1,045	3,127	239	101	340	2,321	1,146	3,467	1,283	558	88	970	2,899	227	99	326	2,156	1,069	3,225
	To Home	405	389	152	3,305	4,251	100	716	816	1,046	4,021	5,067	396	381	149	3,228	4,154	77	489	566	1,003	3,717	4,720
	Total	2,383	1,484	452	8,520	12,839	439	1,533	1,972	4,758	10,054	14,811	2,259	1,422	438	8,276	12,395	382	1,076	1,458	4,501	9,352	13,853
	Ratio	0.19	0.12	0.03	0.66	1.00	0.22	0.78	1.00	0.32	0.68	1.00	0.18	0.11	0.04	0.67	1.00	0.26	0.74	1.00	0.32	0.68	1.00

6.6.3 Number of passengers and ratio of occupied vehicles in taxi

In order to estimate the taxi OD table based on the taxi passenger OD table, it is required to know the number of passengers in a taxi and the rate of occupied taxis to the total of occupied and empty taxis by trip purpose, and in order to estimate the OD table of the external traffic of cars based on the OD table of the external traffic of persons, it is required to know the average number of passengers in a car by trip purpose.

As far as the passenger cars and trucks are concerned, it is easy to estimate the vehicle OD table according to the above method of the modal split. That is, neglecting the passengers' mode, the OD table of the drivers' mode means the OD table of vehicles.

On the other hand the taxi passengers' OD table does not mean the taxi OD table because a certain number of passengers can be accomodated in a taxi. Besides, since the taxi trip include such trips as driving without passengers, the taxi movement does not necessarily correspond to the movement of the passengers. The number of passengers in a taxi estimated by trip purpose, using the number of passengers in a car in each trip purpose by the cordon line survey and the number of passengers in a taxi for all trip purpose by the screen line survey, to which the average of the former numbers of passengers is adjusted to be equal. Then the number of trips of the occupied taxis thus estimated is multiplied by the ratio of the occupied and empty taxis to the former.

Table 6.6-6 shows the numbers of passengers in a car for all trip purposes by the cordon line survey, the number of passengers in a taxi by the screen line survey and the estimated numbers of passengers in a taxi for all trip purposes. The average number of passengers in a taxi is 2.2 persons/vehicle, when empty taxis are excluded, and 1.7 persons/vehicle, when they are included, since the occupied versus the empty is 1.00 : 0.30. The OD tables of taxi passengers are converted into the OD tables of taxies themselves, based upon the numbers of passengers per taxi of 1.6 persons/vehicle for commuting to work and work purposes and 1.8 persons/vehicle for going to school and private purposes.

To the to home trip is applied the number of passengers of the trip made just before the to home trip just as in the case of the modal split. For the external traffic is used the number of passengers shown in the columns of passenger cars in Table 6.6-6.

Table 6.6-6 Number of Passengers Per Taxi

(Person/Vehicle)

Trip Purposes \ Types of Vehicles	Passenger Cars [1)]	Taxis	
		Excl. Empty Vehicles	Incl. Empty Vehicles
Commuting to Work	3.4	2.0	1.6
Going to School	3.9	2.3	1.8
Private	4.0	2.4	1.8
Work	3.5	2.1	1.6
Average	3.7	2.2 [2)]	1.7 [3)]

Remarks:
1) Source : Cordon Line Survey

2) Source : Screen Line Survey

3) Occupied Taxis : Empty Taxis = 1.00 : 0.30
(Source : Screen Line Survey)

6.6.4 Trip distribution of travel modes and its characteristics

The total sum of three of the above estimated OD tables, i.e. drivers, passengers and taxis is nothing else but the OD table of person trips carried by vehicles. And the total sum of two, i.e. drivers and taxis devided by the number of passengers is the OD table itself of vehicles. In other words, the former table shows the number of person trips carried by vehicles and the latter the number of vehicles. The said OD table of vehicles means the OD table of personal transit, since the OD table of mass transit may naturally include traffic of buses and jeepneys other than railways.

The trip distribution is estimated regarding four cases in total, or two plans of the future land use together with two patterns of the future modal split. Table 6.6-7 shows the summary of the present and future four trip distributions and Tables 6.6-8-15 show the future OD tables of mass transit and vehicle traffic in 15 sectors.

Comparisons will be made in Table 6.6-7 or the concentrated pattern in the urban center (the original plan) and the dispersed pattern in the surrounding area of the future land use together with the car-dependent pattern and the mass transit-dependent pattern of the future modal split, in order to conclude which of four cases is worth of further consideration from the viewpoint of the required transportation system.

First comparison is made aboud the difference between the future land use plans. The concentrated pattern may be said to have an expanded aspect of the present. The trip generation is almost not changed in its composition among the urban center, the surrounding area and the outlying area and expands up to the double of the present volume in all areas. But the traffic volume increases to 2.6 times as much as at present between the urban center and the surrounding area.

The trip generation in the urban center has the share of 40% of the total in the present pattern and also the concentrated pattern. But it has the share of only 1/3 of the total trip generation in the dispersed pattern. Trip generation in the urban center in the dispersed pattern is 3/4 of the present and the concentrated pattern. The expanding ratio to the present reaches 1.6. On the otherhand the trip generation in the surrounding area amounts to 2.2 times of the present in the dispersed pattern, but it has an only 10% more volume compared with the concentrated pattern.

The traffic volume between areas increases more than the trip generation in an area in both of the concentrated and dispersed patterns. This phenomen reflects the increase of the trip length accompanied by the widening of the urbanized area in future.

The trip generation increases 2 times the present in each area in case of the concentrated pattern, but into 1.6 times and 2.2 times in the urban center and the surrounding area respectively in case of the dispersed pattern. Therefore the dispersed pattern has a great advantage for planning transportation facilities compared with the concentrated pattern, since the former has a lower concentration in the urban center and a similar increase in the surrounding area. Of course, it is quite difficult to construct every transportation system in a large scale in the urban center.

The next comparison is made about the future modal splits. The proportion of vehicles and mass transit in person trips can be said roughly to be 4 : 6 at present, 6 :4 in the car-dependent pattern and 3 : 7 in the mass transit-dependent pattern. The share of vehicles becomes larger in the car-dependent pattern than at present and that of mass transit becomes larger in the mass transit-dependent pattern than at present. These proportions of each mode depends on the premise that the corresponding transportation facility is constructed enough. From this point of view, the estimated share may be thought in a typical form.

Compared with the present traffic volume, the future traffic volume of vehicles amounts to 3 times in the car-dependent pattern and to 1.5 times in the mass transit-dependent pattern. The future traffic volume of mass transit reaches up to 1.3 - 1.4 times in the car-dependent pattern and up to 2.3 - 2.4 times in the mass transit-dependent pattern. The traffic volume of vehicles in the mass transit-dependent pattern is equal to 1/2 in the car-dependent pattern and the traffic volume of mass transit in the former is equal to 1.7 times in the latter.

Therefore it can be said that both the road system and the mass transit system should be reinforced by 50% of the existing systems in size. This 50% is the minimum requirement. If the road systems is expanded by 50%, the mass transit system should be expanded up to 2.4 times, and, if the latter is expanded by 50%, the former should become 3 times in size. This extent of additional facilities, however, lets the service level and the congestion of the traffic remain at the existing level.

It is necessary to reinforce both of the road system and the mass transit system far from the existing. Especially it is quite impossible to maintain jeepneys as a principal mass transit, and even buses can not improve the circumstance. Therefore it is necessary to introduce the railway system as an urban transportation system equipped with the larger capacity and the higher speed.

The necessity to construct transportation facilities in such a large and wide scale as above mentioned, comes basically from the population increase in the Manila Metropolitan Area and moreover from prolonging trip length owing to the expansion of the urbanization and the development of urban activities. If it is not possible to construct the required transportation facilities at the worst, not only the development would be hindered, but also a confusion would occur in the urban center. It is necessary to take a measure to control the development in order to evade such a confusion.

Table 6.6-7 shows in more detail a combination of the two land use plans (the concentrated pattern and the dispersed pattern) and the two modal split patterns the (vehicle-dependent pattern and the mass transit-dependent pattern), four cases in total.

When comparison among four cases is made of the trip generation in the volume and the expansion rate, the order from the biggest is as follows in case of vehicles in the urban center; concentrated/car, dispersed/car, concentrated/mass transit and dispersed/mass transit. And it is as follows in case of vehicles in the surrounding area; dispersed/car, concentrated/car, dispersed/mass transit and concentrated/vehicle.

It is as follows in case of mass transit in the urban center: concentrated/mass transit, dispersed/mass transit, concentrated/car and, dispersed/car. It is as follows in case of mass transit in the surrounding area; dispersed/mass transit, concentrated/mass transit, dispersed/car and concentrated/car. But in the last case, the difference is negligible between the first and the second and between the third and the fourth.

As a whole, the traffic demand for vehicles and mass transit in the urban center is smaller in case of the dispersed pattern and is smaller in the surrounding area in case of the concentrated pattern.

The minimum size of the required road system would be twice as much in the urban center as at present, if the mass transit is greatly improved. On the other hand the minimum size of mass transit would be considered as the same as present in the urban center, but this is only possible in case of the car-dependent pattern and in this case the size of the road system would be 3 to 4 times as much as at present. This would cause a lot of problems. Therefore, the mass transit-dependent pattern would be better for the future transportation systems. In this case the size of mass transit facilities is twice as much as today. The road system in the surrounding area is 2 to 4 times as much as today and mass transit is 1.5 to 3 times as much.

The increase of the vehicle traffic in the urban center would be farely large in every case. Judging from the present traffic congestion, it is obvious that the improvement of the road network would be necessitated far more strongly in the urban center than in the surrounding area. But the road construction in the urban center is very difficult from the viewpoint of land acquisition. Therefore it is required to try in the field of planning the land use and the transportation system to control the traffic demand for vehicles in the urban center to the minimum level. From here, result measures such as the dispersion of land use, the importance of mass transit and the reinforcement of circumferential traffic corridors. Even in case of dispersed pattern the increase of traffic demand in the surrounding area is almost the same as in the concentrated pattern regardless of the car-dependent or the mass transit-dependent pattern.

The trip generation of vehicles is more concentrated in the urban center than the trip generation of mass transit, irrespective of the concentrated pattern or the dispersed pattern and the car-dependent pattern or the mass transit dependent pattern. This fact indicates that there exists a powerful demand for vehicles in the urban center. As shown in table 6.6-7, the difference of the trip generation in the urban center between mass transit and vehicles is 8% in case of the concentrated pattern and 4% in case of the dispersed pattern regardless of the car-dependent or mass transit-dependent pattern.

The traffic volume between the urban center and the surrounding area has the lower expansion rate only in case of the dispersed and mass transit-dependent pattern than the trip generation in the urban center and the surrounding area. This indicates that the dispersed and mass transit-dependent pattern is very effective to cut down the total size of transportation facilities.

According to the above consideration from various points of view, the dispersed and mass transit-dependent pattern is concluded to be most suitable to control the increasing traffic demand and therefore the required construction of the transportation systems among four patterns combined by the two future land uses and the two future modal splits.

This conclusion is very important because the total amount of investment to transportation facilities in Manila Metropolitan Area is quite large. In this case no other facilities than railways can possibly play the main role as mass transit carrying a large volume of traffic demand at high speed.

Table 6.6-7 Summary of OD Tables

Trips	Areas (Travel Modes / Land Use Plans / Modal Split)	Totals (1,000 Person trips)					Vehicle (1,000 vehicle trips)					Mass Transit (1,000 person trips)				
		Present	Original		Alternative		Present	Original		Alternative		Present	Original		Alternative	
			Car-Dependent	Mass Transit Dependent	Car-Dependent	Mass Transit Dependent		Car-Dependent	Mass Transit Dependent	Car-Dependent	Mass Transit Dependent		Car-Dependent	Mass Transit Dependent	Car-Dependent	Mass Transit Dependent
Trip Generation	Urban Center	5,991	12,192	12,192	9,625	9,625	1,126	4,922	2,776	3,852	2,148	3,673	4,191	7,742	3,393	6,205
		0.42	0.41	0.41	0.35	0.35	0.39	0.44	0.46	0.36	0.37	0.44	0.36	0.38	0.32	0.33
		1.00	2.04	2.04	1.61	1.61	1.00	4.37	2.47	3.42	1.91	1.00	1.14	2.11	0.92	1.69
	Surrounding Area	7,691	15,479	15,479	16,642	16,642	1,708	5,916	3,103	6,747	3,548	4,169	6,384	10,827	6,559	11,417
		0.53	0.52	0.52	0.60	0.60	0.58	0.53	0.52	0.62	0.61	0.50	0.55	0.54	0.61	0.61
		1.00	2.01	2.01	2.16	2.16	1.00	3.46	1.82	3.95	2.08	1.00	1.53	2.60	1.57	2.74
	Outgoing Area	726	1,984	1,984	1,470	1,470	80	273	139	226	121	474	1,078	1,538	717	1,081
		0.05	0.07	0.07	0.05	0.05	0.03	0.03	0.02	0.02	0.02	0.06	0.09	0.08	0.07	0.06
		1.00	2.73	2.73	2.02	2.02	1.00	3.41	1.74	2.83	1.51	1.00	2.27	3.24	1.51	2.28
	Totals	14,408	29,655	29,655	27,737	27,737	2,914	11,111	6,018	10,825	5,817	8,316	11,653	20,107	10,669	18,703
		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
		1.00	2.06	2.06	1.93	1.93	1.00	3.81	2.07	3.71	2.00	1.00	1.40	2.42	1.28	2.25
Trips between Areas	U. C. -Sur.	2,061	5,258	5,258	4,478	4,478	420	2,009	1,035	1 745	913	1,203	2,084	3,682	1,777	3,115
		1.00	2.55	2.55	2.17	2.17	1.00	4.78	2.46	4.15	2.17	1.00	1.73	3.06	1.48	2.59
	U. C. -Sur.	244	787	787	484	484	20	117	63	80	45	174	398	586	218	341
		1.00	3.23	3.23	1.98	1.98	1.00	5.85	3.15	4.00	2.25	1.00	2.29	3.37	1.25	1.96
	Sur. -Out.	418	1,173	1,173	942	942	48	149	71	139	72	260	676	942	496	730
		1.00	2.81	2.81	2.25	2.25	1.00	3.10	1.48	2.90	1.50	1.00	2.60	3.62	1.91	2.81

Remarks: Upper row: Number of trips in thousand.
Middle row, if any : Share of each area to total.
Lower row: Ratio to present.

Table 6.6-8 Future Vehicle OD Table of Car Dependent Pattern of Original Plan

O \ D	CBD-1	CBD-2	A-1	A-2	A-3	A-4	B-1	B-2	B-3	B-4	B-5	C-1	C-2	C-3
CBD-1	144237.	30515.	38148.	57758.	31403.	28169.	13662.	19221.	25791.	15357.	20532.	43233.	21586.	45618.
CBD-2	30584.	46832.	11831.	20357.	8955.	43177.	6376.	10180.	12439.	9624.	26725.	18552.	10189.	22733.
A-1	40099.	12591.	80769.	30605.	11987.	10913.	9609.	12848.	10915.	5065.	7308.	14154.	6566.	15084.
A-2	60848.	21429.	27513.	133345.	29969.	19956.	10321.	16714.	24277.	9778.	13200.	27904.	27467.	30246.
A-3	30984.	8613.	11118.	28422.	106654.	9638.	5905.	6982.	18346.	14862.	8155.	15843.	7223.	19803.
A-4	27584.	41108.	10199.	18698.	9929.	123154.	6548.	9487.	12195.	11380.	33300.	19505.	9851.	23478.
B-1	14185.	7962.	7075.	10994.	6070.	8135.	42692.	4596.	3921.	1879.	3912.	6412.	1928.	4356.
B-2	19663.	10586.	7372.	16954.	6725.	9476.	4714.	63852.	6696.	2309.	4285.	10644.	3762.	5474.
B-3	28856.	13622.	11079.	21912.	13211.	13202.	4363.	7157.	121310.	5135.	6534.	13443.	3639.	16402.
B-4	18088.	11737.	5443.	10890.	10407.	11614.	2034.	2555.	5328.	78952.	5908.	3935.	1634.	12019.
B-5	67209.	45493.	30587.	52355.	33934.	64583.	15949.	21782.	32626.	21166.	146256.	54159.	29484.	56579.
C-1	42224.	17679.	12329.	26537.	14158.	17965.	6694.	5784.	7710.	3531.	9375.	146829.	1097.	4501.
C-2	21281.	10234.	5756.	14770.	6550.	9304.	1903.	3898.	3269.	1383.	3007.	2347.	128963.	2219.
C-3	45386.	24111.	15173.	31745.	20081.	21761.	4733	6137.	17940.	8571.	11527.	6873.	3145.	205204.
C-4	35331.	28729.	9438.	19956.	9865.	30926.	3035.	3792.	6340.	4329.	21492.	3551.	1721.	7879.
E-1	3408.	1796.	1879.	2935.	2210.	2610.	1006.	1758.	2181.	1585.	2063.	2384.	1802.	2620.
E-2	4656.	2455.	2583.	4024.	3066.	3601.	1381.	2455.	3004.	2212.	2845.	3184.	2453.	3508.
E-3	5388.	2815.	2961.	4630.	3521.	4131.	1590.	2815.	3457.	2541.	3268.	3704.	2822.	4062.
TOTAL	640011.	338307.	291253.	506887.	328695.	432315.	142515.	202013.	317745.	199659.	329692.	396656.	265332.	481785.

O \ D	C-4	E-1	E-2	E-3	TOTAL
CBD-1	37677.	3408.	4656.	5388.	586359.
CBD-2	29289.	1796.	2455.	2815.	314909.
A-1	10613.	1879.	2583.	2961.	286549.
A-2	21295.	2935.	4024.	4630.	485851.
A-3	11479.	2210.	3066.	3521.	312824.
A-4	31361.	2610.	3601.	4131.	398119.
B-1	7428.	1006.	1381.	1590.	135522.
B-2	3647.	1758.	2455.	2815.	183187.
B-3	6754.	2181.	3004.	3457.	295261.
B-4	10424.	1585.	2212.	2541.	197306.
B-5	77149.	2063.	2845.	3268.	757487.
C-1	2016.	2384.	3184.	3704.	327701.
C-2	1168.	1802.	2453.	2822.	223129.
C-3	18753.	2620.	3508.	4062.	451330.
C-4	263493.	3458.	4735.	5481.	463551.
E-1	3458.	0.	317.	609.	34621.
E-2	4735.	317.	0.	793.	47272.
E-3	5481.	609.	793.	0.	54588.
TOTAL	546220.	34621.	47272.	54588.	5555567.

Table 6.6-9 Future Vehicle OD Table of Mass Transit-Dependent-Pattern of Original Plan

O \ D	CBD-1	CBD-2	A-1	A-2	A-3	A-4	B-1	B-2	B-3	B-4	B-5	C-1	C-2	C-3
CBD-1	91598.	19787.	22275.	34996.	18491.	17312.	7358.	10179.	14108.	8332.	11700.	18588.	9925.	22629.
CBD-2	19530.	30049.	7057.	12381.	5419.	26359.	3506.	5508.	6919.	5439.	15901.	8148.	4751.	11655.
A-1	23493.	7629.	45697.	17603.	6348.	6380.	5406.	7489.	5970.	2803.	4133.	6296.	3145.	7628.
A-2	36825.	13098.	15693.	78666.	17018.	11743.	5494.	8865.	13432.	5320.	7441.	12132.	14639.	14870.
A-3	18411.	5342.	6317.	16256.	62502.	5682.	3106.	3722.	10512.	8385.	4544.	6866.	3355.	9650.
A-4	16994.	25299.	5691.	11046.	5792.	73552.	3473.	5018.	6619.	6365.	18854.	8372.	4504.	11954.
B-1	7609.	4422.	3771.	5854.	3192.	4423.	23709.	2446.	2064.	1018.	2139.	2767.	915.	2212.
B-2	10393.	5698.	3975.	8915.	3589.	5011.	2512.	36260.	3573.	1269.	2346.	5609.	1849.	2851.
B-3	15838.	7618.	6008.	11942.	7117.	7215.	2306.	3827.	67292.	2759.	3573.	6636.	1735.	8140.
B-4	9881.	6638.	3020.	5990.	5502.	6411.	1104.	1409.	2871.	43663.	3316.	1775.	805.	6728.
B-5	41544.	27985.	18479.	31905.	20576.	38117.	9268.	12830.	19373.	12583.	81619.	28690.	16806.	32062.
C-1	17893.	7573.	5264.	11306.	6013.	7625.	2858.	2537.	3992.	1539.	4029.	74819.	533.	1989.
C-2	9687.	4711.	2685.	6770.	3022.	4250.	907.	1905.	1574.	675.	1431.	1328.	69679.	1108.
C-3	22409.	12356.	7609.	15626.	9757.	10948.	2375.	3164.	8888.	4459.	5931.	2985.	1499.	104327.
C-4	15711.	13271.	4339.	8983.	4398.	14048.	1404.	1807.	2913.	2115.	9989.	1529.	791.	3817.
E-1	2010.	1077.	1017.	1653.	1179.	1456.	507.	849.	1119.	786.	1098.	1107.	886.	1346.
E-2	2795.	1497.	1412.	2295.	1684.	2035.	703.	1191.	1554.	1105.	1526.	1482.	1213.	1816.
E-3	2725.	1448.	1398.	2256.	1639.	1999.	712.	1213.	1564.	1119.	1522.	1561.	1241.	1853.
TOTAL	365346.	195498.	161907.	284443.	183702.	244566.	76708.	110220.	173637.	109734.	181092.	190690.	138271.	246635.

O \ D	C-4	E-1	E-2	E-3	TOTAL
CBD-1	17007.	2010.	2795.	2725.	331815.
CBD-2	13895.	1077.	1497.	1448.	180539.
A-1	4966.	1017.	1412.	1398.	159313.
A-2	9631.	1653.	2295.	2256.	271071.
A-3	5193.	1179.	1648.	1639.	174309.
A-4	14433.	1456.	2035.	1999.	223656.
B-1	4089.	507.	703.	712.	72552.
B-2	1762.	849.	1191.	1213.	98865.
B-3	3127.	1119.	1554.	1564.	159370.
B-4	6005.	786.	1105.	1119.	108128.
B-5	41087.	1098.	1526.	1522.	437070.
C-1	901.	1107.	1482.	1561.	152321.
C-2	572.	886.	1213.	1241.	113645.
C-3	10507.	1346.	1816.	1853.	227855.
C-4	137583.	1677.	2303.	2373.	229051.
E-1	1677.	0.	214.	411.	18392.
E-2	2303.	214.	0.	535.	25324.
E-3	2373.	411.	535.	0.	25569.
TOTAL	277111.	18392.	25324.	25569.	3008845.

Table 6.6-10 Future Vehicle OD Table of Car-Dependent Pattern of Alternative Plan

O \ D	CBD-1	CBD-2	A-1	A-2	A-3	A-4	B-1	B-2	B-3	B-4	B-5	C-1	C-2	C-3
CBD-1	101253.	18772.	27662.	42717.	24402.	18932.	12646.	17062.	22234.	12772.	20961.	35016.	18514.	39419
CBD-2	18991.	26106.	7954.	14050.	6182.	26625.	5338.	8372.	9940	7339.	30651.	15216.	8269.	18296.
A-1	29658.	8372.	57648.	25761.	9218.	7572.	10375.	13717.	10030.	4233.	8893.	11212.	5399.	12951.
A-2	45330.	14592.	21116.	122546.	24284.	14431.	10139.	16224.	25278.	8928.	15930.	24797.	27708.	28585.
A-3	24120	5702.	8449.	23129.	82138.	6831.	5665.	6473.	17746.	14104.	9447.	13074.	6228.	17648.
A-4	18616.	24865.	6938.	13448.	7023.	78092.	5472.	7724.	9919.	9082.	35029.	14111.	7449.	19040.
B-1	12542.	6358.	6773.	10484.	5788.	6780.	61202.	6192.	5100.	2276.	6845.	8853.	2760.	6018.
B-2	17375.	8367.	6481.	16070.	6161.	7739.	6357.	82095.	8372.	2674.	7085.	12582.	4909.	7128.
B-3	24273.	10390.	9570.	20913.	12032.	10574.	5688.	8942.	140621.	5798.	10405.	17490.	4589.	20608.
B-4	14745.	8460.	4363.	9720.	8494.	8688.	2477.	2972.	6010.	87787.	9044.	4496.	1855.	14914.
B-5	57143.	36068.	28905.	50773.	32107.	59224.	20997.	28069.	39154.	24853.	242936.	74247.	36555.	72665.
C-1	34210.	13045.	8992.	23108.	11456.	13173.	9184.	7547.	9625.	3896.	18400.	178925.	1284.	6304.
C-2	18417.	7932.	4417.	13313.	5600.	7187.	2709.	5088.	4149.	1534.	5703.	2531.	144170.	2975.
C-3	37910.	18180.	12889.	29489.	17810.	17371.	6524.	8097.	22499.	10413.	19150.	10171.	4535.	258763.
C-4	28223.	20675.	7556.	17414.	8270.	23206.	4203.	5101.	7916.	5283.	37103.	7375.	3014.	12652.
E-1	2289.	1106.	1235.	2347.	1561.	1643.	1008.	1586.	2043.	1341.	2447.	2149.	1608.	2515.
E-2	3140.	1514.	1693.	3247.	2180.	2274.	1407.	2238.	2841.	1893.	3391.	2900.	2196.	3395.
E-3	3566.	1717.	1886.	3652.	2427.	2544.	1552.	2453.	3164.	2088.	3800.	3212.	2445.	3793.
TOTAL	491801.	232221.	224527.	442181.	267133.	312886.	172943.	229952.	346641.	206294.	487220.	438357.	283487.	547669.

O \ D	C-4	E-1	E-2	E-3	TOTAL
CBD-1	29980.	2289.	3140.	3566.	451337.
CBD-2	23644.	1106.	1514.	1717.	231310.
A-1	8307.	1235.	1693.	1886.	228160.
A-2	18486.	2347.	3247.	3652.	427620.
A-3	9428.	1561.	2180.	2427.	256350.
A-4	23097.	1643.	2274.	2544.	286366.
B-1	9600.	1008.	1407.	1552.	161538.
B-2	4658.	1586.	2238.	2453.	204330.
B-3	8190.	2043.	2841.	3164.	318131.
B-4	12688.	1341.	1893.	2088.	202035.
B-5	108242.	2447.	3391.	3800.	921576.
C-1	3792.	2149.	2900.	3212.	351202.
C-2	1717.	1608.	2196.	2445.	233691.
C-3	24148.	2515.	3395.	3793.	507652.
C-4	318040.	3098.	4280.	4745	518154.
E-1	3098.	0.	317.	609.	28902.
E-2	4280.	317.	0.	793.	39699.
E-3	4745.	609.	793.	0.	44446.
TOTAL	616140.	28902.	39699.	44446.	5412500.

Table 6.6-11 Future Vehicle OD Table of Mass Transit-Dependent Pattern of Alternative Plan

O \ D	CBD-1	CBD-2	A-1	A-2	A-3	A-4	B-1	B-2	B-3	B-4	B-5	C-1	C-2	C-3
CBD-1	63727.	12018.	15576.	25638.	14029.	11344.	7090.	9131.	12411.	6927.	12232.	15192.	8508.	20014.
CBD-2	12040.	16614.	4602.	8531.	3671.	15952.	3047.	4598.	5640.	4144.	18882.	6944.	3904.	9638.
A-1	16766.	4907.	31626.	14623.	5135.	4287.	5914.	8109.	5567.	2347.	4964.	5184.	2646.	6709.
A-2	27172.	8867.	11701.	71186.	13620.	8366.	5566.	8710.	14286.	4881.	9086.	10958.	14985.	14337.
A-3	13986.	3459.	4640.	13036.	46986.	3922.	3062.	3495.	10286.	8088.	5267.	5762.	2918.	8762.
A-4	11198.	14918.	3862.	7819.	3992.	45440.	3020.	4139.	5473.	5095.	19836.	6130.	3437.	9951.
B-1	6936.	3622.	3615.	5740.	3124.	3760.	34043.	3330.	2737.	1243.	3764.	3856.	1295.	3081.
B-2	9253.	4543.	3485.	8527.	3317.	4136.	3429.	46296.	4470.	1476.	3830.	6480.	2378.	3701.
B-3	13586.	5906.	5198.	11541.	6543.	5845.	3080.	4796.	77754.	3127.	5714.	8789.	2170.	10289.
B-4	8060.	4766.	2412.	5344.	4517.	4789.	1362.	1648.	3264.	48209.	5017.	2048.	913.	8388.
B-5	35243.	22270.	16735.	30529.	18904.	33979.	12081.	16106.	22877.	14386.	137694.	37319.	20011.	40010.
C-1	14593.	5630.	3877.	9905.	4911.	5625.	3950.	3326.	4149.	1729.	7828.	91137.	624.	2775.
C-2	8363.	3638.	2071.	6104.	2588.	3287.	1283.	2450.	1970.	745.	2620.	1431.	77238.	1462.
C-3	19026.	9490.	6499.	14736.	8744.	8870.	3301.	4152.	11225.	5365.	9716.	4438.	2121.	131806.
C-4	12681.	9695.	3493.	7911.	3726.	10685.	1948.	2416.	3660.	2568.	16909.	3101.	1345.	5902.
E-1	1420.	691.	699.	1363.	871.	956.	553.	830.	1114.	712.	1412.	1078.	842.	1384.
E-2	1979.	960.	964.	1901.	1220.	1336.	775.	1172.	1557.	1006.	1973.	1455.	1152.	1881.
E-3	1907.	923.	938.	1847.	1187.	1293.	753.	1143.	1522.	983.	1915.	1457.	1145.	1855.
TOTAL	277936.	132917.	121993.	246281.	147085.	173872.	94257.	125847.	189962.	113031.	268659.	212759.	147632	281945.

O \ D	C-4	E-1	E-2	E-3	TOTAL
CBD-1	13660.	1420.	1979.	1907.	252803.
CBD-2	11640.	691.	960.	923.	132421.
A-1	4014.	699.	964.	938.	125399.
A-2	8510.	1363.	1901.	1847.	237342.
A-3	4332.	871.	1220.	1187.	141279.
A-4	10844.	956.	1336.	1293.	158739.
B-1	5293.	553.	775.	753.	87520.
B-2	2254.	830.	1172.	1143.	110720.
B-3	3854.	1114.	1557.	1522.	172385.
B-4	7345.	712.	1006.	983.	110783.
B-5	55067.	1412.	1973.	1915.	518511.
C-1	1654.	1078.	1455.	1457.	165703.
C-2	818.	842.	1152.	1145.	119207.
C-3	13224.	1384.	1881.	1855.	257833.
C-4	165263.	1627.	2247.	2222.	257399.
E-1	1627.	0.	214.	411.	16177.
E-2	2247.	214.	0.	535.	22327.
E-3	2222.	411.	535.	0.	22036.
TOTAL	313868.	16177.	22327.	22036.	2908584.

Table 6.6-12 Future Mass Transit OD Table of Car-Dependent Pattern of Original Plan

O \ D	CBD-1	CBD-2	A-1	A-2	A-3	A-4	B-1	B-2	B-3	B-4	B-5	C-1	C-2	C-3
CBD-1	59053.	10617.	26317.	35218.	21950.	15623.	13198.	17784.	22082.	19683.	21523.	59742.	24880.	62552.
CBD-2	14194.	16448.	6531.	11957.	5158.	21403.	4691.	8016.	9709.	6523.	13325.	21287.	11098.	20697.
A-1	26430.	6001.	72294.	21309.	8867.	6087.	6785.	6131.	8699.	4246.	5361.	16470.	6535.	16452.
A-2	33353.	9952.	21061.	91952.	24241.	12346.	11212.	16132.	18329.	11178.	13054.	38764.	17126.	46192.
A-3	19992.	4078.	8804.	22765.	74125.	6511.	7122.	6508.	12056.	13462.	10087.	22802.	8148.	35201.
A-4	16887.	19796.	6395.	13248.	7121.	76023.	5542.	8202.	10457.	7983.	25180.	23758.	11124.	21418.
B-1	13399.	4849.	6905.	11478.	7182.	5475.	47555.	4973.	4245.	1611.	2590.	9503.	2566.	4850.
B-2	17668.	8283.	6155.	16408.	6192.	7964.	4970.	69161.	6572.	2157.	3735.	8284.	4649.	6584.
B-3	21244.	9150.	8728.	17831.	11824.	9905.	4284.	6606.	120260.	6208.	6236.	11409.	3666.	26608.
B-4	20010.	6891.	4191.	11034.	13823.	8022.	1602.	2149.	6206.	74153.	3079.	4217.	1690.	7161.
B-5	21893.	13567.	5389.	13091.	10413.	26084.	2629.	3871.	6360.	3150.	89835.	11241.	3700.	9680.
C-1	60139.	22790.	16320.	37968.	21306.	23479.	10101.	8285.	10517.	4264.	11424.	256309.	2372.	5462.
C-2	24998.	11876.	6426.	17042.	7448.	10981.	2598.	4747.	3266.	1658.	3457.	2532.	204212.	3045.
C-3	62931.	22087.	16384.	45998.	34750.	21151.	4866.	6432.	26690.	7188.	9485.	5559.	3010.	237664.
C-4	75889.	34912.	14496.	42903.	23624.	41812.	4199.	6217.	13413.	4049.	26121.	2113.	3011.	7749.
E-1	9329.	4573.	6671.	9213.	8215.	8573.	4303.	8247.	8672.	6898.	7607.	11229.	7741.	10193.
E-2	12318.	6042.	8939.	12279.	11050.	11493.	5781.	11151.	11651.	9377.	10246.	14986.	10395.	13622
E-3	18553.	9133.	12689.	17831.	15663.	16573.	8051.	15347.	16296.	12996.	14484.	20510.	14343.	19063.
TOTAL	528280.	221045.	254695.	449525.	312952.	329505.	149490.	210049.	315480.	196784.	276829.	540715.	340266.	554193.

O \ D	C-4	E-1	E-2	E-3	TOTAL
CBD-1	76317.	9329.	12318.	18553.	526739.
CBD-2	31709.	4573.	6042.	9133.	222584.
A-1	14921.	6671.	8939.	12689.	254887.
A-2	44307.	9213.	12279.	17831.	448522.
A-3	25042.	8215.	11050.	15663.	311631.
A-4	40596.	8573.	11493.	16573.	330369.
B-1	4231.	4304.	5781.	8051.	149548.
B-2	6485.	8247.	11151.	15347.	210012.
B-3	14245.	8672.	11651.	16296.	314823.
B-4	4063.	6898.	9377.	12996.	197562.
B-5	24699.	7607.	10246.	14484.	277[illegible].
C-1	2002.	11229.	14986.	20510.	539463.
C-2	3092.	7741.	10395.	14343.	339857.
C-3	7797.	10193.	13622.	19063.	554870.
C-4	243174.	15358.	20784.	28683.	608507.
E-1	15358.	0.	155.	298.	127276.
E-2	20784.	155.	0.	388.	170657.
E-3	28683.	298.	388.	0.	240901.
TOTAL	607505.	127276.	170657.	240901.	5826148.

Table 6. 6-13 Future Mass Transit OD Table of Mass Transit-Dependent Pattern of Original Plan

O \ D	CBD-1	CBD-2	A-1	A-2	A-3	A-4	B-1	B-2	B-3	B-4	B-5	C-1	C-2	C-3
CBD-1	137662.	25679.	52188.	71166.	42908.	32389.	23879.	33487.	41790.	33236.	37642.	105981.	54867.	105615.
CBD-2	30631.	40669.	13935.	24345.	10616.	46726.	9387.	15898.	18856.	13303.	27513.	39557.	20693.	39573.
A-1	52069.	12907.	134330.	40552.	16910.	12582.	12357.	11826.	16579.	7985.	10402.	29988.	12298.	29561.
A-2	68551.	21527.	40333.	182117.	45402.	24571.	19851.	29693.	34168.	19419.	23205.	68445.	31564.	76742.
A-3	39833.	8874.	16833.	43193.	148630.	12752.	12308.	12099.	22021.	22346.	16976.	39751.	15065.	56236.
A-4	33108.	43542.	13185.	25511.	13651.	157213	10736.	15848.	19857.	15417.	47805.	44062.	20780.	40157.
B-1	24120.	9661.	12564.	20242.	12337.	10579.	82432.	8790.	7532.	3039.	4999.	16305.	4441.	8640.
B-2	33343.	16322.	11833.	30351.	11484.	15389.	8770.	121412.	12074.	3956.	6998.	14322.	8183.	11487.
B-3	40314.	17944.	16651.	33359.	21644.	18902.	7598.	12181.	218929.	10604.	11050.	20479.	7058.	43589.
B-4	33287.	13845.	7818.	18916.	22755.	15315.	3009.	3949.	10523.	137857.	6207.	7936.	3109.	13432.
B-5	37389.	27703.	10360.	22857.	17224.	49257.	5087.	7288.	11250.	6389.	172797.	21279.	6984.	18639.
C-1	106932.	41711.	29615.	67383.	37235.	42859.	17319.	14416.	18907.	7869.	21289.	387433.	3605.	9947.
C-2	46226.	21968.	12015.	31668.	13874.	20261.	4471.	8428.	6314.	2967.	6364.	3842.	328923.	5215.
C-3	105703.	41692.	29250.	76176.	55240.	39120.	8596.	11233.	43666.	13450.	18061.	10250.	5244.	395608.
C-4	119568.	63545.	24476.	67293.	36241.	73768.	7087.	9986.	20786.	7561.	46929.	4100.	4521.	13790.
E-1	14173.	7067.	9640.	13657.	11755.	12542.	5995.	11337.	12321.	9614.	10932.	15605.	10881	14586.
E-2	18773.	9360.	12949.	18240.	15881.	16870.	8070.	15407.	16597.	13124.	14749.	20750.	14605.	19392.
E-3	27916.	13954.	18095.	26127.	22166.	23980.	11032.	20780.	22823.	17850.	20518.	27805.	19763.	26661.
TOTAL	969598.	437970.	466070.	813153.	555853.	625075.	257984.	364058.	554993.	345986.	504436.	877890.	563584.	928870.

O \ D	C-4	E-1	E-2	E-3	TOTAL
CBD-1	121142.	14173.	18773.	27916.	971493.
CBD-2	58204.	7067.	9360.	13954.	440287.
A-1	25579.	9640.	12949.	18095.	466509.
A-2	70205.	13657.	18240.	26127.	813817.
A-3	39091.	11755.	15881.	22166.	555810.
A-4	72212.	12542.	16870.	23980.	626476.
B-1	7235.	5995.	8070.	11032.	258013.
B-2	10484.	11337.	15407.	20780.	363932.
B-3	22482.	12321.	16597.	22823.	554525.
B-4	7739.	9614.	13124.	17850.	346285.
B-5	44470.	10932.	14749.	20518.	505172.
C-1	3811.	15605.	20750.	27805.	374491.
C-2	4619.	10881.	14605.	19763.	562404.
C-3	14001.	14586.	19392.	26661.	927929.
C-4	427787.	21464.	29029.	39294.	1017225.
E-1	21464.	0.	464.	893.	182926.
E-2	29029.	464.	0.	1163.	245423.
E-3	39294.	893.	1163.	0.	340820.
TOTAL	1018848.	182926.	245423.	340820.	10053504.

Table 6.6-14 Future Mass Transit OD Table of Car-Dependent Pattern of Alternative Plan

O \ D	CBD-1	CBD-2	A-1	A-2	A-3	A-4	B-1	B-2	B-3	B-4	B-5	C-1	C-2	C-3
CBD-1	44058.	7316.	22691.	27837.	19099.	12723.	10901.	15732.	17708.	17496.	20022.	49211.	21722.	54204.
CBD-2	9712.	9842.	4944.	8374.	3814.	14663.	3350.	6214.	7089.	4941.	11115.	15423.	8560.	15095.
A-1	23021.	4727.	60969.	18648.	7574.	4860.	6630.	5472.	7497.	3579.	6547.	11911.	4896.	13559.
A-2	26445.	6968.	18440.	87895.	20967.	9904.	10136.	15245.	16750.	10298.	13801.	34093.	15543.	42759.
A-3	17437.	3103.	7647.	19799.	64320.	5427.	6475.	5988.	10652.	11648.	10747.	19054.	6975.	32011.
A-4	13437.	13887.	5036.	10376.	5738.	57589.	4286.	6464.	8125.	6230.	25281.	17042.	8402.	16356.
B-1	11211.	3441.	6701.	10486.	6666.	4285.	57707.	5945.	4924.	1789.	4051.	12421.	3372.	6126.
B-2	15815.	6433.	5535.	15595.	5784.	6415.	5959.	80001.	7799.	2282.	5631.	10196.	5807.	7681.
B-3	16919.	6603.	7586.	16318.	10537.	7818.	4888.	7797.	132096.	6494.	8381.	13956.	4690.	30278.
B-4	17799.	5239.	3561.	10182.	11927.	6286.	1782.	2266.	6497.	79560.	4580.	4381.	1697.	8154.
B-5	20737.	10264.	6726.	14230.	11598.	25252.	4096.	5938.	8801.	4680.	130480.	23007.	7025.	16645.
C-1	49569.	16671.	11871.	33414.	17736.	16955.	13189.	10306.	13023.	4391.	23075.	272797.	2178.	7658.
C-2	22054.	9353.	4860.	15525.	6371.	8477.	3435.	5992.	4232.	1641.	6525.	2255.	217117.	3580.
C-3	54635.	16009.	13548.	42713.	31775.	16228.	6135.	7579.	30522.	8125.	16182.	7797.	3632.	270713.
C-4	66271.	24903.	11593.	39043.	20962.	31446.	5106.	6725.	14433.	4288.	44674.	4625.	3033.	11134.
E-1	4518.	2123.	3526.	6142.	4747.	4310.	3274.	5837.	6485.	4638.	6519.	8118.	5571.	7512.
E-2	6024.	2826.	4764.	8322.	6481.	5850.	4486.	8037.	8854.	6637.	8897.	11003.	7569.	10196.
E-3	9190.	4330.	6620.	11879.	8983.	8305.	6121.	10772.	12162.	8703.	12589.	14592.	10216.	14014.
TOTAL	428852.	154038.	206618.	396778.	265079.	246793.	157956.	212310.	317649.	187220.	359097.	531882.	338005.	567675.

O \ D	C-4	E-1	E-2	E-3	TOTAL
CBD-1	66433.	4518.	6024.	9190.	426885.
CBD-2	22680.	2123.	2826.	4330.	155095.
A-1	11823.	3526.	4764.	6620.	206623.
A-2	40075.	6142.	8322.	11879.	395662.
A-3	22051.	4747.	6481.	8983.	263545.
A-4	30510.	4310.	5850.	8305.	247224.
B-1	5163.	3274.	4486.	6121.	158169.
B-2	6930.	5837.	8037.	10772.	212509.
B-3	15214.	6485.	8854.	12162.	317076.
B-4	4425.	4638.	6437.	8703.	188114.
B-5	42989.	6519.	8897.	12589.	360473.
C-1	4438.	8118.	11003.	14592.	530984.
C-2	3009.	5571.	7569.	10216.	337782.
C-3	11302.	7512.	10196.	14014.	568617.
C-4	273868.	10687.	14727.	19844.	607362.
E-1	10687.	0.	155.	298.	84460.
E-2	14727.	155.	0.	388.	115016.
E-3	19844.	298.	388.	0.	159006.
TOTAL	606168.	84460.	115016.	159006.	5334603.

Table 6. 6-15 Future Mass Transit OD Table of Mass Transit-Dependent Pattern of Alternative Plan

O \ D	CBD-1	CBD-2	A-1	A-2	A-3	A-4	B-1	B-2	B-3	B-4	B-5	C-1	C-2	C-3
CBD-1	100676.	16943.	43057.	55173.	36306.	24916.	19835.	29474.	33955.	29025.	35583.	86491.	39734.	90270.
CBD-2	20136.	23607.	10104.	16852.	7607.	30636.	6877.	12253.	13912	9975.	23804.	28631.	15874.	28998.
A-1	43590.	9680.	108828.	34557.	13949.	9654.	12044.	10465.	14353.	6640.	12679.	21535.	9180.	24087.
A-2	53155.	14876.	34229.	173547.	38653.	19125.	18067.	28027.	31662.	17302.	25180.	59847.	28535.	70709.
A-3	33850.	6485.	14148.	37009.	125263.	10200.	11225.	11054.	19655.	19077.	18439.	32780.	12816.	50484.
A-4	25157.	29212.	10002.	19506.	10628.	113026.	8386.	12509.	15503.	11902.	48592.	31507.	15637.	30528.
B-1	20181.	7036.	12136.	18521.	11464.	8396.	105178.	10899.	8986.	3466.	8057.	21699.	6036.	11198.
B-2	29579.	12700.	10558.	28702.	10650.	12428.	10889.	145842.	14576.	4335.	10928.	17995.	10437.	13855.
B-3	32427.	13104.	14545.	30877.	19429.	15010.	8947.	14651.	245187.	11335.	15433.	25187.	9030.	50685.
B-4	29023.	10409.	6573.	17346.	19309.	11901.	3426.	4314.	11225.	150439.	9245.	8474.	3249.	15550.
B-5	35150.	21731.	12961.	25144.	19371.	47905.	8183.	11660.	16153.	9622.	264704.	43550.	13514.	32391.
C-1	87493.	30528.	21460.	58961.	30668.	31019.	22994.	18238.	23449.	8319.	42697.	424047.	3436.	13989.
C-2	40497.	17205.	9100.	28718.	11846.	15630.	6083.	10819.	8146.	3061.	12152.	3554.	355324.	6411.
C-3	90357.	30370.	24001.	70310.	49856.	30003.	11108.	13670.	50999.	15481.	30933.	14491.	6635.	463773.
C-4	102095.	45133.	19185.	60302.	31534.	54792.	8854.	11259.	22824.	8191.	80743.	8738.	5044.	20131.
E-1	7563.	3580.	5397.	9577.	7147.	6698.	4841.	8436.	9710.	6810.	10125.	11843.	8236.	11458.
E-2	10103.	4769.	7282.	12993.	9783.	9101.	6642.	11667.	13280.	9471.	13815.	15954.	11151.	15417.
E-3	15113.	7158.	9938.	18244.	13321.	12707.	8882.	15280.	17903.	12541.	19225.	20650.	14737.	20787.
TOTAL	776145.	304526.	373504.	716339.	466784.	463147.	282461.	380517.	571478.	337492.	682334.	876973.	568605.	970721.

O \ D	C-4	E-1	E-2	E-3	TOTAL
CBD-1	103167.	7653.	10103.	15113.	777384.
CBD-2	41435.	3580.	4769.	7158.	305208.
A-1	19745.	5397.	7282.	9938.	373603.
A-2	62589.	9577.	12993.	18244.	716817.
A-3	33706.	7147.	9783.	13321.	466442.
A-4	53424.	6698.	9101.	12707.	464025.
B-1	9079.	4841.	6642.	8882.	282697.
B-2	11682.	8436.	11667.	15280.	380539.
B-3	24512.	9710.	13280.	17903.	571252.
B-4	8546.	6810.	9471.	12541.	337851.
B-5	78512.	10125.	13815.	19225.	683716.
C-1	8169.	11843.	15954.	20650.	873914.
C-2	4896.	8236.	11151.	14737.	567566.
C-3	20544.	11458.	15417.	20787.	970193.
C-4	493963.	15799.	21695.	28606.	1038888.
E-1	15799.	0.	464.	893.	128577.
E-2	21695.	464.	0.	1163.	174750.
E-3	28606.	893.	1163.	0.	237148.
TOTAL	1040069.	128577.	174750.	237148.	9351538.

§ 6.7 Traffic Assignment

As the final stage of the traffic forecast, is made the traffic assignment to obtain the traffic volume on the proposed subways and expressways. According to the results of the previous section, the traffic assignment is made for the dispersed and mass transit-dependent pattern.

The traffic assignment is made separately for mass transit and vehicles. The result of the former leads to the traffic volume of each of buses and jeepneys and railways. The result of the latter leads to the traffic volume on each of ordinary roads and expressways.

Comparison is made about between the capacity of the transportation system and the traffic demand, to confirm that the traffic capacity is larger than the traffic demand, since, if not, the result of the assignment is unreasonable. Except the construction cost, the capacity of the mass transit system has farely large flexibility, but that of the road system is considered to have a certain limit especially in the urban center, unless the redevelopment is not made. Therefore comparison is necessary about the road system.

6.7.1 Comparison between traffic capacity and traffic demand in road system

The Manila Metropolitan Area, like big cities in the world, has a more rapid increase of vehicles than the population. The total population in the Manila Metropolitan Area will increase from 3,910,000 in 1970 to 7,470,000 in 1983, and this is 1.9 times as much. But the total number of vehicles will increase from 238,000 in 1970 to 913,000 in 1987, in other words, to 3.8 times as much as at present (excluding buses and jeepneys, from 210,000 in 1970 to 830,000 in 1987, to 4.0 times as much as at present). The increasing rate of vehicles is equivalent to double of that of the population. The traffic volume of vehicles increases from 1,460,000 trips in 1971 including enternal trips to 5,560,000 trips in the car-dependent pattern and 2,910,000 trips in the mass transit-dependent pattern in case of the dispersed land use pattern in 1987. This increase is equal to 3.8 and 2.0 in the rate respectively and is a big difference between the two patterns.

This big difference is caused by the share of vehicles in the modal split. This share itself is influenced not only by the above mentioned factors (trip purpose, trip length, car ownership and so on) but also by the relative travel time of vehicles comparing with other travel modes. Supposing the travel time of the other travel modes as constant, the relative time of vehicles will be influenced by the road capacity.

Therefore the share of vehicles is considered as a function of the road capacity.

At the time when vehicles are popular among residents as expected in the Manila Metropolitan Area in 1987, the try to use vehicles as much as possible and the limit to use vehicles is found where it becomes disadvantageous to use vehicles. In other words, the vehicle traffic increases continuously until it reaches to the volume equivalent to the road capacity. Vehicles require not only running space expressed as roads but also parking space. The adequate capacity of parking space is required corresponding to the road capacity. It is obvious that the parking capacity will influence the share of vehicles (except taxis) in the modal split, but this point is not considered here.

The comparison between the road capacity and the traffic demand for vehicles is made at the boundary of sectors. The traffic demand is calculated by summing·up the traffic volume of each OD pair crossing over a boundary of the sector, assuming the vehicle traffic will choose the shortest route. The total road capacity can be calculated at the corresponding sector boundary. Since buses and jeepneys demand traffic space, the road capacity has to have extra room for them. Although the proportion of the bus and jeepney traffic is 1/3 - 1/2 to the total road traffic now at some sections, this proportion would be much decreased when the railway system is introduced. The road capacity is estimated on the basis of the road network consisting of the major throughfares together with the secondary roads shown in Fig. 6.7 - 3 and the expressways shown in Fig. 7.1-1.

Table 6.7-1 shows that traffic demand in each boundary between sectors and Table 6.7-2 shows the road capacity. Comparison is made in Table 6.7-3, which indicates the following.

(1) The traffic demand is far beyond the road capacity in case of the car-dependent pattern, but it is almost within the capacity in case of mass transit-dependent pattern.

(2) The traffic demand is large in the urban center and the radial direction and in some and exceeds the road capacity at many sections in case of the concentrated pattern.

On the other hand in case of the dispersed pattern, the traffic demand is relatively larger in the circumferential direction and the surrounding area and exceeds the capacity at a few sections.

Table 6.7-1 Vehicle Traffic Demand on Boundaries of Sectors

(1,000 Vehicles)

Direction of Traffic	Boundaries of Sectors	Original: Car-Dependent	Original: Mass Transit-Dependent	Alternative: Car-Dependent	Alternative: Mass Transit-Dependent
In CBD	CBD1 CBD2	523	290	405	224
Radial	" A - 1	362	189	287	148
	" A - 2	370	203	291	159
	" A - 3	126	72	97	54
	" A - 4	108	58	77	41
	CBD2 A - 4	550	303	437	242
Circumferential	A - 1 A - 2	289	147	241	124
	A - 2 A - 3	337	186	287	158
	A - 3 A - 4	193	109	162	92
Radial	A - 1 B - 1	394	187	332	162
	A - 2 B - 2	171	88	147	77
	" B - 3	328	167	298	154
	A - 3 B - 3	136	71	113	59
	" B - 4	342	179	294	155
	A - 4 B - 4	149	79	114	61
	" B - 5	605	329	528	291
Circumferential	B - 1 B - 2	105	56	126	68
	B - 2 B - 3	255	131	331	169
	B - 3 B - 4	318	166	389	202
	B - 4 B - 5	474	253	568	301
Radial	B - 1 C - 1	213	94	172	77
	B - 2 C - 1	144	70	178	85
	" C - 2	70	34	72	36
	B - 3 C - 2	198	97	192	95
	" C - 3	172	85	186	93
	B - 4 C - 3	388	201	364	192
	B - 5 C - 4	495	235	479	231
Circumferential	C - 1 C - 2	34	15	44	20
	C - 2 C - 3	22	10	29	14
	C - 3 C - 4	64	32	79	39
External	C - 1 E - 1	25	14	18	11
	C - 2 E - 1	44	23	39	21
	" E - 2	5	2	4	2
	C - 3 E - 2	78	42	64	36
	C - 4 E - 2	11	6	10	6
	" E - 3	109	51	89	44
Radial	CBD A	1,516	825	1,189	644
	A B	2,125	1,100	1,826	959
	B C	1,680	816	1,643	809
	C E	272	138	224	120
Circumferential	1*	572	288	589	297
	2**	985	518	1,004	526
	3***	880	473	923	493

Remarks: * Totals of A1-A2, B1-B2, B2-C1 and C1-C2

** Totals of A2-A3, A3-B3, B3-B4, B3-C3 and C2-C3

*** Totals of A3-A4, A4-B4, B4-B5 and C3-C4 (i.e. Pasig River)

Table 6.7-2 Road Capacity of Boundaries of Sectors

Direction	Boundaries of Sectors (E. or A.)		Number of Lanes (lanes) — Existing: Major	Existing: Secondary	Existing: Total	Additional: Major	Additional: Secondary	Additional: Total	Future: Major	Future: Secondary	Future: Total	Capacity (1,000 vehicles) Future Totals
In CBD	CBD1	CBD2	14	8	22	6	0	6	20	8	28	280
Radial	"	A - 1	8	2	10	2	3	5	10	5	15	150
	"	A - 2	8	0	8	0	0	0	8	0	8	80
	"	A - 3	6	3	9	3	0	3	9	3	12	120
	"	A - 4	3	0	3	0	4	4	3	4	7	70
	CBD2	A - 4	12	11	23	2	4	6	14	15	29	290
Circum-ferential	A - 1	A - 2	3	3	6	3	1	4	6	4	10	100
	A - 2	A - 3	3	6	9	9	0	9	12	6	18	180
	A - 3	A - 4	3	0	3	0	6	6	3	6	9	90
Radial	A - 1	B - 1	2	6	8	8	0	8	10	6	16	160
	A - 2	B - 2	8	0	8	4	0	4	12	0	12	120
	"	B - 3	6	3	9	0	1	1	6	4	10	100
	A - 3	B - 3	0	4	4	7	2	9	7	6	13	130
	"	B - 4	5	3	8	8	1	9	13	4	17	170
	A - 4	B - 4	0	3	3	6	0	6	6	3	9	90
	"	B - 5	19	6	25	11	2	13	30	8	38	380
Circum-ferential	B - 1	B - 2	10	0	10	10	0	10	20	0	20	200
	B - 2	B - 3	6	1	7	6	15	21	12	16	28	280
	B - 3	B - 4	3	0	3	3	12	15	6	12	18	180
	B - 4	B - 5	3	0	3	5	12	17	8	12	20	200
Radial	B - 1	C - 1	4	2	6	8	1	9	12	3	15	150
	B - 2	C - 1	4	0	4	10	0	10	14	0	14	140
	"	C - 2	4	0	4	14	8	22	18	8	26	260
	B - 3	C - 2	2	0	2	8	0	8	10	0	10	100
	"	C - 3	6	0	6	5	0	5	11	0	11	110
	B - 4	C - 3	6	8	14	0	8	8	6	16	22	220
	B - 5	C - 4	16	7	23	0	7	7	16	14	30	300
Circum-ferential	C - 1	C - 2	2	0	2	6	0	6	8	0	8	80
	C - 2	C - 3	1	0	1	6	0	6	7	0	7	70
	C - 3	C - 4	3	2	5	3	4	7	6	6	12	120
External	C - 1	E - 1	6	0	6	4	0	4	10	0	10	100
	C - 2	E - 1	0	0	0	0	2	2	0	2	2	20
	"	E - 2	0	0	0	0	0	0	0	0	0	0
	C - 3	E - 2	0	2	2	8	4	12	8	6	14	140
	C - 4	E - 2	0	0	0	4	0	4	4	0	4	40
	"	E - 3	9	2	11	17	10	27	26	12	38	380
Radial	CBD	A	36	16	52	7	13	20	43	29	72	720
	A	B	40	25	65	44	6	50	84	31	115	1,150
	B	C	42	17	59	45	24	69	87	41	128	1,280
	C	E	15	4	19	33	16	49	48	20	68	680
Circum-ferential	1*		19	3	22	29	1	30	48	4	52	520
	2**		13	10	23	30	14	44	43	24	67	670
	3***		9	5	14	14	22	36	21	27	50	500

Remarks: 1) * Totals of A1-A2, B1-B2, B2-C1 and C1-C2
** Totals of A2-A3, A3-B3, B3-B4, B3-C3 and C2-C3
*** Totals of A3-A4, A4-B4, B4-B5 and C3-C4 (i.e. Pasig River)
2) The capacity is calculated upon the assumption of 10,000 vehicles/lane:day

Table 6.7-3 Comparison of Vehicle Traffic Demand and Capacity

(1,000 Vehicles)

Direction	Boundaries of Sectors		Ratio (Demand/Capacity)				Difference (Capacity/Demand)			
Comparison / Land Use Plan / Modal Split			Original		Alternative		Original		Alternative	
			Car-Dependent	Mass Transit-Dependent	Car-Dependent	Mass Transit-Dependent	Car-Dependent	Mass Transit-Dependent	Car-Depdenen	Mass Transit-Dependent
In CBD	CBD1	CBD2	1.87	1.04	1.45	0.80	Δ 243	Δ 10	Δ 125	56
Radial	"	A - 1	2.41	1.26	1.91	0.99	Δ 212	Δ 39	Δ 137	2
	"	A - 2	4.63	2.54	3.64	1.99	Δ 290	Δ 123	Δ 211	Δ 79
	"	A - 3	1.05	0.60	0.81	0.45	Δ 6	48	23	66
	"	A - 4	1.54	0.83	1.00	0.59	Δ 38	12	Δ 7	29
	CBD2	A - 4	1.90	1.04	1.51	0.83	Δ 260	Δ 13	Δ 147	48
Circum-ferential	A - 1	A - 2	2.89	1.47	2.41	1.24	Δ 189	Δ 47	Δ 141	Δ 24
	A - 2	A - 3	1.87	1.03	1.59	0.88	Δ 157	Δ 6	Δ 107	22
	A - 3	A - 4	2.14	1.21	1.80	1.02	Δ 103	Δ 19	Δ 72	Δ 2
Radial	A - 1	B - 1	2.46	1.17	2.08	1.01	Δ 234	Δ 27	Δ 172	Δ 2
	A - 2	B - 2	1.43	0.73	1.23	0.64	Δ 51	32	Δ 27	43
	"	B - 3	3.28	1.67	2.98	1.54	Δ 228	Δ 67	Δ 198	Δ 54
	A - 3	B - 3	1.05	0.55	0.87	0.45	Δ 6	59	17	71
	"	B - 4	2.01	1.05	1.73	0.91	Δ 172	Δ 9	Δ 124	15
	A - 4	B - 4	1.66	0.88	1.27	0.68	Δ 59	11	Δ 24	29
	"	B - 5	1.59	1.03	1.39	0.77	Δ 225	51	Δ 148	89
Circum-ferential	B - 1	B - 2	0.53	0.28	0.63	0.34	95	144	74	132
	B - 2	B - 3	0.91	0.47	1.16	0.60	25	149	Δ 51	111
	B - 3	B - 4	1.77	0.92	2.16	1.12	Δ 138	14	Δ 209	Δ 22
	B - 4	B - 5	2.37	1.27	2.84	1.51	Δ 274	Δ 53	Δ 368	Δ 101
Radial	B - 1	C - 1	1.42	0.63	1.15	0.51	Δ 63	56	Δ 22	73
	B - 2	C - 1	1.03	0.47	1.27	0.61	Δ 4	70	Δ 38	55
	"	C - 2	0.27	0.13	0.28	0.14	190	226	188	224
	B - 3	C - 2	1.98	0.97	1.92	0.95	Δ 98	3	Δ 92	5
	"	C - 3	1.56	0.77	1.69	0.85	Δ 62	25	Δ 76	17
	B - 4	C - 3	1.76	0.91	1.57	0.87	Δ 168	19	Δ 144	28
	B - 5	C - 4	1.65	0.78	1.60	0.77	Δ 195	65	Δ 179	69
Circum-ferential	C - 1	C - 2	0.43	0.19	0.55	0.25	46	65	36	60
	C - 2	C - 3	0.28	0.14	0.41	0.20	48	60	41	56
	C - 3	C - 4	0.53	0.27	0.66	0.33	56	88	41	81
External	C - 1	E - 1	0.25	0.14	0.18	0.11	75	86	82	89
	C - 2	E - 1	2.20	1.15	1.95	1.05	Δ 24	Δ 3	Δ 19	Δ 1
	"	E - 2	-	-	-	-	Δ 5	Δ 2	Δ 4	Δ 2
	C - 3	E - 2	0.56	0.30	0.46	0.26	62	98	76	104
	C - 4	E - 2	0.28	0.15	0.25	0.15	29	34	30	34
	"	E - 3	0.29	0.13	0.23	0.12	271	329	291	336
	CBD	A	2.11	1.15	1.65	0.89	Δ 796	Δ 105	Δ 469	76
Radial	A	B	1.85	0.96	1.59	0.83	Δ 975	50	Δ 676	191
	B	C	1.31	0.64	1.29	0.63	Δ 400	464	Δ 363	471
	C	E	0.40	0.20	0.33	0.18	408	542	456	560
Circum-ferential	1*		1.10	0.55	1.13	0.57	Δ 52	232	Δ 69	223
	2**		1.47	0.77	1.50	0.79	Δ 315	152	Δ 334	144
	3***		1.76	0.95	1.85	0.99	Δ 380	27	Δ 423	7

Remarks: * Totals of A1-A2, B1-B2, B2-C1 and C1-C2

** Totals of A2-A3, A3-B3, B3-B4, B3-C3 and C2-C3

*** Totals of A3-A4, A4-B4, B4-B5 and C3-C4 (i.e. Pasig River)

Therefore it is possible to assign the traffic demand for the transportation network shown in Figs. 6.7-3 and 6.7-4 only in case of the dispersed and mass transit-dependent pattern. The traffic assignment work is limited to this pattern.

6.7.2 Method and result of traffic assignment

The principles of the traffic assignment for both the mass transit and the road systems is explained as follows;

(1) Each link of the transportation network has its own relation between the traffic volume and the travel time. In this relation the travel time increases according to the increase of the traffic volume already assigned. The travel time increases very quickly when the traffic volume approaches to the traffic capacity.

(2) The traffic demand of each OD pair is assigned to the minimum route in relation to the travel time decided by the above relation. The so-called all or nothing method is used.

(3) The traffic demand of OD pairs is devided into several lots and the travel time is calculated repeatedly according to the traffic volume already assigned on a link at the assignment of each lot. The minumum route is searched according to the travel time thus calculated. The above calculation and search are repeated until the whole lots of each OD pair are assigned. Therefore, it rarely happens that the traffic demand of a certain OD pair concentrates on a particular route.

The relation between the traffic volume and the travel time is shown in Figs. 6.7-1 and 6.7-2. The travel time is estimated multiplying the length of the link and the travel time per unit length obtained in this relation applying the traffic volume (per lane in case of a road) already assigned.

Besides, the transferring time is assumed as follows between mass transit systems; 0.08 hrs. inside C-4 and 0.1 hrs. outside C-4 between the bus system and a railway line and 0.05 hrs. between two railway lines. The reason why such small value are chosen for transfer time is that the actual time should not be considered, but the difference with the transfer time between two buses, since it is obliged to neglect the transfer between buses.

In case that expressways are planned as toll roads, to a link of them is added extra travel time corresponding to the fare to be paid. Conversion is made as follows from the fare to the additional travel time, using the time value discussed later;

fare		time value				
2 pesos	÷	0.19 pesos/min.	÷	60 min. /hr.	=	0.18 hr.

The capacity of railways is computed by the following formula;

capacity — service frequency (2 min.)

120 persons/vehicle x 8 vehicles/train x 30 trains/hr.

peak ratio — congestion — directions

÷ 1/4 (hr. /day) x 200% x 2 ≒ 460,000 persons/day

In the actual assignment 420,000 persons/day, 10% less than the above is adopted as the capacity as shown in Fig. 6.7-1.

The capacity of a road is computed by the following formula;

peak ratio

800 vehicles/hr.-lane x 1/0.08 (hr. /day) = 10,000 vehicles/day-lane

This capacity shows a farely large capacity but is possible enough, if equipped with the additional facilities required for major thoroughfares such as side walks, bus bays and traffic signals.

The transportation network to be assigned to consists of streets, expressways and subways, which are shown in Fig. 6.7-3 and 7.1-1. The traffic assignment is made to the street network and the expressway network for vehicles and to the street network and the subway network for mass transit. The street network shown in Fig. 6.7-3 is not necessarily a faithful copy of the actual streets in the shape and the width. The location of intersections are shifted and two pallarel streets are combined into one. The street network in this figure consists of major thoroughfares and secondary roads. There are numberous minor roads, but they should be available for short trips consiting mainly of intra-zonal trips and then excluded from the network to be assigned to. And also from the OD table to be assigned are excluded those intra-zonal trips and those trips between adjacent zones belonging to A and B sectors, which use these minor roads.

Mass transit trips are assigned at first and vehicle trips next. Before the assignment of the latter, the trips assigned to bus routes are added to links of streets, converting into the number of buses as follows;

capacity		congestion	peak ratio of bus operation		peak ratio of traffic demand		
75 persons/vehicle	x	120%	(1/10	÷	1/4)	=	36 persons/vehicle

Tables 6.7-4 and 6.7-5 show results of the traffic assignment. The total number of users of subways is estimated to be 3,400,000 persons in a day and that of urban expressways 137,000 vehicles per day in the toll system and 428,000 vehicles per day in the free system.

Figs. 6.7-4~ 6.7-7 shows the assigned traffic volume. The traffic volume on streets includes those intra-zonal trips and inter zonal trips between adjacent zones in the urban center, as far as they are estimated to use major thoroughfares and secondary roads. Fig. 6.7-8 shows the estimated congestion on streets.

As to the question of whether the urban expressway should be toll or free, there are various opinions presented, and this question still awaits the solution of many problems for the conclusion to be drawn. The problems are pointed out such as the financial sources of the construction, the timing of opening for traffic, the function of road system as a whole, the traffic volume and so on. Out of these problems, the issue of the traffic volume is to be examined here based on the result of the traffic assignment.

The toll system and the free system of the expressway is, in the first place, compared in the difference of the number of vehicles using the expressway. As is shown in Table 6.7-5, the total number of vehicles which use the expressway when it is toll is only 137,000 vehicles/day. When it is free, it is estimated to amount to 428,000 vehicles/day, that is three times as much. However, the average length of the expressway utilized by a vehicle is 15.0 Kms. in case of the toll system, and is 7.1 Kms. in case of the free system, which means that the length is shortened to almost half. The traffic volume is increased 1.5 times as a whole in case of the free system. This is also known from the increase of vehicle-kilometers from 2,050,000 vehicle kilometers to 3,028,000 vehicle kilometers, that is approximately 1.5 times as much.

The impact upon the ordinary roads is compared in the second place in Fig. 6.7-9, which shows that the traffic volume tends to decrease on ordinary roads which are to compete with the free expressways. However, the amount of this decrease will be 10% at most. It is also considered as natural that the traffic volume of ordinary roads which are connected to expressways follows the trend of increase. But most sections show an increase of 10% or remain at the same level and a few exceptional sections show an increase 50%. Therefore, it may be concluded that the determination of the expressway as free or toll will hardly give any impact upon the traffic volume on ordinary roads which are related to expressways.

In table 6.7-5, it is to be noted that in case of the free system the total vehicle-kilometer is slightly enlarged and on the other hand, the total travel time as well as the average travel speed are improved by almost 10% as compared with the case of the toll system.

To summarize when the expressway is free, the traffic volume on the expressway will increase 1.5 times, while that on the ordinary road will remain almost the same, and the total travel time will be reduced by approximately 10%. However, this single result does not immediately draw the conclusion that the expressway should be free. Furthermore, it will be necessary to investigate such matters as the financial sources of the construction of expressways and the function of the expressway as a part of the road total system. This kind of investigation is conducted in a later stage.

Table 6.7-4 Future Number of Passengers of Railways

(1,000 trips/day)

Number of Person Trips	Total	9,352
	Of Mass Transit Mode	5,806
	Of Railway Mode	4,304
Number of Railway Passengers	Total	6,327
	PNR	1,314
	Subway Line No. 1	1,239
	" No. 2	1,208
	" No. 3	1,013
	" No. 4	1,052
	" No. 5	502

Remarks: The numbers of person trips of the railway mode and of total railway passengers are not equal to each other owing to transferring among railway lines.

Table 6.7-5 Future Number of Vehicles of Urban Expressways

Items \ Fare System		Toll (₱ 2)	Free
Vehicle Trips (1,000 trips/day)	Total	2,908	
	To Be Assigned	1,705	
	Using Urban Expressways	137	428
Vehicle Kilometers (1,000 vehicle-kms./day)	Total	24,135	24,321
	On Urban Expressways	2,050	3,028
	On Street	22,085	21,293
Travel Time (1,000 vehicle-hours/day)	Total	2,211	2,074
	On Urban Expressways	46	121
	On Street	2,165	1,953
Travel Speed (kms./hr.)	Average	10.9	12.0
	On Urban Expressways	44.1	25.1
	On Street	10.2	10.9
Length of Urban Expressways Utilized by One Vehicle (kms.)		15.0	7.1

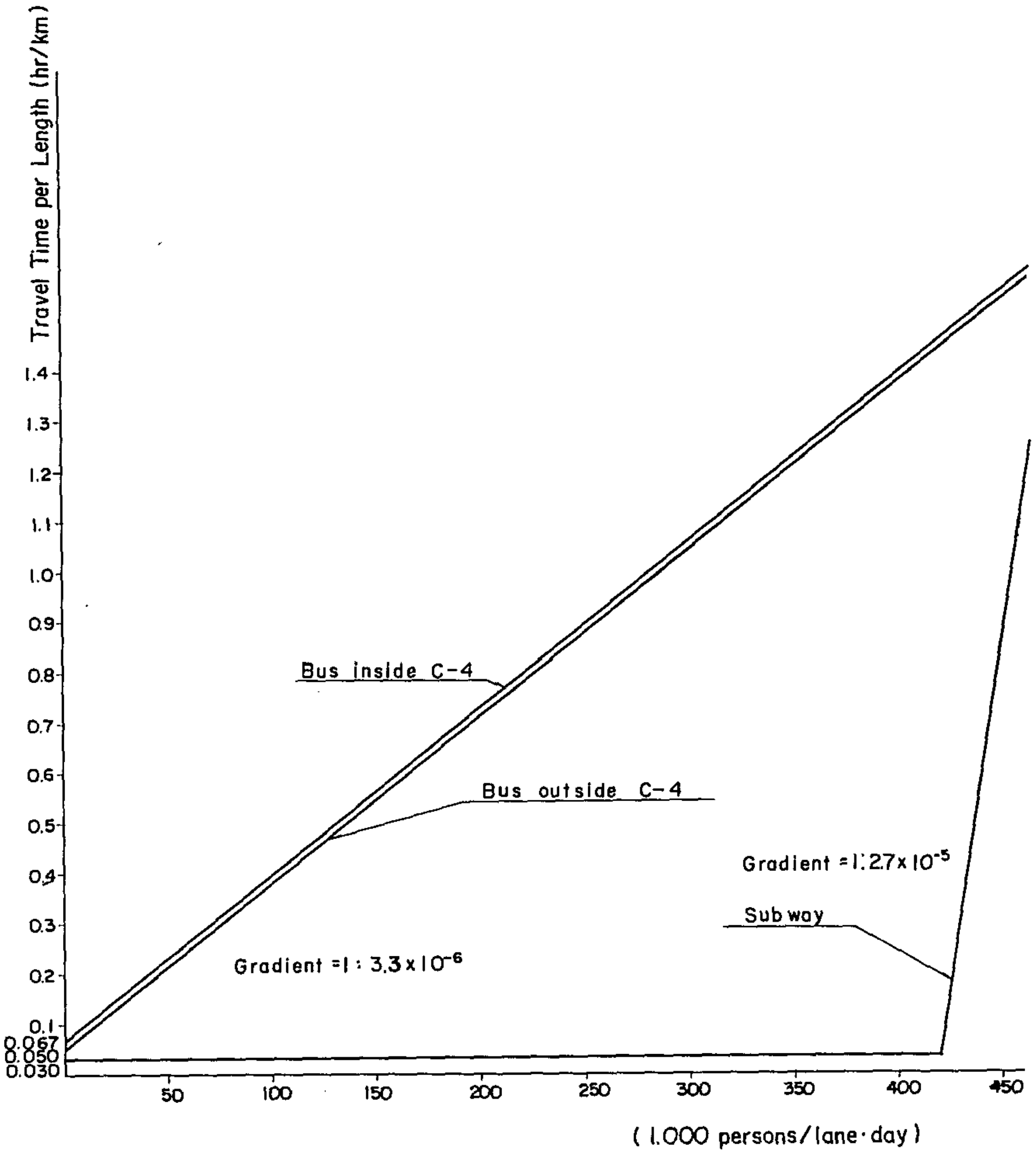

Fig.6.7-1 Relationship between Traffic Volume and Travel Time in Mass Transit

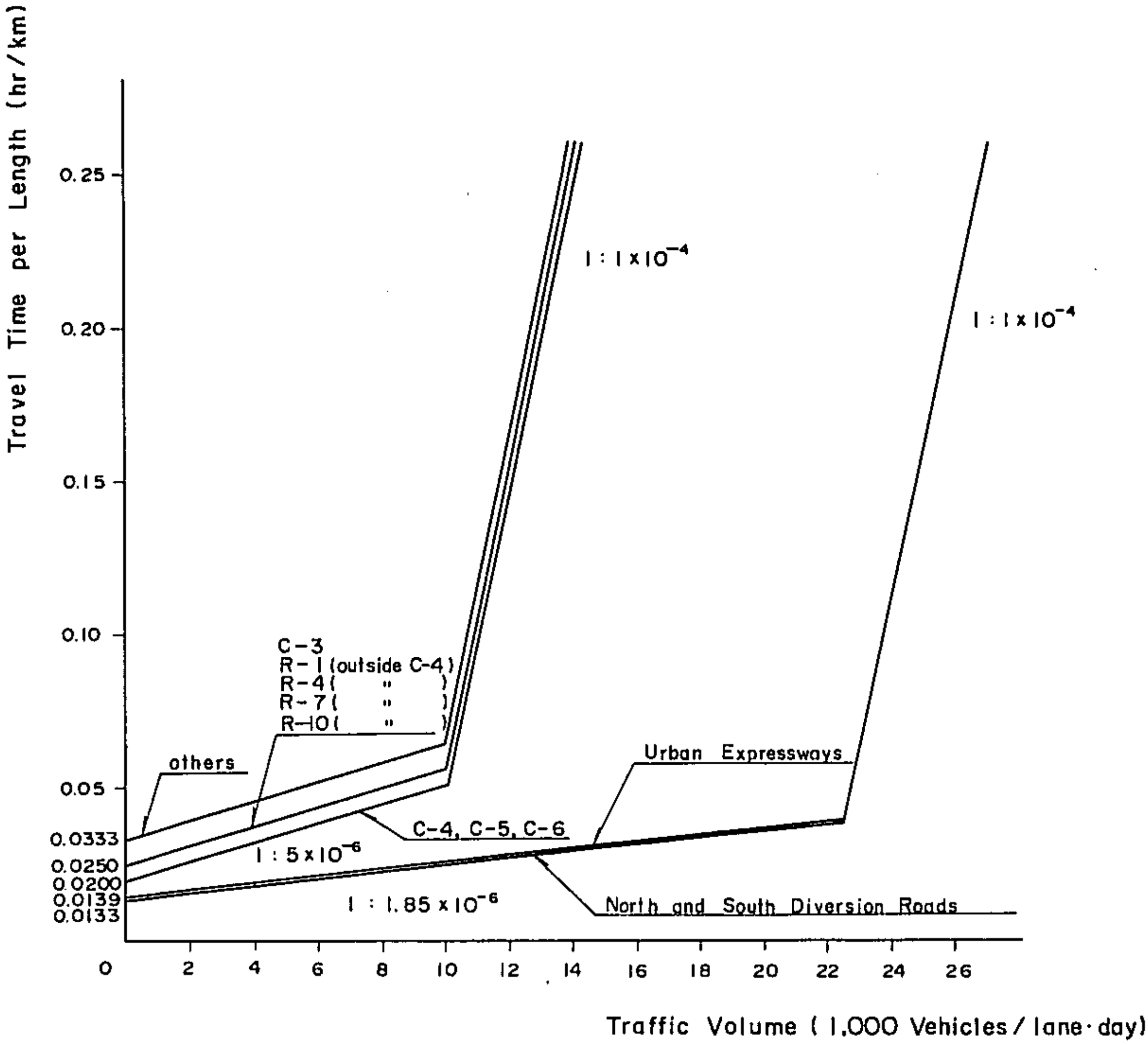

Fig. 6·7－2 Relationship between Traffic Volume and Travel Time on Roads

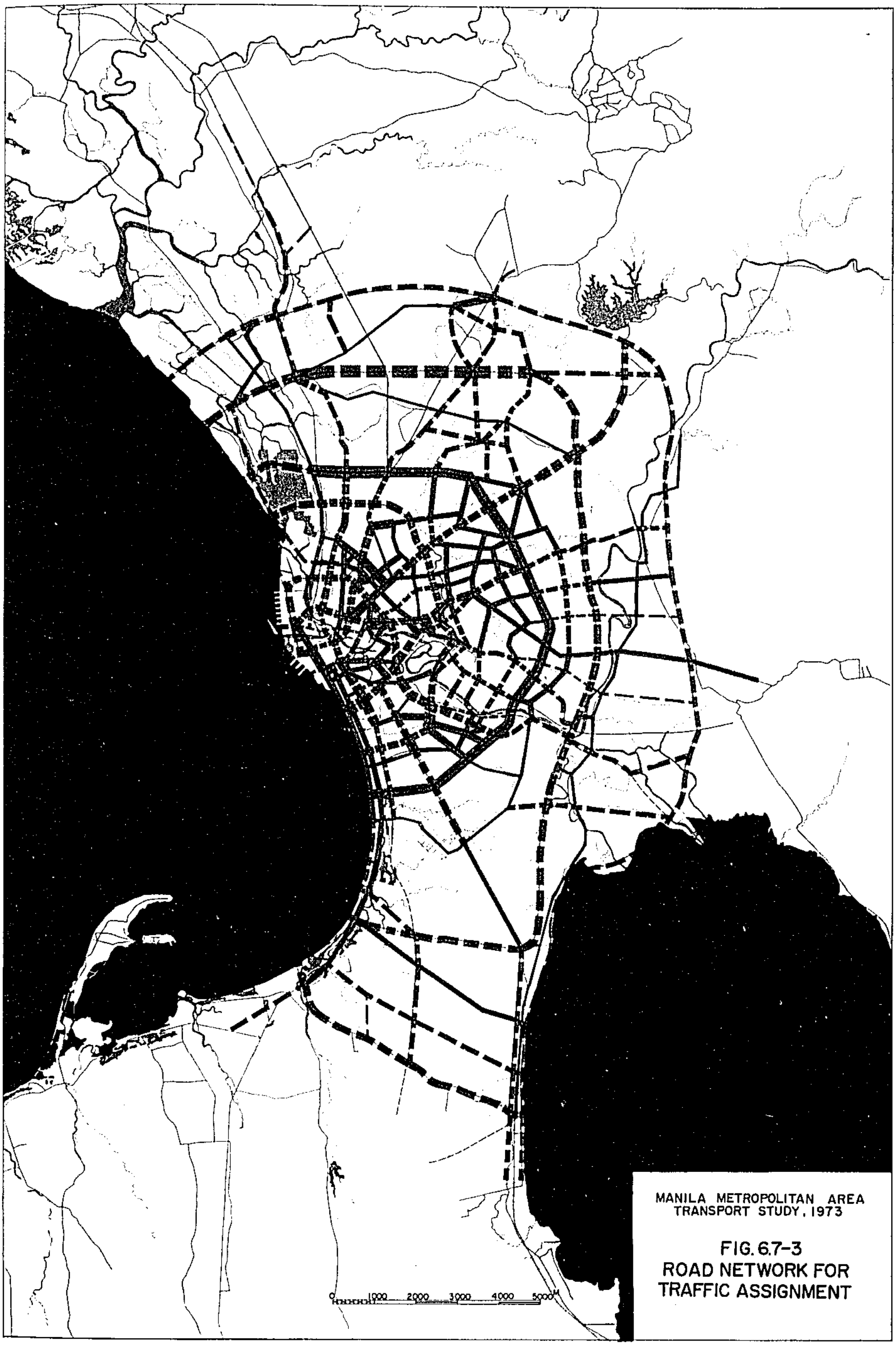

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FIG. 6.7-3
ROAD NETWORK FOR
TRAFFIC ASSIGNMENT

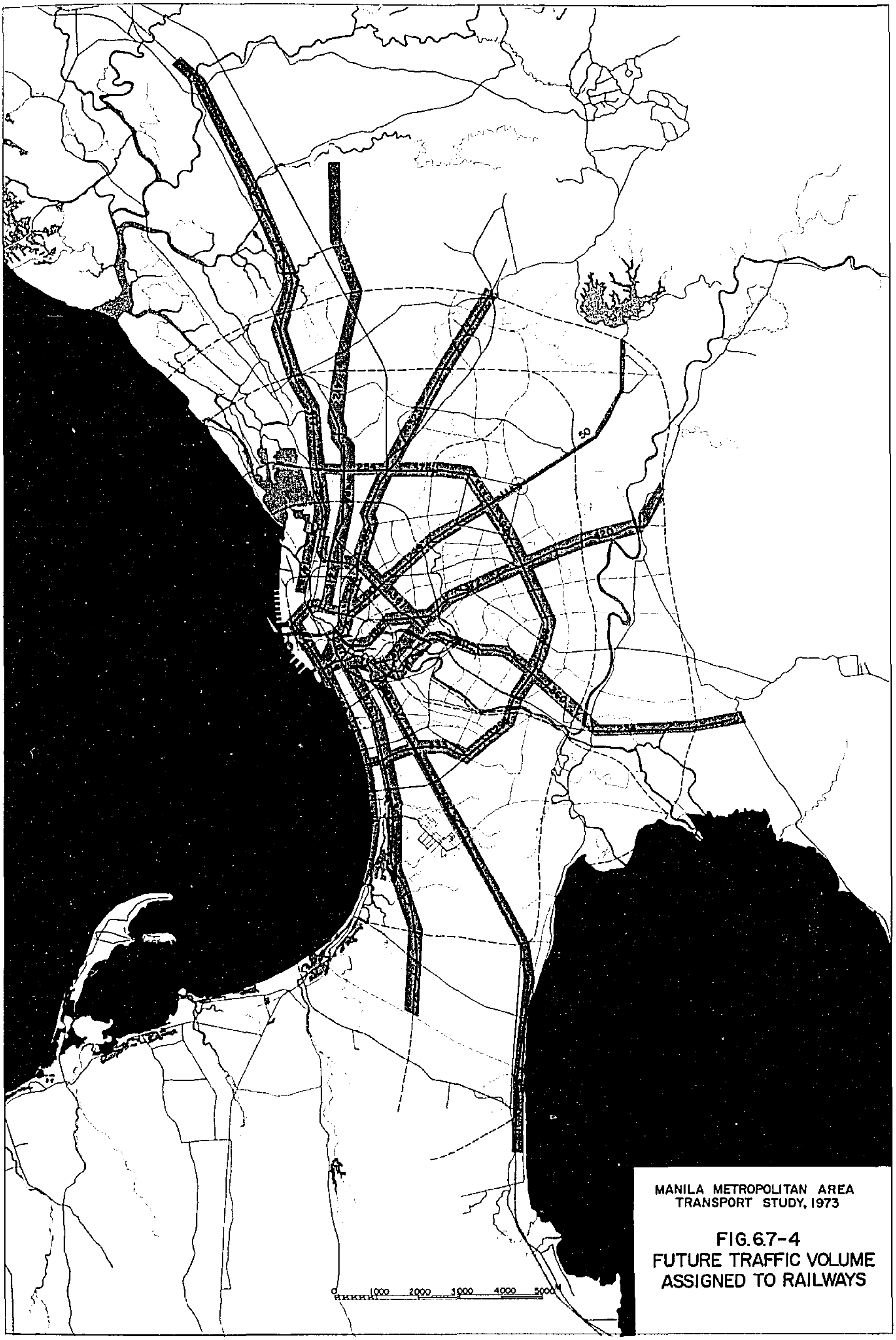

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FIG. 6.7-4
FUTURE TRAFFIC VOLUME
ASSIGNED TO RAILWAYS

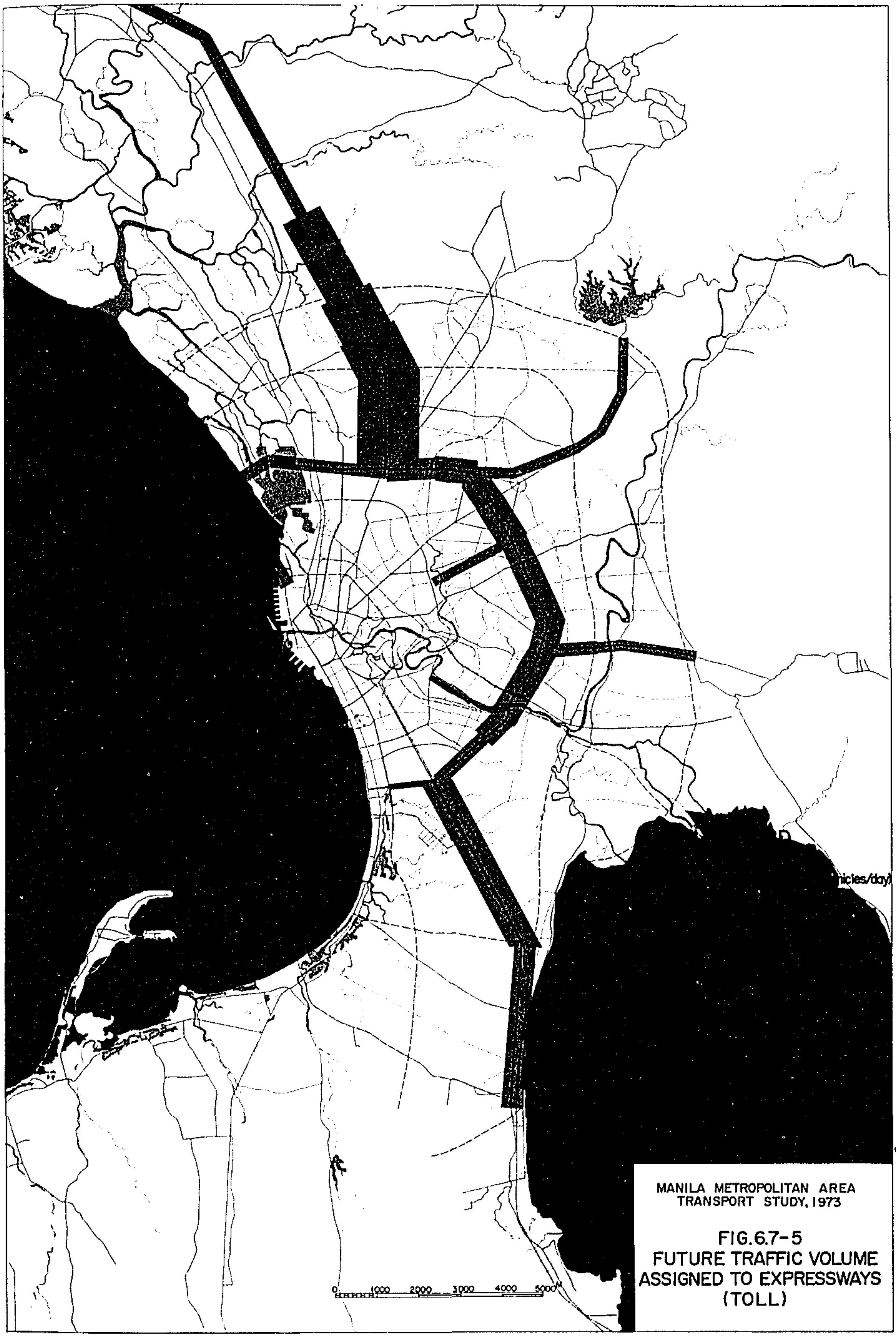

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FIG.6.7-5
FUTURE TRAFFIC VOLUME
ASSIGNED TO EXPRESSWAYS
(TOLL)

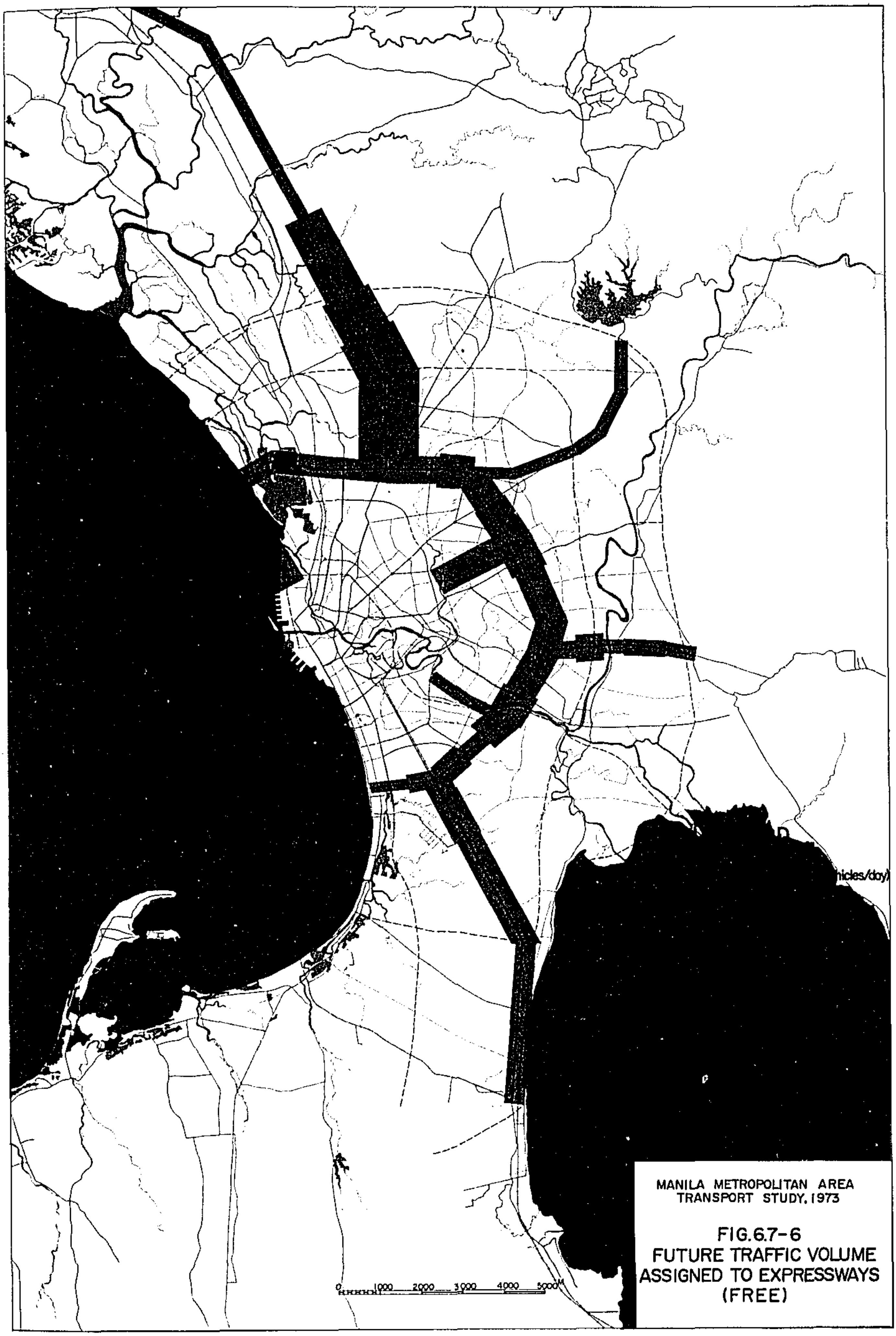

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FIG. 6.7-6
FUTURE TRAFFIC VOLUME
ASSIGNED TO EXPRESSWAYS
(FREE)

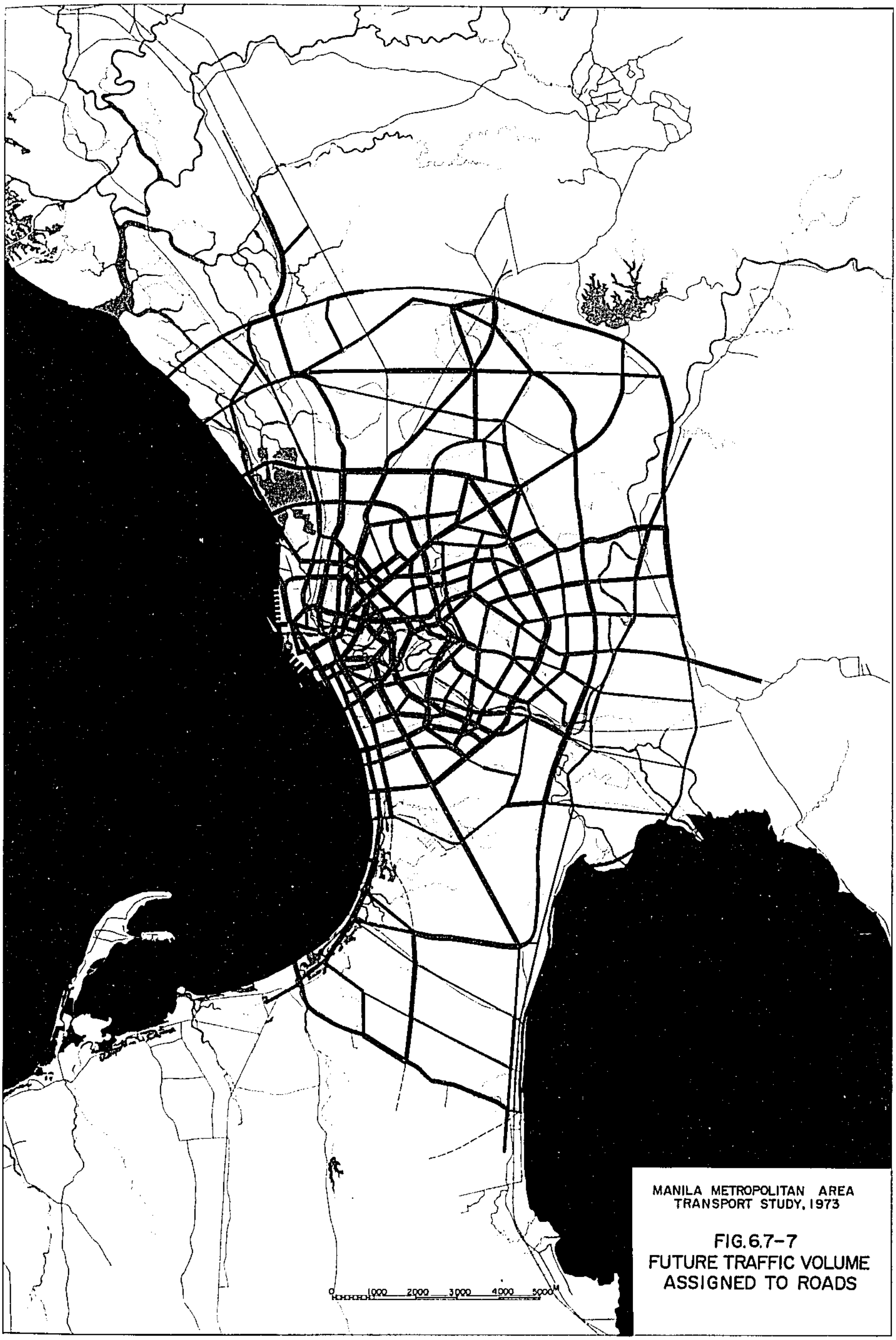

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FIG. 6.7-7
FUTURE TRAFFIC VOLUME
ASSIGNED TO ROADS

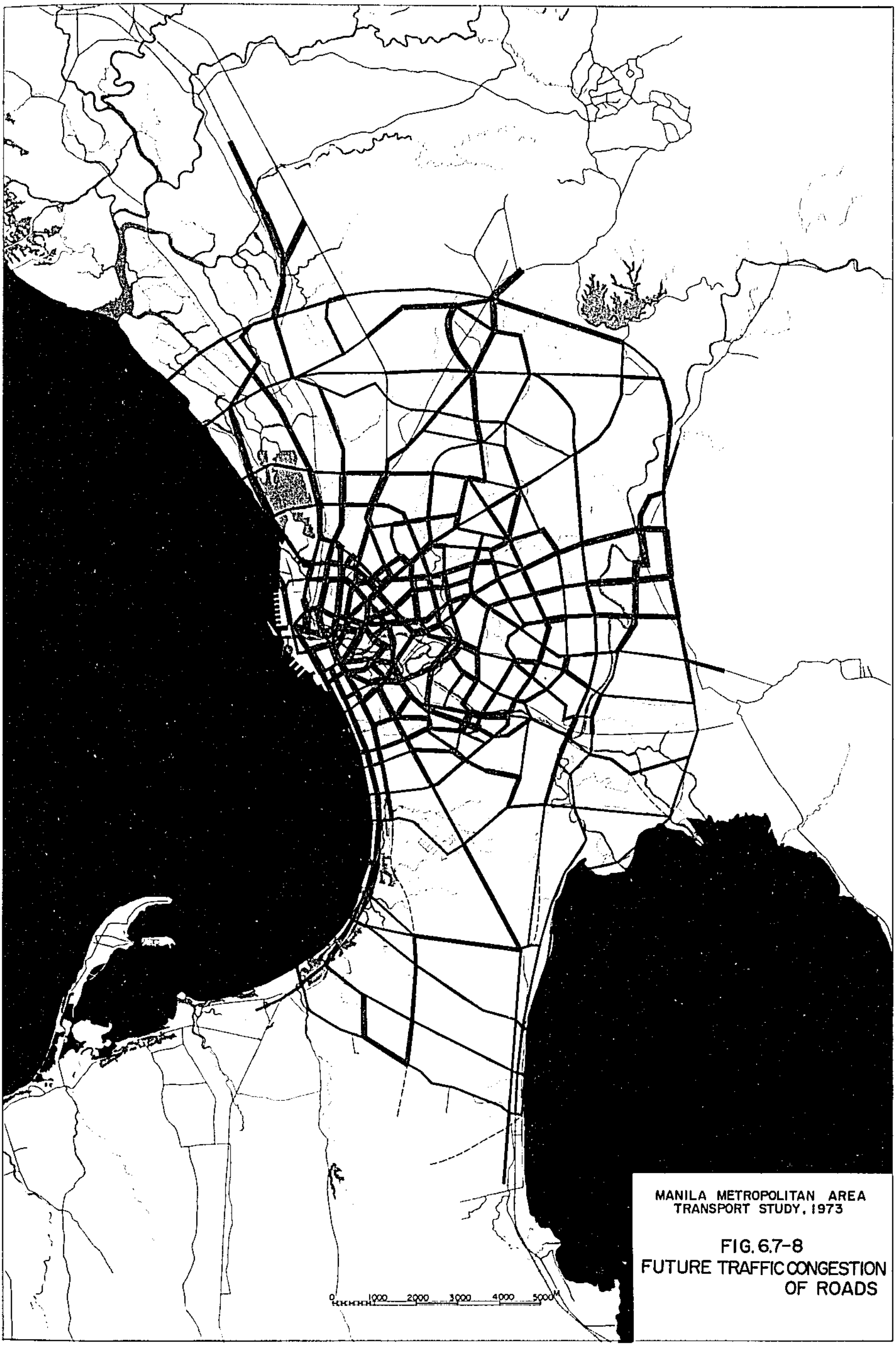

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FIG. 6.7-8
FUTURE TRAFFIC CONGESTION
OF ROADS

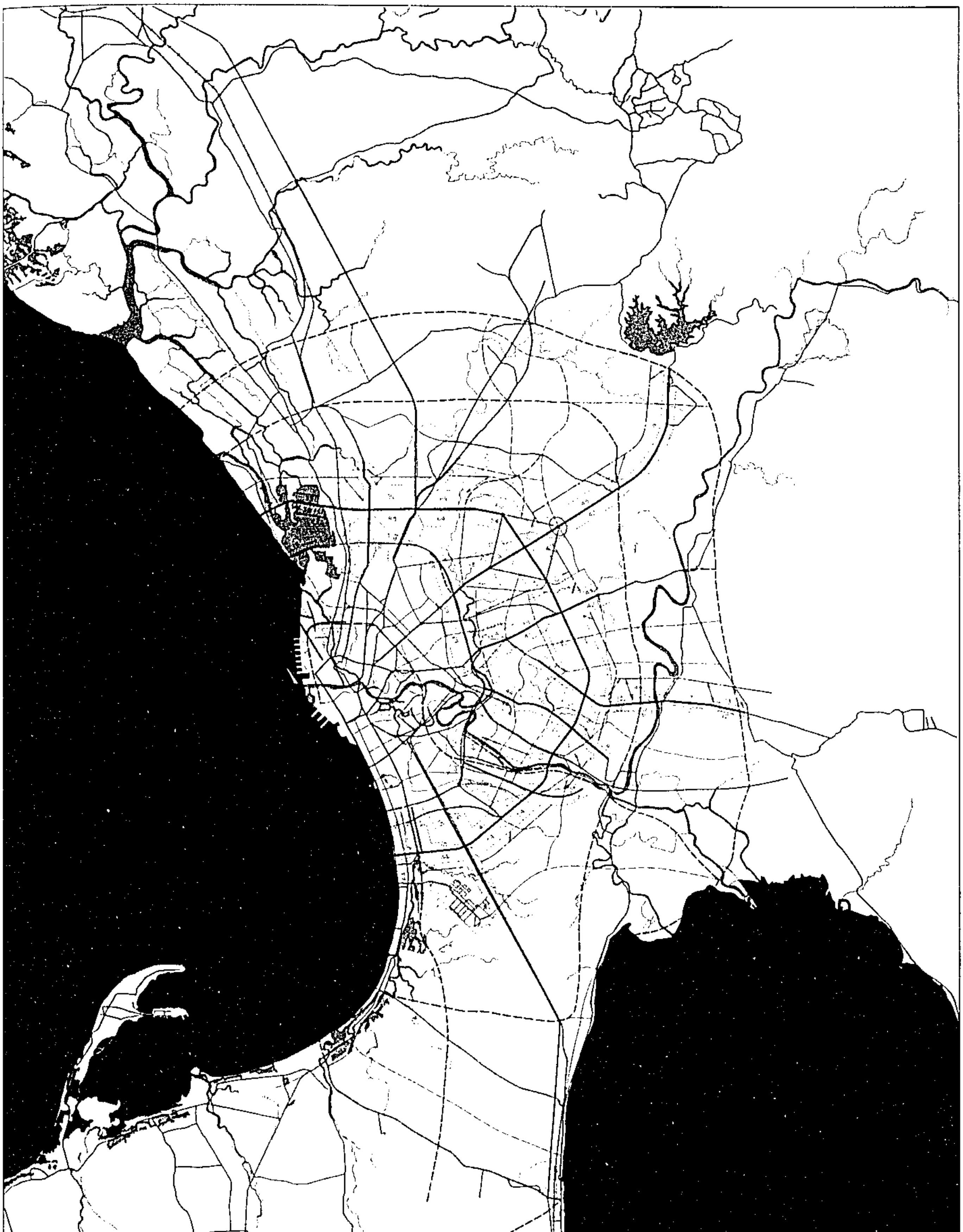

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FIG. 6.7-9
COMPARISON OF TRAFFIC VOLUMES ON STREETS AT TOLL AND FREE EXPRESSWAYS

CHAPTER 7 PROPOSED TRANSPORT SYSTEM

CHAPTER 7 PROPOSED TRANSPORT SYSTEM

In this chapter a new transport system shown in Fig. 7.1-1 is proposed for Manila Metropolitan Area as on the basis of the conclusions on the fundamental structure of the Manila Metropolitan Area discussed in Chapter 5 and the estimated future traffic demand discussed in Chapter 6. While details will be discussed at a later stage, each of the ordinary roads, urban expressways and urban rapid transit railways under study is indispensable as the scope of Manila Metropolitan Area expands and land use and traffic demand require a higher level of transport services.

§ 7.1 Integrated Transport System

With the completion of various transport systems following the quantitative expansion and qualitative elevation of urban activities, a relationship of interdependence and competition develops among these transport systems as each system has its own characteristics. It is important, therefore, that these transport systems are systematically linked one another so as to meet traffic demand efficiently as a whole. From the standpoint of traffic demand, there must be a reasonable means of transport to fulfill its requirements. This is the reason why it is necessary to explain how the *transport system should be as a whole, that is to say, the integrated transport system,* before going into details of individual transport systems.

7.1.1 Need of railway transport system

As repeatedly stated previously, the Manila Metropolitan Area is expanding at a rapid pace. The population is expected to double in 1987 to 7.5 million. Urbanization will expand to a radius of 20 km in all directions from the center of the city. Following such an expansion of the Metropolitan Area, an increase of traffic demand should be expected in two different viewpoints. In general traffic demand increases not only in proportion to the increase of population but also in proportion to the increase of travel distance following the expansion of urbanized district. Although a transport network is assumed far greater in scope in the traffic assignment than the existing one, daily traffic volume on some sections exceed 400,000 persons as a result.

In order to handle such an enormous traffic volume efficiently, no other means of transport than the railway system is conceivable. As previously computed to determine traffic capacity for the traffic assignment, the hourly transport capacity of railways in one direction is as follows.

120 persons/car x 8 cars/train x 30 trains/hr.
x 200% = 58,000 persons/hr (2 minutes headway)
(congestion)

On the other hand, the hourly transport capacity of buses, which are a representative means of transport system for surface traffic, it is as shown below.

75 persons/unit x 60 units/hr. x 120% = 5,400 persons/hr.
(one min. headway)(congestion)

The capacity of the former is 10 times greater than that of the latter. The headway of two minutes for railways is of course the minimum but is possible. The headway of one minute for buses, however, is hypothetical which by no means will guarantee smooth operation of buses when the time requirement for loading and unloading of passengers at bus stops is taken into consideration.

Since one rail track with appurtenant facilities does not require a width twice as great as the width of one lane of a road, a mere calculation of transport capacity of a width of one meter shows that the capacity of railways is at least five times greater than that of buses. This fact also deserves a serious consideration from the standpoint of efficient utilization of urban spaces.

As will be explained in the section for the economic efficiency of railways at a later stage, there is a considerable disparity in the transport cost between the railway transport and the bus transport.

There is also a great difference in travel speed between the two. While the average scheduled speed of the railway transport is 30 km/hr., that of buses is only about 13 km/hr. in congested areas.

The difference is also seen in the flexibility to traffic demand. Assumption of a 200% congestion rate for railways and a 120% congestion rate for bus in computing the transport capacity is the manifestation of this flexibility.

Since the railway transport has many advantages over the bus transport as mentioned above, this system is considered indispensable for the Manila Metropolitan Area to meet part of the diversified transport demand in the future.

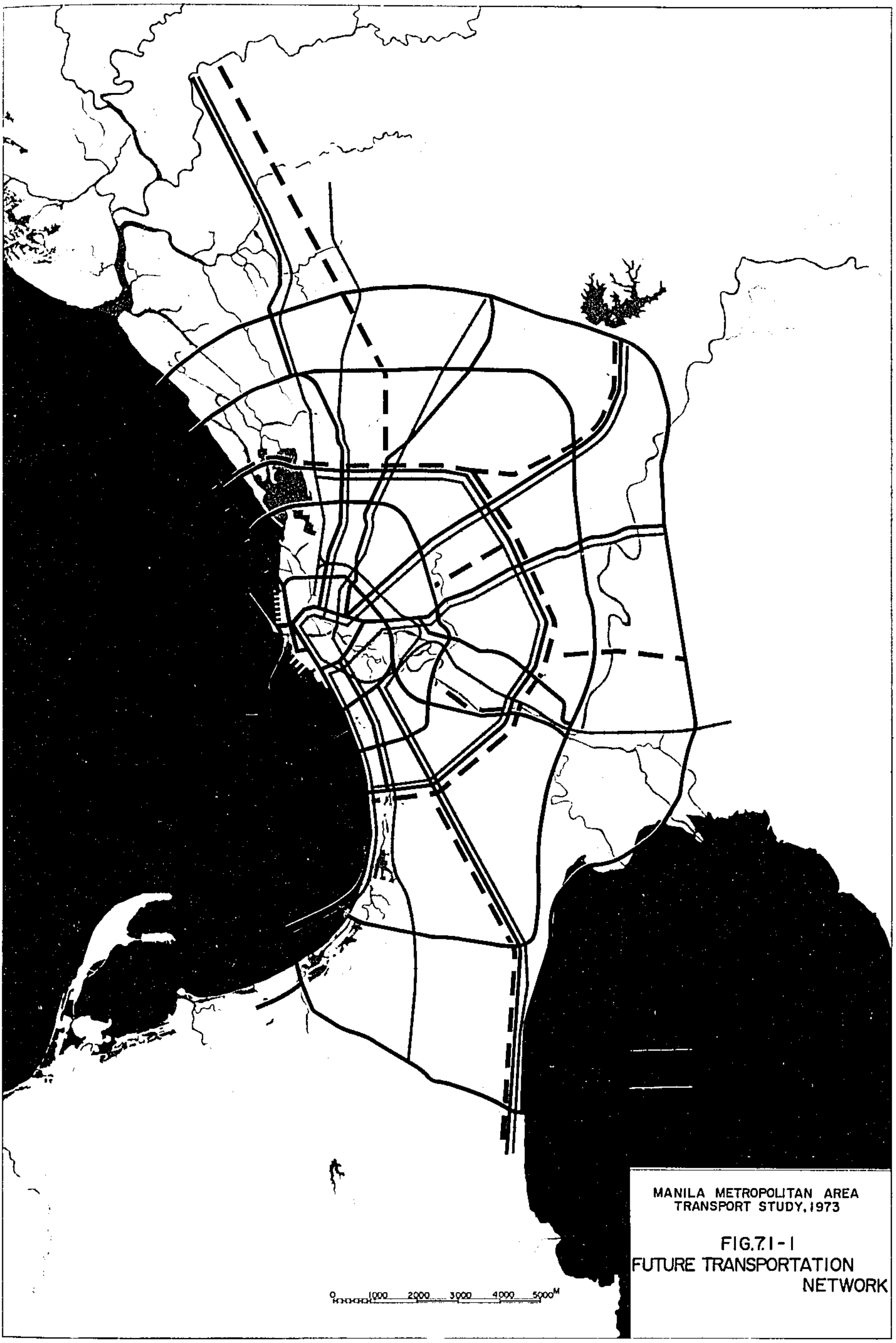

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FIG.7.1-1
FUTURE TRANSPORTATION NETWORK

Because of the characteristics as mentioned so far, the railway transport is considered best as a commuting transportation which requires a longer trip length, a higher speed and a lower transport cost. As the expansion of urbanized area will inevitably increase in the commuting distance and the number of commuters by separating the business district from the residential district with the former limited mainly to the central area and the latter to the suburbs, there will be an increased need for the railway transport.

It is needless to say that the railway transport itself present many problems. Firstly, it requires an enormous investment for construction of facilities. Construction cost of a subway will be two and half to three times greater than that of an elevated expressway and will amount to five to ten times that of a surface road. This problem, however, can be solved in part through pivotal development of residential areas which makes the management of railways easier and by planning a prompt recovery of the capital investment.

Secondly, the railway system requires high level technics including civil engineering, mechanical and electric technology for a wide range of fields such as construction, maintenance and operation.

Thirdly, the relatively long distance between stations, 1 - 3 km as a standard, will limit the service to certain spots. Besides, the spacing between railway routes will have to be expanded. In order to fill up this blank of service, the role of such a transport system as buses will be recognized. It is solely for this reason that the reference was made previously to the supplemental interdependence of transport systems.

Despite these disadvantages, however, the railway transport, with its many unique features which cannot be expected from other transport facilities, will be the system that should be introduced to the Manila Metropolitan Area.

7.1.2 Role of various transport system

It must be emphasized at first that the railway system, no matter how important it may be, will not completely eliminate the need of other transport systems.

Since the railway transport, despite its importance in mass transport in a large quantity, provides only broad and general services from its nature, there is of course a territory which should be left to the bus transport to handle. In other words, the bus transport can take charge of small traffic demands such as a short distance transport and terminal transport of railways.

In a transport study of this magnitude, full consideration must be given to all forms of mass transport. Mono-rails, like railways, belong to the fixed track systems. Track for track, the mono-rail is cheaper to construct than the two-rail system, particularly if the latter is a sub-way (approximately 1/3 to 1/2 the cost of subway provided that there are no replacement costs for roadway space used by the mono-rail); and if the mono-rail can be constructed over roadways or parklands, then right-of-way costs can be reduced also or even eliminated. Of course, if two rail sub-ways are built, then right-of-way costs are eliminated also. However, there are even more important considerations.

Mono-rail passenger capacity is from 1/3 to 1/2 that of the two-rail system. This is mainly because of train switching difficulties which so far, it has been impossible to overcome. These difficulties increase greatly as the length of trains increases. It means that train headways are extended and capacity drops. The passenger demand on the mass-transport routes proposed in this study are already approaching the maximum capacity of the two-rail system. Therefore, it would be necessary to provide two mono-rail tracks in substitution for each two-rail track. It would be impossible to do this over any of the mass-transport routes proposed. In addition, the full capacity of mono-rail could only be achieved with eight car trains for which stations of 160 meters in length would be required. Such stations could not be provided in the Metropolitan Area without extensive expropriation and demolition of buildings.

Because of these disadvantages, the mono-rail is not suitable in areas of higher density development where traffic demands are high, such as the CBD and inner suburbs of the Metropolitan Area, or on, or in the same general direction as any of the major highway and mass transport routes as recommended in this report, and where traffic demands require maximum passenger capacities. Additionally, the mono-rail is not suitable in locations where the attractions of the landscape are likely to be adversely affected by elevated structures no matter how well designed they may be. It follows then, that mono-rail services should only be considered where very special circumstances of routing and passenger loadings occur in the outer areas of the Metropolitan Area or other locations and where no other form of medium capacity mass transport is satisfactory.

One of the most important mass transit systems in the Manila Metropolitan Area is jeepney at present. Although opinions are divided as to the way jeepney should be in the future, it is very likely that the jeepney will become an auxiliary transport system playing a major role as a feeder service in the forecast of the future traffic demand and traffic system. According to the current land use plan, urbanization will extend to the entire Manila Metropolitan Area in the near future and a population density of 150 persons/ha is forecast even for the residential districts in the suburbs. As a result, there will be intensive transport demands in many locations and the traffic demand will easily exceed the capacity of jeepney 8 to 12 passengers. Therefore, jeepney will only be able to play its role as efficient transport system at terminal points where traffic demand is scattered. It is natural that such a situation will be brought about only after the economic and social development of the Manila Metropolitan Area and the materialization of the traffic system mentioned previously.

While the mass transit systems will be diversified to railways and other forms of transport such as private cars and taxis will continue to exist. But the mode of their use will be changed drastically.

If the railway transport succeeds in attaining the required speed and providing comfort of a certain degree and if parking of cars in the city area is restricted to a greater extent, the most part of the present commuting traffic will probably shift from private cars to buses and railways. The main role of private cars will be the transport for work trip often accompanied by the movement of goods for a relatively short distance and for private purpose such as shopping, social mettings, entertainment and sightseeing. There will also be many instances in which private cars are used as an end transport system plying between home and a railway station in the suburbs in the "park and ride system" or "kiss and ride system".

The use of taxi will probably take the similar form. As taxi will not be affected by parking restrictions, it will probably remain as an important transport system especially in the city area.

There is no doubt that parking facilities are indispensable for both private cars and trucks. Since the inadequacy of the road capacity in the city area is an indisputable fact, street side parking must be restricted and off-street parking facilities must be provided instead, because the city center attracts work trips and trips for private purpose requiring mostly these types of vehicles.

Finally, the railway terminals will be touched on briefly. Introduction of the railway system will generate a terminal traffic which in turn will be serviced by buses, private cars and taxis. It is necessary, therefore, to equip railway stations with a facility which allows standing of buses and taxis for a limited time. At least a bus bay and a taxi bay will have to be provided. Some of the railway stations in the suburbs may require a parking lot sufficiently large enough to allow parking of private cars which will be used in the "park and ride" system. Which of these facilities will be required and to what extent will depend on land use in the area within the sphere of railway stations.

To summarize the above discussion, it may well be said that the Manila Metropolitan Area, following the expansion in scope and improvement in quality of its urban activities, will require an intermodal transport system incorporating a wide range of transport facilities from railways to passenger cars.

7.1.3 Road transport system

As the whole transport system diversifies to various systems such as track system and so on, the road transport system, an integral part of the overall transport system, also faces various requirements. Demand for vehicular transport will no longer remain the same. There will appear a demand for vehicular transport which will cover a fairly long travel distance at a high travel speed and which will be able to offer service at an extra cost. Such a demand can be met most satisfactorily with a toll urban expressway. Therefore, the road system should be divided into expressways and ordinary roads for discussion. Although the expressway is directly related to the increase of the capacity of the whole road system, its need and potentiality should be appraised mainly by the extent of such a unique vehicular traffic demand as mentioned above.

As for ordinary roads, improvement and construction should be planned on the basis of the following standard. Since this classification is very rough and general, a more detailed classifying is desirable for practical purposes.

(1) Major thoroughfares

This kind of road, linking the city center with the suburbs or running through the Metropolitan Area, handles vehicular traffic of a relatively long travel distance within the Metropolitan Area as well as the through traffic and entering and existing traffics. Since heavy traffic is likely to concentrate on this kind of roads, it is necessary for this kind of roads to have six lanes or more in general, or at least four lanes and to be equipped with complete traffic safety facilities such as sidewalks. In order to ensure smooth traffic flow and increase traffic capacity at the intersections, progressive or area control system of traffic signals, channelization of traffic and grade separation will be necessary.

(2) Semi-major roads

Although this is a kind of road falling behind major thoroughfares in length, this supplements functions of the major thoroughfares as a linkage of them and aims at collecting and distributing traffic to the minor roads which will be described in the following paragraph. It is desirable that this has four lanes or more.

(3) Minor roads

This is a road which is equivalent to the so-called city street and it provides a direct access to buildings and is connected to semi-major roads or a major thoroughfare. It is desirable that the minor roads are used only by the traffic entering or existing the buildings located along roads and not by through traffic.

In order to secure smooth traffic flow and the safety of traffic in planning a road network as a systematic facility mentioned above, installation of appurtenant facilities and improvement of the road management must be considered. Main appurtenant facilities include traffic signals, median strips, lane-markings, side-walks, pedestrain crossings, lightings and bus bays. The most important aspect of the road management will be how to regulate the stopping and parking of automobiles.

Only the road system equipped with such appropriate facilities as mentioned above will be able to meet the vehicular traffic demand involving various factors such as vehicle types, trip purposes and OD pairs.

7.1.4 Land use and transport network

The transport network based on the land use plan will take the following form depending on the characteristics of each transport system mentioned previously.

While the land use plan may be said to aim the dispersion of urban activities, the present CBD will still be the main nucleous of the Metropolitan Area and the created sub-centers will remain as satelites. Therefore, the new transport network will be planned on the basis of the existing structure of radial and circumferential routes. However, there will be a slight difference in the composition of the above two depending on individual transport systems.

As the primary purpose of the railway system is to transport commuters, the network will have to comprise mainly radial routes which will see an intensified traffic demand. Judging from the estimated traffic demand, circular routes are considered only as a linkage between sub-centers.

As for major thoroughfare network, on the other hand, the circular routes must be enhanced to a considerable extent even though the radial routes hold a relatively large share. This is required firstly to mitigate the burden of the radial routes which are now nearing the limit of improvement and secondly to provide a means of surface transport to meet traffic demand in circular direction, which is too small for the railway system.

Particularly the urban expressway, must have its main route constructed through sub-centers in a circular direction to provide an access to the sub-centers and accelerate the creation of sub-centers. Since a large work traffic demand requiring a high speed transport is expected to generate between sub-centers, it is absolutely necessary to link these sub-centers with an expressway. There is no doubt that a large traffic demand exists centering to the present CBD in radial directions. However, construction of radial expressways without drastic improvements of surface roads in CBD will only bring about a meaningless result by attracting traffic delays at a specific point. Even when the improvement of surface roads in CBD helps the radial expressway function efficiently, it will only accelerate the concentration of traffic in CBD and bring about a new cause of traffic congestion in CBD. For this reason, the dispersed pattern of land use, and the circular expressway are inseparable.

On the basis of this fundamental concept of transport network, individual transport networks will be discussed in detail in the following sections.

§ 7.2 Road Network

In this section, a major thoroughfare network will be proposed on the basis of the preconditions set forth in the preceding section. As it is obvious that the proposed major thoroughfares alone cannot meet the ever increasing traffic demand, the semi-major roads will also be touched in the discussion.

7.2.1 Major thoroughfare network

The major thoroughfare network will consist of radial and circumferential roads with the present CBD being the core of the network, and several new sub-centers will be arranged along the most important circumferential road. For such a road network, ten or eleven radial thoroughfares and six circumferential thoroughfares will be planned.

Hereinafter, individual routes will be taken up for discussion one by one.

For convenience of explanation, radial thoroughfares will be numbered from R-1 to R-10 starting from the south and circumferential thoroughfares will be numbered from C-1 to C-6 starting from inside. C-4 is also called Epifanio De Los Santos Avenue (or Highway No. 54). Since there is a great difference in the land use, the traffic volume, the level of services, the priority of construction and so on between the inside and outside of C-4, there will often be a case in which the two will be dealt separately.

(1) C - 1

This is a circular route passing through the present CBD and consists of Claro M. Recto Avenue, P. Cosal Extension, Ayala Bridge and Ayala Boulevard. It has four to six lanes and widening of road for the entire length is not considered practical, apart from partial improvement.

(2) C - 2

This is a route which almost encircles the present CBD and has a radius of 4 - 5 km.

The existing sections are called Tayuman St., Gov. Forbes, Nagtahan Br. and Harrison Blvd. respectively but there are several missing sections. Judging from the estimated traffic volume, at least six lanes will be required.

(3) C - 3

This is a circular road at a distance of 8 - 9 km from CBD. As the distance between C-2 and C-4 is about 8 km, it is desirable to provide two major thoroughfares between the two from the standpoint of major thoroughfare network density. The neighborhood of this route, however, has already been fully developed and this C-3 alone can be planned.

The only existing section of C-3 is Buendia Ave. in Makati and Pasay city. As the width of C-3 is required to be six lanes, other sections will have to be constructed almost from the beginning. It may be said, however, that C-3 is a very important route from all angles including traffic volume, location and function.

(4) C - 4

This is a circular route having a radius of 11 - 13 km fromCBD and is presently handling a large traffic volume under the name of Epifanio De Los Santos Ave. However, it has deadends near Sangandaan in Caloocan city and in Pasay city. Therefore, these deadends must be extended westward to join R-10 and R-1 along the shoreline of Manila Bay to complete a network.

If several sub-centers are to be created along this route in the future, lay-bys must be provided on both sides of the road for entrance and exit from the buildings and eight lanes should be secured for travelled way. Since construction of a subway system is also planned along C-4 in addition to an urban expressway, this thoroughfare will become the most important axis of traffic in the Manila Metropolitan Area.

(5) C - 5

This route is planned outside of C-4 and is about 15 km from CBD. The existing sections are Katipunan Ave. in Quezon city and Rodriguez Avenue in Pasig. Since a six-lane road is ideal for this route, either of the existing roads is insufficient in width. In the area near Valenzuela and Novaliches in the north, the right of-way planned for Republic Avenue will be appropriate for C-5.

(6) C - 6

This is a circular route which is located at the outermost of the Manila Metropolitan Area under study and is about 20 km from CBD. It passes through Meycauyan, Novaliches, Constitution Hill, Marikina and Taguig and subsequently runs southward along Laguna De Bay. From the vicinity of Alabang on the coast of Laguna De Bay to Zapote on the coast of Manila Bay, the existing road called Manila South Road will be widened to a six-lane road as a branch of C-6 which will be used to be the axis of development of the neighboring area.

A six-lane road at the widest section is considered sufficient for the target date of the project. When the development of the area in the distant future is taken into consideration, however, it is very reasonable to plan for the construction of an expressway along the proposed route in order to make it function effectively as the outermost circular thoroughfare for effective use of land which should be developed around suburban centers.

(7) R - 1

This is a road which runs along the coast of Manila Bay through Parañaque and Las Piñas located in the southern section of the Metropolitan Area and connects to Cavite or Rosario outside of the Metropolitan Area.

Judging from the estimated traffic volume, this road must be provided with six lanes. Partial improvement of the present Roxas Blvd. may be sufficient for the section inside C-4. Since there is a plan to reclaim the part of Manila Bay beyond Manila International airport, construction will be easier if R-1 route is planned on this reclaimed land. In such a case, the existing road will be improved to function as a semi-major road.

For this R-1 route planned for a reclaimed land, a study should be made on the need for the addition of an expressway in relation to the development plan for the area outside of the Metropolitan Area at the early stage of the planning. In such a case, the expressway section of R-1 will be a four-lane road and the surfaced section will also be a four-lane road.

(8) R - 2

This route, corresponding to Taft Avenue, originates in CBD, runs southward in parallel with R-1 and meets C-4 in Tabon of Pasay city.

Since traffic volume increases nearer to CBD as a matter of course, it is unavoidable that the section inside of C-2 or C-3 has six lanes and the section outside has four lanes. This means that the existing condition will have to be maintained almost unchanged.

(9) R - 3

This route is one of the most important major thoroughfares, extending outbound from C-2, touching Makati at its westside and serving areas along Lagna De Bay and other southern areas of the Metropolitan Area.

It is desirable that South Diversion Road annexed to this R-3 is connected directly with the urban expressway planned for C-4, which will be discussed at a later stage. Judging from the estimated traffic volume, four lanes will be sufficient for South Diversion Road. and four lanes will be sufficient for the frontage road which is expected to be provided along South Diversion Road. The section inside C-4 will be a six-land road.

(10) R - 4

This route extends southeast along the south bank of the Pasig river and connects to C-6 near Taguig.

Since there is almost no existing section of this route, it must be constructed from the beginning. As there is a need for a major thoroughfare to provide a linkage between C-1 and C-2 in the south of Pasig River, it is desirable to extend C-1 to the beginning of R-4 in anticipation of the possibility of conversion of a creek to the site for this section. The section inside C-4 should require six lanes and that outside should require four lanes.

(11) R - 5

While all other radial routes originate in C-1 or C-2, R-5 alone is planned to branch off from R-6 near Sampaloc halfway between C-2 and C-3, extends to east along the north side of the Pasig River and reaches Pasig.

The greater part of this route consists of the existing roads called Shaw Blvd. and Pasig Blvd. respectively, and construction of a section connecting to R-6 will virtually complete the route. The route will be a four-lane road.

(12) R - 6

This is a trunk route which begins at C-1 in Quiapo, passes through Cubao and reaches Markina. The section between C-2 and C-4 consists of existing roads such as Magsaysay Blvd., Sta. Mesa and Aurora Blvd.

Four to six lanes will be required in general and the section between the merging point with the above-mentioned R-5 and C-1, should have 6-8 lanes since this section has a large increase of traffic volume.

(13) Ortigas Avenue

Ortigas Avenue cannot be ignored as an integral part of the radial thoroughfare network. It is the only major thoroughfare at present to link the Metropolitan Area with castern municipalities such as Cainta, Tay Tay and Antipolo.

As there is a plan to extend the urban expressway over this thoroughfare in the future, a fundamental improvement of this thoroughfare will be necessary to provide at least four lanes. As the section of Orgigas Avenue with four lanes exists inside C-4, its extension over a short distance will link this road with R-6 in the vicinity of San Juan. However, R-6 also merges with R-5 on the way and the burden is already too heavy for R-6. If R-6 is provided with six lanes or more, its linkage with R-5 and Ortigas Avenue may be appropriate. If the width of R-4 is limited to four lanes, it is advisable to extend Ortigas Avenue to C-2.

(14) R - 7

This is a route extending in northeast direction from C-1 and reaching Quezon. It passes through Quezon Blvd. and Commonwealth Avenue and meets C-6 in the vicinity of Constitution Hill.

The section inside C-4 is a six-lane road at present and further widening of the road cannot be expected. Judging from the estimated traffic volume, four lanes will be sufficient for the section outside C-4 as a rule.

(15) R - 8

This is one of the three proposed major thoroughfares which will link CBD with the northern section of the Metropolitan Area. Originating in C-1, it reaches Novaliches via Rizal Avenie, A. Bonifasio Avenue and Novaliches Road. It branches off to North Diversion Road, a major thoroughfare extending to outside of the Metropolitan Area, at Balintawak where it corsses C-4.

Widening of A. Bonifacio Avenue to at least four lanes is absolutely necessary, though the improvement work will be extremely difficult. It is also desirable that Novaliches Road shall be widened to four lanes.

(16) R - 9

R - 9 consists of Jose Abado Santos, Rizal Avenue Extension and MacArthur Hwy. and passes through such districts as Caloocan city, Valenzuela and Meycauayan.

If a part of Rizal Avenue Ext. inside C-4 is widened from the present four lanes to six lanes, the entire length will be a six lane road. MacArthur Hwy. outside C-4 should have at least four lanes.

(17) R - 10

This road is non-existence at present but is very important from the standpoint of the present traffic condition and future development of the area. For the section inside C-4, this route will be planned for the reclaimed land in Manila Bay, making the best of the Manila Bay reclamation project, and will run northward along the coast of Manila Bay. In CBD, it extends to the south of the Pasig River to augment the road capacity across the Pasig River which is insufficient at present.

Since an expressway is expected to be constructed along it outside C-2, the section outside C-2 will be a four-lane road and the section inside will be a six-lane road.

The above is an outline of the proposed major thoroughfare network consisting of six circumferential and eleven radial thoroughfares (including Ortigas Ave). Under the dispersed pattern of land use the circumferential traffic is expected to increase at the rate higher than the radial traffic. Despite such a prediction, C-1 and C-4 are the only roads that can properly function as circumferential roads at present. Therefore, the development of major circumferential thoroughfares will be most important and urgent.

On the basis of the estimated traffic demand, a major thoroughfare should have a width of six lanes as a rule but the width of four lanes will have to be accepted where the widening of roads is extremely difficult.

7.2.2 Semi-major road

As mentioned previously, the semi-major road holds the intermediate position between the major thoroughfares and the minor roads, and only the road network consisting of these three elements will be able to function effectively. In the case of the Manila Metropolitan Area, at present the meshes of major thoroughfare network are so rough compared with the urban development that it is often necessary to travel a long distance before reaching a major thoroughfare and traffic volume increases on minor roads to the extent that cannot be handled by them. Therefore, it is absolutely necessary to provide semi-major roads on a large scale.

Semi-major roads should be planned to have four to six lanes depending on the traffic volume on the specific route. The difference between the semi-major road and the major thoroughfare is not in the number of lanes but in the length. While the major thoroughfare has a greater length in order to link CBD with the suburbs, the semi-major road may be of a relatively short length just sufficient for providing a linkage among major thoroughfares.

Although this report assumed the semi-major road network as shown in Fig. 6.7-3 for the purpose of traffic assignment, planning of the semi-major road network cannot be made under this survey. The planning should therefore be initiated after a detailed survey is made following the finalization of the major thoroughfare network.

As an example of the semi-major road network conceived, a total of about five bridges will be added over the Pasig river, one between C-1 and C-2, one between C-2 and C-3 and three between C-3 and C-4. Since the existing bridges are eight inside of C-4 and the planned bridges are two (the extension of R-10 and the expressway) except the above five, the total number of bridges inside C-4 will be fiteen. As the distance between the mouth of the Pasig River and the Guadalupe C-4 is about 14 km, the average distance between two bridges will be about 0.9 km, and this density almost equals to that of the Sumida river which flows through downtown of Tokyo.

§7.3 Expressway Netrowk

The proposed urban expressway will be constructed along the route of surface road C-4 in accordance with the previously discussed transportation system. This route was selected mainly due to the fact that the ever increasing traffic demand in circumferential direction must be satisfied that the accessibility to sub-centers to be developed along C-4 as the axis must be improved so as to meet a large traffic demand generated in sub-centers and that C-4 is advantageous for road construction because it has a 50 m right of way alleviating the problem of land acquisition considerably.

When the expressway is to be located on the C-4, it must be of the elevated structure for the greater portion. Some branch routes, however, may be built by embankment or cutting.

Against this main route selected along C-4, several branch routes will be planned in radial directions both inside and outside C-4. The principles of the planning of branch routes in radial directions are as follows.

(1) Branch routes inside and outside will not be joined with each other directly but will be arranged so as to alternate them with the main route in-between. This arrangement is required to provide relative improvement of the accessibility to the planned sub-centers and also to avoid the complicated and therefore costly multi-layer structure of a four leg crossing.

(2) All inside branch routes with one exception will be connected to C-3. Connection of a branch line to a radial road will induce the concentration of a traffic demand to the radial road, but there is no radial road that has an extra capacity to meet such a demand. Accordingly, the branch route will have to be connected to a circumferential road. C-2 is already handling traffic to the capacity and furthermore the extension of a branch route to C-2 will cause a serious problem of land acquisition. For this reason, it would be most desirable to link the inside branch line to C-3.

At present, two existing expressways, North and South Diversion Roads are available as major approach highways to the Metropolitan Area from north and south. In view of the size of traffic volume, the North Diversion Road should be widened to eight lanes.

Although the direct linkage of these two existing expresways with the planned urban expressways over C-4 is desirable, it will entail a complicated design for the interchange. Both of these expressways should be provided with interchanges for linkage with C-5 and C-6.

Based on the above-mentioned two principles for the planning of branch routes of the proposed urban expressways and the existence of the present two expressways taken into account, the following are proposed for the individual branch routes of the planned urban expressways, by mentioning them clockwise from the north.

(1) Inner Branch Route No. 1

This route will be constructed along R-10 on the coast of Manila Bay. As it is planned for the reclaimed land, it can be built of embankment. Because of the proximity to C-3, this route alone will be extended to C-2. It is desirable for a room to be reserved for the extension to the north in parallel with R-10 after the target year.

(2) Outer Branch Route No. 1

This branch route will be branched off from the main route to avoid Quezon Memorial Park and will reach Constitution Hill via Commonwealth Avenue.

The primary purpose of this route is to offer a higher level of service to traffic by making the most of the spacious right of way on Commonwealth Avenue. In addition, this route can be constructed in the center of the avenue by cutting.

(3) Inner Branch Route No. 2

This branch route extends to C-3 by making the use of Diliman Creek in the vicinity of Cubao. Although the construction of another inner branch route between North Diversion Road and Outer Branch Route No. 1, is desirable unavailability of a suitable site for such a route and the difficulty in construction have eliminated such a plan.

(4) Outer Branch Route No. 2

This route is planned on Ortigas Ave. to provide a means of communication to the eastern section.

(5) Inner Branch Route No. 3

Mainly due to the problem of land acquisition, this route is planned along the Pasig River and will be extended to C-3.

(6) Outer Branch Route No. 3

This route is planned along the coast of Manila Bay together with R-1 as a project after the target year of the current project. It will be necessary, however, to make a further study to determine whether this branch route should be provided as a mere branch route similar to the one planned together with R-10 in the north of Manila Bay or as an expressway connecting cities outside the Metropolitan Area.

§7.4 Railway Network

The proposed railway network consisting of improvement of the existing railway system and a subway system, must be planned in such a manner as to make the two systems supplement with each other. The following is an outline of the basic plan of the railway network.

7.4.1 Improvement of Philippine National Railways

The Philippine Nation Railways (PNR) now have Tutuban Station in the central business district to the north of the Pasig River. With this station as the central station, two lines extend from it in opposite directions, one to the north and the other to the south. The north bound line passes through outlying areas such as Bocave and Bigao via Sangandaan, Valenzuela, Meycauayan and Marilao and reaches San Fernando in northern part of Luzon, 270 kms from Manila. The south-bound line branches off from the north-bound line, swings to the cast reaching Paco via Sampaloc and Pandacan, runs southward through Makati reaching the coast of Laguna De Bay in the vicinity of Sucat of the outlying area, passes through Muntinlupa and reaches Legaspi situated 470 kms south of Manila.

Judging from the estimated traffic demand, the north-bound line may be straight to the north from Tutuban Station just like the existing line, but the south-bound line will handle more passengers heading for the north-bound line than Tutuban Station. This is probably because the transfer to the subway system will be more convenient as a means to get to CBD. The area in which the railway system should be improved as urban transport systems include Marilao, Bocaue or Malolos to the north and up to Calamba in the south. The north-bound line, in particular, is expected to have a larger traffic demand.

Improvement of the railway system in order to turn it to a means of urban transport will include construction of double tracks, electrification of the lines, construction of elevated railways, and relocation and addition of stations. It is needless to say, that the double track system and electrification of the lines are indispensable for the enhancement of transport capacity and the increase of transport speed.

The elevated structure is required to avoid at-grade crossings with the road system over the long continuous distance. Grade separation is already constructed in some places where roads pass over the railway line but the elevated structure of railway system will be much easier and cheaper because a road network of higher density is expected in the future. Of course, the continuous grade separation may be limited to the inner area (inside the major thoroughfare C-4) as a rule. In the suburbs where land use along the line permits, the line may be constructed on the surface and individual grade separations with major roads. There is absolutely no reason for planning the underground structure of PNR. This is because the electrification of long distance trains are not expected to be operated on the improved sections in the near future, and secondly, the land site occupied by the PNR has a width of about 30 ms and no hindrance whatsoever is expected for the construction of elevated structures of double tracks.

As it is necessary to provide stations of the urban railways at an interval of less than 1 km in CBD and at an interval of 2 - 3 km in the suburbs and there are very few existing stations in the study area, the rearrangement of stations should be planned in parallel to the land use plan.

7.4.2 Subway system

Since the primary purpose of the subway system is to transport commuters, its network consists of radial lines converging on the present CBD and a circumferential route linking the proposed sub-centers. For the radial lines, three lines passing through CBD and one line ending in CBD may be considered. For the circumferential line, one line will be sufficient. Improvement of the north-bound line and south-bound line of the PNR is, of course, a precondition for this subway network. Good connection between the lines should be provided by crossing or touching the lines in and around CBD and only one transfer or two will be required at most for travelling any direction.

While the proposed new railway system is simply called the subway system, the section actually built underground will be limited to the inner area where acquisition of land is very difficult and other sections will be of elevated structures or possibly surfaced depending on the density of road network crossing the lines and land use along the lines.

(1) Subway Line No. 1

This line, originating in Constitution Hill in Quezon city in the northeast of the Metropolitan Area, runs along Commonwealth Ave., Quezon Bldg. Ext. and Claro Recto Avenue and then crosses the Pasig River near Delpan Br. In the south of the Pasig river, it runs north of Rizal Park and enters Taft Avenue where it turns southward, passes the immediate west of Manila International Airport and reaches Talon in Las Pinãs. It may be built as elevated structure near the airport and as surfaced further south.

Although the traffic demand is concentrated more or less in the southern half of this line, the northern half will be very important as a linkage between the capital Quezon city and CBD of Manila city.

(2) Subway Line No. 2

If this line is to be located further west than the previously mentioned Line No. 1 in the northern section of the Metropolitan Area, the beginning of this line will probably be located in the vicinity of Navaliches. This line runs toward CBD in parallel with Quirino Avenue. As the line need not be constructed immediately overhead or underground of the road in the suburbs, it will be constructed surfaced or elevated on the route separated from the road. It goes underground near Balintawak, passes beneath A. Bonifacio avenue, crosses Line No. 1 and enters Taft Avenue once near Quezon Ave. After meeting Line No. 1 in the east of Rizal Park, it runs southeast separating from Taft Ave. crosses the Pasig River again at Paco in parallel with the PNR and extends toward east in the south of Shaw Blvd. In this neoghborhood the line may be built as elevated structure by making use of the PNR site. As it extends east, it may be built underground beneath Shaw Blvd. and extended to Cainta via Pasig.

This line is expected to play an important role in providing services to the east and north sections of the Metropolitan Area.

(3) Subway Line No. 3

Of a total of five subway lines, this Line No. 3 alone is circumferential. Since the objective of this line is to provide a linkage between the proposed sub-centers, it has to be located along the major thoroughfare C-4 and the entire length must be built underground. Though an expressway of the elevated structure is planned for this route, C-4 has a 50 m. right of way and construction of both the subway and the expressway along C-4 is possible with some precautions in construction work.

In order to provide connection with the PNR, this Line No. 3 begins in Sangandaan and extends to Makati along C-4, providing connections to all other subway lines crossing it. In Makati, it will be built under Pasay Road separate from C-4 so as to pass the business district. The line ends where it meets

Subway Line No. 5 to be built under Roxas Blvd.. Toward the end, it is connected with the PNR's southbound line and Subway Line No. 1.

(4) Subway Line No. 4

This line begins in Markina to the east of the Metropolitan Area, heads toward CBD via Cubao under Aurora Blvd., Sta. Mesa, Magsaysay Blvd. and Laurel Street and then crosses the Pasig River along Ayala Br.. It connects to the PNR in the middle of Magsaysay Blvd.. After crossing Ayala Br. and heading for west, it immediately crosses Subway Line No. 2 and Line No. 1 in succession and runs straight southward along Roxas Blvd..

As Manila Bay lies in the immediate west of Roxas Blvd., selection of this road for a subway line seems not advisable. Selection of A. Mabini or M.H. del Pilar in the east of Roxas Blvd. is more desirable from the standpoint of the range of service.

However, although Mabini and M.H. del Pilar have widths less than 20 meters which is the minimum for a station, full length continuity of this width is not necessary. Consequently, either A. Mabini or M.H. del Pilar could be alternative routes for a subway.

Since, Line No. 4 is close to Line No. 1, and both lines serve the same traffic corridor, the possible combination of the two lines along Taft Avenue or A. Mabini or M.H. del Pilar should be recognized as a likely alternative during the detailed feasibility study phase. This possibility is significant as the combined alignment appears to have a better service coverage than separate lines along Roxas Blvd. and Taft Avenue.

In consideration of the future reclamation along the coast of Manila Bay, the extension of this line southward will be constructed on the abandoned PNR line and will extend near to Zapote.

(5) Subway Line No. 5

As the north section of the Metropolitan Area is planned primarily as residential districts, a large traffic demand for transport from this district to CBD is expected. This demand exceeds the capacity of PNR's north-bound line and as a result, another subway line is required between the PNR line and Subway

Line No. 2.

The beginning of the additional line, Line No. 5 is located in Marilao or in the hilly area east of Meycauayan. It is located possibly underground beneath MacArthur Hwy. near Valenzuela and passes under Rizal Ave. Ext. inside C-4. It ends in the immediate east of Tutuban Station of the PNR.

CHAPTER 8 MAJOR THOROUGH FARE NETWORK

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§ 8.1 Forecast of Future Traffic Demand

On the basis of the estimated traffic demand discussed in Chapter 6, traffic volumes and congestion on the major circumferential roads (C-1) - (C-6) and major radial roads (R-1) - (R-10) and Ortigas Avenue estimated for 1987 are shown in Table 8.1-1.

Sections of roads shown in the table were selected as the sections with the largest traffic volume within the routes or as the representative sections which shows a general tendency of the route. For details of future traffic volume, please refer to Fig. 6.7-6 Assigned Traffic Volume of Roads.

A macroscopic observation of future traffic volume in the greater Manila Metropolitan Areas shows that most sections of C-1 and C-2 will have the largest traffic volume of 60,000 vehicles/day - 100,000 vehicles/day as expected, followed by Roxas Boulevard and Roxas Boulevard Extention connecting to C-1 and C-2 with 60,000 vehicles/day - 80,000 vehicles/day.

On C-3, traffic volume will be as great as 60,000 vehicles/day - 100,000 vehicles/day in most sections between R-1 and R-7 and drops to 20,000 vehicles/day - 60,000 vehicles/day between R-7 and R-10.

On C-4, most sections between R-4 and R-9 will have a traffic volume of 60,000 vehicles/day - 100,000 vehicles/day and other sections will have a traffic volume of 20,000 vehicles/day - 60,000 vehicles/day.

On C-5, the majority of the sections will have a traffic volume of 20,000 vehicles/day - 60,000 vehicles/day and on C-6, only a few sections will have a traffic volume of 40,000 vehicles/day - 60,000 vehicles/day. Most C-6 sections will have a traffic volume of 10,000 vehicles/day - 40,000 vehicles/day.

As discussed so far, traffic volume will increase nearer to CBD on circumferential roads and will be larger inside C-2 on radial roads. Radial roads with a large traffic volume between C-2 and C-3 are R-1, R-2, R-3, R-4, R-6, R-7, R-8 and R-9, most of which will have a traffic volume of 60,000 - 100,000 vehicles/day. Outside C-4, traffic volume on North Diversion Road will be specially large and the traffic

Table 8.1 - 1 Future Daily Traffic Volume of Major Roads

Name of Road	Link No.	Section	Daily Traffic Volume(x1000)	Traffic Congestion	Remarks
C - 1	1	Claro M. Recto (M. Roxas Intersection - Juan Luna)	32	0, 5	
	2	do. (Juan Luna - Jose Abad Santos)	55	0, 9	
	3	do. (Jose Abad Santos - Rizal Ave.)	59	1, 0	
	6	P. Casal	95	2, 4	
	7	Ayala Blud	64	1, 6	
C - 2	29	Tayuman	58	1, 0	
	30	do.	69	1, 2	
	31	Gov. Forbes	65	1, 1	
	37	Harrison	67	1, 1	
	38	do.	41	0, 4	
C - 3	76	5th Ave.	38	0, 6	
	77	do.	43	0, 7	
	82	Gregorio Araneta Ave	58	1, 0	
	85		67	1, 1	
	89		94	1, 0	
	91	Buendia Ave.	49	0, 8	
C - 4	172	Highway 54 (Samson Road)	89	0, 9	
	178	do. (Near Murphy)	74	0, 9	
	186	do.	57	0, 7	
	191	do. (Near San Roque)	38	0, 5	
C - 5	298	(Near Karuhatan)	16	0, 3	
	395	(Near Dona Faustina Village)	34	0, 7	
	312	(Near Pasig)	63	1, 0	
	315	(Near Bicutan)	25	0, 4	
C - 6	401	(Near Obando)	38	0, 6	
	410	(Near Bayan Bayanan	49	1, 2	
R - 1	425	Qurino Ave. (Near Zapote)	34	0, 8	
	167	Roxas Blvd.	57	1, 0	
R - 2	63	Taft Ave.	95	1, 2	
	162	South Diversion Road	63	1, 1	
R - 3	159	South Diversion Road	68	1, 1	
	502	do.	25	0, 6	
R - 4	157	(Near Sta. Ana Race Track)	86	1, 1	
	465	(Near Buting)	4	0, 1	
R - 5	149	Shaw Boulevard	59	0, 8	
	462	do. (Near Bagong Ilog)	9	0, 2	
R - 6	51	Legarda	82	0, 8	
	449	(Near Poblacion)	46	1, 1	
R - 7	130	Espana	79	1, 3	
	443	Commonwelth Ave.	18	0, 3	
R - 8	46	(Near San. Lazaro Race Track)	102	0, 9	
	199	A. Bonifacio	52	1, 3	
	439	Quirino Highway	48	1, 2	
R - 9	198	Rizal Avenue Extension	73	1, 2	
	43	Jose Abad Santos	68	1, 1	
	494	(Near Meycauayan River)	54	1, 4	
R - 10	40	(Near North Harbor)	55	0, 9	
	195	(Near Bangkulasi)	33	0, 8	
	320	(Near Navotas)	35	0, 9	

volume on radial roads between C-4 and C-6 will be 80,000 vehicles/day - 100,000 vehicles/day. Traffic demand on North Diversion Road will grow in the future following the development of residential districts and industrial districts in the north. Traffic congestion was calculated with the following formula.

$$\text{Traffic Congestion} = \frac{\text{Estimated daily traffic volume (vehicles/day)}}{\text{10,000(vehicles/lane.day) x number of lanes}}$$

where: 10,000 (vehicles/lane.day) = Daily traffic capacity per lane.

§ 8.2 Route Improvement Plan

In this section, generally acceptable approaches to the improvement of routes in Manila Metropolitan Area, improvement plans for each route, and finally the approximate priority of the routes for improvement work will be discussed. The following approaches to the improvement of routes may be considered.

8.2.1 General outline of route improvement

(1) *Improvement of road network*

In Manila Metropolitan Area, the road network is not adequate as a whole and an unexpectedly large number of roads have such defects as discontinuity, dead ends, multileg intersections and zigzag horizontal alignment. Therefore, the establishment of an effective network will require completing of the unfinished sections to promote systematic and supplemental functions of major roads, secondary roads and minor roads, the developing of new roads do complete the planned network and the improvement of horizontal alignments of roads.

(2) Widening of roads

In many cases of circumferential roads and radial roads are not utilized efficiently due to lack of organic linkage between the roads in the number of lanes and road width. Widening of roads will be planned to standardize the number of lanes and width of various roads which are continuous in the same direc- tion and whose functional characters are identical.

As there are relatively quite a few vehicles which have gone out of order and have to be parked, as is noted in the Philippines, it is to be required that sufficient shoulder should be reserved for the emergency parking lane so that the traffic would not be disturbed by such vehicles.

(3) Strict enforcement of traffic regulations and instructions

Traffic regulations	Prohibition of stopping, left-turn, U-turn passing, across entire lines, crossing by pedestrians, and enforcement of one-way traffic and division of vehicular traffic by lanes and directions.
Traffic instructions	Division of lanes, establishment of stop lines, and designation of directions of vehicular traffic and locations of pedestrian's crossings.

(4) Clear distinction between sidewalks and travelled ways. Improvement of sidewalks.

(5) Installation of lighting facilities and guard rails.

(6) Construction and improvement of parking facilities.

(7) Management and maintenance of roads. (Repair of road surface, improvement of drainage facilities and maintenance of fences and others).

The following discussion will deal with the improvement of each route.

8.2.2 Improvement plan of each route

1) C - 1

This is an important circumferential road within CBD, which has and will have the largest traffic volume and the highest level of congestion. The present travel speed in the peak hours is very slow at about 5 km/hr on Claro M. Recto and P. Casal Ext. Traffic congestion level on Legarda, P. Casal Ext., and Ayala Blvd. is estimated at more than 1.5 and serious traffic delays are expected on these roads in the future.

As the cause of these traffic delays, a decrease of traffic capacity due to the following reasons may be pointed out in addition to the increase of traffic volume in CBD.

1. On-street parking due to lack of adequate facilities in CBD. The road form of C-1 at the intersection is not right-angled intersection with other secondary roads and minor roads which are connected to the intersections in a disorderly manner, thereby hampering efficient channelization.

2. There is no uniformity in the number of lanes in the entire length of C-1 with Claro M. Recto being six-lane road and P. Casal Ext., and Ayala Blvd. being four-lane roads.

3. In the section of Claro M. Recto toward the coast, the railway line running from Manila North Harbor to Tutuban Station is laid on the road surface, which is a major obstacle to the passage, crossing and turn-around of vehicular traffic. Railway tracks on the road surface are not desirable from a viewpoint of both aesthetics of the city and traffic safety.

Accordingly, the following is conceivable for the improvement of C-1.

1. Although the acquisition of land and removal of buildings are difficult, especially in CBD, it is desirable to widen Legarda, P. Casal Ext., and Ayala Blvd. from the present four-lanes to six-lanes.

2. It is also necessary to alleviate the deficiency of parking space through improvement and construction of parking areas and by strictly enforcing regulations against on-street parking especially in CBD.

3. As a large number of pedestrians cross roads in CBD and the flow of traffic is obstructed by many jaywalkers, efforts should be made to provide traffic signals for pedestrians and pedestrian crossings in sufficient numbers and at the same time road signs for control and instructions such as stopping lines, division of lanes, parking zone, no U-turn and traffic direction for vehicular traffic.

In CBD most sidewalks are so narrow that pedestrians are often forced out to the roadway adding to the deficiency of the capacity of the roadway. For this reason, it is urgent to make clear separation of sidewalks and roadways and ensure the safety of pedestrians through improvement and widening of sidewalks and installation of curbs and guard rails. Where widening of sidewalks is impossible new, improved regulations requiring property owners to provide consistent building set backs or continous arcading may be necessary.

Since C-1 and most of the secondary roads in CBD are used as jeepney and bus routes and frequent stopping and starting for loading and unloading passengers are the major contributing factors to the aggrevation of traffic in CBD, appropriate unification and sometimes adjustment or even abolition of jeepney and bus routes, improvement of bus and jeepney bays and stops and rearrangement of bus and jeepney stops are desirable.

One-way traffic arrangements are now in effect mainly on the minor roads to the right bank of the Pasig river inside C-1. It is desirable that one-way traffic routing be also extended to the sections of C-1 near multileg intersections with a complicated traffic flow such as Plaza Avancena and the other intersections as a provisional measure until the realization of grade separation to control and channelize traffic at intersections.

Secondary roads inside C-1 are expected to handle a comparatively large traffic volume in the future. A traffic count in September 1971 shows that traffic volume is greater on such secondary roads as Jones Br. (49, 200 vehicles/day), MacArthur Br. (53, 100 vehicles/day) and Quezon Br. (74, 300 vehicles/day) than on Ayala Br. of C-1 (49, 000 vehicles/day).

As these roads are very important for traffic efficiency in CBD, improvements are advisable in parallel with the improvement of C-1.

2) C - 2

At present, a section of about 1.4 km in length between Plaza Dilao and Colle Otis, a section of about 0.9 km in length between Plaza L. Avelino and Lealtad and a section of approximately 2.9 km in length which begins at Prifil Br., meets M. Roxas Boulevard Extension, runs southward on Roxas Blvd. Ext. and meets Claro M. Recto are non-existent, which fact greatly hampers effective function of C-2 as a circumferential road. It is needless to say, therefore, that these missing sections should be completed as soon as possible.

The six-lane Harrison Blvd. presents no problems but Calle Tayuman, among others on C-2, has only three lanes. In order to make the entire section of C-2 a six-lane road, widening of roads after acquisition of necessary land space will be required. In addition, because Pasig Line, an extension of South Diversion Road, Ramon Magsaysay Blvd. - Aurora Blvd. are connected directly to C-2, improvement and completion of missing sections on C-2 are urgently required for dispersion of traffic concentration on C-1.

3) C - 3

The existing section which will be used as part of C-3 includes Buendia Ave. (four-lane and six-lane) between Makati and Pasig city, Gregoria Araneta Ave. (four-lane), Tayaytay and 5th Avenue. In view of the estimated traffic volume, location and function, C-3 should have at least six lanes.

At present, a portion of Buendia Ave., about 1.0 km in length, is a six-lane road and if this used as part of C-3, the remaining portion that has to be completed will be about 17.5 km in length.

Like C-1 and C-2, the proposed C-3 passes through districts where acquisition of land and removal or relocation of buildings are extremely difficult. It is desirable, therefore, that its route be selected in the river land such as the San Juan river and on the existing roads which may be widened while avoiding such locations as La Loma Cemetery, North Cemetery and Chinese Cemetery in the northern section, but retaining route location about halfway between C-2 and C-4.

Although the approximate route of C-3 has been determined, it is natural that a more detailed study and a field survey should be made for the final sele ction of the optimum route. Because of the difficulty in route selection for C-3, the alignment may have zigzag portions. It is hoped, however, that efforts will be made to make the alignment as smooth as possible by fully recognizing the importance of this road.

As the daily traffic volumes near the intersections of C-3 with major radial roads R-1 through R-10 are expected to reach 70,000 vehicles/day - 100,000 vehicles/day in the busiest section and 30,000 vehicles/day - 50,000 vehicles/day in the less busy section, grade separation of intersections must be considered.

4) C - 4

The C-4 route which is now playing an important role in the present traffic system is a relatively improved road as compared with other circumferential roads, and therefore has heavy traffics. Through traffic per lane at the crossing point of the Pasig river (Guadalupe Br.) is 15,300 vehicles/day·lane comparable to the 18,600 vehicles/day·lane on Quezon Br.

The incomplete portion of C-4 includes a section of about 1.5 km (between radial roads R-1 and R-2) in the vicinity of Baclaran and a section of about 7.0 km (between radial roads R-9 and R-10) near the fish pond in the north. The total length of C-4 including incomplete sections is about 25.0 km.

While grade separation of intersections of C-4 with other major radial roads will be inevitable in the future, it is desirable to enhance the capacity of C-4 for the time being through adoption of progressive system signals, provision of left-turn lanes by sacrificing the 6 m wide medial strip, and by provision of stop lines, separation of sidewalks and travelled road ways and enforcement of no stopping and parking regulations near intersections as in the case of C-1.

Construction of elevated expressway over C-4 will enhance the capacity of C-4 and increase its importance as a main traffic axis. On the other hand, however, a further concentration of buildings along C-4 will certainly invite such environmental pollution problems as noise, vibration, exhaust gas and possible infringement of the right to enjoy light and air. It is important, therefore, to initiate a study at the present stage to work out measures to counter these problems.

5) C - 5

It is desirable that this road should have at least six lanes. Use of the proposed Republic Ave. (95 m wide in the right of way) as part of C-5 is conceivable and the use of Katipunan Ave. (four lanes) and Eulogio Rodriguez Ave. (four lanes), as routes for connection with R-1 will also be planned. In any event, acquisition of land will be necessary for widening of the existing roads and construction of new roads in order to secure six lanes continuously.

While the land price in Manila Metropolitan Area decreases almost in proportion to the distance from CBD except in such sub-centers as Makati as shown in Fig. 8.2-1, future acquisition of the right of way is expected to become more difficult as a result of the constant rise in land cost and compensation and the increasing concentration of buildings along the route. It is advisable, therefore, to initiate purchase of land as soon as possible.

6) C - 6

C-6 should be planned from a long-range point of view and acquisition of land must be initiated in advance as in the case of C-5.

In order to eliminate the need for land acquisition in the future when the construction of an additional road or urban expressway on the same route becomes necessary, a sufficient width of the right of way should be obtained at the beginning.

The highest elevation of the proposed route C-6 is about 90 m which does not seem to present any problem in vertical alignment, but problems exist in road construction such as reclamation, soft ground and drainage in the fish pond district in the north and in the northern part of Laguna de Bay and in marsh land, fish ponds and salt beds in the south-west.

7) R - 1 through R - 10

There are a total of elevan major radial roads in Manila Metropolitan Area, from R-1, to R-10, plus Ortigas Ave. Each of them is very important. Basic policy for the improvement of these radial roads has already been discussed in the preceding Chapter 7 and the improvement plans for circumferential roads may also be applied to these radial roads depending on the nature and conditions of individual roads. For this reason, detailed discussions for the improvement of R-1 through R-10 will not be attempted here.

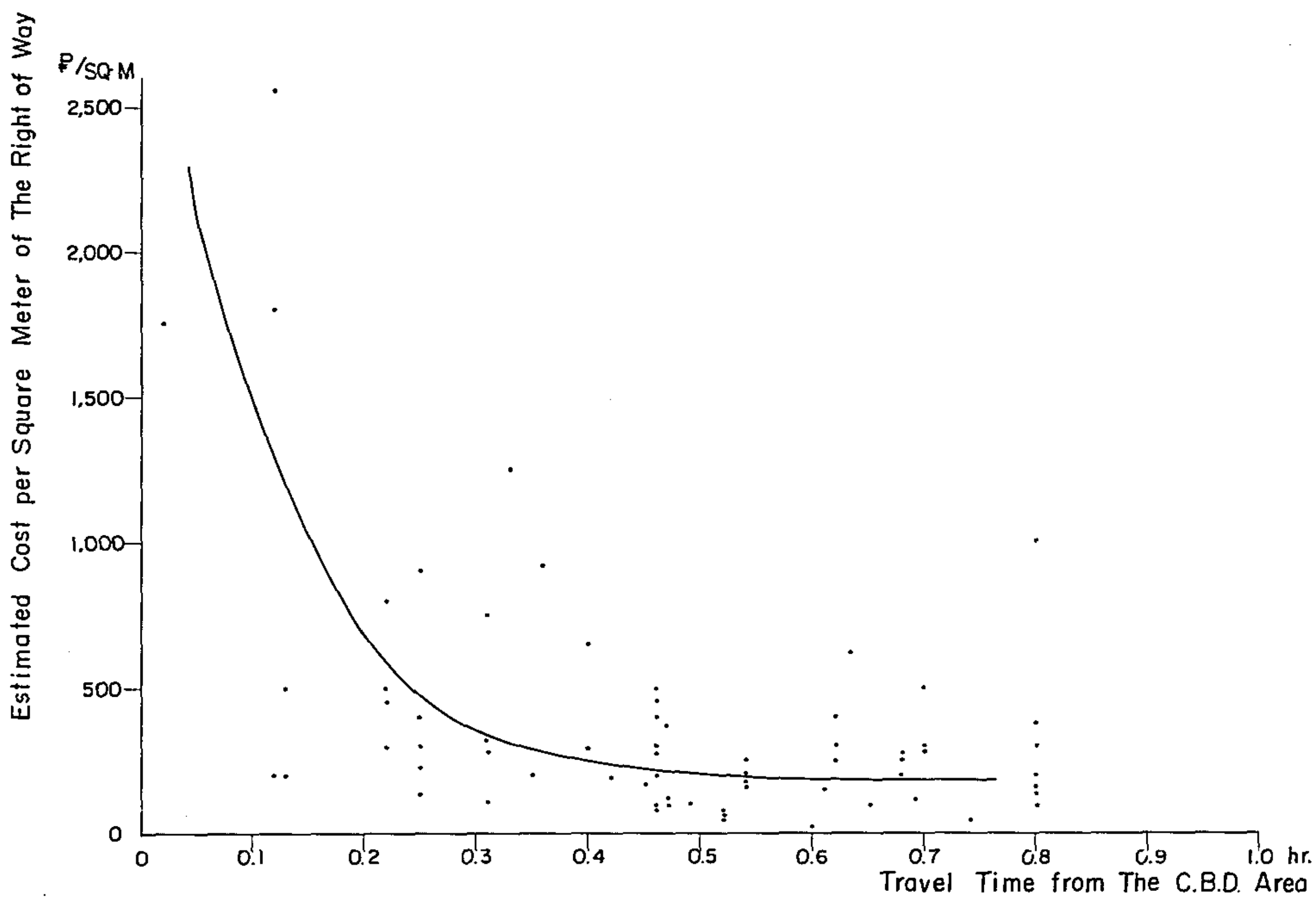


Fig. 8.2-1 Relation between The Travel Time and The Estimated Cost of The Right of Way

§ 8.3 Intersection Improvement Plan

8.3.1 General outline

Inappropriate handling of traffic flow at intersections may be pointed out as one of the causes of traffic congestion in Manila Metropolitan Area.

Various factors causes disturbance of traffic flow, and decrease of traffic capacity of the intersection, thereby inviting traffic delays and congestion as follows:

(1) In general, most of the intersections are insufficient in capacities as compared with volumes of through traffic.

(2) Grade separation is not used at the intersections where major roads intersect despite the fact that traffic volumes exceed the traffic capacity of grade intersections.

(3) Progressive system signals are not in use.

(4) Lack of left-turn lanes or insufficient width of left-turn lanes causes vehicles waiting for left-turn near intersections to block through traffic thereby decreasing intersection capacity.

(5) There is a strong tendency toward the concentration of traffic in specific sections because of the disorganized road network and the existence of multileg intersections such as four-way or five-way intersections which hamper smooth traffic flow.

(6) Rotary intersections exist in large numbers on major roads with heavy traffic and the advantages of the rotary intersection is lost completely. In other words, the advantages of the rotary intersection that it allows continuous flow of traffic when there is small traffic volume without stopping vehicles and that it unifies traffic in a simple flow even at a multileg intersection of four ways or more are not valid any longer and the smooth continuous traffic flow is hampered by vehicles stopping, slowing and moving out of direction, thereby increasing the danger of accidents. Besides, the rotary intersection entails longer walking distances for pedestrians and provision of a longer pedestrians' crossings, thereby blocking the vehicular traffic with a crowds of people.

(7) Road signs and markings for traffic control and instructions such as stopping lines at intersections, lane markings, marking of left-turn lanes, pedestrian crossings, no parking, no U-turns and one-way street are not clearly shown or they are posted in very limited locations. As a result, drivers lack understanding of traffic regulations which in turn brings about an obstacle to the controlled and smooth traffic flow.

(8) Lack of traffic education and discipline coupled with the deficiency of·traffic capacity, worsened traffic congestion.

While the removal of the above-mentioned causes of traffic obstruction will lead to the improvement of intersections, it is more advisable to give priority to the development of a method which will ensure high efficiency of traffic by taking into account the financial position and management and maintenance abilities.

8.3.2 Signal control

Because of the constant diverging, merging and crossing of vehicles and surges of pedestrians. It is inevitable that the traffic pattern at the intersections becomes more complicated and invites traffic accidents, obstructs smooth flow of traffic and lowers traffic capacity of the road.

Systematic and appropriate distribution of the right of way among respective traffic movements by means of traffic signals are expected to bring about enhancement of traffic capacity, efficient use of major roads, decrease of traffic accidents and protection of pedestrians. The advantages of traffic signals, however, can be obtained only when a systematic and comprehensive study is made of such factors as the characteristics of roads and demand for pedestrian crossing backed by traffic volume by directions, hourly change of traffic volume, capacity of road at the intersection, land use and development pattern in the sphere of the intersection of roads, and signals are installed at appropriate places in systematic combination with such measures as traffic regulations and instructions, or through appropriate combination of these signals for wide area coordinated traffic control.

The types and advantages and disadvantages of signals classified from the standpoint of operation and efficiency and the requirements for their installation are discussed below.

Fixed time signal

This is a signal which is designed to repeat signals according to the predetermined program. Elements to be set for signal control are the time cycle, sequence of phase, percentage of phase and the time of yellow signal for each phase.

1) Advantages

1.1) As the fixed time signal is effective for progressive control of traffic, its use on major roads with relatively short distances between major intersections will accelerate traffic flow. It is often more effective than the traffic actuated signal which can hardly be used for progressive control at all.

1.2) When there is a breakdown of a vehicle or unexpected obstruction on the intersection approach, there is less possibility of inappropriate signals with the fixed time signal.

1.3) In general, the fixed time signal involves a relatively low cost for installation and maintenance and requires simple operation and easy maintenance.

2) Disadvantages

2.1) The single-stage fixed time signal for which only one program can be provided lacks flexibility in its function and cannot adapt itself to variable traffic conditions without adjustment.

3) Conditions for justifying installation

The single-stage fixed time signal is suitable for the intersections with the following conditions.

3.1) Intersections where hourly change of traffic on two intersecting roads have the same trend.

3.2) Intersections where hourly change of traffic of both the primary road (road with larger traffic volume) and the secondary road are not great and where traffic volumes especially on the secondary road does not show a sharp increase over time.

3.3) Intersections where the demand for pedestrians crossing the intersection is for a long time.

The multi-stage fixed time signal is effective even when there are marked changes of traffic volume over time zones such as peak hours, off-peak hours and night-time. However, since the traffic pattern in these time zones is stable, it is necessary for the multi-stage fixed time signal to satisfy the requirements of the single-stage fixed time signal in each time zone.

b) Traffic actuated signal

This is a signal whose vehicle detectors installed at the intersection approaches register the passage of vehicles and which is designed to change the phase time at the intersection according to the traffic. Its purpose is to give appropriate signals corresponding to momentary changes of traffic demand, thereby increasing traffic efficiency.

The traffic actuated signal may be divided roughly into the following two types.

Semi-actuated signal	Signal with vehicle detectors installed only at part of intersection approaches and which gives phase by actuation only for that part.
Total-actuated signal	Signal with vehicle detectors installed at all approaches and which gives all phase by actuation.

1) Advantages

1.1) As it responds to changes of traffic volume even in a short time and gives signal corresponding to the demand, it eliminates unnecessary stoppage and delay of traffic.

1.2) As its green light is shown according to traffic volume at the approaches of the multi-phase control intersection, it helps curtail waste time with the resultant increase of traffic capacity.

1.3) While the fixed time signal tends to cause traffic delay by unnecessary stoppage with resultant disregard of signals by drivers at night when there is light traffic, there is no such a possibility with the traffic actuated signal.

2) Disadvantages

2.1) Change from the independent control system to the progressive control is very difficult and progressive control of all traffic actuated signals involves technical difficulty.

2.2) It requires generally high installation cost.

2.3) Breakdowns of vehicles or unexpected and unregistered obstructions and approaches may result in inappropriate signals.

2.4) Maintenance cost is high and repair and readjustment, particularly of vehicle detectors, require high skill.

3) Conditions for justifying installation

Semi-actuated signal

3.1) When there is need to give opportunity to vehicles approaching intersections to enter with a minimum hindrance to the heavy traffic of major roads.

3.1.1) When there is a sharp change of hourly traffic on secondary roads and there is concentration of demand in specific hours during the day where the traffic volume for both directions exceeds 18,000 vehicles/12 hrs. on major roads and 25,000 vehicles/12 hrs. on the city streets.

3.1.2) Where the requirements described in the preceding item 3.1.1) are fulfilled and there is a clear difference in peak hours between major roads and secondary roads or the secondary road has a large demand for entrance and exit of vehicles.

3.2) The conditions that make the pedestrains the main factor for the installation of traffic signals are a traffic in both directions exceeding 8,000 vehicles/12 hrs. on major roads and a traffic exceeding 12,000 vehicles/12 hrs. on the city streets.

Total-actuated signal

3.3) When it is required to provide vehicles with an opportunity to enter or exit (cross) the intersection with a minimum hindrance to the traffic of major roads, all of the following conditions must be fulfilled.

3.3.1) Each entrance has the alignment suitable for installation of a vehicle detector.

3.3.2) Requirements for the installation of a semi-actuated signal are fully met.

3.3.3) While failing to meet the requirement for progressive control, the traffic on main roads shows a tendency toward mass traffic.

3.4) When there is need to increase control efficiency at the intersections with the demand close to traffic capacity.

Where the requirements (requirements for installation of fixed time signals described in 3.3) are fulfilled and any one of the following conditions exists.

3.4.1) There is a sharp difference in the pattern of hourly fluctuation of traffic on the intersecting roads.

3.4.2) Geometrical structure of intersections and traffic flow are so complicated that the control by more than three-indications is required, additionally, the flexibility of indication time of signal is considered to have a favorable effect on the efficiency of traffic control.

3.4.3) When the intersection of major roads cause a bottleneck in the traffic of the neighboring area.

c) Automatic actuated type progressive signal

This is a series of signals designed to provide progressive control for groups of signals on a certain route or in an area. More definitely, it is a traffic control system consisting of vehicle detectors, main control apparatus, unit control apparatus, heads and communication system. Information on traffic measured by vehicle detectors installed in the typical locations within the control area is first received by main control apparatus, computation and comparison are made by computer built in the main control apparatus, comparisons are made automatically against the pre-determined control standard, progressive signal indication is determined and instructions are sent to unit control apparatus for signal indication.

Other signals include pedestrians' signal and blinker signal.

Situation in Manila Metropolitan Area

The following discussion will deal with traffic situation and signal control in Manila Metropolitan Area.

On the major radial roads, traffic in the morning peak hours (7:00 - 9:00 a.m.) is extremely heavy on the lanes leading to CBD and is generally small on opposite lanes. In the evening peak hours (5:00 - 7:00 p.m.), traffic is heavier on the lanes leading to the suburbs. There is a tendency, however, that traffic volume in both directions equalize in CBD.

With the expansion of the metropolitan area in the future, peak hour traffic by direction on the radial roads will be more equalized than today. On the circumferential roads, meanwhile, no significant variation is noticed in the traffic volume between time zones and between directions.

On the basis of the present and future traffic situation, characteristics of signal apparatus and the actual condition of the Philippines discussed so far, installation of signals is discussed in detail hereinafter.

Fundamentally, adoption of the integrated control system which controls traffic signals with electronic computers is desirable. In other words, it is desirable to institute integrated traffic control comprising wide area coordinated control with an electronic computer installed in the center for central district, progressive control for major roads, and local traffic actuated control for major intersections where there are markets or churches in the neighborhood and there is sharp fluctuation of traffic by hour and day. When various factors of Manila Metropolitan Area are taken into consideration, however, it will be extremely difficult to adopt the automatic actuation type progressive signal from the beginning.

For major radial roads and circular roads, it is desirable to adopt the progress control system which allows the operation of a series of signals along the road in conformity with the traffic condition on each road, enabling vehicles to pass along the road in minimum time and reducing the number of stops. However, adoption of the progressive signal to full extent is difficult at present from a financial, maintenance and operational point of view. It is desirable, therefore, to install multi-stage fixed time signals at intersections of major roads inside C-4 with priority given to those intersections with high traffic demand where the possibility of traffic delays or accidents may not be avoidable with such measures as channelization, and then shift to the progressive control system when the number of fixed time signal apparatus is becoming less effective and upon comparative study of traffic situation at that time.

Since the proposed intersections of complete grade separation may consist of intersections which are built for grade separation from the beginning and intersections which are given grade separation following the phase of signal control, it is necessary to determine the type of signal by taking into account various factors related to the specific intersection.

While the signal system in Manila Metropolitan Area include the type which hangs only one signal from a cable at the center of the intersection and the post type, they are provided in small number and some of them are installed at unappropriate locations and hard to recognize. It is desirable, therefore, to select proper types of signal and locations for their installation by taking into consideration the field of vision and the sight distance of drivers.

Although the adoption of the signal control that shortens travel time of vehicles passing the area to a minimum through a combination of local actuated control and progressive control is desirable for the area where there is high density of road network like in CBD, it is advisable to forgo for the time being the adoption of traffic actuated signal which involves high installation and maintenance cost and requires high levels of techniques for repair and readjustment of vehicle detectors.

As the benefit derived from traffic signal may vary greatly not only with the signal itself but also with other factors, it is essential to plan for the efficient operation of signals by giving due consideration to the following.

1) Strict enforcement of traffic regulations

2) As the restriction of stopping and parking in the entrance and exit of the intersection improves visibility with the resultant increase of travel speed and traffic capacity, it is desirable to provide a no stopping-parking zone for a length at least 30 m.

3) Since the bus stop located close to the intersection decrease of traffic capacity, it is advisable to relocate such bus tops far from the intersection as much as possible.

4) Where there is some left-turn traffic at each cycle, expansion of the width of entrance by shifting the center line is often effective for the enhancement of traffic capacity. However, the decrease of the width of exit to less than 4 m is not advisable in some cases.

5) As the signal control alone is not sufficient at times at the intersection with a large number of pedestrians and many right and left-turn traffics, it is necessary to assign a policeman to direct right and left-turn vehicles and traffic of pedestrians while leaving the signal to automatic operation in order to avoid the possibility of accidents and prevent traffic congestion.

8.3.3 Channelization

Though many of the roads have lanes designated specially for left-turn traffic provided through removal of median strip, there are very few road signs which show the separation of lanes such as the left-turn lane, through traffic lane and right turn through traffic lane, channelization to the left-turn lane and stopping lines. As a result, the left-turn lanes are not necessarily used efficiently.

Smooth flow of traffic at the intersection can only be expected from a systematic combination of appropriate traffic control by signal, channelization and strict observance of traffic rules. Lack of any of these elements will make the investment fruitless no matter how large the space provided for intersections.

One of the reasons for constant traffic delays at intersections on C-4 with a relatively large space is the lack of the above conditions in addition to large traffic volume. At some intersections corner-cutting of corners is not provided and this is a major obstacle. It is desirable to provide corner cutting of at least R = 4 m of radius of curvature. Where the acquisition of the right of way permits, a radius of curvature of R=10 m at the corner is desirable also in consideration of the sight distance at the intersection.

For the intersections, the three core-compound curve which is closer to the travel course of vehicles is superior to a simple circular arc.

For the intersection where the acquisition of the right of way is not so difficult, addition of a right-turn lane to the outside of the intersection is desirable to ensure that the traffic capacity of the intersection corresponding to the traffic of the road.

For roads on which the decrease of traffic capacity is caused by the lack of left-turn lane and stopping of through vehicles, it is necessary to provide a left-turn lane by removing a portion of median strip. Where partial removal of median strip is not practical, addition of a lane for through traffic to the outside portion of the road way and channelization with lane marking to prevent cross-lane movement may also be conceivable.

While there are not a few major roads which have walls about one meter high built on the median strip for the purpose of preventing jaywalkers, it is necessary to reduce the height of walls to the height of curbs for at least 30 m from the intersection in order to ensure adequate sight distance near intersections.

8.3.4 Grade separation

The grade separation of main roads is suggested as the most effective measures to dissolve the difficulty in traffic which is to be apprehended at present and in future in Manila Metropolitan Area.

The grade separation plan is specified as to the following regions.

1) grade separation inside C-2 (excluding that on C-2)
2) grade separation inside C-4 (excluding that on C-4)
3) grade separation on C-4
4) grade separation outside C-4

1. Grade separation inside C-2 (excluding that on C-2)

Except for the grade separations under way inside of C-2, it is desirable not to construct any more grade separations regardless of the increase in traffic demand in future.

The reasons for this are mainly as follows:

1) It is extremely difficult to procure land within C-2 where buildings are quite congested. Even when that may be procured, the cost for it will be very high.

2) Inside C-2 the road network is closely distributed and moreover the length of each road is very short. Therefore, it is quite difficult to plan a

construction of rampways and others without hindering the traffic in and out of these roads. Even if the construction can be planned, it is to be feared that the traffic going in and out of the roads which cross the roads on which rampways are planned will be restricted or impaired.

3) When some of the adjacent intersections are integrated into a grade separation, the resulting type is a continuous grade separation. However, there is relatively little traffic which may use such continuous grade separation, but rather there is more of refracted traffic. In this respect, continuous grade separation cannot be utilized to greater effect.

4) It is to be predicted that inside of C-2 grade separation cannot be sufficiently effectivated because of the traffic left over even after the realization of grade separation out of intersections.

5) In the area inside C-2, where traffic congestion is remarkably observed, even when several intersections are made into a continuous grade separation or into separate grade separations, the following surface intersection comes to interfere with the flow of traffic and as a result the traffic capacity of roads is not fully and smoothly displayed. In this cases the grade separation is not realized to best effect.

As has already been mentioned, it is desirable not to add any more intersections inside C-2. However, it is necessary to have grade separations at such intersections as those with busy traffic, e.g. the intersections of C-1 and R-2 or of C-1 and R-6, those with multiple divergence and complicated traffic flow, those of between major routes, etc.

In the CBD, traffic conditions in any district have an immediate serious effect on traffic in adjacent areas. Therefore, grade separation of intersections in any specified area will be of no use if traffic delays occur at at-grade intersections in the adjacent districts. It is desirable, therefore, to maintain general equibrium of the standard for grade separation of intersections inside C-4 after making a comprehensive study of the overall traffic situation.

For Plaza Lawton, a north-south junction where there is heavy and complicated traffic including through traffic crossing Jones, MacArthur, and Quezon Bridges (49, 200 vehicles/day, 53, 100 vehicles/day and 74, 300 vehicles/day, respectively), construction of an interchange is desirable and in fact, is now under construction.

The intersection of R-6 and C-1 is very important for handling traffic on C-1 and through traffic between CBD and the suburbs.

2. Grade separations inside C-4 (excluding those on C-4)

   It is to be recommended that diamond-type grade separations should be planned for intersections of between major routes and a part of intersections made up by a major route and a narrow road.

   However, this does not mean that all intersections of between major routes themselves are made into grade separations.

   The following are the intersections which are considered possible to make into grade separations or requiring to do so, judging comprehensively from traffic volume or surrounding circumstances, etc.

   intersections of R-2 and R-6 concerning C-1 .... 2 places
   intersections of R-2 and R-6 concerning C-2 .... 2 places
   intersections of R-3 and C-3, and
   intersections of Pasay Road, Vito Cruz and C-2 ..... 4 places

   Next, the necessity of grade separation is explained by exemplifying the above-mentioned intersections.

   Plaza L. Avelino, where R-6 (Ramon Magsaysay Boulevard) meets C-2 (Nagtahan), is an important intersection with heavy traffic (46,000 vehicles/day as of September 1971) from Aurora Blvd. There is a plan for the construction of a new road in parallel to Calle Legarda which links L. Avelino with the intersection where R-6 meets C-1. If this new road and C-2 are constructed as planned, L. Avelino will become a six leg intersection and will not be able to handle traffic with the present at-grade intersection. It is deriable, therefore, to provide a grade separated intersection in this case.

   At the intersection of R-3 (South Diversion Road) with Buendia Avenue there is relatively heavy traffic between CBD and Makati which has the character of a sub-center, and left-turns are very difficult for the traffic from CBD to Makati. Therefore construction of an interchange is desirable for this intersection.

   As the intersection of R-8 (A. Bonifacio a two lane road at present but widening to a four-lane road is planned) which receives North Diversion Road with Del Monte

Avenue (two lanes) handles heavy through traffic, but the through traffic is forced to take a curved course and the traffic flow is greatly hampered. Since this inefficiency in the handling of traffic at intersections increases traffic jams at A. Bonifacio and Del Monte Avenue, already deficient in traffic capacity, it is desirable to provide a grade separated intersection if the acquisition of the right of way is possible.

As the intersections of C-2 (Harrison Boulevard) with R-3 (South Diversion Road) will have increased through traffic when the unfinished sections of C-2 completed, it is desirable to provide an interchange for this intersection where a major circumferential road and a major radial road meet.

For other ordinary intersections where roads other than major roads meet, where traffic is not so heavy and where acquisition of the right of way and removal of buildings are extremely difficult, at-grade intersections are desirable in principle.

Though various types of grade separation are available as described in the following paragraph b) Grade separation of C-4, it is important to select the optimum type after making a thorough study of natural and social environmental conditions of each intersection such as the topography, importance and characters of intersection roads, availability of the right of way and the existance of properties which require compensation.

The cost of construction per intersection including the land price is in the order of 7.5 million on the average though it varies somewhat with the size of grade separation and other requirements.

3. Grade separations on C-4

In Manila Metropolitan Area the function of roads in the circumferential direction is noticeably weak. Because of this, importance may be attached to the improvement and construction of C-4, which will also strengthen the function of such roads in the circumferential direction.

The improvement and construction of radial roads must not be neglected. However, the strengethening of radial roads invites the concentration of traffic upon a certain short time period, which is accompanied by the limit of road capacity in urban center, and thus eventually may in some cases result in the acceleration of traffic congestion in urban center. Moreover, traffic may flow quite smoothly on radial roads in suburban areas but may be congested in urban center. In this respect, it is more effective and important in Manila Metropolitan Area to strengthen circumferential roads than radial roads.

At present C-4 is playing an important role as a major circumferential road, As the peak hour traffic in both directions at intersections of Aurora Boulevard, Shaw Boulevard, Quezon Boulevard, Pioneer Street and Rizal Avenue Extension exceeds the capacities of at-grade intersections, traffic jams at these intersections are impending overall functions of C-4 and at the same time are lowering the efficiency of major radial roads which play an important position in the traffic linking CBD with the suburbs.

In order to eliminate the deterioration of function of C-4 for the above-mentioned reason, it is to be suggested to make grade separations out of intersections at 12 places as are shown in Table 8.3-1.
Simultaneously, it is desired to decide the way of fixing ramps (location, height, length, form, etc.) centering around the consideration of the traffic on C-4.

In order to make the most of the function of C-4 and ensure effective investment, it is desirable to plan the improvement of intersections in stage by considering the overall balance of the improvement standard and financial aspect while avoiding concentration on improvement work for specific intersections on C-4. This is because a large investment for improvement of one specific intersection will not have an immediate effect on the general increase of traffic capacity of C-4 and major radial roads if other incomplete intersections cause a bottleneck in the smooth traffic flow.

Each type of grade separation for the intersections described in the last part of this section is the result of a careful study of the difficulty in actual land acquisition and removal or relocation of buildings. Intersections on C-4 with buildings standing close to the road on four corners are Cubao Intersection, Kamuning and Rizal Avenue Extension (Monument), and there are no intersections free at building. From a long-range point of view, while considering the increase of traffic backed by the remarkable annual population growth rate of 4.0%, it is desirable that efforts should be made to acquire land, and that effective efforts should be made to select the intersection type having close similarity to a complete grade separated interchange with least level crossings and weavings at the present stage when land acquisition and removal of buildings are relatively easier than will be the case in the future.

Table 8.3 - 1 *Grade Separation of C-4*

No.	Name of Radial Road	Type	Remarks
1	A. Mabini-C-4 (R-9)	Type - 3	
2	North Diversion Road (R-8)	Special Type	Already completed
3	Congression Ave.	Type - 1	
4	Quezon Boulevard (R-7)	"	
5	Kamuning Road	Type - 2	
6	Aurora Boulevard (R-6)	"	
7	Shaw Boulevard	"	
8	Boni St.	Special Type	
9	J. P. Rizal Ave. (R-4)	Type - 1	Already completed
10	Buendia Ave.	Type - 3	
11	Ayala Ave.	Special Type	
12	South Diversion Road (R-3)		Manila teams plan

For the rotary intersection with a monument in the center such as Rizal Avenue Extension, grade separation by removing the monument is of course desirable. If the removal of the monument is difficult because of national sentiment, construction of C-4 under Rizal Avenue Extension is conceivable.

When increased through traffic resulting from completion of the Philippine-Japan Friendship Highway as well as the fact that a series of road linking South Diversion Road, C-4 and North Diversion Road are the mainstay of the north-south traffic are taken into consideration, the interchange type is considered most suitable for intersections on the already completed Manila North Diversion and the proposed South Diversion Road.

4. Grade separation outside C-4

Comments on specific plan for improvement of C-5 and C-6 are here refrained, for they do not exist at present. But the principles of how to deal with grade separations are indicated plainly.

In case of intersections on C-5 and C-6, it is necessary to set up a following plan for intersections which can well conform to the principles of construction of C-5 and C-6.

1) The cloverleaf type is recommended for the intersections of between major routes or of major route and semi-major route where vacant lot is available at present and the land can be acquired.

2) The diamond type is recommended for areas where development has gone further and the acquisition of land is very difficult.
If this diamond type is impossible, it cannot be helped sometimes to have surface intersections with systematized signals.
In any case, it is to be hoped that the land for C-5 and C-6 should be acquired at an earliest possible time after duely considering the type of intersections.

The following discussion deals with the type and structural aspects of grade separations.

While the survey team recommends construction of an expressway on C-4, grade separation of main intersections on C-4 presents some structural problems. In other words, it is necessary to take into consideration the structure of the proposed expressway in planning grade separation of C-4. The types of grade separation which are conceivable within the present right of way of 50 m with the expected difficulty in land acquisition and relocation of buildings are the following three.

Type - 1	Over-type structure of four lanes of C-4.
Type - 2	Under-type structure of four lanes of C-4.
Type - 3	Under-type structure of radial roads.

These types are shown in Fig. 8.3-1 through 8.3-4. Since these are only the standard types, a careful study must be made of various factors to select the design which is best suited to local conditions in actual construction.

The South Diversion Road Interchange was planned by the Manila Team, for which the acquisition of the right of way has already been completed. A partial revision will be made to the plan of the South Diversion Road Interchange as shown in Fig. 8.3-4 so as to leave the possibility of constructing an expressway on C-4 in the future. This plan is for an intersection with four-lanes of C-4 carried under South Diversion Road and P N R.

For this case, after the survey and study about the rainfall, it is necessary to construct the sufficient drainage facilities.

Grade separation of C-4 will be planned only for intersections with radial roads of four lanes or more as a rule. Table 8.3-1 shows the proposed grade separations of C-4 including the ones already completed or proposed by Manila Team.

Estimated construction cost (1971) for the nine proposed grade separations based on March, 1971 data provided by the Manila team is as follows:

Type - 1	Two places x 6,540,000 = P 13,080,000--
Type - 2	Three places x 4,680,000 = P14,040,000--
Type - 3	Four places x 5,240,000 = P20,960,000
South Diversion Road Interchange	= P32,000,000--
	TOTAL = P80,080,000
	Source: Refer to the Table 9.5-2

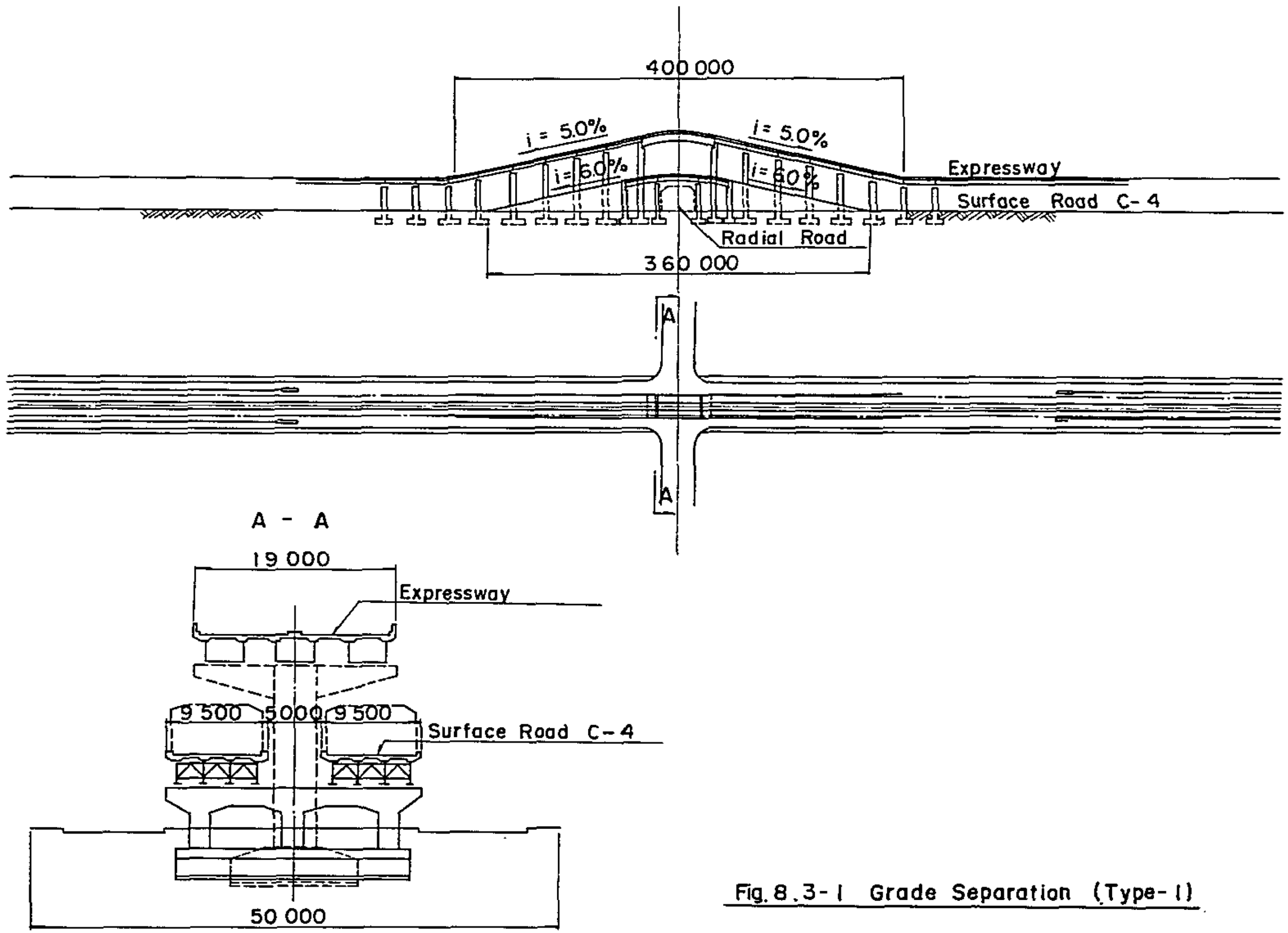


Fig. 8.3-1 Grade Separation (Type-1)

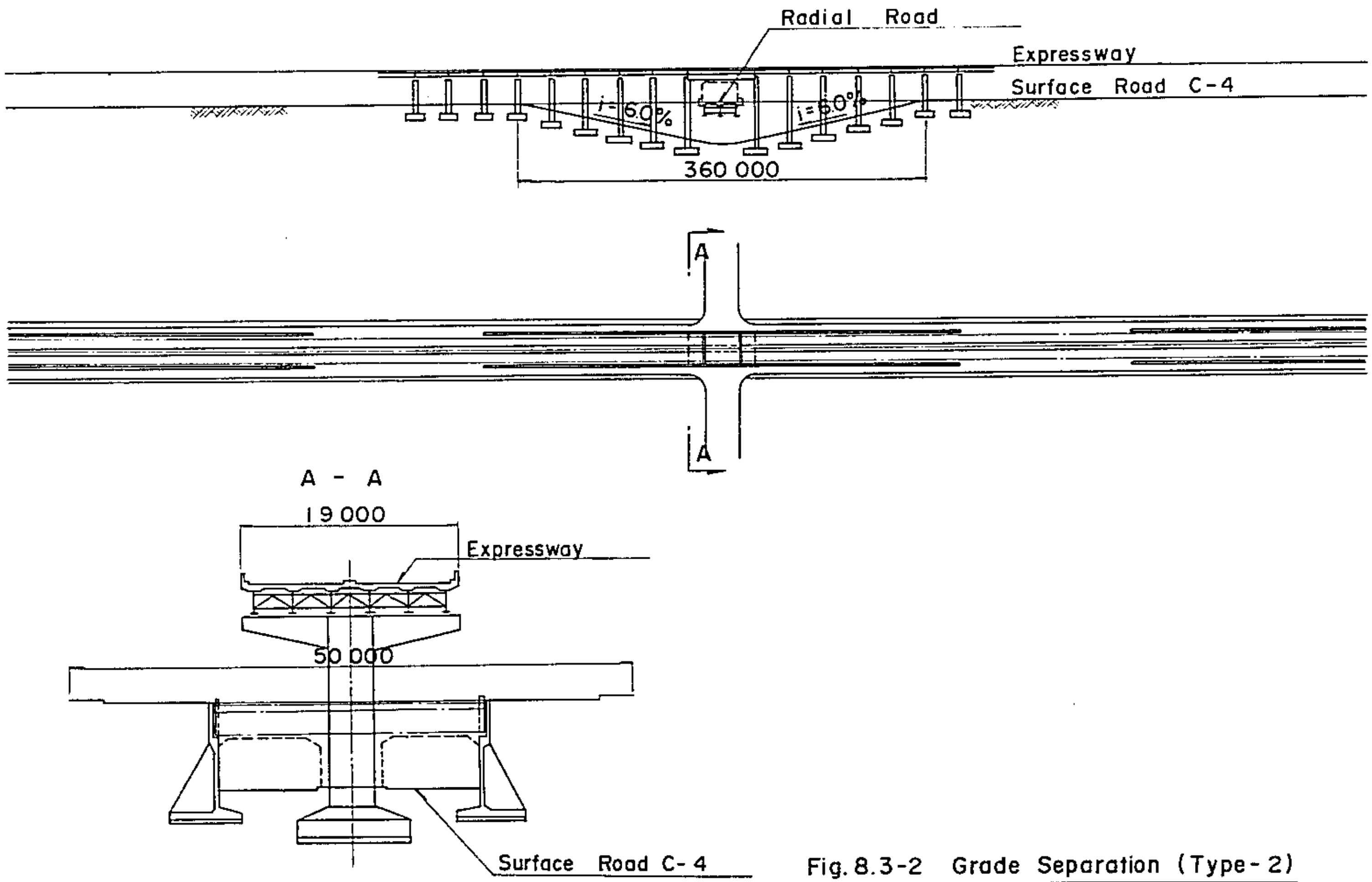


Fig. 8.3-2 Grade Separation (Type-2)

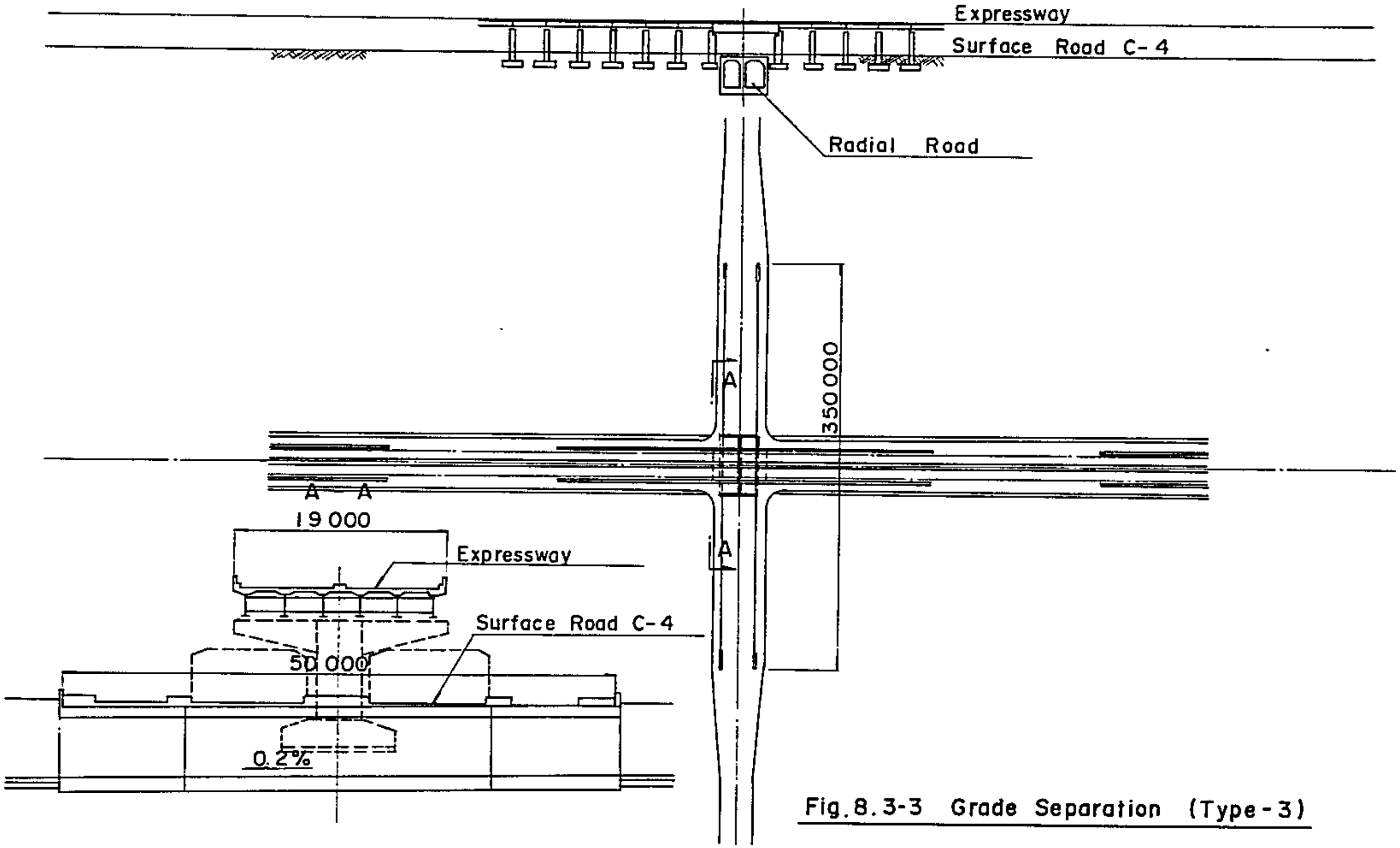


Fig. 8.3-3 Grade Separation (Type-3)

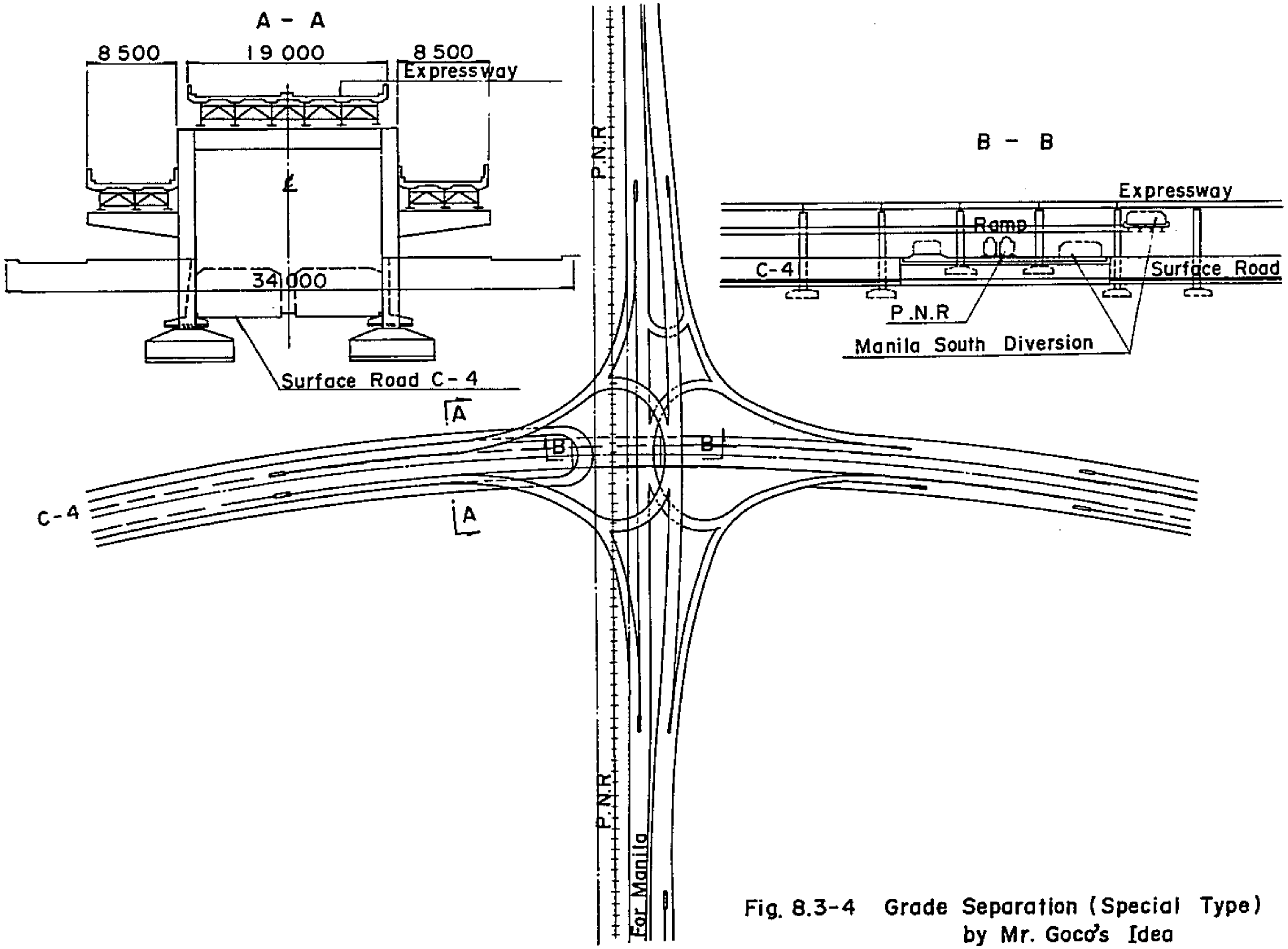


Fig. 8.3-4 Grade Separation (Special Type) by Mr. Goco's Idea

§ 8.4 Priority of construction

It is considered as natural to first undertake improvement of routes and intersections which will require less investment and entail higher effect of improvement. As the continuous grade separation in built-up areas costs much for construction, its priority in construction will be lowered in case sufficient effect as to match the construction cost cannot be expected out of that construction. For the time being, further investigation has to be conducted in order to state detailed priority of construction with respect to each route and intersection. And this seems even difficult at present. Therefore, mention is here made only on construction works which are considered to necessitate construction completed urgently, that is, within the coming five years.

Improvement of main intersections inside C-4
Construction of the missing 5 kilometer section of C-2
Construction of 19 kilometer C-3
Construction of the missing 2 kilometer section of R-6
Construction of the extention of R-1 beyond C-4
Construction of R-4 inside C-4
Construction of R-10
Construction of missing sections of C-4

As regards C-5 and C-6, it is necessary, for the time being, to acquire enough right of way over the entire routes.

The other major thoroughfares, together with the secondary roads, proposed in this study are desired to be almost completed within ten years to come. Their priority should be studied further, based upon the yearly plan of development of the Area.

CHAPTER 9 URBAN EXPRESSWAYS

CHAPTER 9 URBAN EXPRESSWAYS

This chapter deals with detailed route planning, selection of structural design and computation of construction cost on the basis of the traffic demand forecast in Chapter 6 and the urban expressway network proposed in Chapter 7. In addition, the priority of route for construction will be proposed, the benefits derived from the entire network will be analyzed and the policy of the project planning will be proposed in this chapter.

§ 9. 1 Estimated Annual Traffic Volume

The traffic demand forecast in Chapter 6 shows that the total number of vehicular trips will increase from 1, 457, 000 in 1971 to 2, 908, 000 in 1987 at an annual growth rate of 3. 1% of the latter. Assuming the number of vehicles using urban expressways (137, 000 vehicles/day in case of toll system and 428, 000 vehicles/day in case of free system) will increase at the same rate, the annual traffic volume for a 30 year period will be as shown in Table 9.1-1.

§ 9. 2 Basic Policy of Planning and Design Standard

9. 2. 1 Basic policy of planning

In planning an urban expressway called Manila Expressway hereinafter for Manila Metropolitan Area, the following points must be studied carefully.

a) Route selection and structural design

Since the acquisition of land for construction of Manila Expressway in the over-populated Manila city will not only face a difficulty from a political point of view but will also require an enormous investment involving various problems, utmost efforts must be made to utilize public land to the extent possible.

Therefore, the route of the proposed expressway should be selected on the existing roads (including Highway 54), over the river, and on land to be reclaimed.

Construction of this expressway, may cause problems such as the bisection of communities, a decrease of river efficiency as a result of construction of bridge piers and damages to the living of fishermen resulting from reclamation of the sea.

Table 9.1 - 1 Annual Traffic Volume on Urban Expressways for 30 Years

(million vehicles)

Years		Toll	Free
in Calendar	from Opening		
1987	1	50	156
1988	2	52	161
1989	3	53	166
1990	4	55	171
1991	5	56	175
1992	6	58	180
1993	7	59	185
1994	8	61	190
1995	9	63	195
1996	10	64	200
1997	11	66	205
1998	12	67	209
1999	13	69	214
2000	14	70	219
2001	15	72	224
2002	16	74	229
2003	17	75	234
2004	18	77	239
2005	19	78	243
2006	20	80	248
2007	21	81	253
2008	22	83	258
2009	23	85	263
2010	24	86	268
2011	25	88	273
2012	26	89	277
2013	27	91	282
2014	28	92	287
2015	29	94	292
2016	30	96	297
Totals		2,184	6,793

For solution to these problems, construction of roads connecting to the communities, improvement of rivers including the expansion of river width, preservation of the minimum fishery resources and compensation for fishing, rights may have to be considered, and in fact, these measures have been taken in Tokyo in the construction of expressways. Though the construction of the expressway along the alignment of the existing roads and the river may cause some unfavorable consequences such as the frequency of curves. Problems of undesirable longitudinal slope and complicated design of bridges can be solved through various technical measures.

(b) Economical construction of expressways and promotion of related industries.

It is needless to say that a study must be made to pursue economy in the design of structures and adopt the most economical design in order to minimize the cost of construction and that consideration must also be given to the future maintenance of structures.

From the standpoint of maintenance, concrete structures which require no painting will be more advantageous than steel structures. Adoption of concrete structures which use rich domestic materials is also advantageous for the encouragement and development of domestic industries in the Philippines.

However, steel structures must be used for interchanges or ramps where the use of steel structures is definitely required from a structural point of view and where the use of concrete is not practical in the erection of work.

(c) Protection of aesthetics

The expressway which plays a part in the preservation of scenic beauty of the city must possess a corresponding structural beauty. The structures that possess a smooth flow of stress will provide the structural beauty as well. It is necessary, therefore, to make a careful study for individual cases by placing emphasis on these points.

Since there are a number of cultural properties located along the route of the proposed expressway, appropriate measures must be taken to protect these properties, and the design of structures sympathetic these properties must be adopted, paying due consideration to the materials to be used.

(d) Environmental protection

Construction of an expressway (mainly elevated type) often causes annoyance to the residents in the neighborhood such as vehicle noise, exhaust gas and shielding of light and air. It is necessary, therefore, to make a careful study of the possibility of these environmental disruptions in advance and take appropriate measures to eliminate or minimize the damage to people's life.

While there are not many effective means to prevent these environmental disruptions at the present stage, a study should be made on the advisability of providing sound proofing walls at specific locations on the expressway where the need exists as a measure against vehicle noise. As for exhaust gas, the automobile manufacturers are being pressed for the development of effective means, and as far as the expressway is concerned, the most effective means at the present stage will be to prevent traffic jams.

For light and air, a fairly good result may be obtained if an auxiliary road (buffer zone) is provided on both sides of the expressway.

Expressway structure which has little possibility of being accompanied by these environmental disruptions are the underground type, depressed type and park road type. However, each of these types requires an enormous investment for the acquisition of the right of way and for construction work and therefore is not practical in general within the densely populated area.

(e) Noise and vibrations caused by construction work

As the noise and vibrations caused by construction work of expressways in urban areas may induce a flood of complaints from the residents along the route necessitating the payment of compensations or suspension of the work, it is absolutely necessary to employ a construction method that keeps noise and vibrations to a minimum.

For the Manila Expressway project, noiseless and vibrationless cast-in-place piles or high strength bolts rather than rivete should be used to eliminate these problem.

(f) Measures against earthquakes

As the Philippines in an earthquake country belonging to the circum-Pacific seismic zone like Japan, there is no need to emphasize the necessity of earthquake proof construction of structures.

The Philippines adopts a seismic (lateral force coefficient) intensity of Kh = 0.1 at present but it should be raised up to about Kh = 0.2 judging from the seismic records in that country. Therefore, this value will be used in structural calculation for the Manila Expressway project.

Since the fall of a girder of expressway in the event of an earthquake invites the worst situation paralyzing functions of related roads and interfering with the evacuation of personnel to safety and firefighting activities, any structure of the elevated type must be provided with an appropriate device to prevent the fall.

(g) Relations to surface roads

Connection of the expressway to surface roads will be provided at the beginning and the end of the route and at the ramp. Selection of locations for these connections must be made upon a careful study of geographical condition, land use, traffic demand and structural requirements.

There is a plan for grade separation of all major roads intersecting Highway 54 as an urgent improvement. Therefore, the planning of an expressway along Highway 54 should be made by giving due consideration to the relationship with the grade separation plan.

The above is an outline of main points to be considered in the project planning. Other related matters will be discussed in detail in the paragraphs which follows.

9.2.2 Design standards

Since the design standards both in Japan and the Philippines are established on the basis of A.A.S.H.O. specifications with partial revisions according to local conditions and domestic requirements in both countries, the use of either standards does not seem to make much difference. Therefore, the Japanese design specifications will be applicable in principle to the construction and planning of Manila Expressway. In the following sub-paragraphs, a few comments will be made on the structural design specifications and geometric standards.

a) Structural design specifications

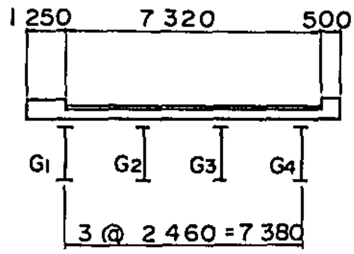
Comparative calculation of liveload, a factor which exerts the greatest influence upon structural design, between A.A.S.H.O. Spec. and the Japanese shows that the Japanese Spec. has a slightly higher safety factor. As there is no great difference between the two in other design aspects and there is a similarity in geological conditions between the two countries, application of the Japanese Spec. is considered appropriate.

(1) Comparison of A.A.S.H.O. Spec. and Japanese Spec.

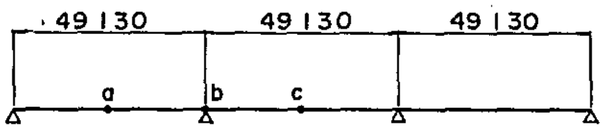
For reference purpose, a calculation will be made as shown below to determine the difference in the moment produced by live load of a three-span continuous beam.

Load designation	Japanese Spec.	TL-20
	A.A.S.H.O. Spec.	H20-44

Width



Effective span



Live load

	T.L-20	H20-44
Uniform Load	350 kg/m²	315 kg/m²
Concentrated L.	5,000 kg/m	8,165 kg/m

Bending moment

Points	T.L-20	H. 20-44	△
a	393.3	289.9	103.4
b	-410.3	-363.6	-46.8
c	283.0	203.4	79.6

Bending moment at points a, b and c can be obtained while paying attention to beam G 3 and the results are compared.

As evident from the above results, the Japanese Spec. is more on the safer side as far as live load is concerned.

(2) Structural design specifications

Major loads and strength per unit area of major materials to be considered in the design of structures are shown in Table 9.2-1 and Table 9.2-2 respectively.

Explanations are other design items will be omitted here.

Table 9.2-1 Major Loads

Principal Loads	1	Dead Load
	22	Live Load
	3	Impact Load
	4	Influence of prestress
	5	Earth pressure
	6	Water pressure
	7	Temperature change
Secondary Loads	8	Wind Load
	9	Influence of seismic
	10	Drying shrinkage of concrete
	11	Movement of bearing support
	12	Braking Load
Special Loads	13	Erection Load
	14	The other

Table 9.2-2 Minimum Strength per Unit Area of Materials

	Description	Minimum Stress	Remarks
Concrete	Generality	70 kg/cm^2	Fck = 210 kg/cm^2
	"	100 "	Fck = 300 "
	Prestress	133 "	Fck = 400 "
Reinforcement	Deformed Bar	1,500 "	
Tendon Wire	12-ϕ7	93 "	
	12-ϕ12.4	105 "	
	SS41	1,400 kg/cm^2	
Steel	SM50Y	2,100 "	
	SM58	2,600 "	

b) Geometric standard

For geometric standard, the Japanese Geometric standard will also be applied as a rule. As there are some differences in the type of automobiles between the Philippines and Japan, the Philippine standard will be applied to the width of lanes.

The standard width of lanes according to the design speeds differs between the two countries as shown in Table 9.2-3 below.

Table 9.2-3 Width of Lanes

Design Speed	Japanese Standard	Philippine Standard
40 km/h	3.00 m	3.05 m
60 "	3.25 "	3.35 "
80 "	3.50 "	3.65 "

Table 9.2-4 Geometrical Standard

		Elevated Way	Banking Way	Ramp and Crossover Road
Design Speed		60 km/hr	80 km/hr	40 km/hr
Minimum radius of curvès		120 m	230 m	50 m
Maximum cant		10%	10%	10%
Length of transition curve		over 50 m	over 70 m	over 35 m
Sight distance		over 75 m	over 110 m	over 40 m
Longitudinal grade (At most)		5% (7%)	4% (5%)	7%
Radius of vertical curve	Crest	1,400 m	3,000 m	500 m
	Sag	1,000 m	2,000 m	500 m
Length of vertical curve		over 50	over 70	over 35 m
Length of acceleration and deceleration area		over 180 m	over 230	-

Main items of geometrical standards to be applied to the Manila Expressway are shown in Table 9.2-4. The road width to be applied to the expressway is shown in Fig. 9.2-2.

In the case of the elevated type, shoulders will be built narrower for the economu of expressways. To compensate this, an emergency parking zone will be provided for every 500 m., as shown in Fig. 9.2-1.

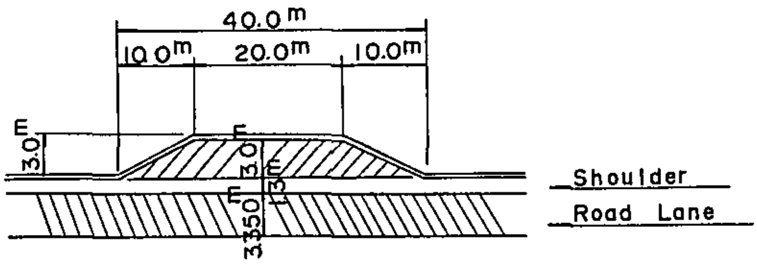


Fig. 9.2-1 Emergency Parking Zone

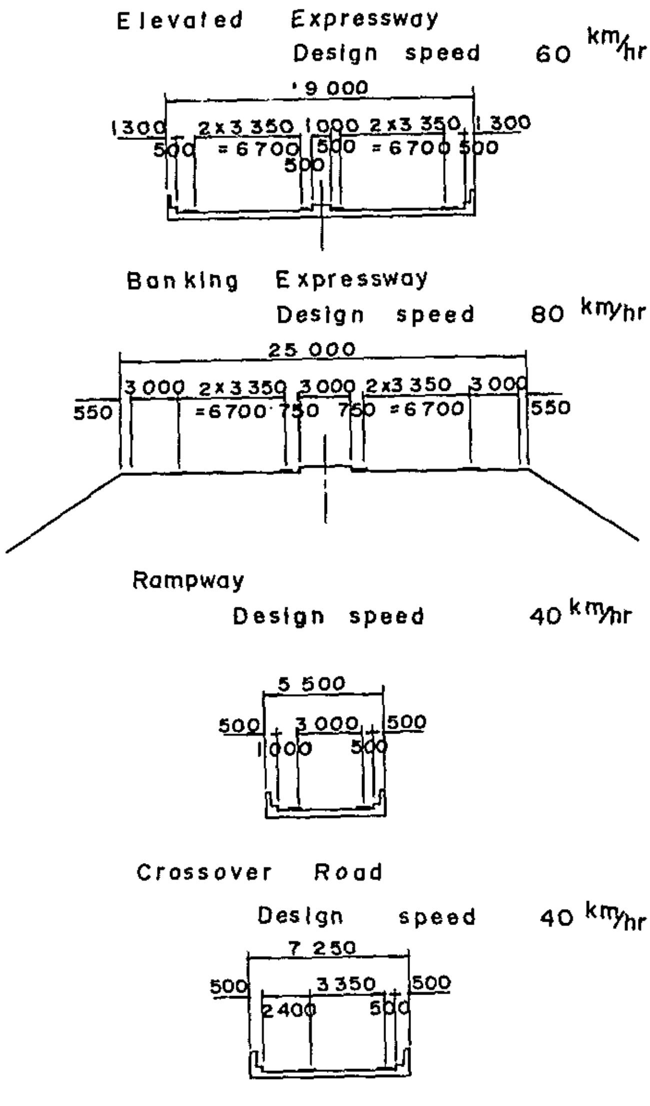


Fig. 92-2 Typical Road Width

§ 9.3 Interrelation between Expressways and Surface Roads

9.3.1 Route selection

As shown in Fig. 9.3-1, Manila Expressway consists of six proposed routes and two completed routes, South Diversion Road and North Diversion Road. In this section, route selection will be discussed for the six proposed routes.

The characteristics of Manila Expressway network is that five routes--Route No. 2 to Route No. 6--extend to CBD and the suburbs as a feeder from the axis road, Route No. 1 planned along Highway 54. All of these routes with the exception of Route No. 2 are linked to Route No. 1. The method used for linkage is a Y-junction as shown in Fig. 9.3-12. This design stems from a concept that Route No. 1 is the main line and other routes are branch lines.

Profiles of each route are shown in the following figures.

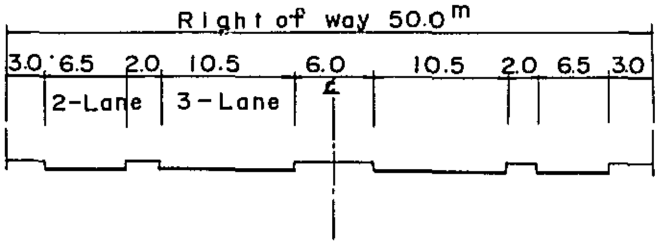
Route No. 1	Fig. 9.3-2 - Fig. 9.3-5	(4)
Route No. 2	Fig. 9.3-6	(1)
Route No. 3	Fig. 9.3-7	(1)
Route No. 4	Fig. 9.3-8	(1)
Route No. 5	Fig. 9.3-9 and Fig. 9.3-10	(2)
Route No. 6	Fig. 9.3-11	(1)

Major construction materials to be used for each of these routes are shown in Table 9.3-1.

Route No. 1

This route is the core of Manila Expressways and therefore constitutes the main part of the object. Selection of this route within the right of way of Highway 54 involves many problems in relation to the Related Roads.

For Highway 54, the right of way 50 m. in width has been secured except for the section in the Caloocan district.



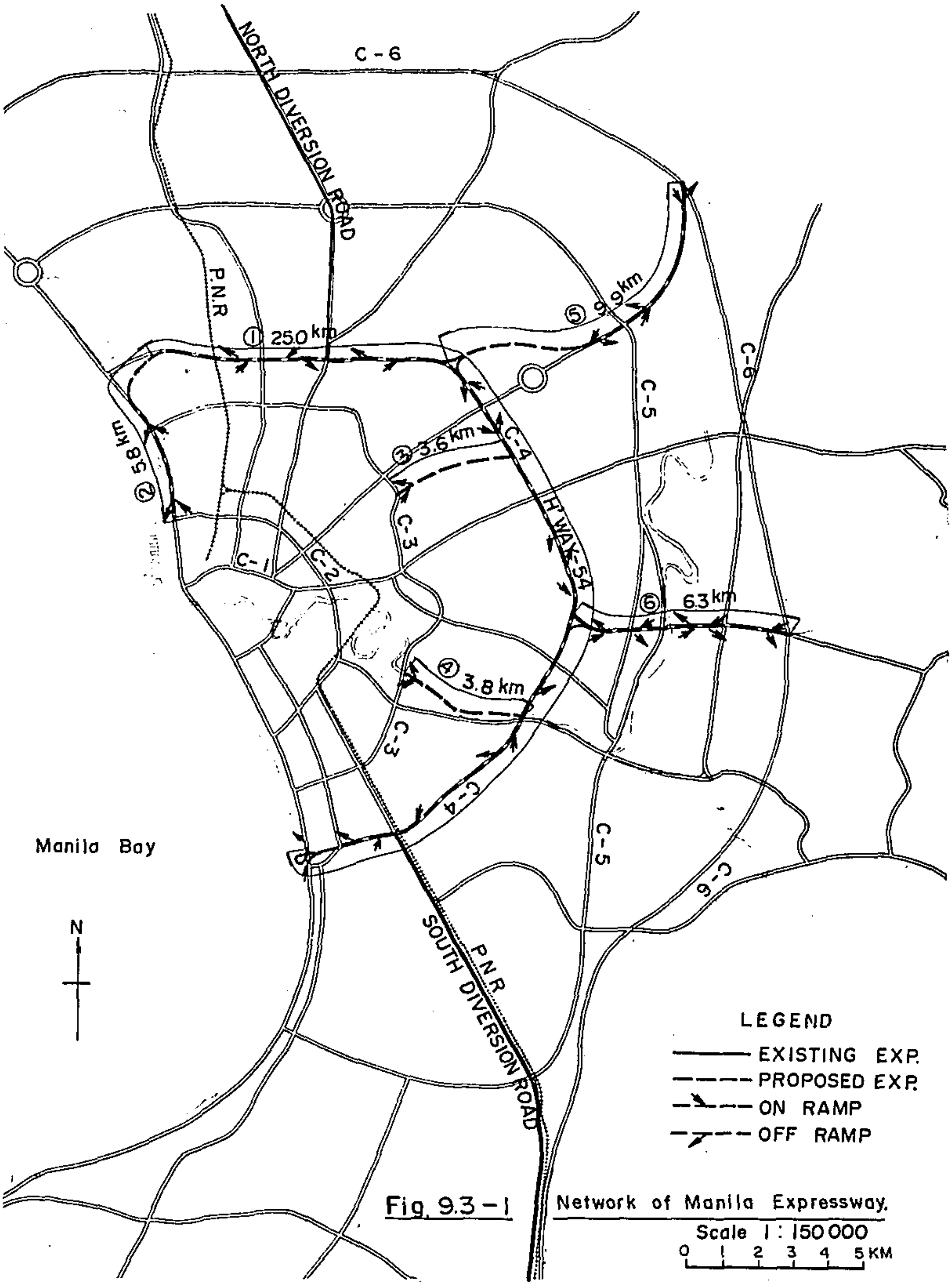


Fig. 9.3-1 Network of Manila Expressway.

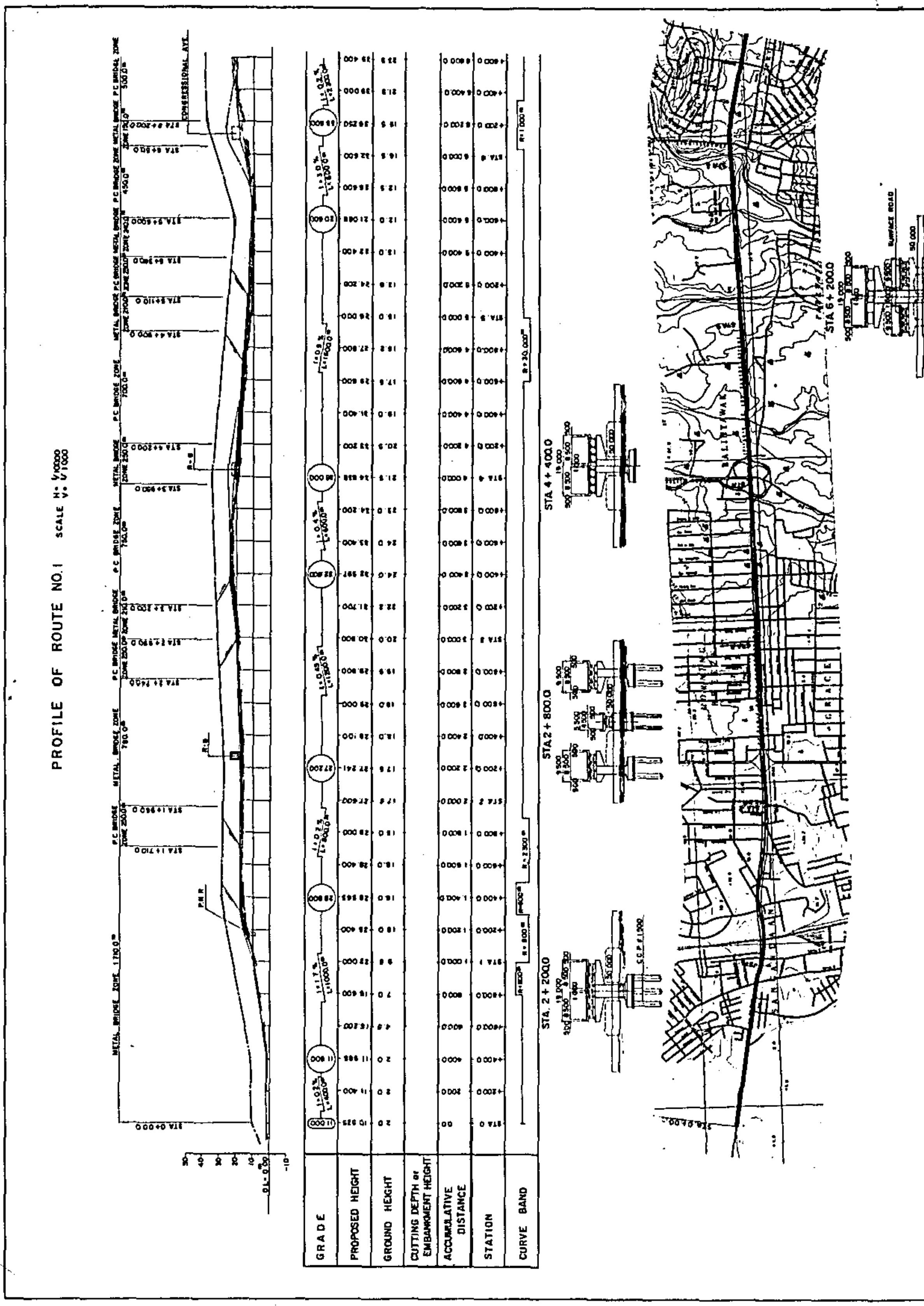


Fig. 9.3 - 2
Profile of Route No.1-1

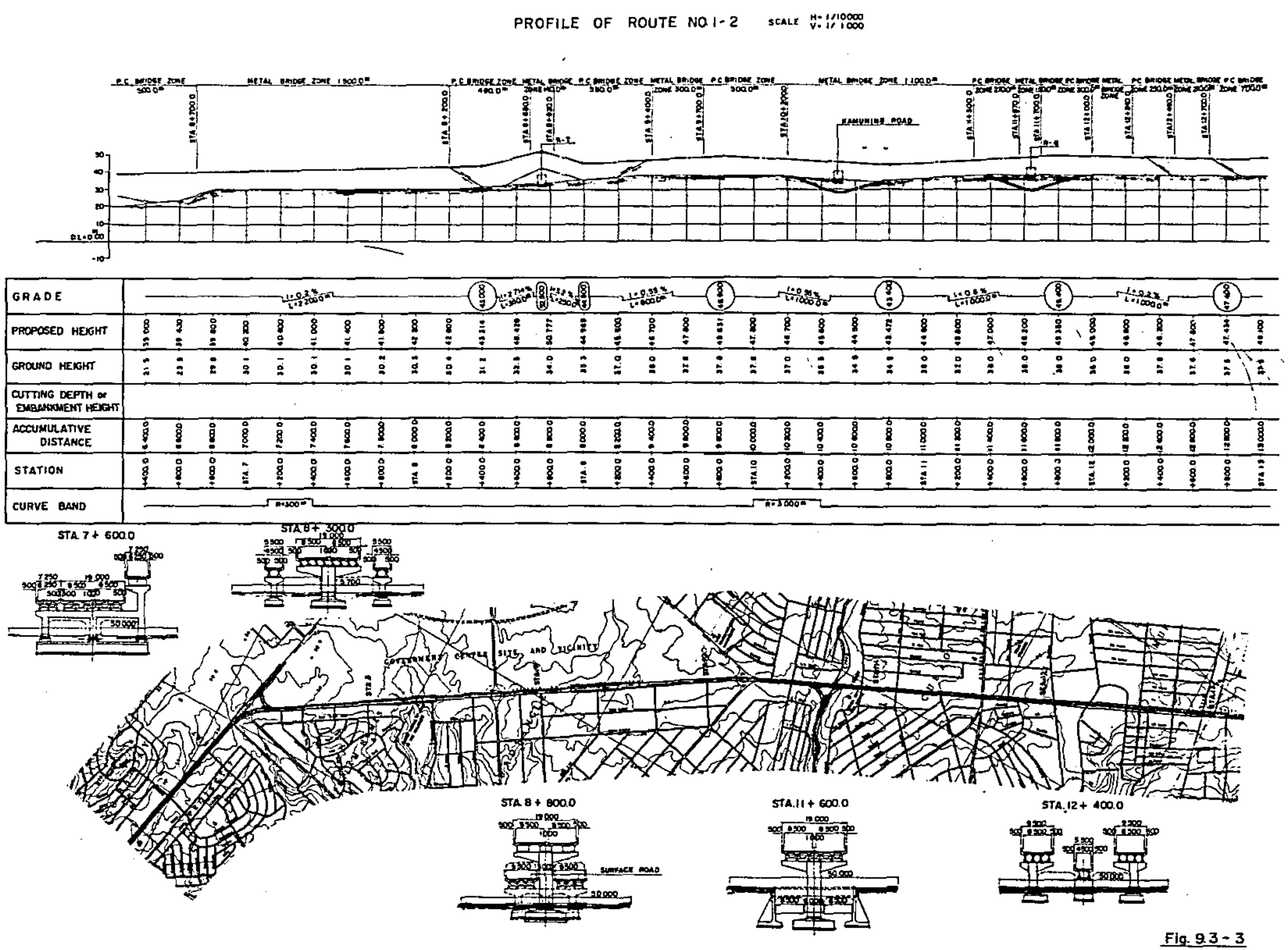


Fig. 9.3-3
Profile of Route No. I-2

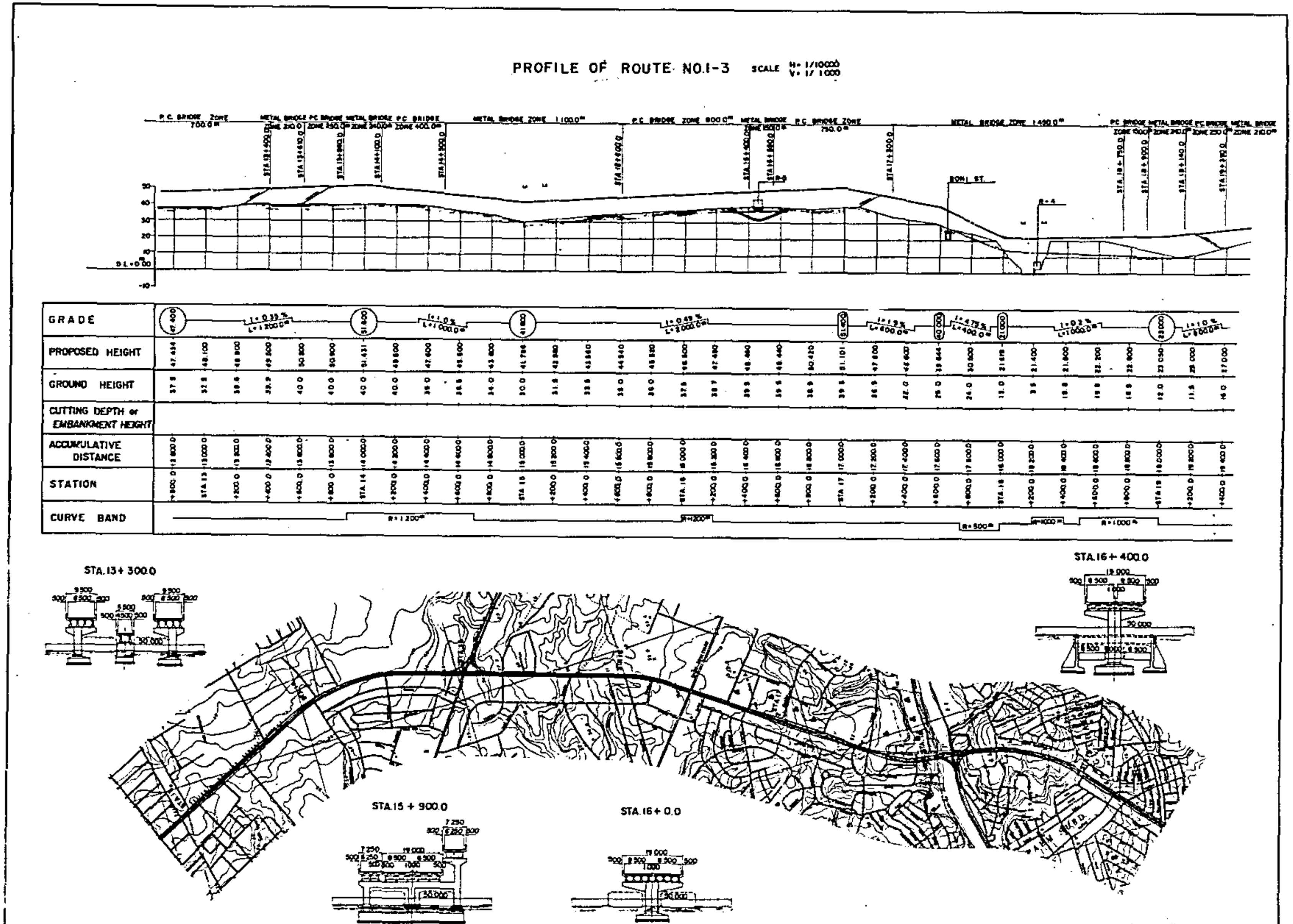


Fig. 9.3-4
Profile of Route No.I-3

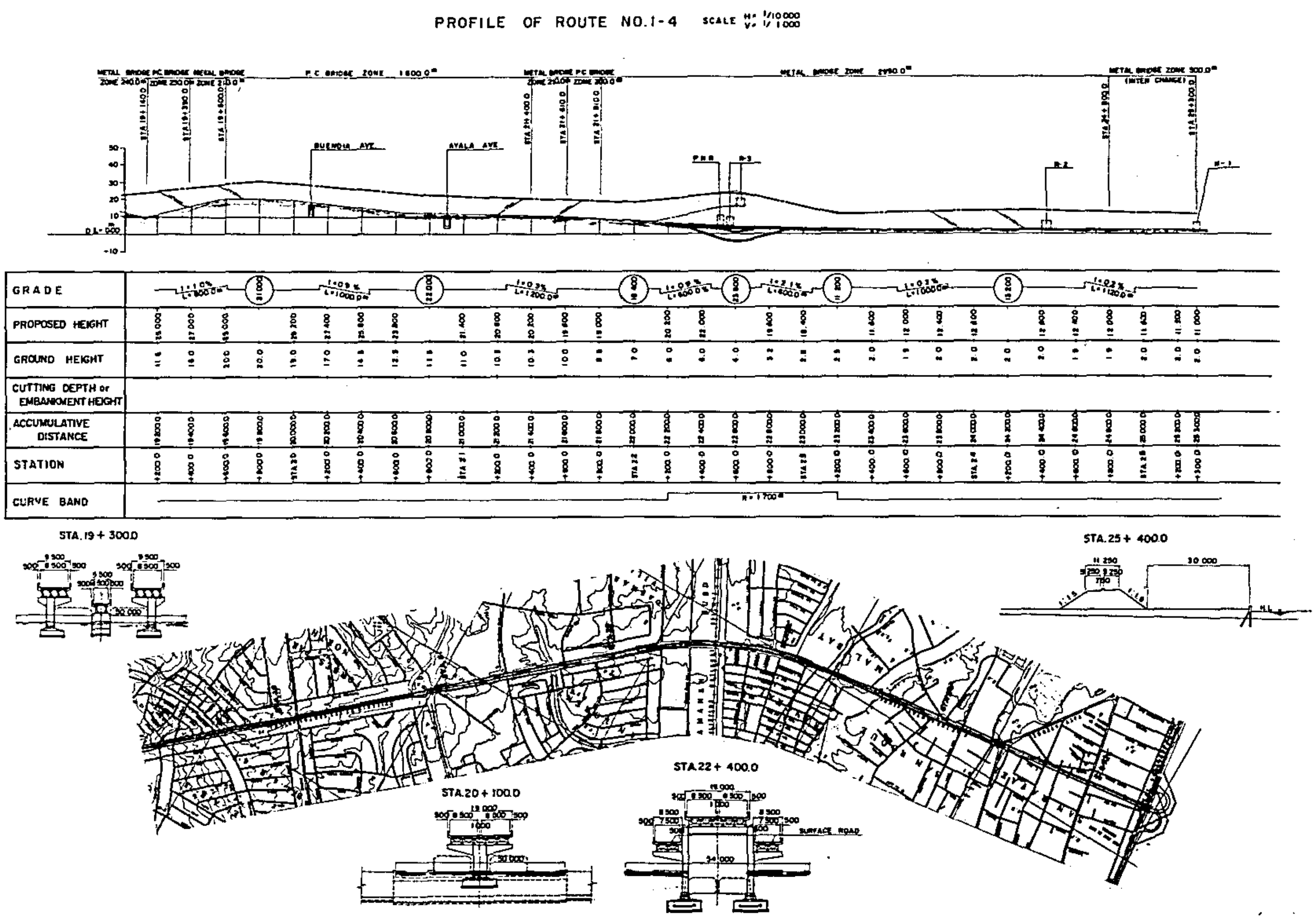


Fig. 9.3-5
Profile of Route No.1-4

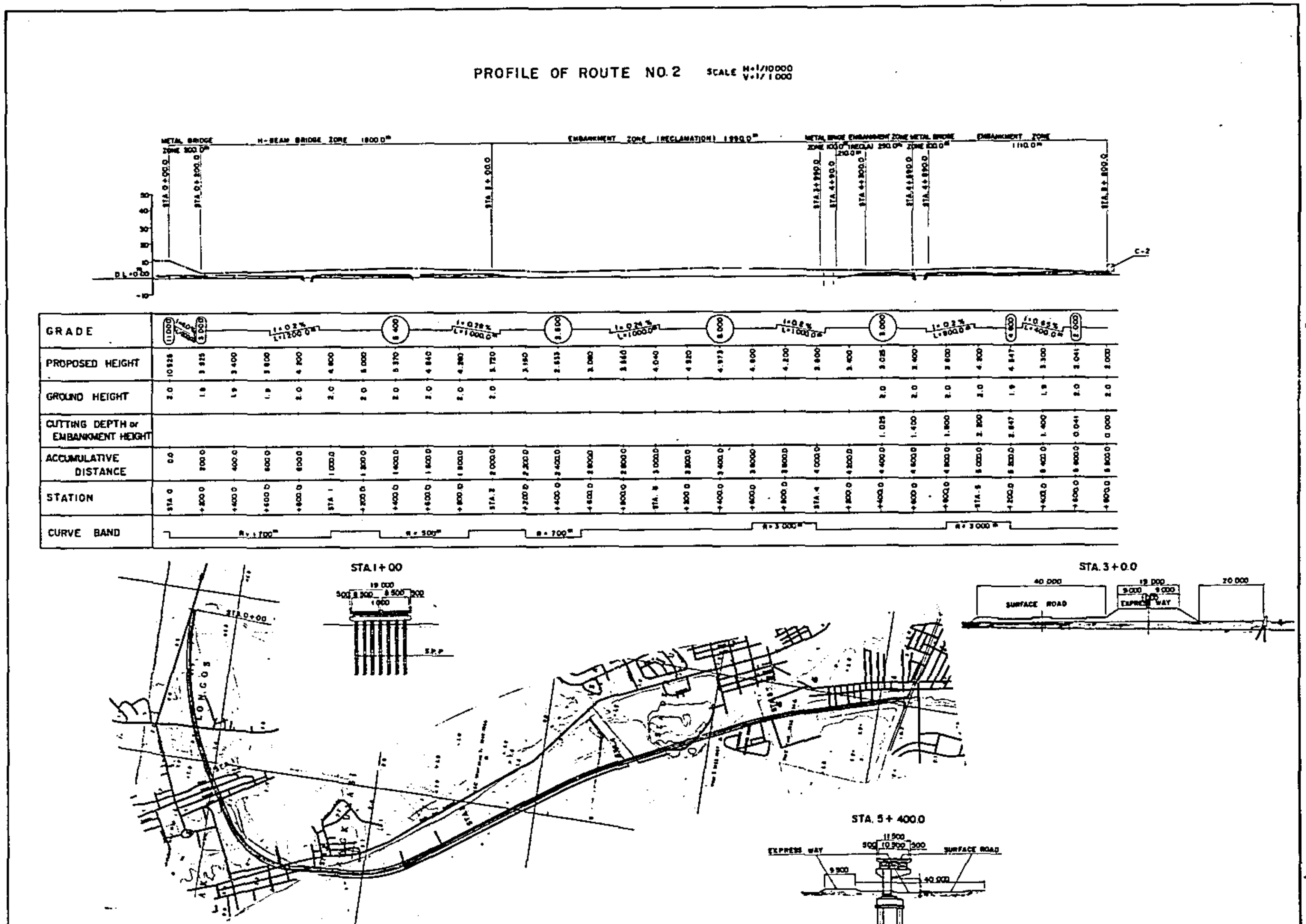
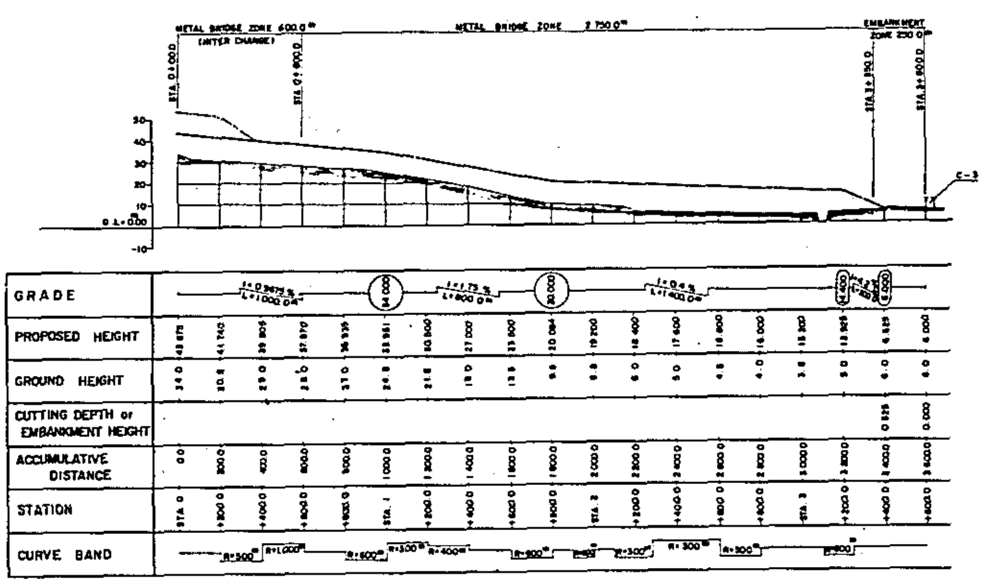


Fig. 9.3-6
Profile of Route No.2

F -ILE OF ROUTE NO.3 SCALE H: 1/10000 V: 1/1000



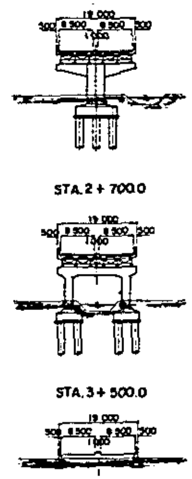


Fig. 9.3-7
Profile of Route No.3

PROFILE OF ROUTE NO.4 SCALE H: 1/10000 V: 1/1000

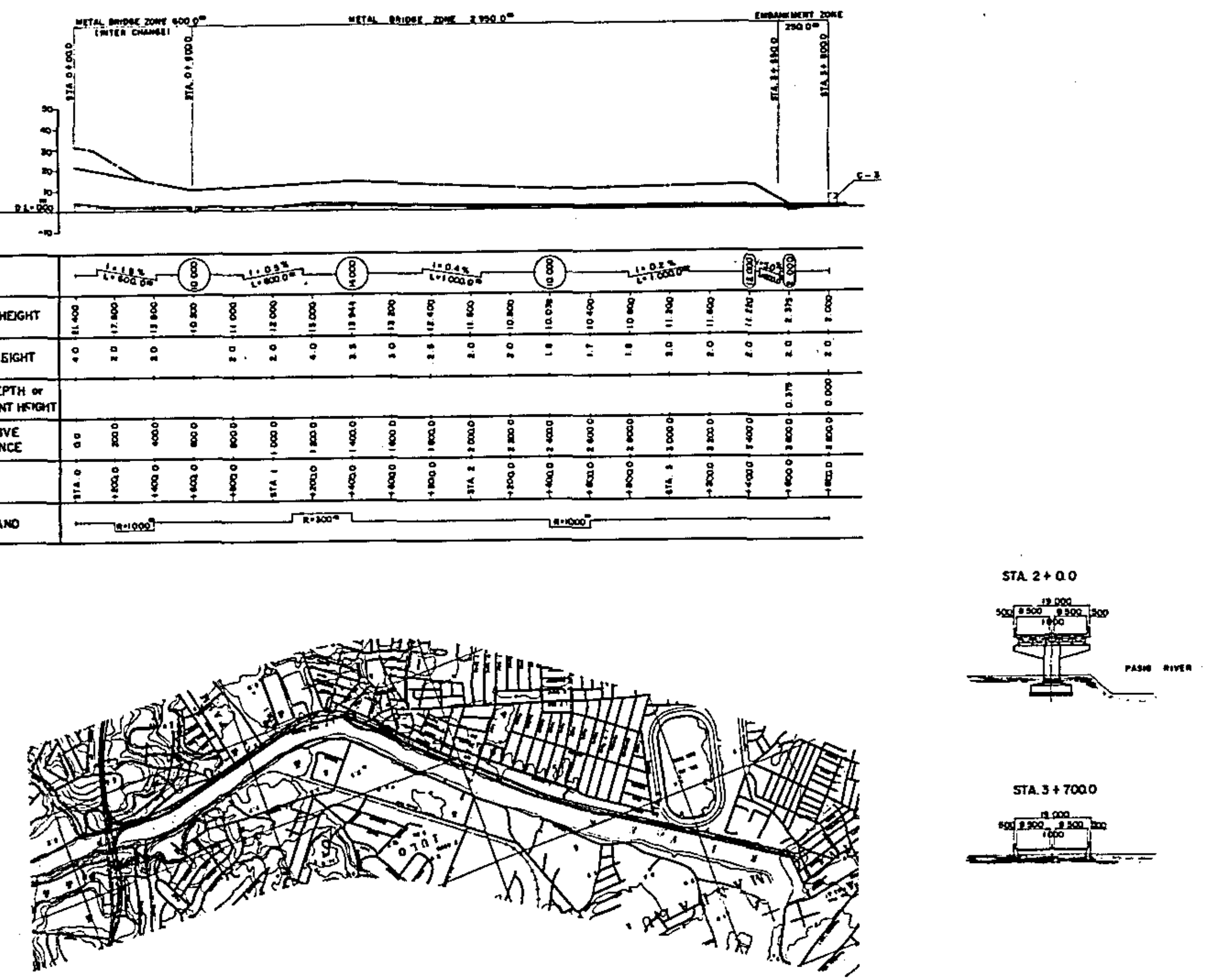


Fig. 9.3 - 8
Profile of Route No.4

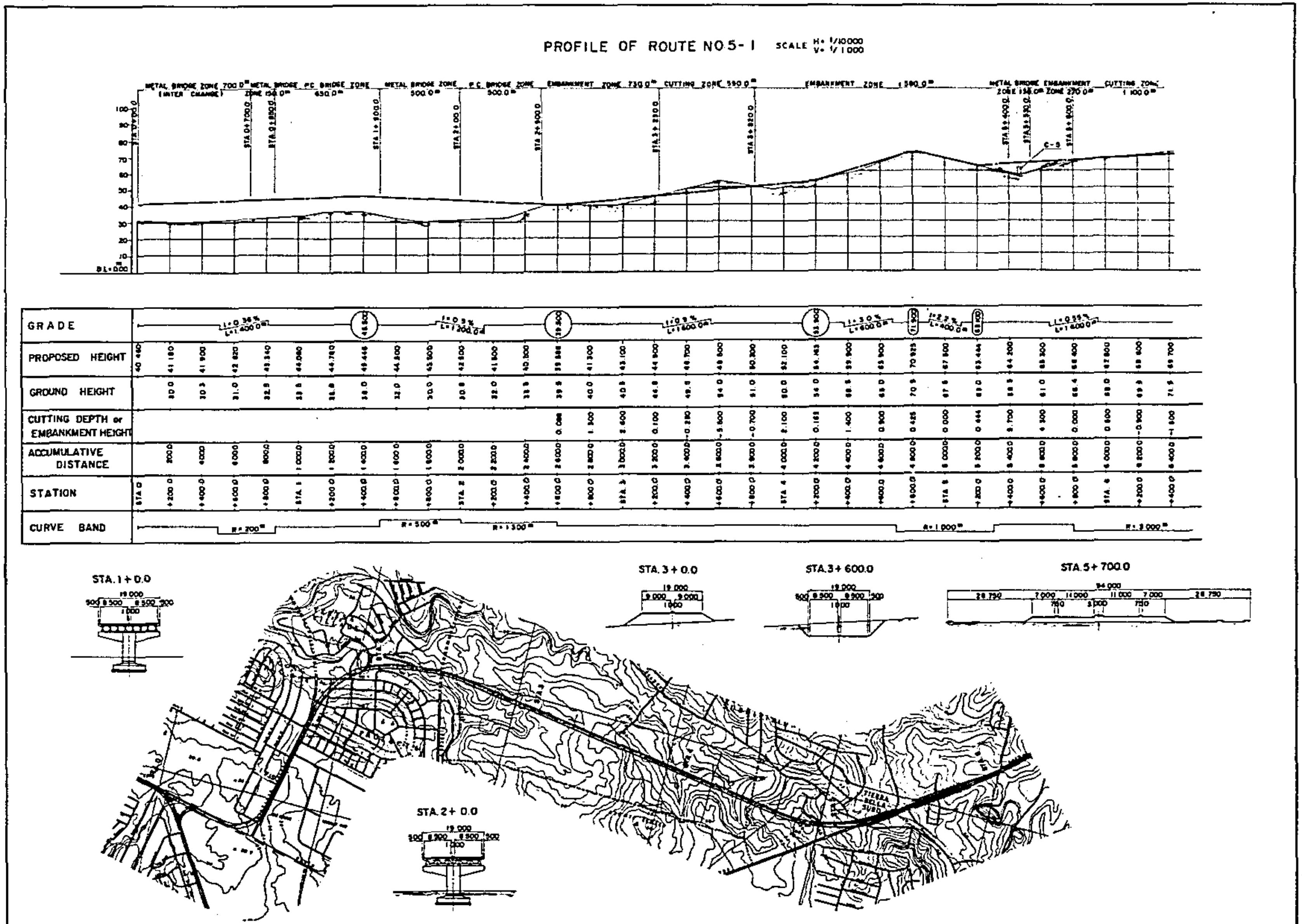


Fig. 9.3-9
Profile of Route No.5-1

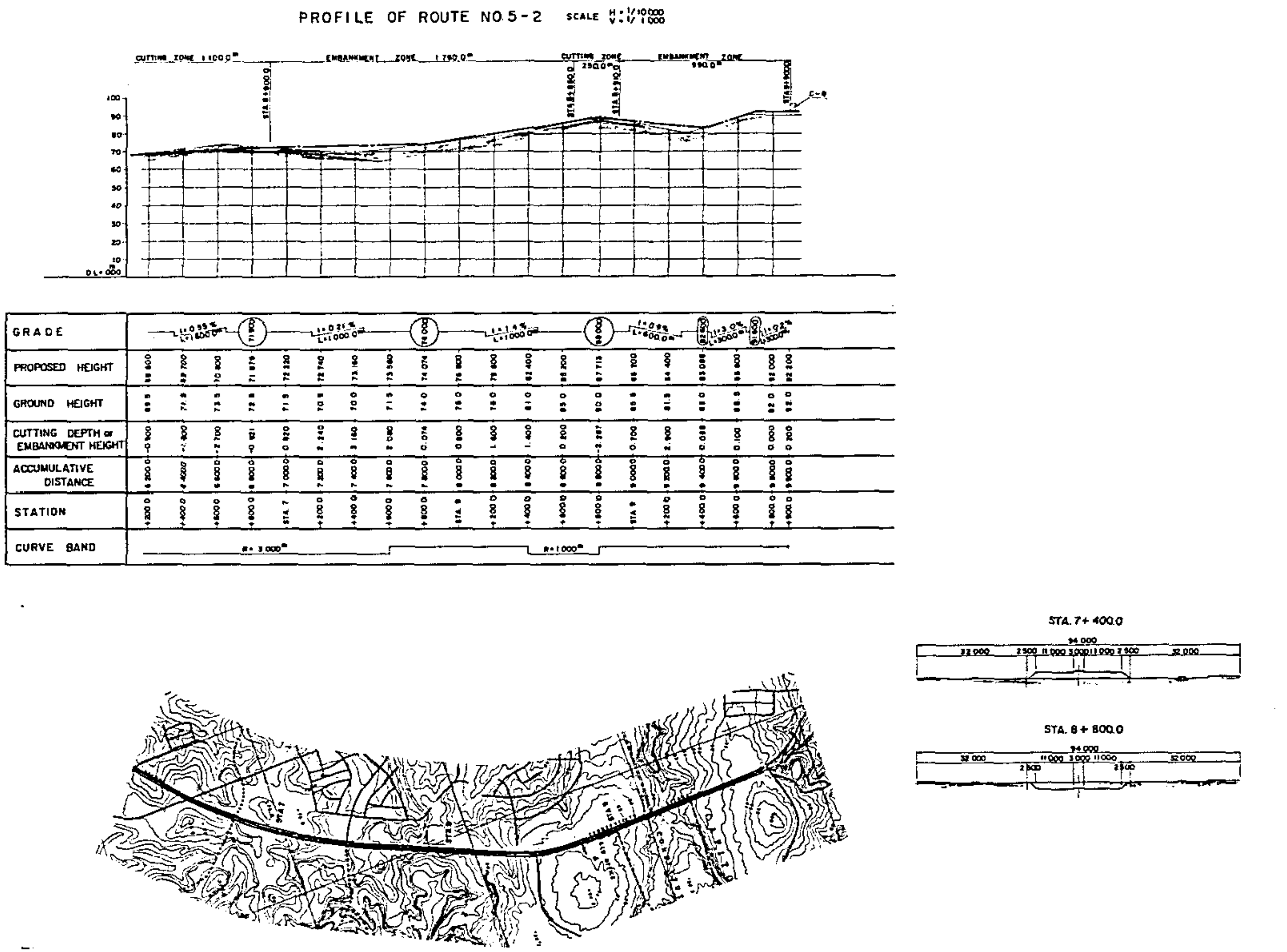


Fig. 9.3-10
Profile of Route No.5-2

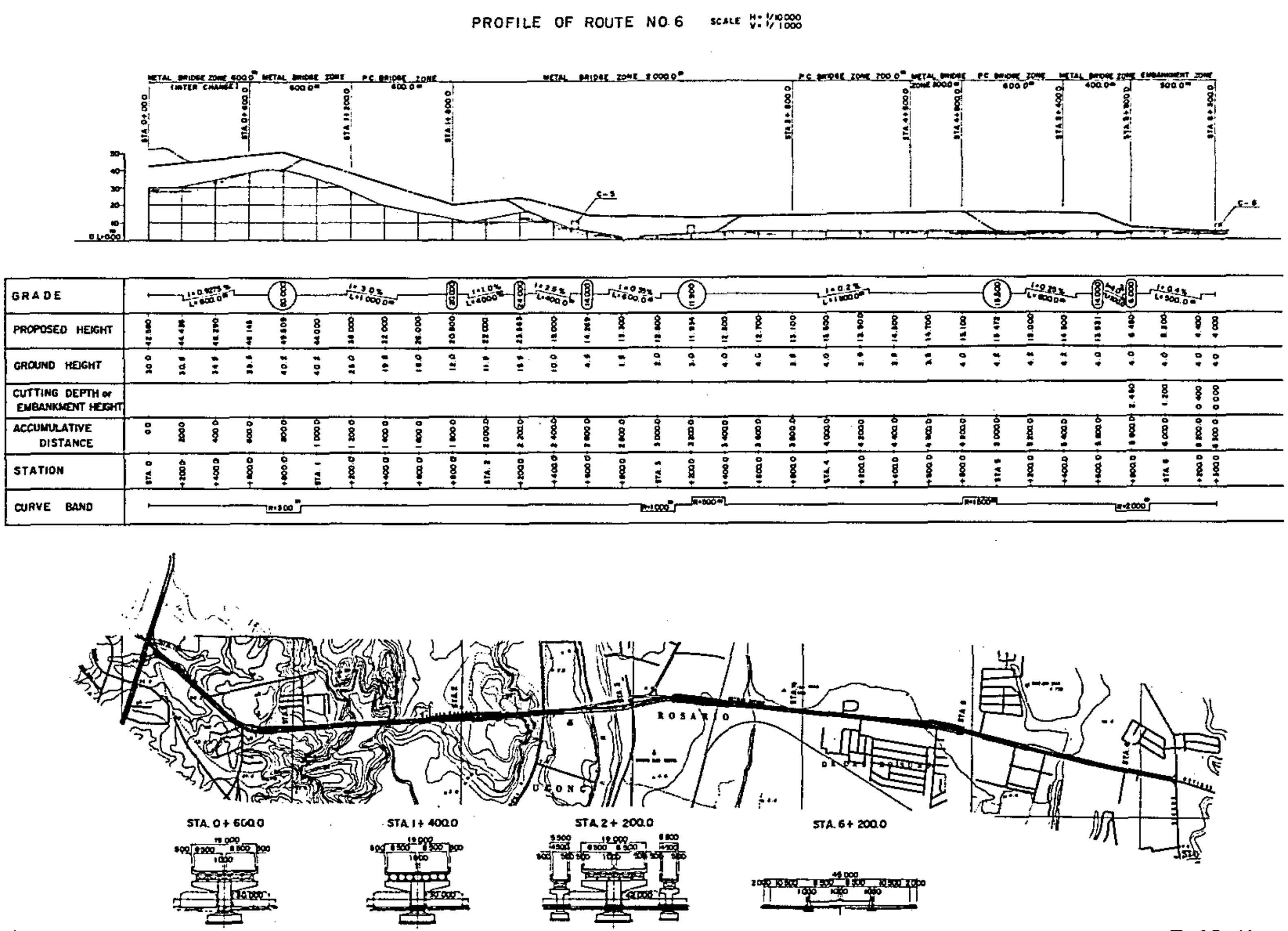


Fig. 9.3 - 11
Profile of Route No.6

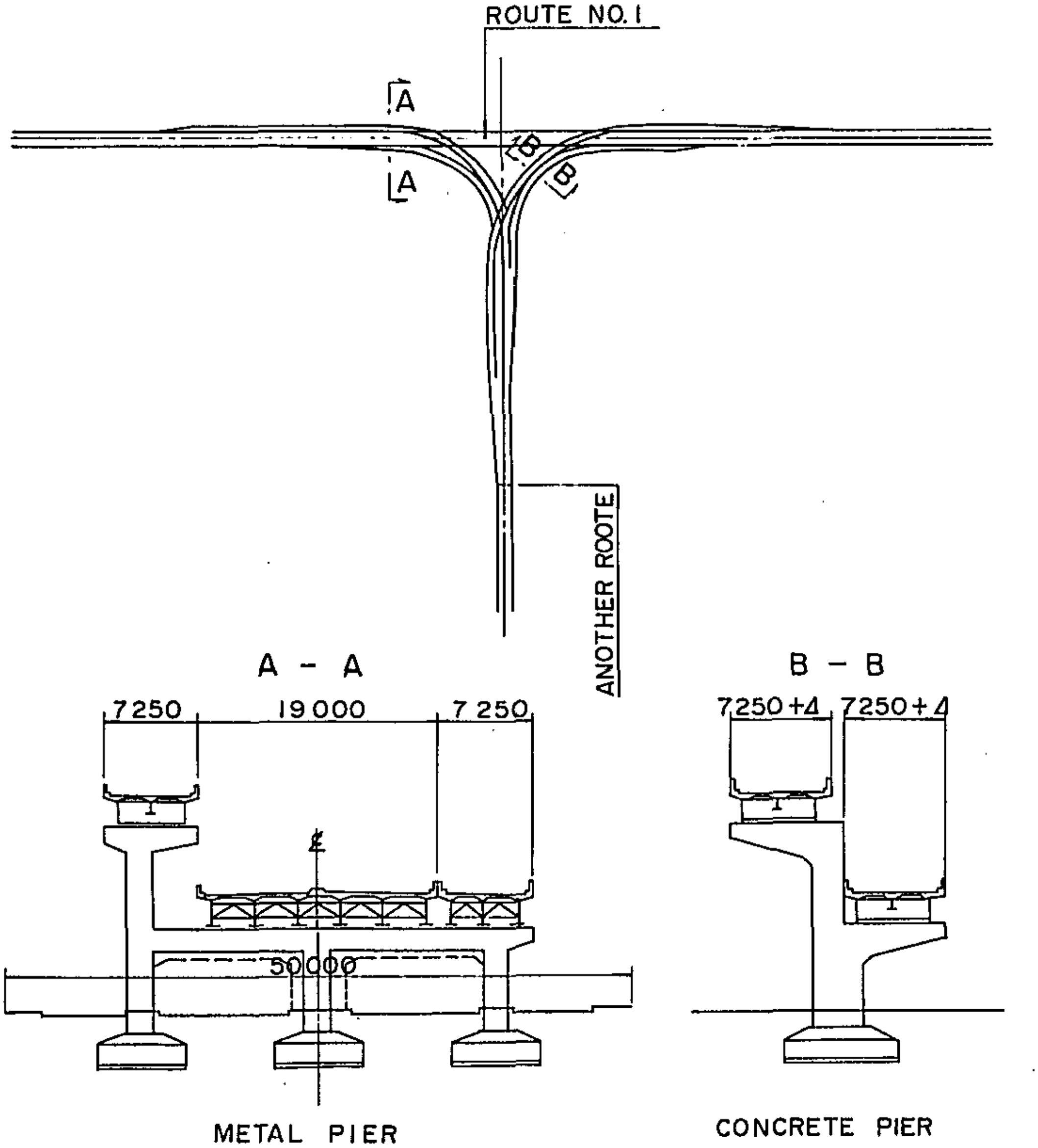


Fig. 9.3- 12 Y - Junction

Table 9.3 - 1 Major Materials to be used for Each Routes

Route Nos.			Unit	No. 1	No. 2	No. 3	No. 4	No. 5	No. 6	Total
Super Structure	Steel	Bridge	t	32,860	5,112	6,307	6,638	1,756	8,019	60,692
	Steel	P.C	"	2,339	-	-	-	249	411	2,999
	Concrete		m^3	165,054	8,136	11,386	12,213	14,615	32,472	243,876
	Bar		t	31,448	1,709	2,392	2,565	2,730	6,256	47,100
Sub Structure	Steel	Pier	"	9,511	-	-	-	-	2,916	12,427
	Concrete		m^3	317,475	9,753	26,055	26,019	21,991	56,232	457,525
	Bar		t	25,630	532	2,297	2,082	1,760	3,990	36,291
dation	Steel	Pile	"	-	3,384	-	-	-	-	3,384
	Concrete		m^3	51,621	-	14,810	12,982	-	1,434	80,847
	Bar		t	4,605	-	1,332	1,168	-	112	7,217
Inter-change and Ramp	Steel	Bridge	"	27,453	-	-	-	-	3,348	30,801
	Concrete		m^3	132,981	-	-	-	-	19,876	152,857
	Bar		t	14,151	-	-	-	-	1,568	15,719
	Soil		m^3	61,580	-	-	-	-	11,880	73,460
Earth Work			"	-	160,274	4,040	5,125	275,814	10,250	455,503
Recla-mation	Steel	Sheet pile	t	8,800	1,884	-	-	-	-	10,680
	Soil		m^3	1,056,000	88,200	-	-	-	-	1,144,200

Note: Temporary works are not included.

Since the area along Highway 54 has already been urbanized to a great extent, acquisition of the right of way on a large scale is almost impossible. Therefore, median strips and part of sidewalk should be utilized for the construction of piers of elevated structures. The rampway of the expressway will be provided within the median strip which has a width of 6 m so that all Related Roads may be maintained in the present condition.

The main structural problem confronting the planning of Route No. 1 is the relations with grade separation of Highway 54. Since the grade separation of intersections on Highway 54 precedes the construction of the expressway, due consideration must be given to the correlation between the expressway and all intersections along Highway 54 in the design of the expressways.

It may be advantageous in respect of the total cost of construction and construction time to make a pre-investment study for the construction in part of the piers structures for the expressway at the time of grade separation work on Highway 54. However, since pre-investment often involves many difficult problems such as fund raising, organization of construction firms and other political implications, a structural design that allows independent work for the expressway should be selected if possible.

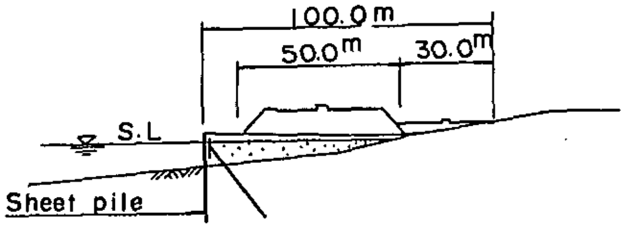
The grade separation plan for Highway 54 has been discussed in detail in the section for the Related Roads.

Route No. 2

This route is an extension of Route No. 1. It passes through Longas and Tonsuya to reach Manila Bay from which it extends along the coast toward CBD and connects with C-2.

Since Longas and Tonsuya are important districts as fish pond, due consideration should be given to such problems as the payment of compensations to fishermen in route selection for the expressways. In these districts, therefore, short span elevated ways should be planned and the land under the elevated way should be preserved as fish pond as before.

After reaching Manila Bay, the sea along the coast will be reclaimed and the expressway will be constructed on the reclaimed land as a banking road. Since the estuary cannot be reclaimed, this section must be an elevated way as a matter of course. The width of reclaimed land should be about 100 m. in anticipation of the future construction of a surface road along the expressway. The ordinary section of the expressway will be a low banking road about 1 to 2 m. high and the portions crossing surface roads will be built as grade separation with a high embankment 5 to 6 m. in height.



Route No.3 and Route No.4

Both of these routes improve the efficiency of Route No. 1 by providing a linkage between CBD and Route No. 1. Route No. 3 extends to CBD by way of the creek near Quezon City Hall and its end connects to C-3. Route No. 4 begins at the point near Guadalupe Br., extends to CBD along the Pasig river and its ends connects to C-3 as in the case of Route No.3.

Since these two routes run along the river, locations and dimensions of sub-structures must be determined after making a careful study on their effects on the river management. Besides, as the soil along the river is expected to be soft alluvium, careful attention must be paid to the design of foundation structures.

The beginning of these routes are connected to Route No. 1 by Y-junction and their ends are linked to C-3 at-grade.

Route No. 5

Route No. 5 passes the following points. North Ave. in Quezon City - Mindanao Ave - North of Project 6 - Commonwealth Ave. - Constitution Hall - C-6.

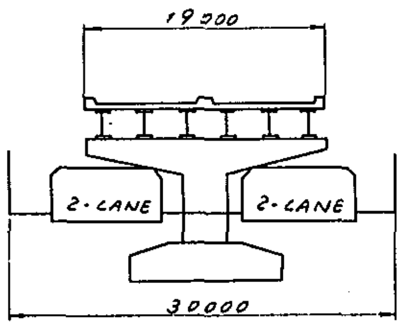
This route is one of the feeder routes from the suburbs and will play an important role in the future development of the suburbs.

Since the route passes a mountainous region, this route should be planned as a surface road. Since Commonwealth Ave. has already secured a width of 94 m for the right of way, construction of an expressway on this route will be relatively easy. Either the overpass type or the underpass type may be selected as necessary for crossing other roads. Additional rampways may be provided on C-5 with the development of business areas along the rate in future.

Route No. 6

Like Route No. 5, this route provides a linkage between Route No. 1 and the suburbs. This route also extends along Ortigas Ave. and reaches C-6.

Ortigas Ave. is a four-lane (30 m) road between C-4 and C-5 and narrows to two lanes (20 m or 12 m) between C-5 and C-6. According to the future traffic demand forecast, at least four lanes should be provided for the entire length. When the construction of an expressway is taken into consideration, however, a width of 30 m. will be required for ordinary section and another 12 m. will be required for the section where rampways are planned.



Like Route No. 5, this route may be planned as a surface road. In such a case, at the right of way of a width of at least 80 m will be required. When the future urbanization of the area along the route is taken into consideration, the elevated type will be most appropriate for this route.

9.3.2 Ends of expressways

The beginning and the end of each route will be connected to related roads as shown in Table 9.3-2 below. And preliminary designs of these ends are shown in Fig. 9.3-13 through Fig. 9.3-17.

Table 9.3-2 Related Road of Each Routes

Route Nos.	Related Road	Remarks
No. 1	R-1	On Roxas Blvd.
No. 2	C-2	On R-10
No. 3	C-3	
No. 4	C-3	
No. 5	C-6	On Common Weath Av.
No. 6	C-6	On Ortigas Ave.

9.3.3 Ramp ways

The rampways as referred to herein are entrances and exits in between and *do not include entrances and exits at the beginning and the end of the expressway.* In other words, it is an entrance and exit provided along the route. The location of rampways is generally determined on the basis of the future land use plan and traffic demand forecast. For Route No. 1, however, there may be a case in which a rampway will not necessarily be provided where it is most needed because of structural reasons such as the location of intersections with surface roads and the sphere of influence of Y-junction. Therefore, the location of rampways for the proposed expressway were determined upon consultation with the Manila Team. Table 9.2-3 shows the number of entrances by route.

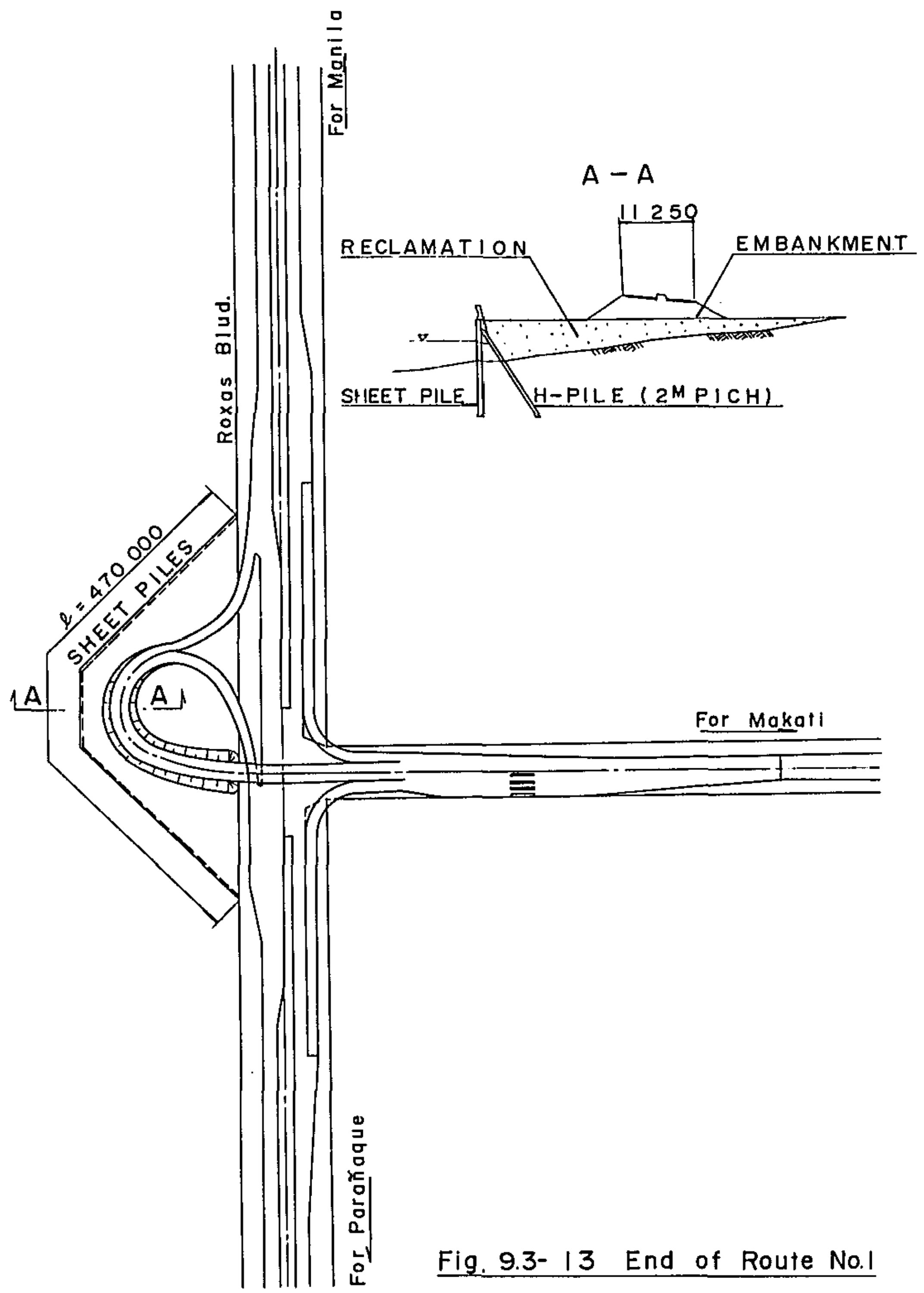


Fig. 9.3- 13 End of Route No.1

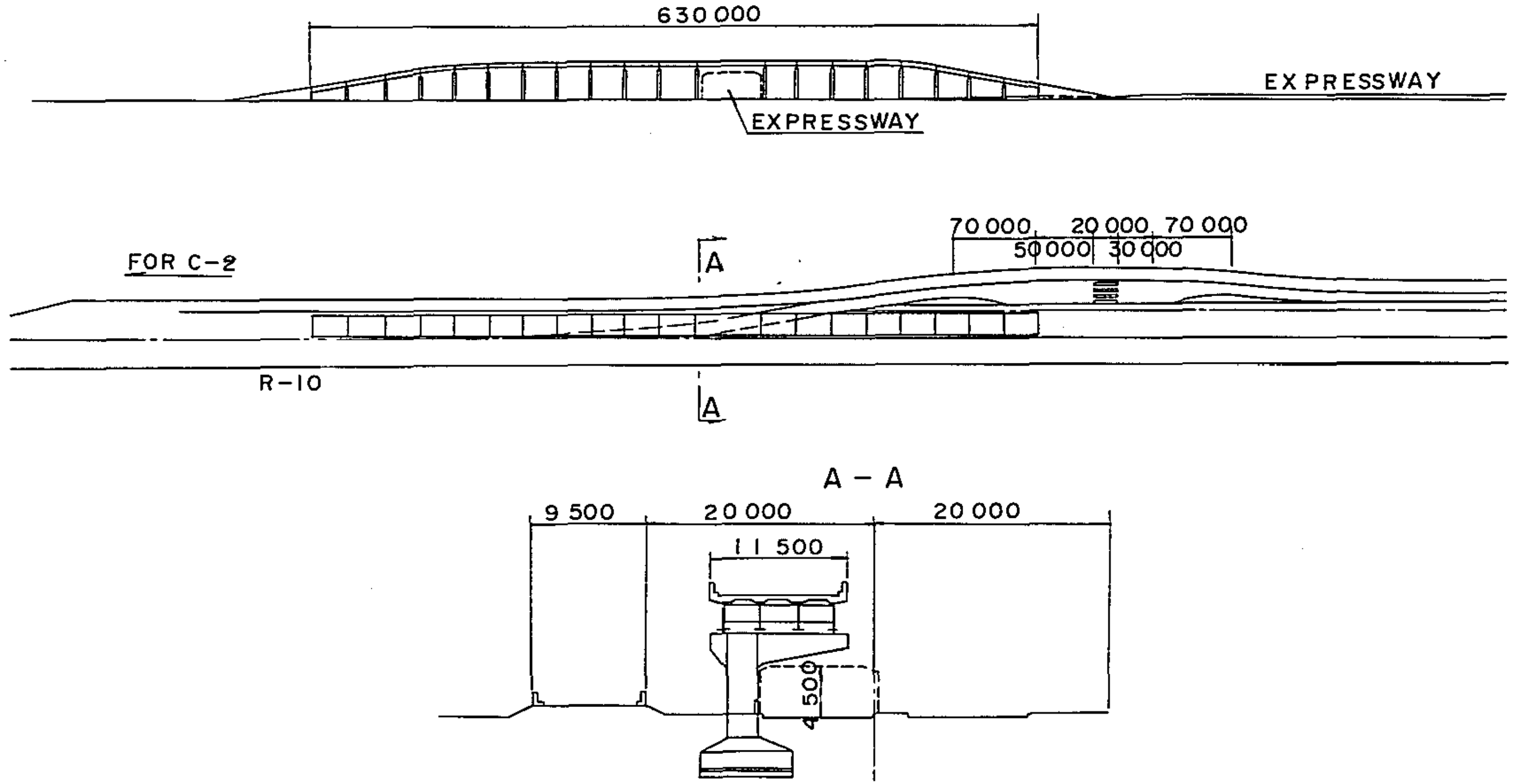


Fig. 9.3- 14 End of Route No.2

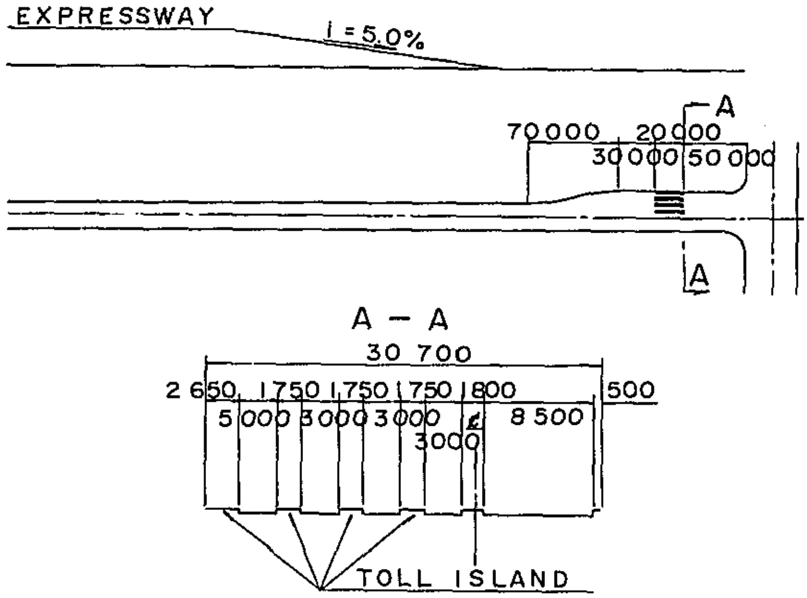


Fig. 9.3-15 End of Route No.3 and No.4

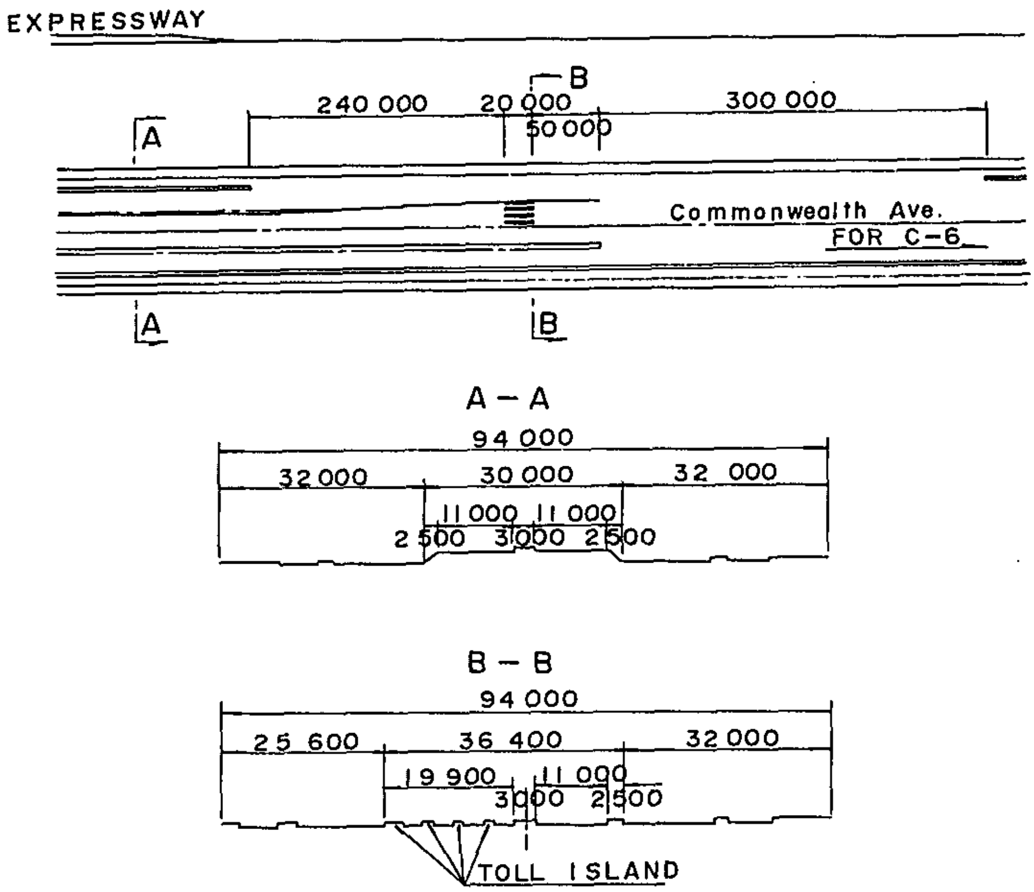


Fig. 9.3-16 End of Route No. 5

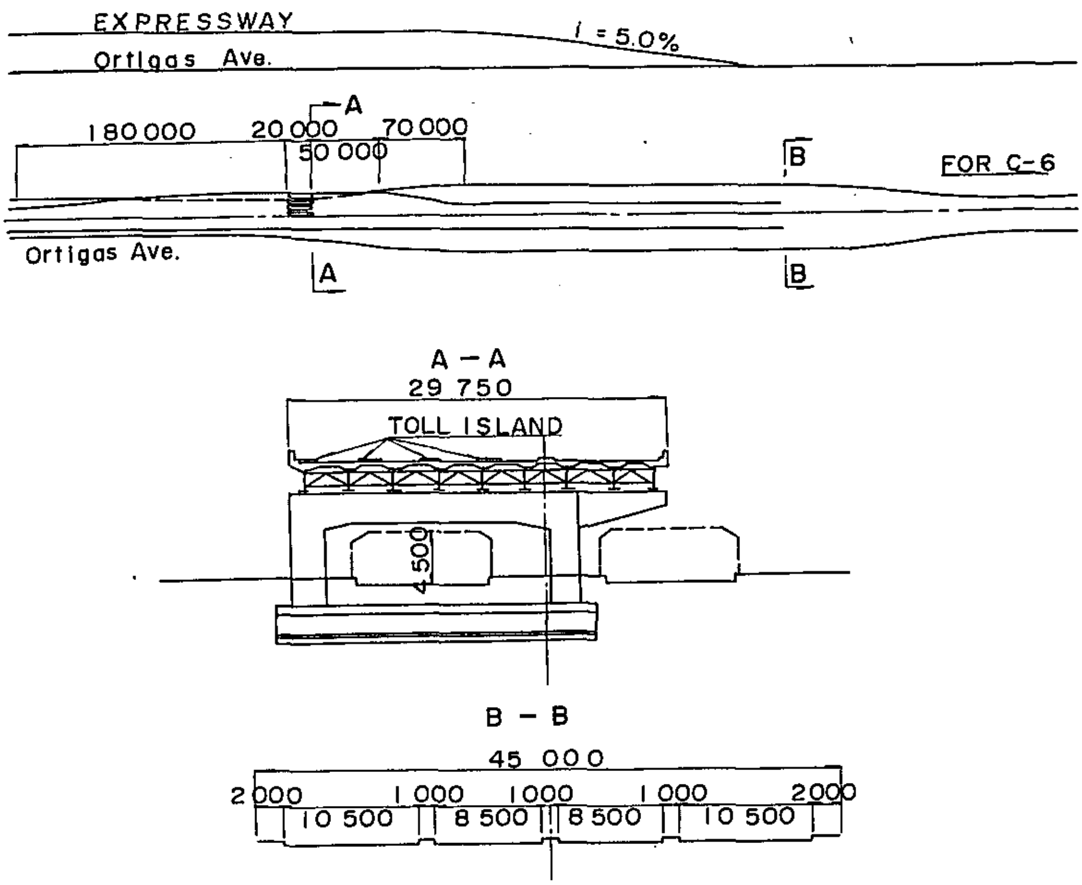


Fig. 9.3-17 End of Route NO.6

Table 9.3-3 Number of Entrance (Ramp)

(Unit: Pair)

Route Nos.	Total Length	Side Ramp	Center Ramp	End Ramp	Total
No. 1	25.3 km	2	8.5	1	11.5
No. 2	5.8 "	1	-	1	2
No. 3	3.6 "	-	-	1	1
No. 4	3.8 "	-	-	1	1
No. 5	9.9 "	2	-	1	3
No. 6	6.3 "	4	-	1	5
Total	54.7 k.m	9	8.5	6	23.5

Note: Half pair means one off ramp near Show Blvd.

Although the type of ramp structure varies with the conditions of the surface road to be connected, either the side ramp or the center ramp should be adopted for Manila Expressway. Where the expansion of the right of way of a surface road is readily available, a parallel arrangement of a pair of ON and OFF ramps as side ramp is desirable (Fig. 9.3-18). However, as the right of way of C-4 over (under) which Route No. 1 is planned, is limited to 50 m. a parallel arrangement of a pair of ramps will not be practical. In order to provide a rampway through the use of a 6 m. width of median strip, the center ramp type with a staggered arrangement of ON ramp and OFF ramp is desirable (Fig. 9.3-19). For Route No. 1, two pairs of ramps near Quezon Memorial Park should be side ramps and the rest should be center ramps.

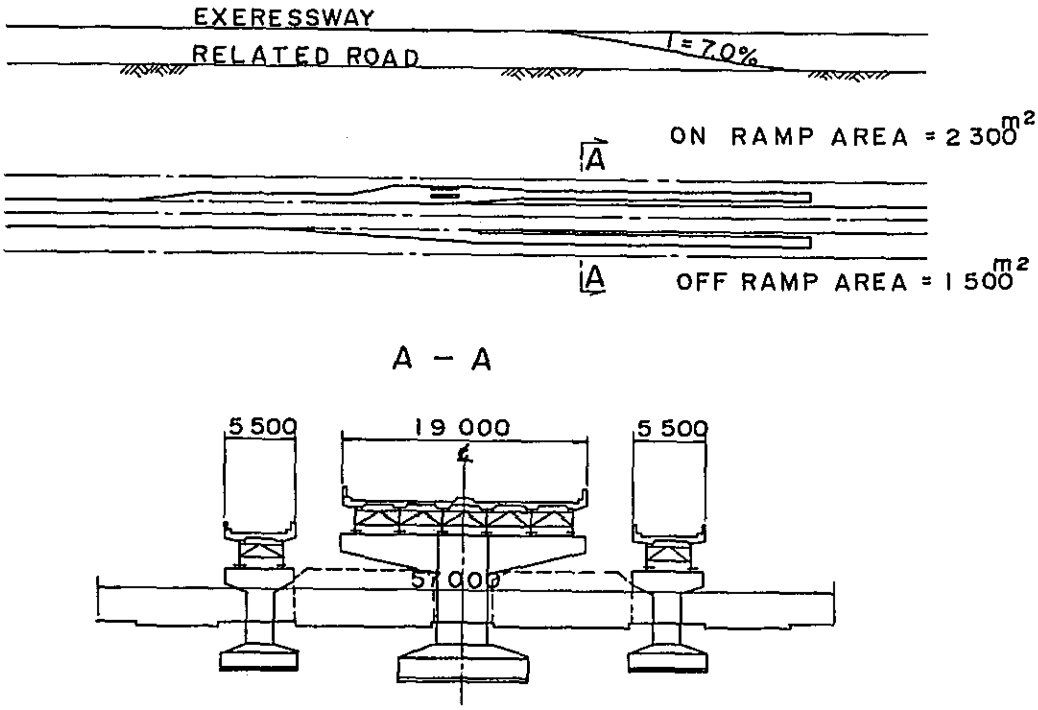
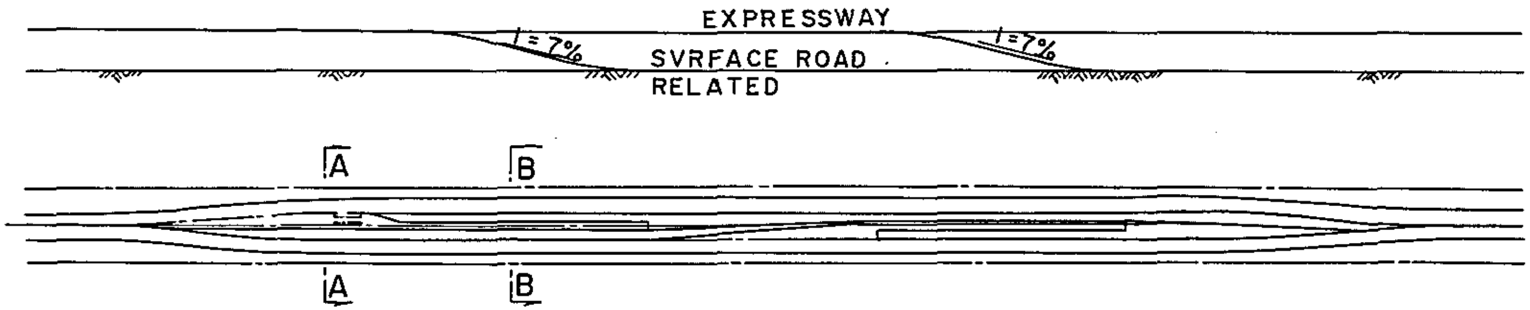


Fig. 9.3-18 Side Ramp



ON RAMP AREA = 2 100 m^2 OFF RAMP AREA = 1 900 m^2

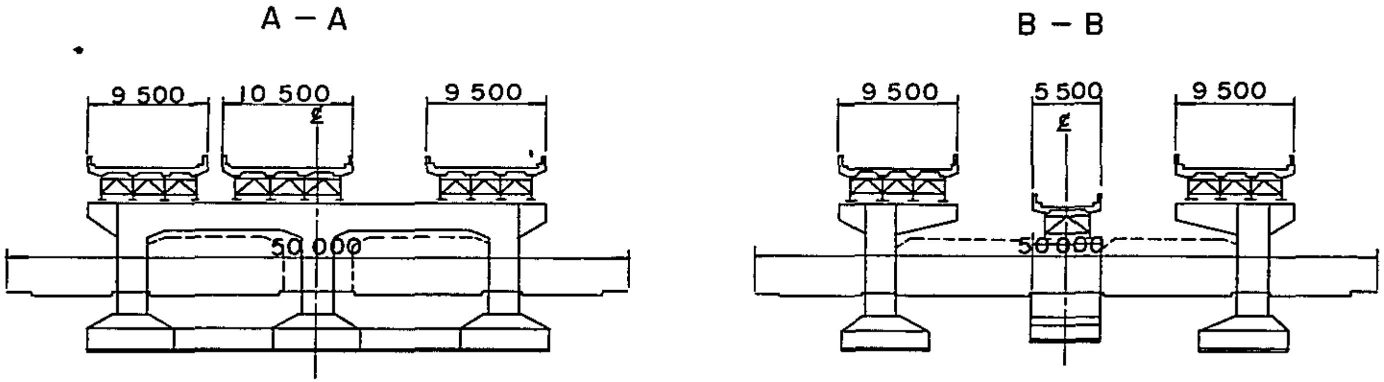


Fig. 9.3-19 Center Ramp

§ 9.4 Type of Structures

9.4.1 General outline

The proposed Manila Expressway is an urban expressway and the majority of its routes pass through the existing city area. Therefore, all the routes, except Route No. 2 and part of Route No. 5 should be of the elevated type. The standard elevated type includes two-way type and one-way type. Either of them may be selected depending on the conditions of the related roads and creeks below the expressway or the requirement for rampways or any other reasons. In general, however, the two-way type is more economical, and adoption of this type is desirable where conditions permit.

In this section, the elevated bridge is discussed in two parts, superstructure and substructure so as to provide a guideline for the selection of the optimum type of structures. For the convenience of study, the superstructure is further divided into steel girder, prestressed concrete (refers to P. C. hereinafter) girder bridge and the substructure into pier body and foundation work.

For various facilities required for the toll road, reference drawings will be furnished.

9.4.2 Superstructure

i) Selection of structure type

The superstructure generally has three types, steel girder bridge, P.C. girder bridge and reinforced concrete (referred to R.C. hereinafter) girder bridge. Since most of the routes of Manila Expressways are to be constructed over the existing related roads, the type which will cause the least obstruction to the through traffic on the related roads during construction must be selected. For this reason, R.C. girder bridge which requires a complete staging work is especially excluded from the study.

While steel girder is very costly in comparison with P. C. girder, its total weight is about half of the weight of P. C. girder and is therefore very advantageous where the foundation is not firm. It also enables construction of bridges having a complicated shape such as curved bridges and trapezoidal bridges without difficulty.

Although the type of superstructure for Manila Expressway cannot be determined simply because of the political reasons as well as technical problems, the following should be used as the basis for the selection of the type for the time being.

Steel girder bridges should be used for the section toward Manila bay where the foundation is weak, the area along the Pasig river and creeks which is believed to be composed of alluvial soils and for the portion which requires a special design for the construction of interchanges or rampways. For the section with the standard road width toward the mountainous region where the soil is firm, PC girder bridge should be used to improve the economic efficiency of the bridge.

ii) Steel girder bridge

For steel girder bridges, the simple composite girder, continuous girder and continuous box girder are generally in use. The weight of steel per unit roadway area varies with the span as shown in Fig. 9.4-1.

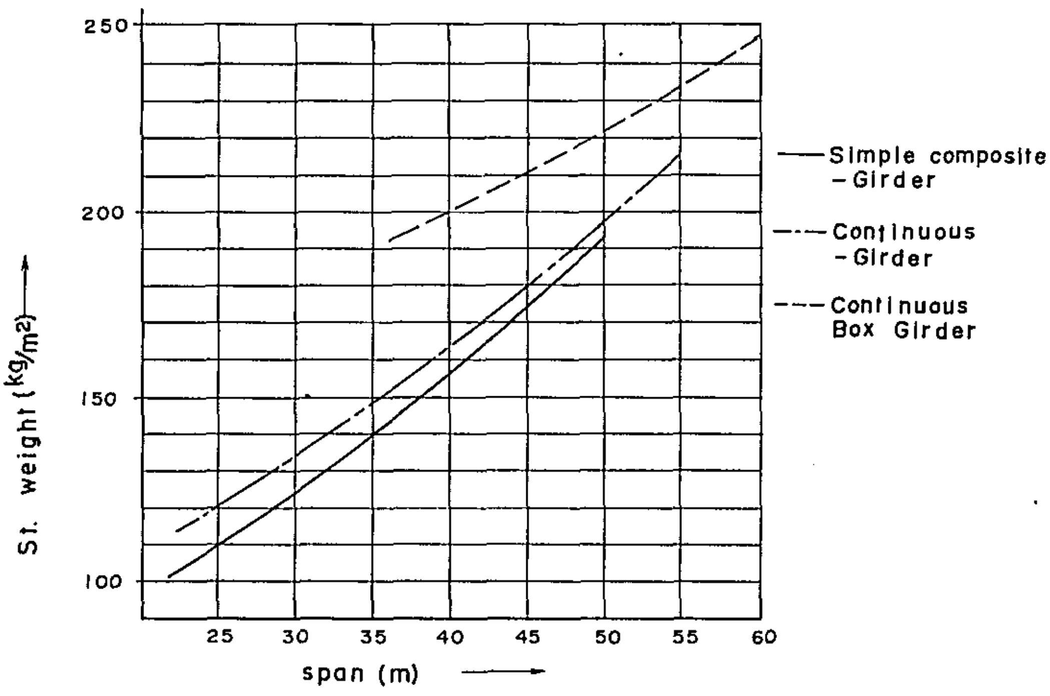


Fig. 9.4-1 Weight of Steel (kg) Per Unit Roadway Area

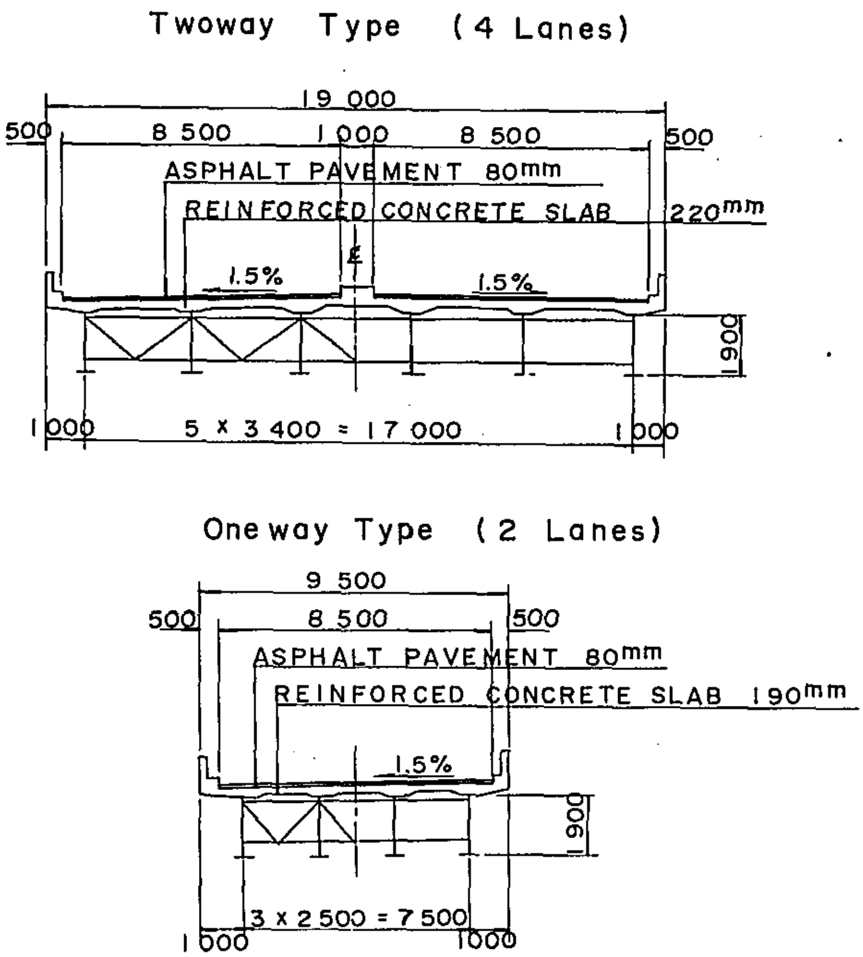


Fig. 9.4-2 Typical Cross Section of Simple Composite Girder

As the standard type of steel girder bridges for Manila Expressways, simple composite girder with a span of 30 m - 40 m will be most economical. The standard type includes two-way type and one-way type. Fig. 94-2 shows the typical cross-section of a simple composite girder. The depth of main girder should be standardized to 1. 9 m. so as not to disrupt the aesthetics in view of the fact the proposed road is an urban expressway.

For the sections other than the standard type sections where roadways are expanded or curved under the influence of rampways, interchanges or where a long span bridge is used, the continuous box girder type should be adopted to ensure the safety of the structure.

iii) P. C. girder bridge

P. C. girder bridge includes the simple girder, simple composite girder and continuous box girder. Of these, the simple composite girder is most appropriate for the efficiency of construction work and should be used as the standard P. C. girder for Manila Expressways. Fig. 9. 4-3 shows concrete volume and tendon weight per unit roadway area.

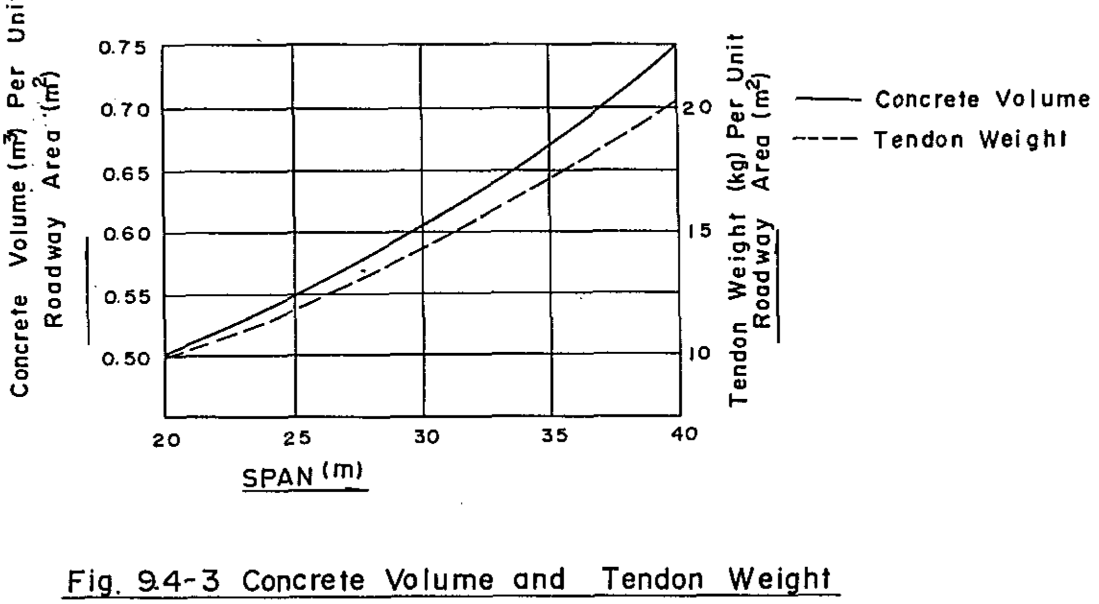
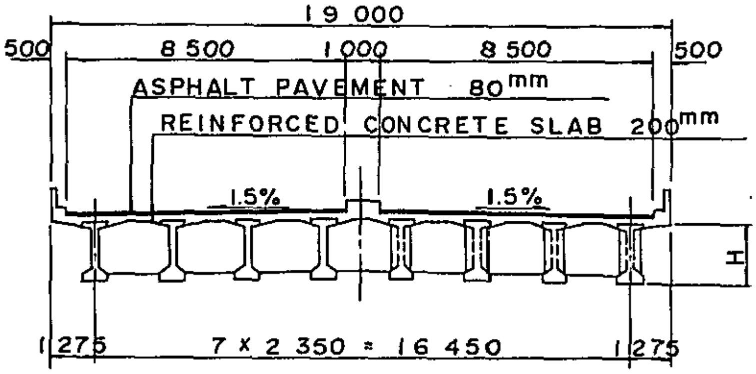
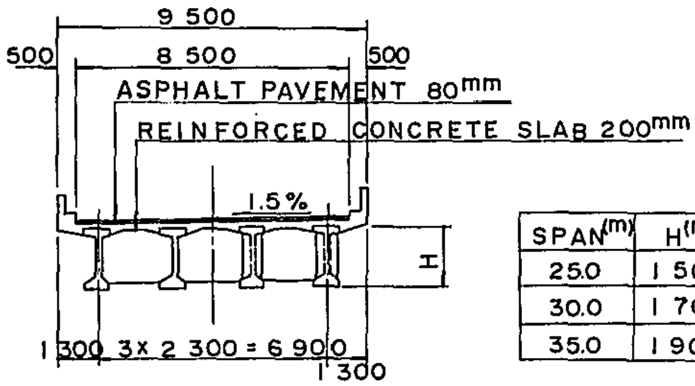


Fig. 9.4-3 Concrete Volume and Tendon Weight Per Unit Roadway Area

Twoway Type (4 Lanes)



Oneway Type (2 Lanes)



SPAN(m)	H(mm)
25.0	1 500
30.0	1 700
35.0	1 900

Fig. 9.4-4 Typical Cross Section of Simple Composite Girder

The simple composite girder is manufactured in the plant or yard, transported to the site and placed in position on the bridge pier and slab concrete is cast in place. The aim is to obtain a composite effect on live load. Accordingly, this type is able to omit lateral prestress and adopt the curved girder with small curvature by adjusting the length of slab overhang, thereby making construction work very easy.

In the section of Route No. 1 towards elevated areas (near Quėzon or Cubao) where the soil condition is favorable, the simple composite girder with a span of about 25 m. should be used to obtain high economic efficiency.

Like the steel girder bridge, the P.C. girder bridge has the two-way type and one-way type. Fig. 9.4-4 shows typical cross section of simple composite girder.

9.4.3 Substructure

a. Type of substructure

The purpose of substructure is to transmit the load of superstructure to the ground safely and smoothly.

As shown in Fig. 9.4-5, substructure may be divided largely into pier and foundation structure. The pier structure may be classified further into R.C. pier and steel pier by the material to be used. The foundation structure may also be divided into footing foundation, pile foundation and caisson foundation. The type of substructure varies with the type, dimensions and reaction of superstructure and soil condition. Selection of the optimum type will contribute to the safety and economy of the work.

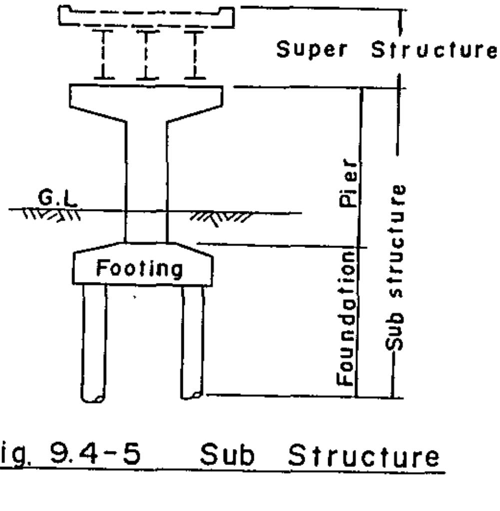


Fig. 9.4-5 Sub Structure

b. Pier

The pier takes various forms as shown in Fig. 9.4-6 depending on the type, dimensions, reaction and position of superstructure.

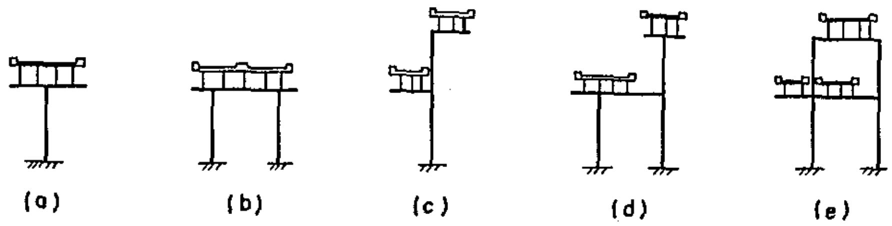


Fig. 9.4 - 6 Types of Pier

For structures of a relative small height like (a) through (c), adoption of R.C. pier will greatly improve the economic efficiency of pier. For structure of a greater height and complicated shape like (d) and (e), steel piers must be used. Although the cost of steel pier is about 2.5 times greater than that of R.C. piers, it allows fairly complicated designs and is advantageous when used for extraordinary sections such as interchanges and rampways.

c. Foundation works

As shown in Fig. 9.4-7, the geology of Metropolitan Manila Area consists of reclaimed area, alluvium (recent) and Guadalupe tuff (pleistocene). The reclaimed land was once a part of Manila bay and consists mainly of sand dredged from the bay. The alluvium recent extends widely in the estuary of the Pasig river including Manila city and consists mainly of sand, silty mud, and clay with a content of shell and organic matter in part. The Guadalupe tuff extends to such districts as Bulacan, Rizal and Laguna and is very favorable as foundation for structures.

Fig. 9.4-7 should be used as a guideline for the selection of the type of foundation structure in designing Manila Expressway. While either the pile foundation or the caisson foundation should be used in Manila city and the area near Manila bay bordered by the P N R extending in north-south direction, the footing foundation should be used for other areas where Guadalupe tuff exists.

For the use of pile foundation in the city area, cast-in-place concrete pile should be used as a noiseless and vibration-less contruction method. In the suburbs

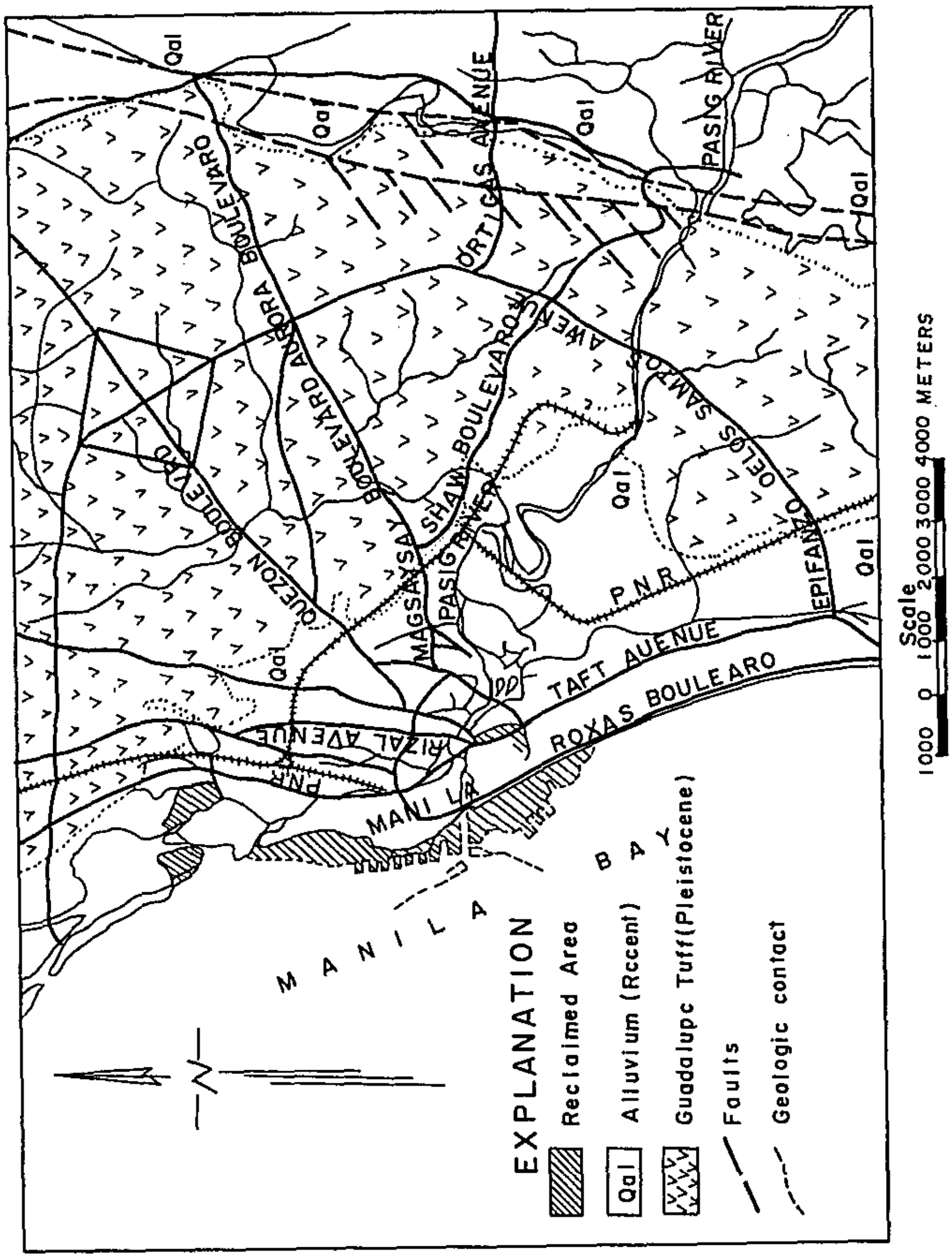


Fig. 9.4 - 7 Geological Map of Manila

the use of steel pipe pile will be more economical. For bridges on the Pasig river and bridge piers for superstructures with a long span and greater reaction, the caisson foundation should be used.

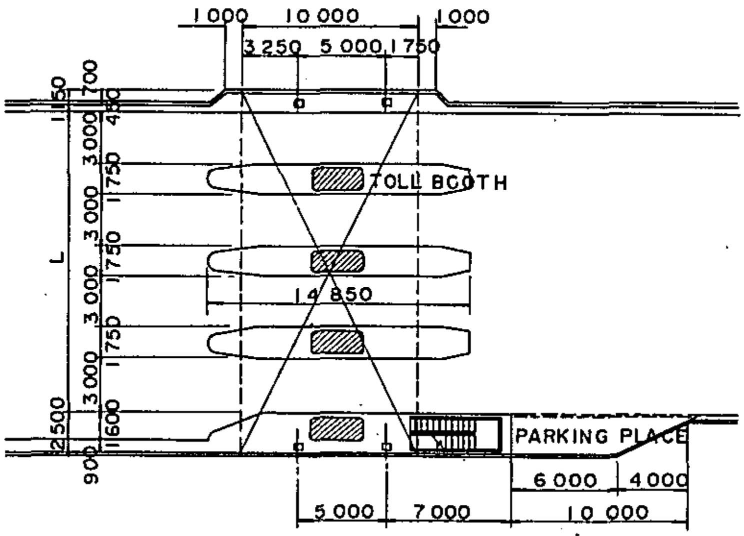
9.4.4 Road facilities

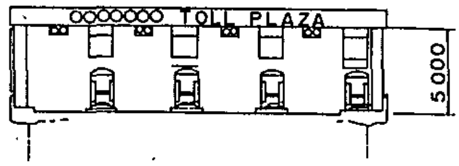
In order to use the proposed expressway as a toll road, various facilities will have to be provided. In the following paragraphs, the toll plaza, one of the main road facilities, and other facilities will be described briefly.

The toll plaza will be located at the beginning and the end of the expressway and also at each ON ramp. The number of toll boothes must be determined in proportion to the estimated traffic demand. For this expressway, the capacity per booth is assumed to be 650 vehicles/hr. However, at least two boothes must be provided for each lane. Fig. 9.4-8 shows the standard type of the toll plaza.

The expressway must also be equipped with such facilities as lighting facilities and road marks in addition to toll plaza and refuge zones. Fig. 9.4-9 shows the standard type of these facilities.

Besides, installation of emergency telephones and fire fighting equipment is also desirable as may be necessary. It is necessary, therefore, to select the location and design structures in advance so as to enable installation of these equipment when needed.





LANE NUMBER	L (M)
2LANE 2BOOTH	7 750
3LANE 3BOOTH	12 500
4LANE 4BOOTH	17 250

Fig. 9.4-8 Toll Plaza

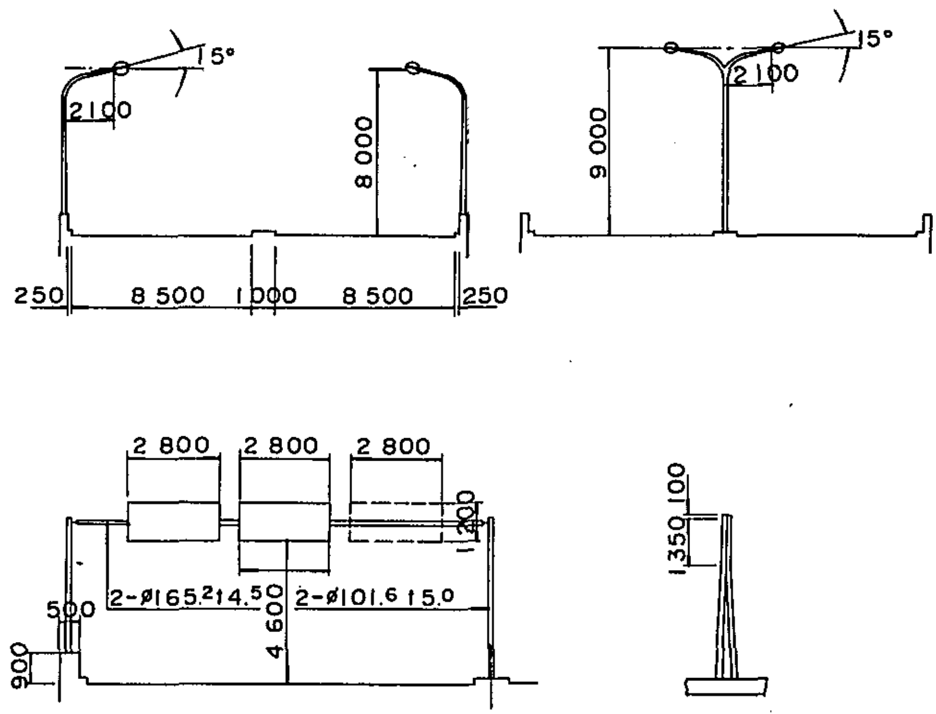


Fig. 9.4-9 Illumination and Road Mark

§ 9.5 Construction Cost

From analysis of the data obtained in the Philippines for calculation of construction cost, the following may be pointed out as general characteristics.

(a) Wage is 20% to 40% lower of that in Japan.

(b) Import materials (such as steel materials) are higher than in Japan by 20% to 40%.

(c) Cost of concrete work and other earth works is lower than in Japan by 20% to 40%.

For reference, the comparison of wages in Table 9.5-1 and that of construction materials in Table 9.5-2 are shown respectively.

On the basis of these facts, construction cost of Tokyo's expressway revised for adaptation to local conditions will be applied to this project.

Computation will be made by first obtaining bridge length by type from longitudinal section of each route and multiplying it by unit cost of each type of structure. Results of this computation are shown in Table 9.5-3. The total construction cost including institutional cost, cost of land and expenses (expenses for surveys, engineering and supervision) is shown in Table 9.5-4. For the computation of this construction cost, the prevailing price index was used at the conversion rate of ₱1 = ¥50.

Table 9.5-1 Comparison of Wages

March, 1971 Unit: ₱

	Manila	Tokyo
Ordinary Laborer	9.00	42.00
Mabon	12.00 - 14.00	58.00
Carpenter	12.00 - 14.00	56.00
Steel Man	12.00 - 14.00	47.00
Foreman	15.00 - 18.00	50.00
Welder	12.00 - 14.00	46.00
Rigger	8.00 - 12.00	34.00
Hy. Equipment Oprts.	15.00 - 20.00	49.00

Conversion rate ₱1 = ¥50

Table 9.5 - 2 Comparison of Unit Cost of Construction Materials

March, 1971 Unit: ₱

Materials	Class, Size and Quality	Unit	Manila	Tokyo
Concrete	"A" $fc' = 211\ kg/cm^2$	m^3	195.00	240.00
	"C" "	"	205.00	260.00
	Concrete seal under worter pour	"	210.00	300.00
	Prestressed C. inclusive erection	"	1,300.00	1,650.00
	Concrete pavement $t = 23^{cm}$	m^2	17.00	26.00
Bearing Piles (Driven)	Reinforced Concrete $40^{cm} \times 40^{cm}$	m	100.00	60.00
	Steel H-Piles $30^{cm} \times 30^{cm}$	"	250.00	160.00
	Tubular Piles $\phi 40^{cm}$ $t = 7^{mm}$	"	190.00	-
	Prestressed Piles $35^{cm} \times 35^{cm}$	"	150.00	90.00
	Untreated timber piles $\phi 20^{cm}$	"	80.00	100.00
	Cast-in-lace concrete piles $\phi 1.0^{m}$	"	-	500.00
	Steel pipe piles $\phi 60^{cm}$ $t = 9$	"	-	280.00
Steel Sheet Piles	(Inclusive driving works)	kg	2.50	1.60
		m	375.00	240.00
Earth Work	Roadway and Drainage Excavation	m^3	3.80	6.00
	Excavation for Structure	"	8.00	12.00
	Borrow or Filling Materials	"	17.00	24.00
	Foundation Fill	"	12.00	30.00
Reinforcing Bars	$fs = 1,270\ kg/cm^2$ (SD40)	kg	2.0	1.30
Structural Steel	$fs = 1,550\ kg/cm^2$ (SS41) Fabricated and erected	kg	5.0	4.10

Note: Wage and Contractor's profit are included.

Conversion rate is ₱1 = ¥50

Table 9.5 - 3 Cost of Structural Works

Unit: Million P

Route Nos.		No. 1	No. 2	No. 3	No. 4	No. 5	No. 6
Viaducts	Super	458.1	36.8	56.2	59.0	33.1	100.8
	Sub	286.8	14.4	37.8	40.1	13.9	62.7
Earth Works		-	15.1	1.0	1.0	28.3	1.9
Interchanges		241.5	-	-	-	-	-
Ramps		79.8	-	-	-	-	-
Reclamations		3.2	34.3	-	-	-	-
Totals		1,069.4	100.6	95.0	100.1	76.2	202.4

Table 9.5 - 4 Construction Cost of Urban Expressways

Unit: Million P

Route Nos.	No. 1 25.0 km	No. 2 5.8 km	No. 3 3.6 km	No. 4 3.8 km	No. 5 9.9 km	No. 6 6.3 km	Remarks
Structural Works	1,069.4	100.6	95.0	100.1	76.2	202.4	
Facilities for toll road	5.3	0.5	0.3	0.5	0.3	1.0	
Site expenses	27.9	10.5	1.1	1.5	3.7	1.2	
Administrations	220.7	22.6	19.2	20.4	16.1	40.9	20%
Totals	1,323.3	134.2	115.6	122.5	96.3	245.4	
Average Cost	53.0	23.2	32.2	32.2	9.9	39.0	Million

Total Cost 2,037.3 million P

§ 9.6 Benefits

9.6.1 Benefits to be analyzed

The following may be pointed out as benefits derived from the construction of Manila Urban Expressways.

(a) Direct effect ..... Benefits to those utilizing Manila Urban Expressways.

(1) Time cost saving ..... Users of Manila Urban Expressway can save travel time between the origin and destination of a trip and allocate bank of this time to other production activities.

(2) Funning cost saving ..... Vehicle operating cost such as cost of fuel, oil and wear and tear on vehicles, is reduced due to the reduction of travel time.

(3) Decrease of accidents .... Because of the separation of travelled ways from the opposite traffic by medial strips and elimination of at-grade intersections, traffic accidents between vehicles can be largely prevented. The separation of vehicular traffic from pedestrians eliminates the possibility of accidents involving pedestrians.

(4) Improvement of comfort ..... Because of high standard of road design, comfort of drivers will be increased to a greater extent and the fatigue of drivers will be decreased.

(5) Prevention of damage to cargo ..... Good road conditions will prevent damage to cargo with resultant savings of packing and other cost.

(b) Indirect effect ..... Benefits to those who do not use Manila Urban Expressways.

(6) Alleviation of traffic congestion ..... Shift of a part of traffic to Manila Urban Expressways will alleviate traffic congestion on the existing surface roads with resultant time cost saving and running cost saving for vehicles using the existing roads.

(7) Increase of utilization value of land ..... Reduction of travel time from CBD will promote higher land use in the suburbs.

Table 9.6 - 1 Average Fuel Cost Saving

Vehicle Types / Items \ Fuel kinds	Medium Cars		Smaller Cars	Ordinary Trucks	Smaller Trucks	Buses	Averages (Weighted)
	High Oct. G.	Regular G.	Regular G.	Diesel Oil	Regular G.	Diesel Oil	
A Cast Savings	3.395¢	2.910¢	2.010¢	3.432¢	3.720¢	3.278¢	
B Share of Vehicles	36%	36%	4%	10%	12%	2%	100%
C (A x B)	1.222	1.048	0.080	0.343	0.446	0.066	3.205

Remarks 1) Formula for fuel cost savings ΔC (Refer to Table 9.6-2):

$$\Delta C = (C_g - C_e) \cdot F_c$$

where C_g: Fuel consumption on surface road (cc/km.)

C_e: Fuel consumption on urban expressway (cc/km.)

F_c: Fuel unit cost (¢/ℓ)

2) Shares of the vehicles are shown in Table 9.6 - 3.

Table 9.6 - 2 Fuel Cost Savings

Items \ Vehicle Types		Medium Cars (6 persons, 2000cc)	Smaller Cars (5 persons, 1200cc)	Ordinary Trucks (6 - 8 tons, 6400cc)	Smaller Trucks (2 - 4 tons, 1900cc)	Buses (75 passengers, 8000cc)
C_g	Fuel Consumption on Street (cc/km.)	208	139	391	297	400
C_e	Fuel Consumption on Expressway (cc/km.)	111	72	235	173	251
C_g-C_e	Difference (cc/km.)	97	67	156	124	149
F_c	Fuel Cost (ȼ/ℓ)	High Oct. G. 35 Regular G. 30	Regular G. 30	Diesel Oil 22	Regular G. 30	Diesel Oil 22
ΔC	Fuel Cost Savings (ȼ/km.)	High Oct. G. 3395 Regular G. 2910	2,010	3,432	3,720	3,278

Remarks : Travel speed is 10 km. /hr. on streets and 44 km. /hr. on expressways, based upon the traffic assignment shown in Table 6.7-5. Refer to Table 9.6-4 as to the fuel consumption at each travel speed.

Table 9.6 - 3 Share of Vehicles in Manila

Vehicle Types / Years	Passenger Cars	Jeeps	Taxis	Motor Cycles	Trucks	Jeepneys	Buses	Totals (Vehicles)
1968	50.1%	12.9%	4.3%	6.2%	9.9%	14.7%	1.9%	116,904
1969	52.6	10.0	7.4	3.2	9.6	15.2	2.0	142,006
1970	58.9	8.9	4.8	4.2	9.9	11.7	1.9	107,269
For Estimation	High Oct. G. Use 36% Regular G. Use 36%			4%	10%	12%	2%	100%

Source: Land Transport Commission

Table 9.6-4 Relationship between Travel Speed and Fuel Consumption

(cc/km.)

Vehicle Types / Travel Speed (km./h)	Mini Cars (360cc)	Smaller Cars (1200cc)	Medium Cars (2000cc)	Smaller Trucks (2-4 ton)	Ordinary Trucks (6-8 ton)	Buses (70-86 passengers)
4	119	170	245	328	415	421
6	112	160	233	321	410	417
8	104	149	220	311	403	410
10	97	139	208	297	391	400
12	90	130	196	285	375	387
14	85	122	185	273	358	374
16	80	115	175	262	343	362
18	76	109	166	253	332	350
20	73	104	160	244	321	339
22	70	100	154	235	312	329
24	68	96	149	228	303	320
26	66	94	144	220	294	312
28	64	91	140	213	286	303
30	63	88	135	208	280	296
32	61	85	131	202	271	288
34	60	82	127	196	264	282
36	58	80	123	191	258	276
38	57	77	120	186	252	268
40	56	75	116	181	245	262
42	55	73	113	176	240	256
44	54	72	111	173	235	251
46	54	70	108	170	231	246
48	54	69	106	167	227	242
50	53	68	105	165	223	238
52	53	67	103	163	220	235
54	53	66	101	161	218	232
56	54	66	100	161	216	230
58	55	66	99	161	213	228
60	55	65	98	161	211	227
62	56	65	97	162	210	228
64	56	65	97	163	212	230
66	57	66	96	163	214	232
68	58	66	96	164	216	234
70	59	67	95	165	219	237
72	60	67	95	167	222	240
74	61	68	94	170	225	243
76	62	69	94	173	229	246
78	63	70	93	176	233	249
80	65	71	93	179	237	253

Source: Tokyo Expressway Corp.

(8) Decrease of inventory-sales ratio .... Reduction of transportation time and certainity of transportation of goods will decrease goods in stock with resultant improvement of capital turnover and mitigation of interest payment burden.

(9) Expansion of market ..... Reduction of travel time expands the range of daily commercial activity with resultant expansion of market.

(10) Accelerated development of resources ..... Reduction of travel time will accelerate development of untouched tourist resources, natural resources and manpower resources.

(11) Decentralization of population ... Expansion of commuting range and industrial area will accelerate decentralization of population.

(c) External uneconomic effects ..... Demerits brought about the construction of Manila Urban Expressway.

(12) Destruction or disturbance of some natural environment and cultural properties may result from road construction.

(13) Such environmental disruptions as noise, vibration, exhaust gas and radio and television interference may occur.

Among these various benefits, some have no market price, some are valued by different standards depending on individuals points of view and some cannot be observed objectively because of their psychological nature. It is impossible, therefore, to express all of these benefits in monetary term.

In this section, therefore, calculation will be made only for two benefits, namely, (i) - time cost saving and (ii) - running cost saving, all of which can definitely be expressed in monetary term and a comparison of these benefits with cost will be made hereinafter.

As the external uneconomic effects or demerits can be prevented or avoided generally by adopting appropriate road design and construction methods, and the cost required for such measures is included in the construction cost, they are excluded from this calculation.

9.6.2 Estimation of benefits

(a) Formula used for calculation of running cost savings, S:

$$S = Q \cdot \{S_g - (S_e + S_a)\}$$

where:

Q = Traffic volume on urban expressway

S_g = Running cost on surface road

S_e = Running cost on urban expressway.

S_a = Running cost for detouring on surface road to get to urban expressway.

Running costs consist of the following.

a. Fuel cost
b. Cost of lubricants
c. Cost of tires and tubes
d. Repair cost
e. Other maintenance costs

Among these cost items fuel cost shows a significant difference in the running cost between the expressway and the surface road. Therefore, the running cost savings will be represented by the difference in fuel cost in this estimate. Running cost per km. in Manila calculated on the basis of the data furnished by the Tokyo Expressway Corporation is shown in Table 9.6-1.

(b) Calculation method of time cost savings

Calculation method of time cost savings varies with passenger car, truck and bus.

(i) Formula used for calculation of time cost savings for passenger car:

$$\Delta T_p = P_p \cdot Q_p \cdot (T_g - T_e)$$

where :

ΔT_p = Time cost savings for passenger car.

P_p = Time value of a passenger of passenger car

Q_p = Average number of passengers per passenger car.

T_g = Travel time required on surface road.

T_e = Travel time required on expressway.

(ii) Formula used for calculation of time cost savings for truck:

$$\Delta T_t = \frac{K}{T_g} - \frac{K}{T_e}$$

where: ΔT_t = Time cost savings for truck

K = Fixed cost (personnel expense, depreciation of vehicles, etc.), required for operation of truck.

T_g = Travel time of truck when surface road is used.

T_e = Travel time of truck when expressway is used.

(iii) Calculation method of time cost savings for bus.

Time cost savings for bus consist of (1) savings for a bus operating company resulting from the improved turnover of buses and (2) savings for passengers resulting from speed up of bus operation.

(1) Time cost savings for a bus operating company may be calculated in the same manner as for truck. However, all of the time cost savings for buses cannot be used effectively because of the fixed operating schedule and for this reason, some allowance must be made in calculation.

(2) Time cost savings for passengers of buses, T_b, may be calculated with the following formula:

$$T_b = P_b \cdot Q_b \cdot (T_g - T_e)$$

where: P_b = Time value of a passenger of bus

Q_b = Average number of passengers per bus

(iv) Time value in Manila

Time value, P may be calculated with the following formula:

$$P = \frac{\text{Income}}{\text{Working hours}}$$

Working hours

i) For day workers

8 h x 60' = 480'

ii) Monthly salaried workers on 5 working days

$$(365 - 53 - 53 - 8) \times \frac{1}{12} \times 8h \times 60'$$

(Days in a year) (Sunday) (Saturday) (Holiday) (Month)

$= 10,040'$

iii) Monthly salaried workers on 6 working days

$$(365 - 53 - 8) \times \frac{1}{12} \times 8h \times 60' = 12,160'$$

Time value calculated on the basis of Selected Economic Indicators of the Philippines 1970 published by the Presidential Economic Staff is shown in Table 9.6-5.

(v) Time cost savings per unit distance for each type of vehicles calculated on the basis of Table 9.6-5 are shown in Table 9.6-6. However calculation was made on the following preconditions.

(1) Passenger cars

i) Average Number of passengers is to be 1.55 persons/ vehicle as indicated by the OD survey.

ii) Income level is for monthly wage earners and 50% is represented by 5 days workers and the remaining 50% by 6 day workers.

$$\Delta T_p = P_p \cdot Q_p \cdot (T_g - T_e) = \left(\frac{5.438 + 4.490}{2}\right) \cdot 1.55 \cdot (T_g - T_e)$$
$$= 7.694(T_g - T_e)$$

(2) Buses, trucks and jeepneys

Because of the limited data available, the time cost savings for buses and jeepneys T are to be calculated with the following. And time cost savings for trucks are considered to be the same as for buses.

$$\Delta T = P \cdot Q \cdot (T_g - T_e)$$

Table 9.6 - 5 Time Value

Classes of Workers \ Income or Time Value	Income (1970)		Time Value/minute		
	$	₱	1970	1975	1980
Daily Skilled	1.76	11.325	2.359¢	3.083¢	4.029¢
Unskilled	1.43	9.202	1.917	2.505	3.274
Monthly Salaried	84.85	546.009			
5 days workers			5.438	7.107	9.288
6 days workers			4.490	5.868	7.699
Monthly Wage	39.15	251.930			
5 days workers			2.509	3.279	4.539
6 days workers			2.072	2.707	3.539

Remarks: Conversion rate is $1.00 = P6.435.
Annual growth rate is 5.5%.

Table 9.6 - 6 Time Cost Savings (1970)

Vehicle Types	Passenger Cars Motor Cycles	Jeepneys	Trucks Buses	Totals
A Savings	7.694¢	5.536¢	22.142¢	–
B Share of Vehicle	76%	12%	12%	100%
C A X B	5.848¢	2.657¢	0.664¢	9.169¢

where: P: Time Value of buses and jeepneys, which is 50% of the arithmetic mean of income for daily skilled, daily unskilled and monthly wage earners on 6 working days and 5 working days (therefore, 50% of passengers are jobless).

Q: Average Number of passengers, which is 20 persons/vehicle for bus and 5 persons/ vehicle for jeepney based upon the screen line survey.

T_g: Travel speed on surface roads

T_e: Travel speed on expressways

for buses

$$\Delta T_b = P_b \cdot Q_b \cdot (T_g - T_e)$$
$$= (\frac{2.359 + 1.917 + 2.509 + 2.072}{4}) \cdot \frac{50}{100} \cdot 20 \cdot (T_g - T_e)$$
$$= 22.142 (T_g - T_e)$$

for jeepneys

$$T_j = P_j \cdot Q_j \cdot (T_g - T_e)$$
$$= (\frac{2.359 + 1.917 + 2.509 + 2.072}{2}) \cdot \frac{50}{100} \cdot 5 \cdot (T_g - T_e)$$
$$= 5.536 (T_g - T_e)$$

(3) Total of all vehicle type

$$\Delta T = \Delta T_p \cdot S_p + \Delta T_b \cdot S_b + \Delta T_j \cdot S_j$$
$$= 9.169 \cdot (T_g - T_e)$$
$$= 40.178 \ (₱ /\text{minuts})$$

where : S_p, S_b, S_j : Shares of vehicle types

(Refer to Table 9.6-6)

T_g : Travel speed on surface roads (10 kms. /hr. from Table 6.7-5)

T_e: Travel speed on expressways (44 kms. /hr. from Table 6.7-5)

(vi) Benefits derived from Manila Urban Expressways

Calculation of benefits derived from Manila Urban Expressways on the basis of the foregoing results show the following. The prices used for calculation are based on the 1970 prices.

Running cost savings

Δ S = Q· L· Δ C

= 2, 184 million vehicles x 12 kms. x 3. 205 centavos

= 840.0 million pesos

where Q : Traffic volume over 30 years

L : Length of urban expressway used by a vehicle (15 kms. x 0.8*)

* detour reduction

Δ C : Fuel cost savings per km. (Refer to Table 9.6-1)

Time cost savings

Δ T = Q· L· T

= 2, 184 million vehicles x 12 kms. x 40.178 centavos

= 10, 530 million pesos

where Q : Do.

L : Do.

T : Time cost savings per km.

Total 11, 370 million pesos

9.6.3 Estimation of expenses

(a) Construction cost calculated in Section 9.5 of this report is used.

(b) Maintenance and repair cost (cost required for maintenance and repair of road structures) calculated on the basis of data for Tokyo Expressway is as follows.

Maintenance and repair cost = Construction cost (2,037.3 million Pesos) x 0.005 x 30 years

(c) Administration expenses (mainly personnel expense for toll collection) were calculated with the following cumulative method and were estimated at 4.31 million pesos a year.

Details of calculation

$$40 \text{ lanes (Total of toll plazas)} \times 2 \text{ persons} \times 4 \text{ shifts} \times \frac{365 \text{ days}}{231 \text{ days}} = 506 \text{ persons}$$

231 days = 365 days - 53 days (Sunday) - 53 days (Saturday) - 8 days (Holiday) - 20 days (Annual leave)

$84.85 x 6.435 (pesos/dollar) x 12 months x 1.3 (overhead expenses) = 8,518 (pesos/person.year)

8,518 x 506 persons = 4,310,108   4.31 million persons

The number of clerical workers was considered to be the equivalent of the number of toll collectors who are not required at night.

9.6.4 Comparison of cost and benefit

A comparison of cost incurred by the construction and use of Manila Urban Expressways for a period of 30 years and the benefits derived is shown in Table 9.6-7.

Table 9.6-7 Comparison of Cost and Benefit of Urban Expressway

(million Pesos)

Cost	Construction cost	2,037.3
	Maintenance and repair cost	305.6
	Administration expenses	129.3
	Sub-total	2,472.2
Benefit	Travel cost savings	840.0
	Time cost savings	10,529.9
	Sub-total	11,369.9
Balance (Net Benefit)		8,897.7

9.6.5 Comparison between toll and free systems

Comparison is made here between the toll and the free systems of Manila Urban Expressways, after estimating changes in benefits and costs under the free system.

Table 9.6-8 shows time and running costs per day in 1987 under the toll and free systems, based upon the results of the traffic assignment in 6.7.

The total of the time and running costs is 13,780,000 Pesos per day in 1987 under the toll system in Table 9.6-8, and 13,085,000 Pesos under the free system. The difference is about 700,000 Pesos, that is 5% of the total amount. When the above costs are assumed to increase in proportion to the total trips year by year, the total of them for a period of thirty years amounts to 219,130 million Pesos in case of the toll system and 208,078 million Pesos in case of the free system through the following formula, the difference being 11,052 million Pesos:

$$\sum_{n=1}^{30} Cf \times 365 \text{ days} \left\{ 1 + \frac{2,908 - 1,457}{1,457} \times \frac{n-1}{16} \right\}$$

where : Cf: Costs per day in 1987 (13,780 thousand Pesos in case of the toll system and 13,085 thousand Pesos in case of the free system)

1,457,000 trips : The total trips in 1971 (Refer to §9.1)
2,908,000 trips : The total trips in 1987 (Refer to §9.1)

Among the project cost of expressways are saved expenses for facilities of toll road (about 8 million Pesos from Table 9.5-4) and administration expenses during thirty years (about 129 million Pesos from Table 9.6-7) in case of the free system, the total of both items being 137 million Pesos.

The difference of benefits between the toll and free systems of the urban expressways for a period of thirty years is 11,189 million Pesos (11,052 million Pesos + 137 million Pesos).

Since the benefits of the toll urban expressways is 8,898 million Pesos, the free urban expressways bring in the benefit of 20,087 million Pesos (8,898 million Pesos + 11,189 million Pesos), that is about 2.5 times as much.

§9.7 Construction Priority

Completion of the proposed expressway at one time is not possible and construction must be carried out in stages starting from the section with the highest efficiency in proportion to the progress of urbanization, growth of traffic demand and in relation with urban renewal plans. It is desirable to open the completed sections in stages for commercial operations. For that purpose, however, the length of a completed section must be at least 10 km.

In consideration of the above, the order of priority for construction is to be as follows.

1st stage:	Route No. 2 and a section of Route No. 1 up to North Interchange (9.4 km).
2nd stage:	Section of Route No. 1 from North Interchange to Fort Againaldo beyond Cubao (105 km).
3rd stage:	Section of Route No. 1 from Fort Aguinaldo South Interchange (9.1 km).
4th stage:	Remainder of Route No. 1 (2.1 km), Route No. 3 (3.6 km) and Route No. 4 (3.8 km).
5th stage:	Route No. 6 (6.3 km).

Table 9.6 - 8 Time and Running Costs in Case of Toll and Free Systems

Fare Systems / Roads / Items		Toll			Free		
		Express ways	Streets	Totals	Express ways	Streets	Totals
A	Total Travel Time (1,000 minutes)	2,760	129,900	132,660	7,260	117,180	124,440
B (A×9,169)	Time Costs (1,000 pesos)	253	11,911	12,164	666	10,744	11,410
C	Total Vehicle - kilometers (1,000 Vehicle-kms.)	2,050	22,085	24,135	3,028	21,293	24,321
D	Weighted Means of Running Cost (Centavos/Vehicle-km.)	3,933	6,952	10,885	5,131	7,139	12,270
E (C × D)	Running Cost (1,000 pesos)	81	1,535	1,616	155	1,520	1,675
F (B + E)	Total Cost	334	13,446	13,780	821	12,264	13,085

Remarks:
1) All the above values are per day in 1987.
2) As to A and C, refer to Table 6.7-5.
3) As to 9,169₱/minute, refer to Table 9.6-6.
4) As to D, refer to Table 9.6-9.

Table 9.6 - 9 Weighted Means of Running Cost

Items \ Vehicle Types	Medium Cars (2000cc)	Smaller Cars (1200cc)	Ordinary trucks	Smaller trucks	Busses	Weighted Means
A. Fuel consumption at speed of 44km/hr.	111 cc/km	72 cc/km	235 cc/km	173 cc/km	251 cc/km	
B. Unit Fuel Cost	32.5 ¢/ℓ	30 ¢/ℓ	22 ¢/ℓ	30 ¢/ℓ	22 ¢/ℓ	
C. (A × B)	3.608 ¢	2.160 ¢	5.170 ¢	5.190 ¢	5.522 ¢	
D. Vehicles Share	72 %	4 %	10 %	12 %	2 %	
E. (C × D)	2.597 ¢	0.086 ¢	0.517 ¢	0.623 ¢	0.110 ¢	3.933 ¢
F. Fuel consumption at speed of 25km/hr.	146	95	298	224	316	
G. (F × B)	4.745	2.850	6.556	6.720	6.952	
H. (G × D)	3.416	0.114	0.656	0.806	0.139	5.131
I. Fuel consumption at speed of 11km/hr.	202	134	383	291	393	
J. (I × B)	6.565	4.020	8.426	8.730	8.646	
K. (J × D)	4.727	0.161	0.843	1.048	0.173	6.952
L. Fuel consumption at speed of 10km/hr.	208	139	391	297	400	
M. (L × B)	6.760	4.170	8.602	8.910	8.800	
N. (M × D)	4.867	0.167	0.860	1.069	0.176	7.139

6th stage: Route No. 5 (9.9 km).

For Route No. 2 in the first stage, reclamation of Manila bay must precede construction of the road. Since the section of Route No. 1 up to North Interchange has a portion in which the standard width (50 m) has not been secured for C-4, it is necessary to initiate widening of the right of way as part of the surface road improvement project.

For the second and third stages attention must be paid to the relations with grade separation of C-5 in designing and planning the work. In the fourth stage construction of Route 3 and Route 4 must be timed with the completion of C-3 which is to be connected to these roads or must start after the completion of C-3. In the fifth and sixth stages the work must be timed with the progress of urban development in the suburbs. There is no need to rush construction of Route No. 5 as Commonwealth Ave. (Right of way-94 m) is already available.

The priority of construction mentioned above is outlined in Fig. 9.7-1. Though the target years of these construction works must be determined through further detailed investigation, their plans should be decided and thereby the lands be acquired at least within the next three years. The first stage should be completed in the initial five years. In the following five years the second, the third and a part of the fourth stage should be completed, so that the service of circumferential roads can be commenced. The rest is to be realized within 15 years to come.

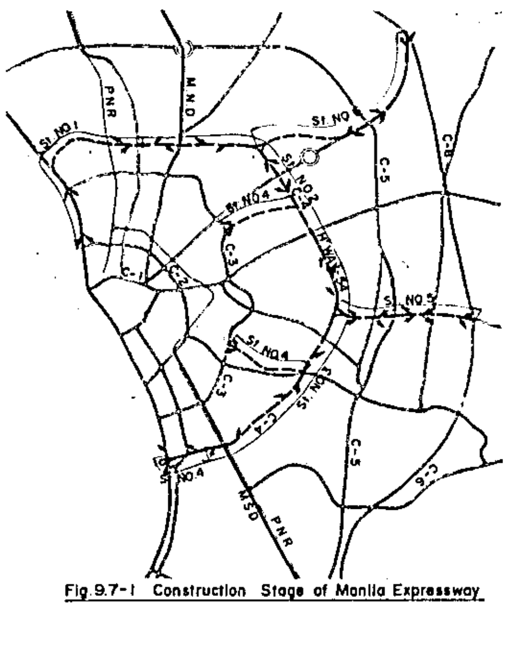


Fig.9.7-1 Construction Stage of Manila Expressway

§ 9.8 Operating Plan

9.8.1 Construction fund

Road construction funds generally comprise the following four accounts.

1. General account
2. Special account
3. Revenue from toll charge
4. Borrowings

The general account has its revenue from taxes and the special account has its revenue from automobile fuel tax, automobile registration tax and other taxes established as special purpose taxes. These two accounts of road construction funds are supplied at the responsibility of the central government.

In general roads are constructed and improved as public facilities that constitute the basis of social life at the responsibility of local governments using revenue from taxes and are open to the public free of charge. In special case, however, part of the cost is carried directly by users for the roads which require large capital expenditure, high maintenance and repair cost but which afford great benefits to the users.

In any country there is a limit to the financial capability of the government and raising funds for a large project in a short period of time is extremely difficult. However, when the realization of the road project cannot be anticipated in the foreseeable future if financed by government funds and the project is very promising for its high economic efficiency. Construction may begin with loans introduced on the premise of adopting the toll road system, thus realizing social development in advance.

In general an urban expressway project is suitable for a toll road system, since it requires a tremendous investment in a short period of time, it generates great social benefits and affords great benefit directly to the users. Its early realization can be expected through adoption of the toll system reinbursing the construction cost.

Manila urban expressways bring in greater benefits definitely in case of the free system, compared with the toll system. However, the proposed urban expressways are desirable to be open for traffic as early as possible, considering the estimated traffic conditions. Therefore the proposed urban expressways are desired to be constructed and managed under the toll system.

9.8.2 Operating Organization

The fundamental role of the operating organization which constructs and manages Manila Urban Expressway will be to raise funds for construction and improvement of roads, which cannot be realized with the government funds, and accelerate road construction and improvement on behalf of the government. This operating organization, therefore, is bound to have a stong color of a public body on one hand and have a nature of private enterprise on the other because its management depends on the revenue from toll charge.

Since this operating organization performs with loans, it must have sufficient operating capabilities and organizational structure to with the confidence of investors.

Since part of the construction and improvement of road, which are originally the responsibility of the central and local governments, is carried out by this operating organization the central government must maintain close coordination with the operating organization and must make efforts to aid the operating organization attain the objectives by providing advice, guidance and assistance. At the same time, the government must exercise sufficient appropriate supervision to guard against the loss of credit with the public which might result from the suspension of operation.

Capital structure of the operating organization having the characteristics mentioned above may take any of the following three forms.

1. Private capital
2. Half-government and half-private capital
3. Central or local government capital

Selection of any of the above forms depends largely on whether the following requirements may be satisfied or not.

1. The interest of investors must be protected through granting the right for compulsory collection of toll charge by law.

2. The central and local governments must make possitive efforts to provide long-term loans with low interest rates.

3. Since this project is closely related with the regional development projects of the central and local governments a close coordination must be maintained with these projects for the implementation of this project.

4. The addition of traffic police function is desirable for the management of toll road.

5. Due to the fact that the service life of the project is very long and that the toll charge of the minimum level is desirable, this project is not totally fitted for the pursuit of profits.

6. The operating organization must be a body which enables the central government to exercise appropriate control and supervision.

7. The operating organization will not be required to exist after repayment of construction fund and therefore is not a permanent organization.

In the Philippines, The Construction and Development Corporation of the Philippines (CDCP), established by private capital, is now operating such toll reads as Manila North Expressway and Manila South Expressway and other public facilities.

Construction cost of Manila Urban Expressways is estimated to be about 30 times that of Manila North Expressway and about 15 times that of Manila South Expressway.

There is no specific reason why the operating organization requiring such an enormous investment need not be the one invested wholly by private capital. However, in view of the fact that a large amount of subsidies must be provided by the central and local governments, that the interest of investors must be protected and that the project is not totally fitted to commercial purpose, therefore it is advisable that the operating organization is a body from the central government or local governments, or a body established with partial investment of the central or local government so that the opinion of the central government or local government may be sufficiently inducted.

9.8.3 Fare system

Tariff systems of toll roads can be of three types mileage rate system, that rate system and section rate system.

The mileage rate system is the system which determines the rate in proportion to the distance covered by the user and is appropriate to distribute fair shares of burden among users. This system is being employed for Manila North Expressway and Manila

South Expressway.

The flat rate system requires payment of a fixed rate regardless of the distance covered by users and therefore is the most simple toll collection system. This system is advantageous when there is no great difference in the distance of trip between users and where efficient handling of large traffic volume is required.

The section rate system is an intermediate form of the mileage rate system and the flat rate system. In this system the toll road is divided into some blocks and toll charge of a fixed rate is applied to each block. This system is applicable to the section in which traffic characteristics or benefit differs greatly from that in other sections and the treatment on the same level as other sections is not justified.

The greatest merit derived from urban expressways is the reduction of travel time since the time lost at the toll gate accounts for a large part of the total travel time, the toll system that ensures prompt handling of traffic is desirable.

Since a large traffic volume on Manila Urban Expressways must be handled in a small space at the toll plaza, adoption of the following system will be appropriate.

1) The flat rate system should be adopted as a rule and the section rate system should be adopted as substitute when necessary.

2) Vehicles should be handled into two classes, small car and large for toll purposes.

3) Toll rates should be round numbers so as to preclude the need for marking change and the ratio of small car and large car should be 1 : 2 or 1 : 5.

4) Discount coupons should be issued for publicity.

5) Season tickets should not be issue as they induce purpose-less trips and causes traffic congestion.

9.8.4 Profitability

The profitability of a toll road consists in whether the toll revenue within a certain period can reimburse the construction and main[illegible] costs or not. The following formula is applied to the profitability.

$$(C + C \cdot r \cdot n + \sum_{i=1}^{n} M) = \sum_{i=1}^{n} Q \cdot R$$

where :
- C : Construction cost
- r : Interest
- n : Period
- M : Maintenance cost
- R : Toll charge
- Q : Annual traffic volume

Followings are assumed for calculation to examine if the proposed expressways can be planned as a toll road:

1. Toll charge is 2 Pesos per vehicle, which is thought the maximum.

2. Interest rate on capital is 4%, 4.5%, 5.0% and 5.5%.

3. Construction cost is 2037 million pesos, annual maintenance and repair cost is 14.6 million pesos, and traffic volume is to be that estimated in Chapter 6, all of which were used for calculation of benefit. And additionally the construction and maintenance costs are assumed 20% and 30% extra.

4. Interest during construction is not counted.

From the calculation on the basis of the above conditions, the term of repayment is determined to be as follows.

Construction Cost (million pesos)	Interest (%)	Term of Repayment (years)
2,037.3	4.0	29
"	4.5	32
"	5.0	36
"	5.5	43
2,448.8 (20% extra)	4.0	39

Construction Cost (million pesos)	Interest (%)	Term of Repayment (years)
2, 448.8 (20% extra)	4.5	46
2, 648.5 (30% extra)	4.0	46

The above result is tentative and further study will be required about the feasibility of the proposed urban expressways. A repayment program is shown in Table 9.8-1 in case of the construction cost of 2,037.3 million Pesos and the interest of 4%.

Table 9.8 - 1 Repayment Program of Urban Expressways

Years		Annual Traffic Volume (Million Vehicles)	Annual Revenue (Million Pesos)	Annual Maintenance Cost (Million Pesos)	Repayment (Million Pesos)	Balance (Million Pesos)	
in Calendar	from Opening					without Interest	with Interest
1987	1	50.	100.	14.60	85.40	2033.50	2114.83
1988	2	52.	104.	14.60	89.40	2025.43	2106.45
1989	3	53.	106.	14.60	91.40	2015.05	2095.65
1990	4	55.	110.	14.60	95.40	2000.25	2080.26
1991	5	56.	112.	14.60	97.40	1982.86	2062.18
1992	6	58.	116.	14.60	101.40	1960.78	2039.21
1993	7	59.	118.	14.60	103.40	1935.81	2013.24
1994	8	61.	122.	14.60	107.40	1905.84	1982.07
1995	9	63.	126.	14.60	111.40	1870.67	1945.50
1996	10	64.	128.	14.60	113.40	1832.10	1905.39
1997	11	66.	132.	14.60	117.40	1787.99	1859.51
1998	12	67.	134.	14.60	119.40	1740.10	1809.71
1999	13	69.	138.	14.60	123.40	1686.31	1753.76
2000	14	70.	140.	14.60	125.40	1628.36	1693.50
2001	15	72.	144.	14.60	129.40	1564.10	1626.66
2002	16	74.	148.	14.60	133.40	1493.26	1552.99
2003	17	75.	150.	14.60	135.40	1417.59	1474.29
2004	18	77.	154.	14.60	139.40	1334.89	1388.29
2005	19	78.	156.	14.60	141.40	1246.89	1296.76
2006	20	80.	160.	14.60	145.40	1151.36	1197.42
2007	21	81.	162.	14.60	147.40	1050.02	1092.02
2008	22	83.	166.	14.60	151.40	940.62	978.24
2009	23	85.	170.	14.60	155.40	822.84	855.76
2010	24	86.	172.	14.60	157.40	698.36	726.29
2011	25	88.	176.	14.60	161.40	564.89	587.49
2012	26	89.	178.	14.60	163.40	424.09	441.05
2013	27	91.	182.	14.60	167.40	273.65	284.60
2014	28	92.	184.	14.60	169.40	115.20	119.81
2015	29	94.	188.	14.60	173.40	-53.58	-55.73

CHAPTER 10 URBAN RAPID TRANSIT RAILWAYS

CHAPTER 10 URBAN RAPID TRANSIT RAILWAYS

In this chapter detailed route planning, selection of structural types and estimation of construction cost for each route are made on the basis of the traffic demand estimated in Chapter 6 and the urban rapid transit railway network proposed in Chapter 7.

This chapter also discusses the priority of routes for construction of urban rapid transit railway system, analysis of benefit derived from the entire network and the basic policy of operating plan.

§ 10.1 Estimated Annual Traffic Volume

According to the traffic demand forecost made in Chapter 6 the number of railway passengers in 1976 is estimated at 6, 327, 000. As the number of passengers using the mass transit system is expected to increase from 4, 158, 000 in 1971 to 9, 352, 000 in 1987, the annual growth rate is determined to be 3.5% of the latter from these two figures. On the assumption that the number of railway passengers will increase at this rate, the daily and annual traffic volume on railways for a period of 30 years will be as shown in Table 10. 1-1.

However, since the capacity of a railway section is 460, 000 as already mentioned in Section 6.7, the number of passengers in a certain section cannot exceed this figure. Besides, the average travel distance by railway is 9.0 kms. as previously mentioned, the number of passengers in a certain section or sections of length under 9.0 kms. will not increase even from the number below the capacity of the section if the number of passengers in the adjoining sections has reached the capacity.

§ 10.2 Basic Policy of Planning

The planning of the Manila Urban Rapid Transit Project will be based on the following step :

a) Scope of the planning

The total length of network as planned in Chapter 6 is 183.4 km. For the section which are inside C-4 inclusive and, near to outside C-4 having a total length of 121.1 km, calculation of construction cost will be made upon precise route selection and selection site for stations and the structural type to be

Table 10.1 - 1 Annual Traffic Volume on Railways for 30 Years

(million persons)

Years in Calendar	Years from Opening	PNR	Subway Line No. 1	Subway Line No. 2	Subway Line No. 3	Subway Line No. 4	Subway Line No. 5	Totals
1987	1	480	452	441	370	384	183	2310
1988	2	507	477	465	390	406	193	2438
1989	3	535	504	492	412	428	204	2575
1990	4	554	533	519	435	446	216	2703
1991	5	575	562	548	450	465	"	2816
1992	6	586	580	563	466	"	"	2876
1993	7	598	594	572	"	"	"	2911
1994	8	610	"	581	"	"	"	2932
1995	9	623	"	"	"	"	"	2945
1996	10	637	"	"	"	"	"	2959
1997	11	652	"	"	"	"	"	2974
1998	12	667	"	"	"	"	"	2989
1999	13	667	"	"	"	"	"	"
2000	14	"	"	"	"	"	"	"
2001	15	"	"	"	"	"	"	"
2002	16	"	"	"	"	"	"	"
2003	17	"	"	"	"	"	"	"
2004	18	"	"	"	"	"	"	"
2005	19	"	"	"	"	"	"	"
2006	20	"	"	"	"	"	"	"
2007	21	"	"	"	"	"	"	"
2008	22	"	"	"	"	"	"	"
2009	23	"	"	"	"	"	"	"
2010	24	"	"	"	"	"	"	"
2011	25	"	"	"	"	"	"	"
2012	26	"	"	"	"	"	"	"
2013	27	"	"	"	"	"	"	"
2014	28	"	"	"	"	"	"	"
2015	29	"	"	"	"	"	"	"
2016	30	"	"	"	"	"	"	"
Totals		19030	17364	16963	13707	13754	6412	87230

employed. For the extensions to the suburbs, howevèr, calculation of construction cost will be made on the basis of construction cost per unit of surface railway and elevated railways. Construction cost of the entire network will then be the total of two sections. Fig. 10.2-1 shows an outline of the proposed network, and Fig. 10.2-2 shows typical cross section of rapid transit railway.

b) Route selection

The most important priority in planning the network of urban rapid transit is to determine the future characteristics of the city through analysis and a careful study of the present state of that city.

Due considerations of a transport system in the future metropolitan structure of Manila, where such a gigantic project is planned for the first time, requires planning of a well balanced, rapid transit network. Special attention is given to the following:

(1) As rapid transit is aimed mainly at the transportation of commuters it must be planned for areas which are densely populated at present or are expected to be highly populated areas in the future.

(2) Improvement of the present Philippine National Railways (PNR) will be part of the proposed network.

Improvement of the present PNR by construction of an elevated railway will greatly contribute to the alleviation of traffic congestion on surface roads in Manila city.

(3) In anticipation of the combined outward development of the suburbs, the network should be designed so that further extension and future track increases of each route will be technically easy.

Surface structure will be more economical in the suburbs.

(4) To reduce project cost and construction time routes should avoid priveately owned lands if possible.

(5) Taking into consideration reasonable walking distance for passengers, the distance between stations should be about 700 m - 1,000 m. in CBD and 1,500 m. - 2,000 m. in outlying area.

(6) Additional land will be needed for car-sheds and maintenance shops. In order to maintain the harmony between these structures and its surroundings, special considerations should be given to the city planning in the vicinity.

c) Other structural facilities

The rapid transit system should use tunnels in high and medium areas and surface elevated or depressed railways in the outer and low densely suburbs.

The PNR improvement should adopt the elevated type in areas where heavy surface traffic is observed. Improvement of surface railway will be possible in some areas. Electric supply, drainage, ventilation, air conditioning, and disaster prevention equipment must be included in the tunnel section. Planning of these structures and facilities must be made after a careful study of the natural and environmental conditions of the site.

Special attentions must be given to drainage and ventilation since Manila and suburbs are subjected to frequent typhoons, hot climate, and high humidity.

d) Cost and benefits of the plan in operation

The analysis of the operations and the cost benefit will be based upon the 1987 commuters' demand and on the assumption that the entire network will be completed by that date.

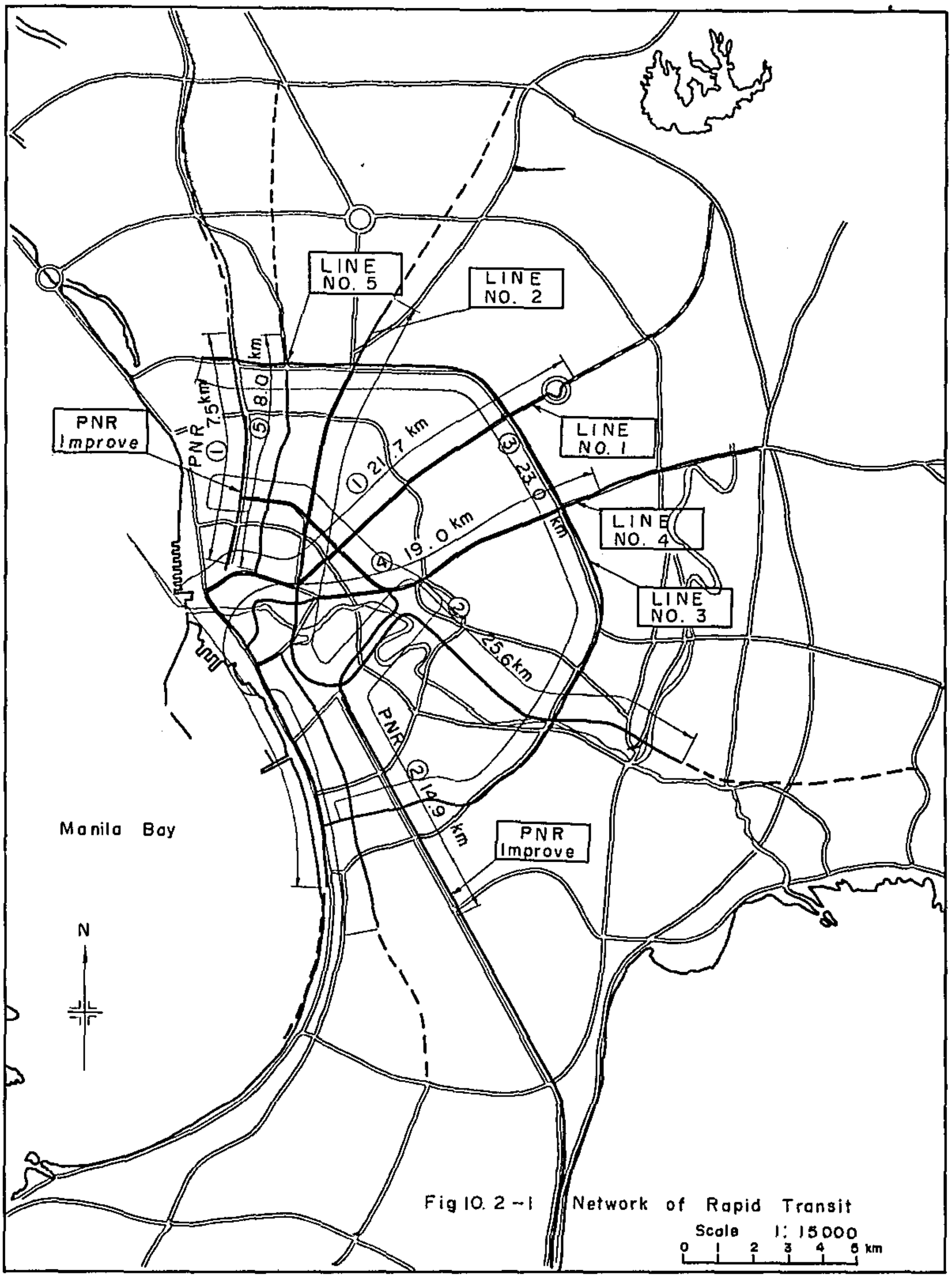


Fig 10. 2 - 1 Network of Rapid Transit
Scale 1: 15000
0 1 2 3 4 5 km

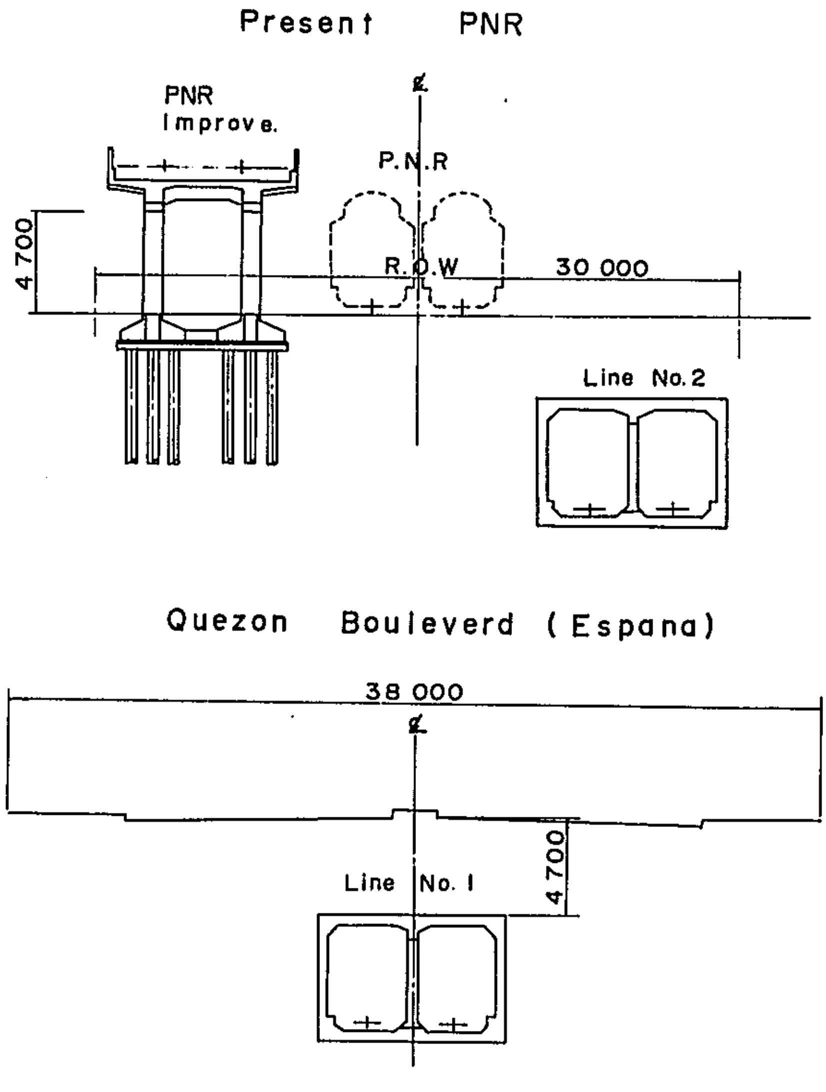


Fig.10.2-2 Typical Cross Section of Rapid Transit.

§ 10.3 Planning of Major Routes

The rapid transit system for Manila and suburbs will consist of the subway system and the PNR improvement project. Five lines are proposed for the sub-way system, as shown in Fig. 10.3-1. The PNR improvement project involves the electrification of the existing north and south lines from Tutuban Station.

10.3.1 Subway

Line No. 1

This line originates in Quezon Memorial, passes through Espana and Quezon boul., Claro M. Recto Avenue, San Nicholas District, Bonifactio Street, Taft Avenue and ends south of the Manila International airport.

Line No. 2

This line starts in Manotoc Subd., passes through A. Bonifacio St., Quezon Boul., and P. Burgos, Paca, Mandaluyong and Pasig ending at Cainta.

Line No. 3

This lines starts from Sangandaan, extends along Highway 54 passing through Quezon, Cubao, Pasig, Makati and ends in Pasay.

Line No. 4

This line begins in Quirino, passes through Aurora Boulevard and Ramon Magsaysay Boulevard, extends along the north side of Malacanang Palace, crosses the Pasig River at the point downstream of Ayala Bridge, runs in front of the City Hall passing through Intramuros, passes Bonifacio and Roxas Boulevard and extends from its end near Roxas Boulevard to the future reclaimed land.

Line No. 5

This line originates in Marulas, extends southward along Rizal Avenue, passes by Tutuban Station and connects Line No. 1.

Since each of these routes were planed with a map on a scale 1/20,000; a further study must be made for accurate alignment of the route and the location of stations.

Fig. 10.3-2 through Fig. 10.3-4 show the profiles of Line Nos. 1, 2 and 3. The profiles of Line Nos. 4 and 5 are not shown.

10.3.2 PNR improvement

Since the existing railway is aimed mainly for long distance transportation and has a low operating frequency, it is not yet suited for high volume transport commuters. It is necessary to construct an elevated and electrified railway along the existing route. However, the railway should be elevated only inside of C-4. Grade separation of the remaining section should be planned only for the crossings with major roads. Since the existing railway has a width of 30 m. right of way, the construction of an elevated railway will be relatively easy. Fig. 10.3-5 shows a profile of PNR improvement. It is advisable that in the future the present surface railway be also elevated for the section inside C-4. Fig. 10.3-6 shows cross sections of typical structure.

10.3.3 Outline of facilities

The structure type of the above-mentioned five lines of the subway system and the PNR improvement will consist of the tunnel, elevated structure and surface railways as necessary. The construction facilities required for the type of structures are listed in Table 10.3-1.

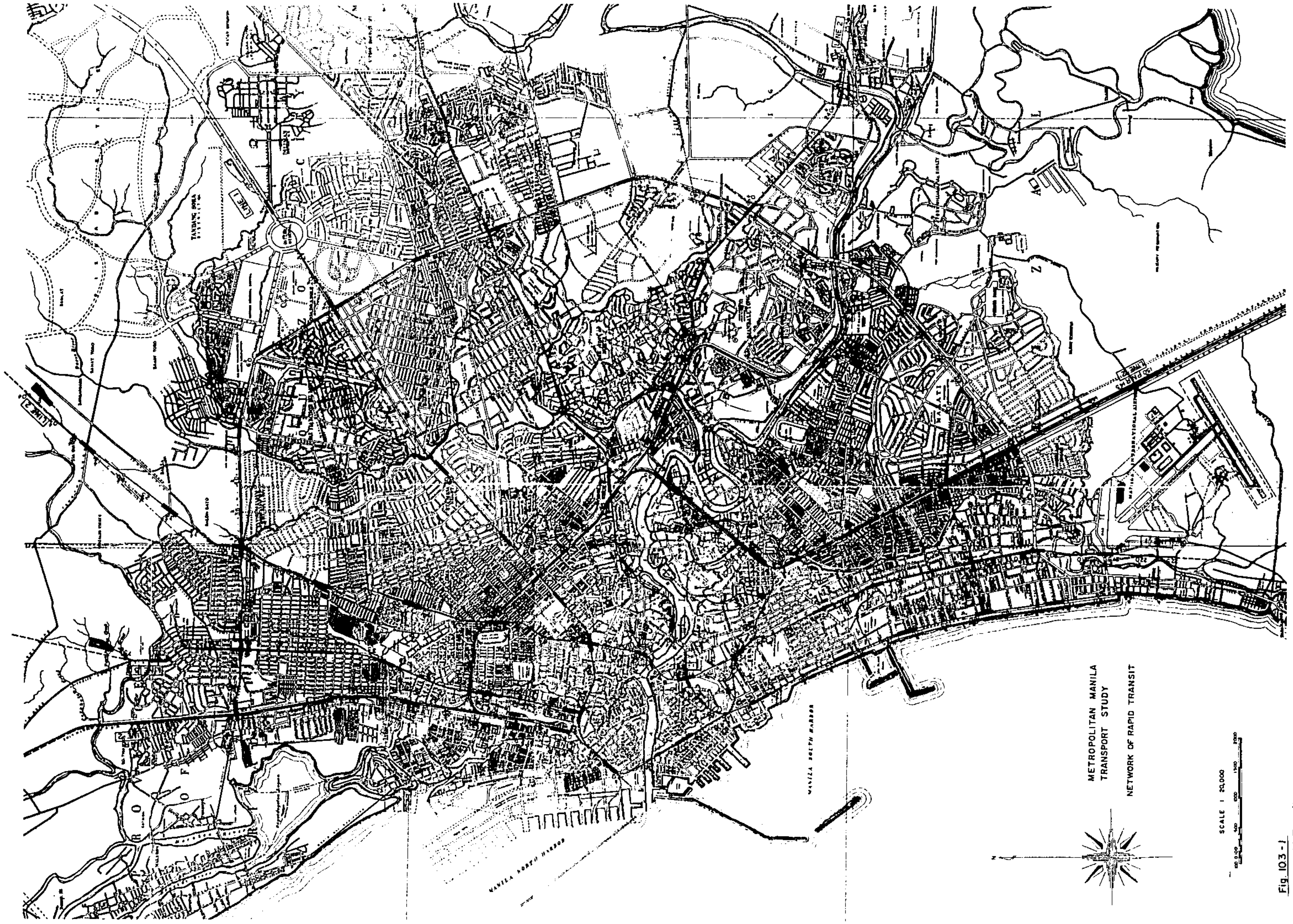


Fig. 103-1
Network of Rapid Transit

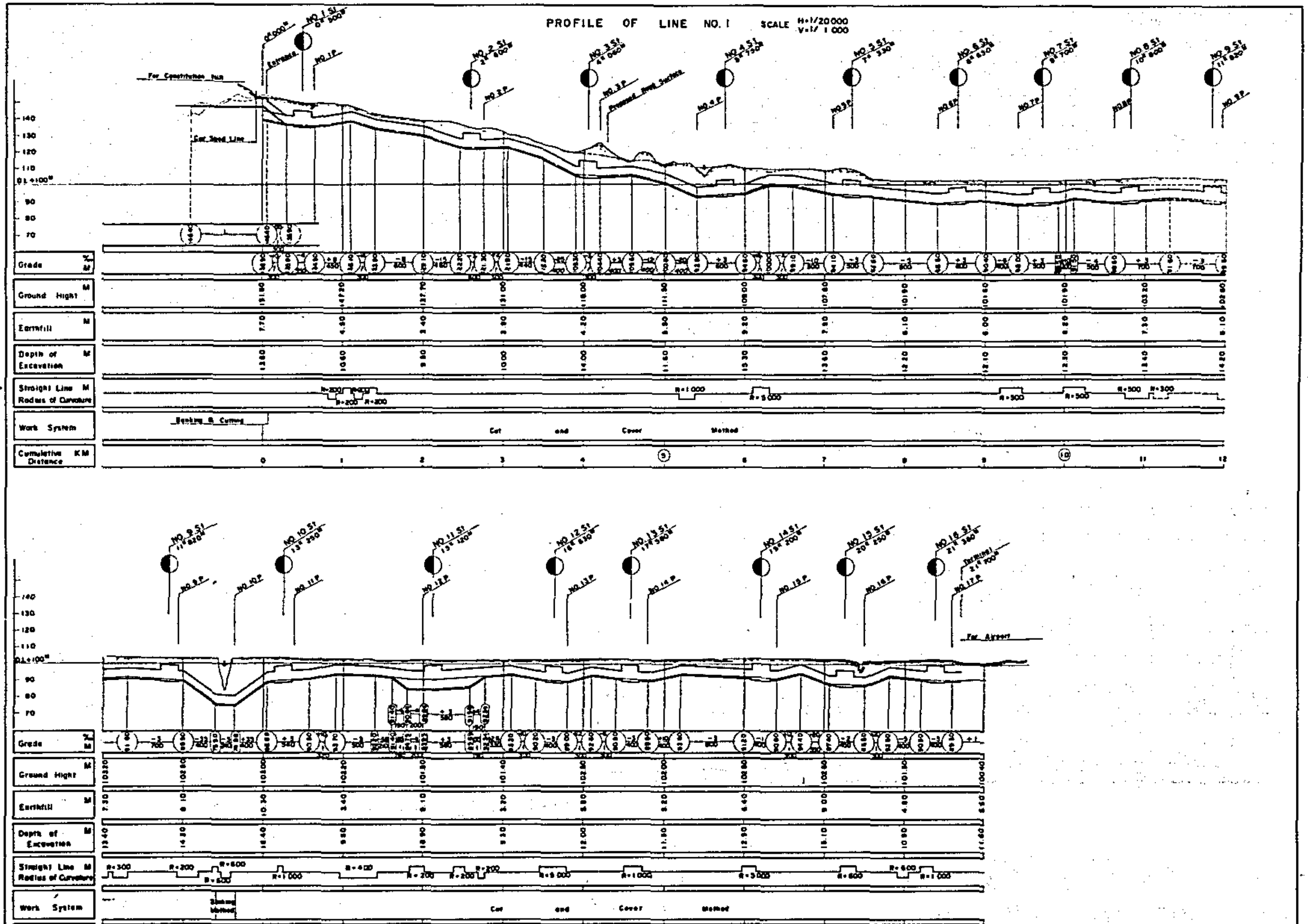


Fig. 10.3 - 2
Profile of Line No. 1

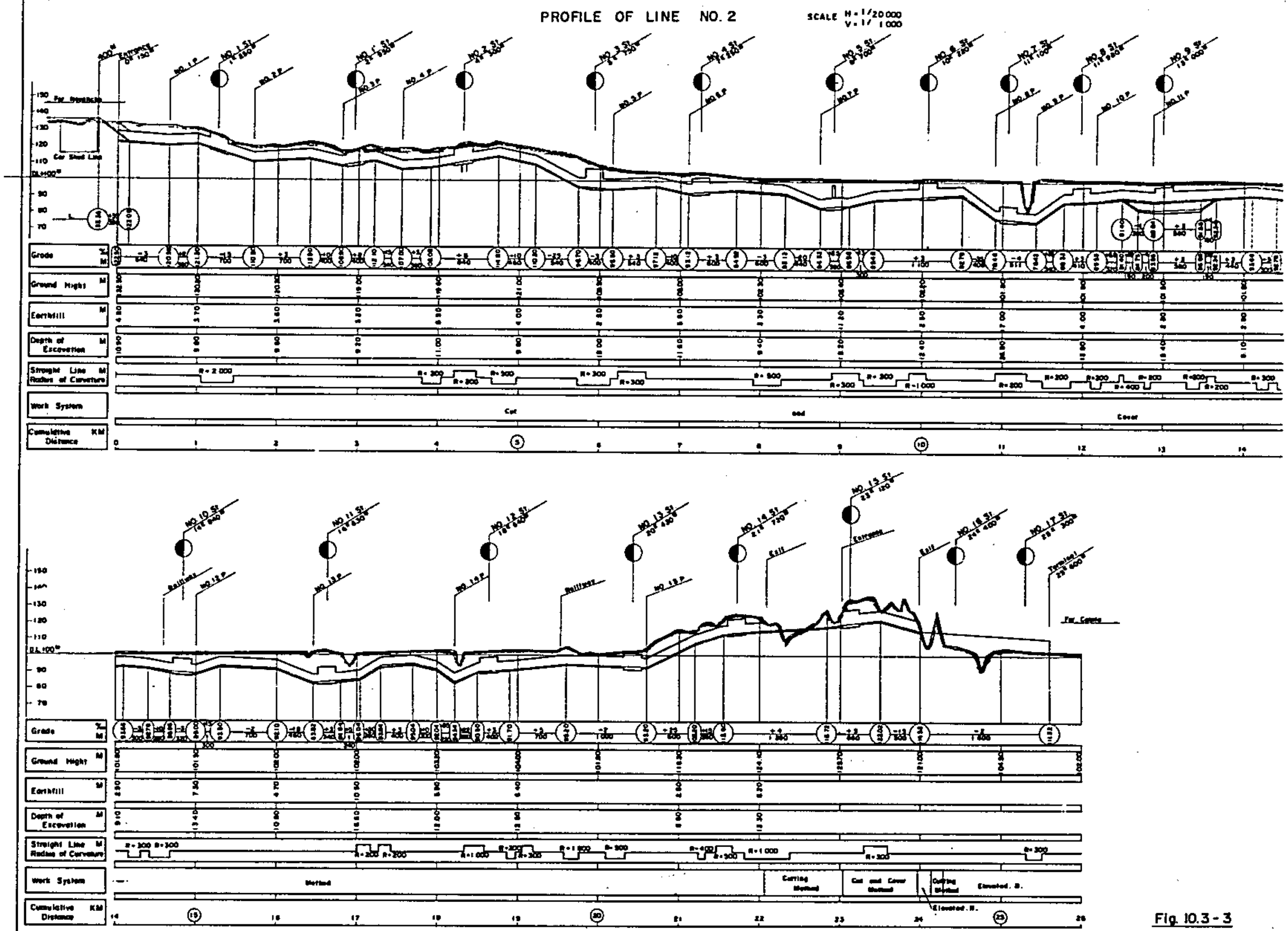


Fig. 10.3-3
Profile of Line No. 2

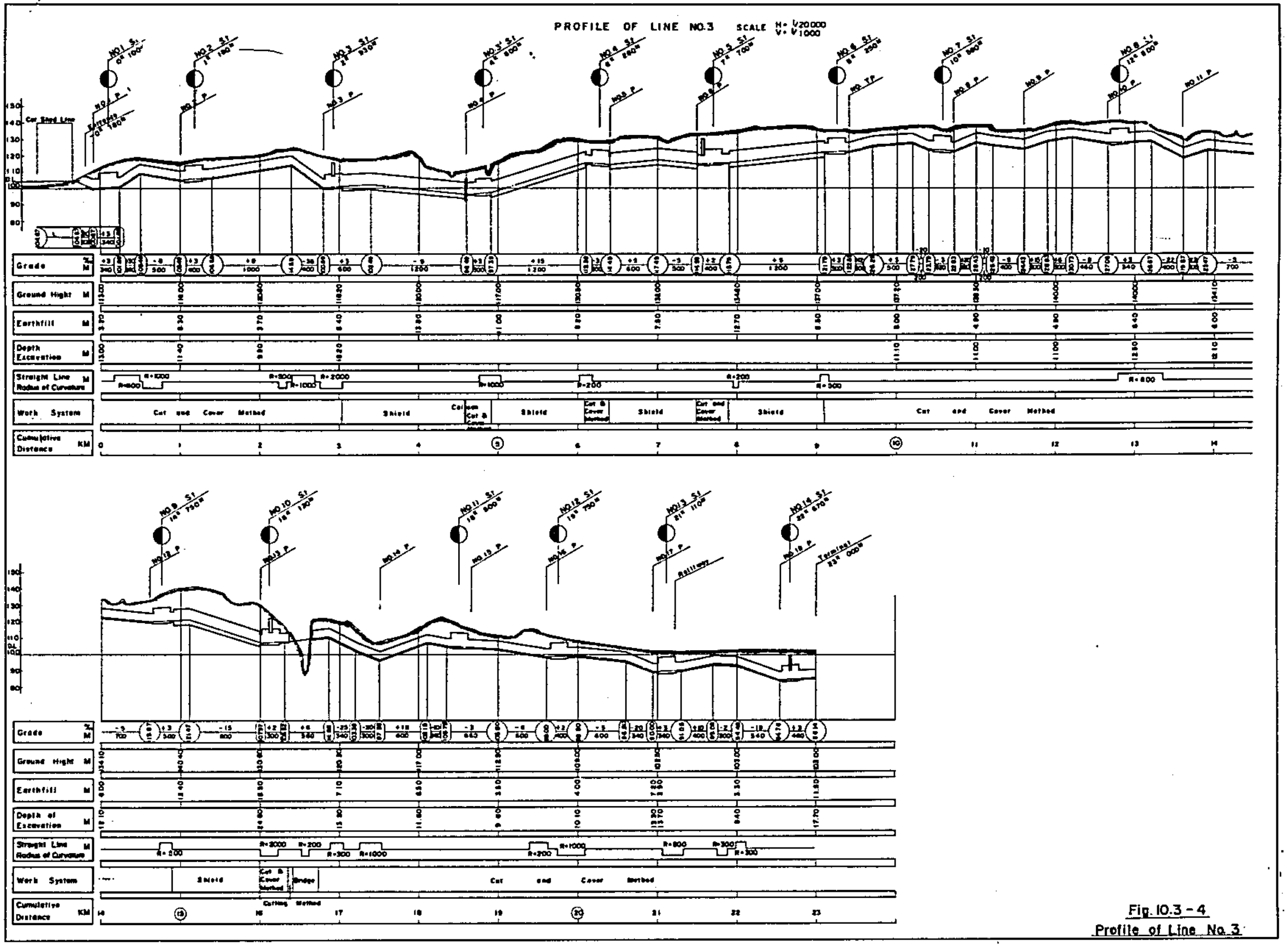


Fig. 10.3 - 4
Profile of Line No. 3

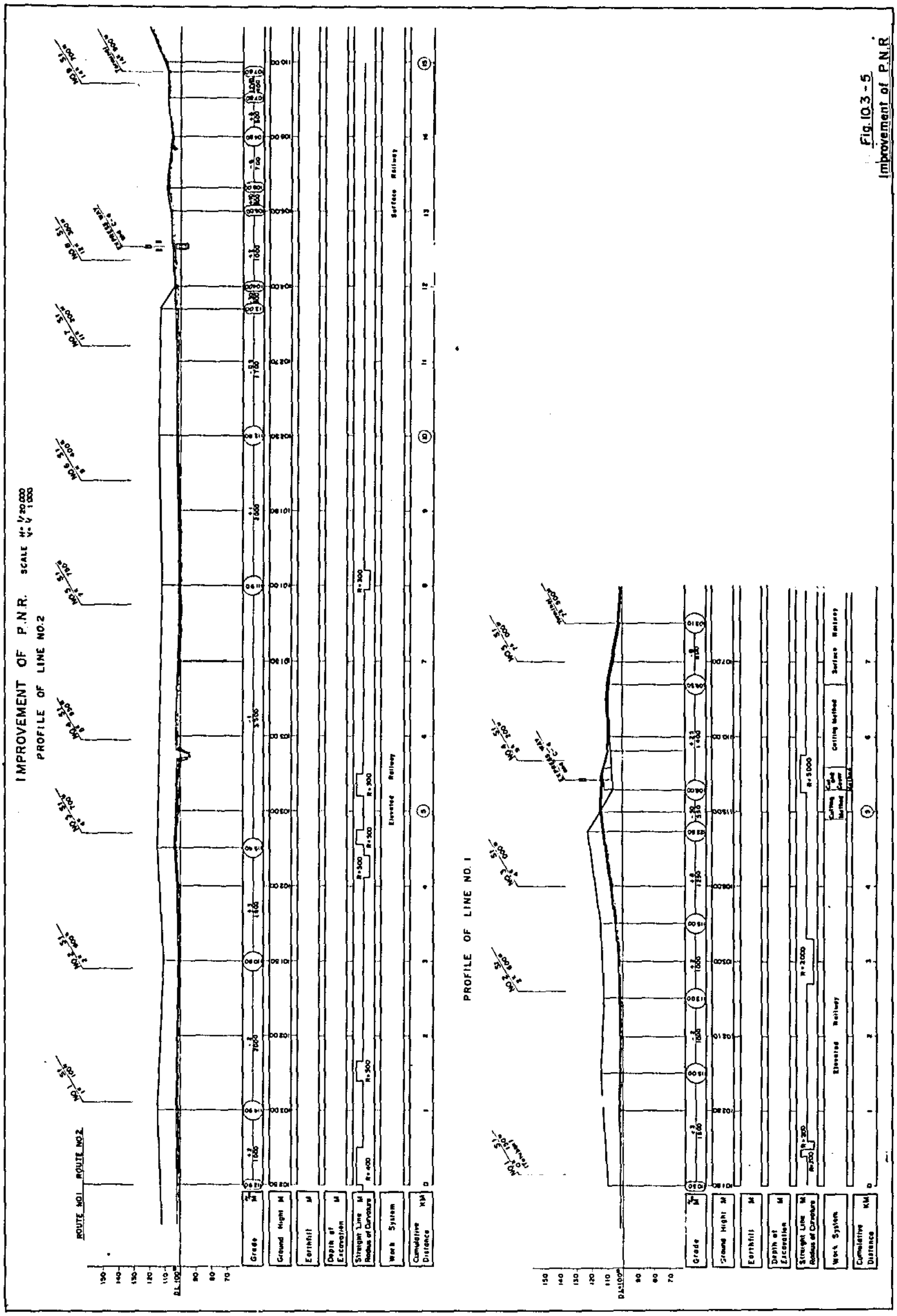

IMPROVEMENT OF P.N.R.
SCALE H: 1/20,000 V: 1/1,000
PROFILE OF LINE NO.2
PROFILE OF LINE NO.1
ROUTE NO.1
ROUTE NO.2
Grade
Ground Hight M
Earthfill M
Depth of Excavation M
Straight Line M
Radius of Curvature
Work System
Cumulative Distance KM
Elevated Railway
Surface Railway
Cutting Method
Fig. 10.3-5
Improvement of P.N.R

Table 10.3 - 1 Summary of Equipments for Subway Construction and PNR Improvement

Item	Unit	Line No. 1	Line No. 2	Line No. 3	Line No. 4	Line No. 5	P N R Improve	Remarks
Total Length	Km	21.7	25.6	23.0	19.0	8.0	22.5	
Tunnel L.	"	21.7	22.0	23.0	19.0	8.0	0.3	
Viaduct L.	"	-	1.6	-	-	-	17.0	
Surface L.	"	-	1.0	-	-	-	5.2	
Tracks	"	47.4	55.2	53.0	42.0	18.0	45.0	
Stations	Nos.	16	17	15	14	6	14	
Buildings	m^2	88,000	92,000	88,000	75,000	35,000	80,000	
Electric Substations	Nos.	4	5	4	4	2	4	
Electric Rooms	Sets	24	26	24	22	10	24	
Wirings	"	1	1	1	1	1	1	
Facilities of Signals	"	1	1	1	1	1	1	
A. T. S.	"	1	1	1	1	1	1	
Facilities of Communications	"	1	1	1	1	1	1	
Car Sheds	Nos.	1	1	1	1	1	-	

§ 10.4 Type of Structure

The rapid transit project includes the subway project and the PNR improvement project. The following is a study made on the optimum types of various structures required under these projects.

10.4.1 Design standards

Rolling stock gauge and construction gauge and other dimensions of structures shown in Fig. 10.4-1 will be applied to the proposed rapid transit system. For the gauge of track, the standard gauge of 1,435 mm, the most widely used gauge in the world, will be adopted. For the PNR improved section, however, the narrow gauge of 1,065 mm will be adopted in consideration of the future extension of services to the present PNR Major design standards are shown in Table 10.4-1.

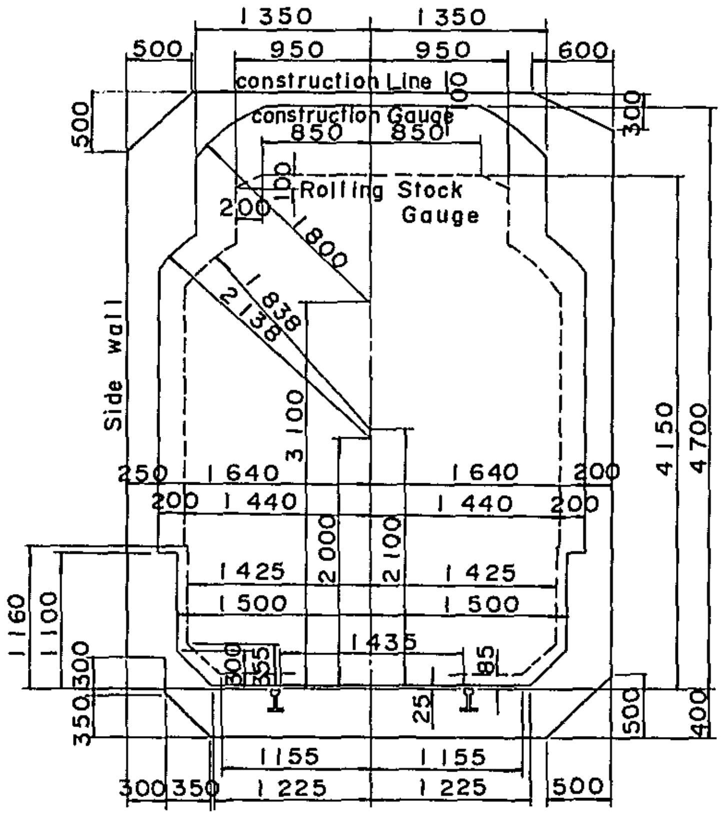


Fig 10.4-1 Construction Gauge and Rolling Stock Gauge.

Table 10.4 - 1 Design Standards

Item		Standards	Remarks
Minimum radius of curvature	Main line	160 m	
	Line attache-dat line Junction of main line	100 m	Radius of curvature at No. 8 junction is taken into consideration.
	Line along the platform	500m(400)	
Length of transition curve		When radius of curvature is smaller than 800m $L = 0.07\frac{V^3}{R}$ (m)	V: Velocity R: Radius of curvature V for R is provided separately.
Distance between transition curves in opposite directions		Longer than 15m	If impossible, straight line is not interposed.
Cant		$C = \frac{V^2}{R}$ (mm) C: Cant (mm) V: Velocity(km/hr) R: Radius (m)	No cant is provided where radius of curvature exceeds 800m. at the part along the platform. In case radius is less than 800m cant is provided for the train speed, 20 km/hr. Reduction in cant is made covering the straight length 300 times as long as the cant, where transition curve is not provded.
Maximum grade	Main line	35/1,000(50/1,000)	
	Within station	10/1,000	
	Side line	45/1,000	Less than 3/1000 for side line where retention of car is required.
Minimum grade		2/1,000	Not applicable to tracks along the platform (only underground)
Minimum longitudinal curve radius		3,000 m	Only when the plane curve radius is longer than 300m and when unavoidable, it can be made 2,500m and 2,000m respectively for the main line and side line.
Enlargement of construction gauge by means of curve.		W: $\frac{20,000}{R}$	W: Length to be extended on both sides (mm) R: Curve radius (m)
Slack		Where radius of curvature is smaller than 600m $S = \frac{4,500}{R} - 5$	S: Length to be extended toward inward of the curve (mm) R: Curve radius (m)
Space between R.L. and track bed bottom	Concrete bed	400 mm	500mm, in case the radius of curvature is smaller than 200m.
	Ballast bed	700 mm	The gravel ballast bed is used under houses or sections requiring protection from vibration.
Minimum space between centers of tracks			Surface line 3,600 m Underground line 4,130 m

Notes: (1) Increase of cants slack and excess shall be reduced over the full length of the transition curve.

(2) The minimum radius of curvature indicates the radius of the inward track.

(3) Relation between R and V in the formula for cant and the length of transition curve.

R(m)	160 60	200!00	250	300	350	400	Over 530
V(km/h)	42 42	50 50	55	60	65	70	80

10.4.2 Types of tunnel structure

Tunnel structure may be a box, arch or tube type as shown in Fig. 10.4-2. When the subway is constructed at a relatively small depth, the cut and cover method is generally employed for the box structure. The tube structure is used when the subway is constructed at a great depth from the ground level and the shield driving method may be employed to excavate a tunnel by means of compressed air. The arch type structure is used only in special cases and therefore is not widely employed.

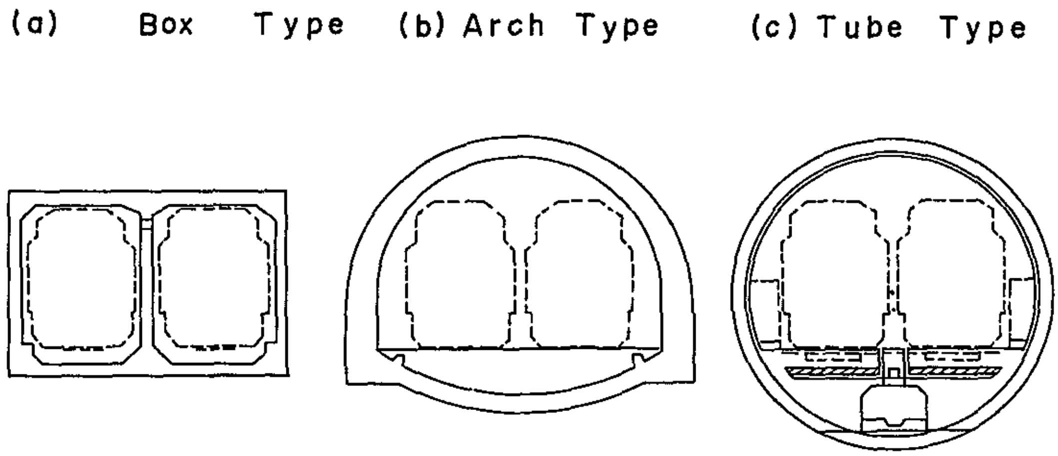


Fig. 10.4-2 Tunnel Structure Types.

The geography of Metropolitan Manila Area may be divided largely into two sections. One is the drainage basin and the delta area of the Pasig River, where the geology consists of sand of high fluidity, silt and cohesive soils. Since the part of Manila City is a low land area with the elevation of about 2 - 5 m from the sea level, the groundwater level is generally quite high. The other section extends along Highway 54 including Quezon city and consists mainly of guadalupe tuff providing good foundation and construction conditions.

In the planning of the constructions of tunnels, a safe and most economic construction method must be selected, giving due consideration to the topography, surface conditions (surface traffic included) and underground equipment in addition to the above geological conditions mentioned.

Some details of tunneling methods follow:

(a) Cut and cover method

In area where soil conditions are favorable and the groundwater level is low, H-piles are driven at intervals of about 15 m as shown in Fig. 10.4-3 (Type A). Sheathing boards are placed between the H-piles as excavation progresses. As the depth of cut increases, timbering, cross beams and walings are placed.

As the soft ground consisting of silt fractions or sandy silt layers usually has a high groundwater level, steel sheet-piles are driven prior to the start excavation as shown in Fig. 10.4-4 (Type B). For determination of the depth of sheet piles, a detailed geological study must be made in advance to prevent the possibility of heaving. Where the construction location does not permit the driving of sheet piles because of the public noisance and vibrational problems, excavation may precede and continuous cast-in-place concrete piles may be used as retaining walls in place of sheet piles, or retaining walls may be built directly underground and used as sidewalls.

In order not to obstruct traffic during construction it is essential that plank or other forms of temporary decking for street surfaces cut and cover excavation.

Type-A is the standard method to be employed for Line No. 3, which was planned along Highway 54. Type-B is the standard method applicable to the data area of the Pasig River where Line No. 1 or Line No. 2 is planned.

(b) Caisson method

The caisson method is employed for constructing a tunnel across narrow or medium rivers or where a tunnel is constructed at a relatively great depth in the soft ground. While this method has such disadvantages as the use of compressed air, it is a safe and accurate method for construction of tunnel. A rough drawing of this construction method is shown in Fig. 10.4-5.

(c) Sinking method

The sinking method is very advantageous as it enable construction of a tunnel at a relatively shallow depth when crossing wide rivers such as the Pasig River. A further advantage is the availability of a dock at the estuary of the

Pasig River for preparing steel elements for this method. In adopting this method, however, special care must be exercised so that it has no adverse effect on nearby river structures. A rough drawing of this method is shown in Fig. 10.4-6.

(d) Shield driving method

This method is employed for constructing a tunnel at a relatively great depth or where structures exist on the surface where the construction is taking place. With this method, a tunnel is dug horizontally with a shield machine regardless of the surface condition. Use of this method in the area with appropriate foundation will ensure efficient and safe progress of construction work. When this method is used, the cross section of a tunnel is usually circular.

10.4.3 Types of elevated structure (PNR improvement included)

While most of the proposed railways routes are of the underground structure except for a portion of Route No. 2 near its end, it is desirable to plan elevated structures of the future extensions to the suburbs as practically as possible to save construction costs. Grade separations at traffic intersections must be taken into considerations.

For the designs of elevated railways, the reinforced concrete three-span rigid frame bridge shown in Fig. 10.4-7 should be used as the standard type. However, P.C. bridges or metal bridges may be used for special cases for example a long span bridge. Since the elevated type causes more noise and vibration problems than the tunnel, the ballast roadbed should be employed. Synthetic rubber tie-plating should be used as a measure against these problems.

The elevated type should be employed not only for the extension of the subway but also for the improvement of PNR inside C-4. Even though the PNR adopted the narrow gauge (1, 065 mm), the elevated structure may be of the same type as that for the subway.

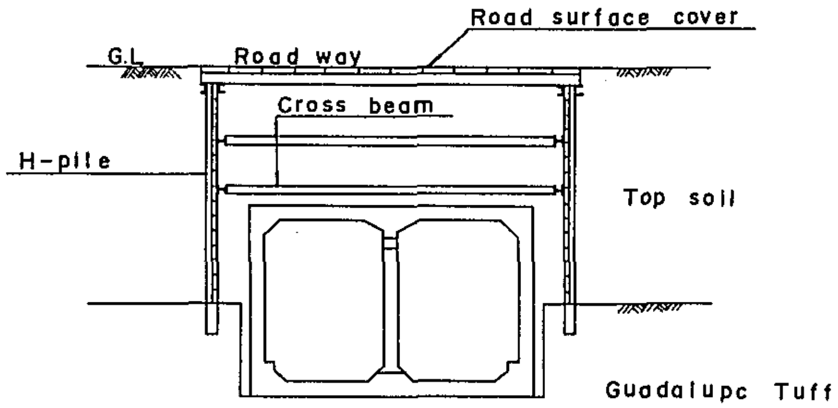


Fig.10.4-3 Cut and Cover method (Type-A)

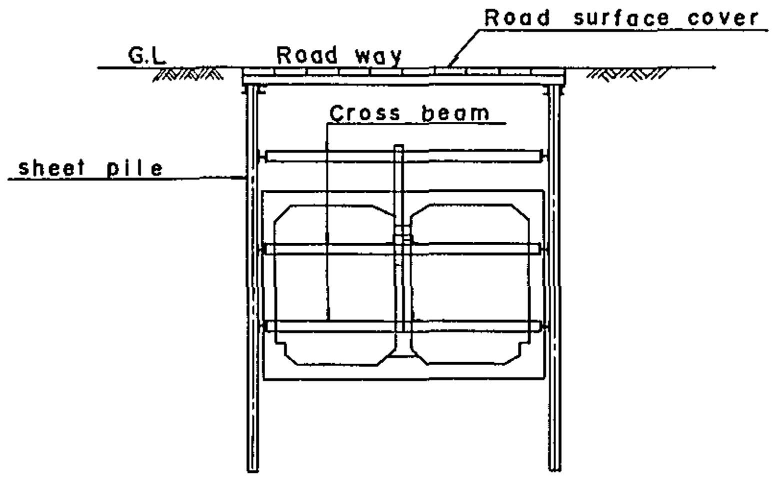


Fig.10.4-4 Cut and Cover method (Type-B)

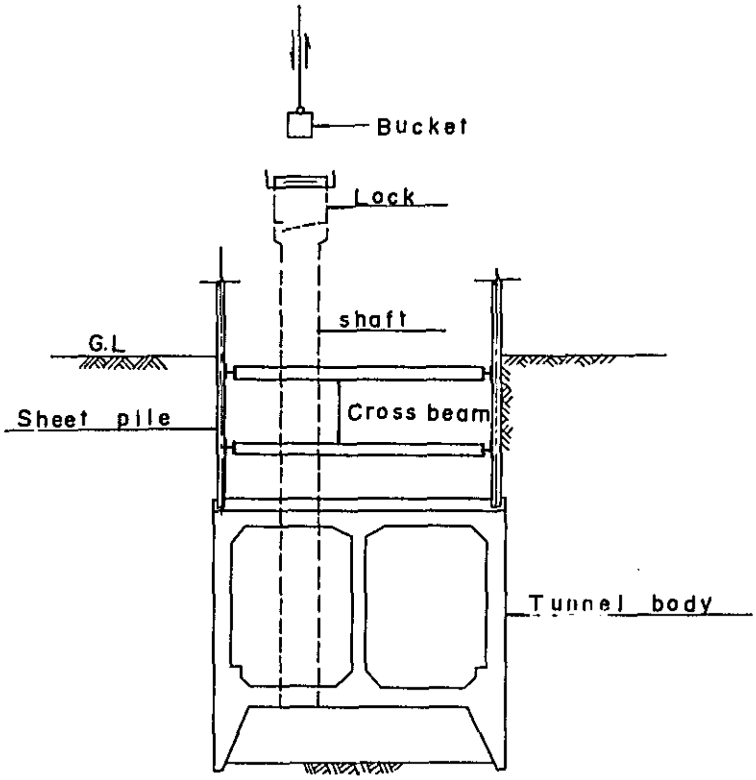


Fig. 10.4-5 Caisson Method.

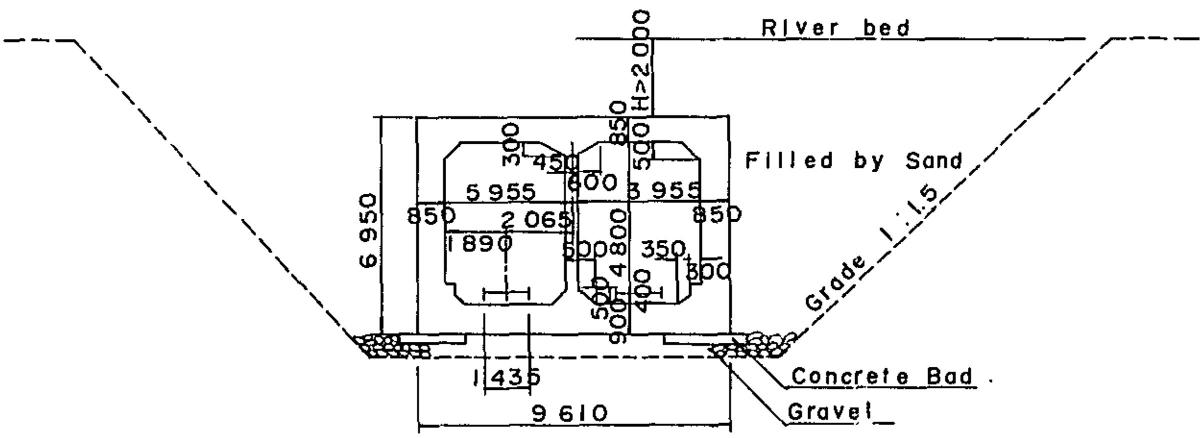
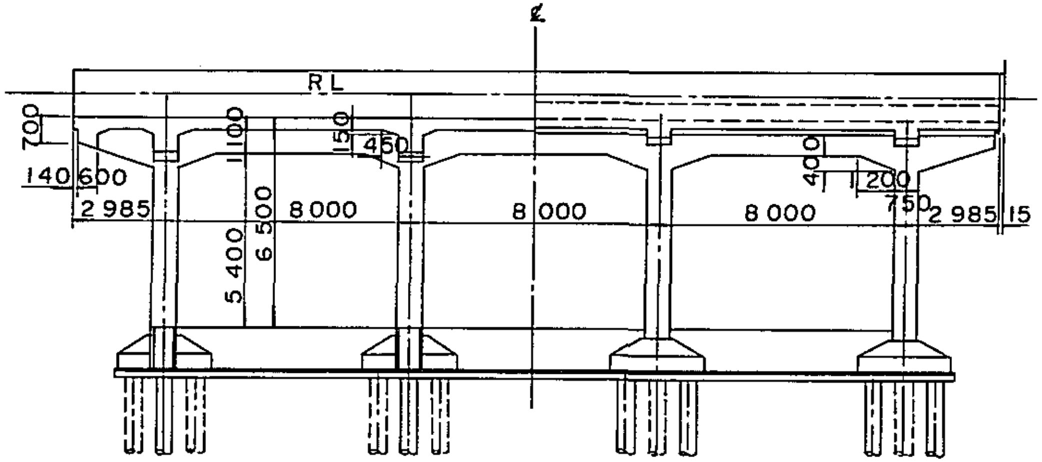


Fig. 10.4-6 Sinking Method.

Side View



Cross Section

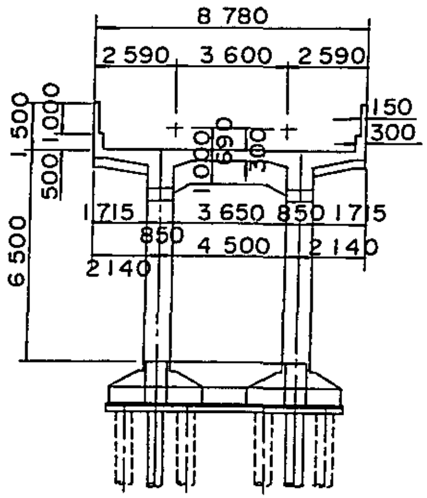


Fig.10.4-7 Standard Elevated Railway.

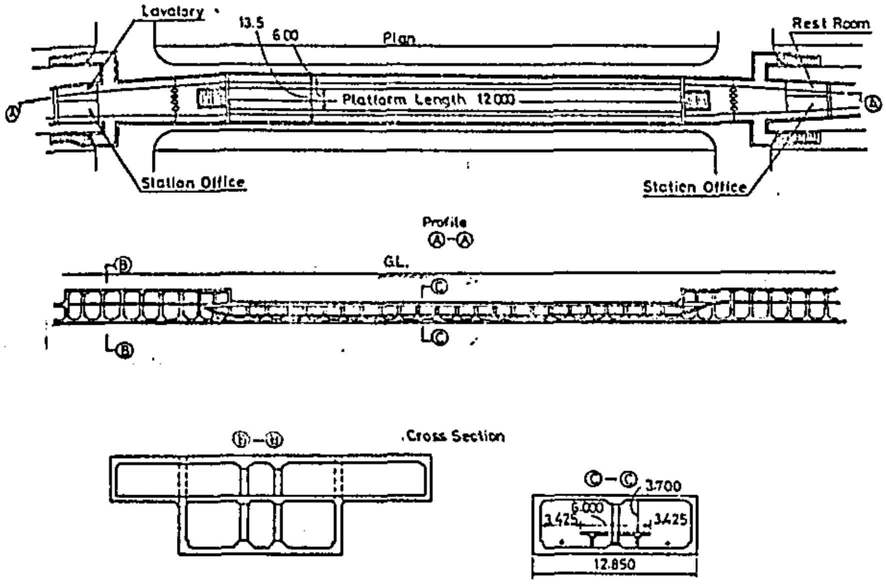
10.4.4 Types of station

A comparison of construction cost of an underground station with that of a standard tunnel section shows that the former costs is about three times more than the latter on the average. Therefore, the selection of the size of a station is an important factor of the planning.

There are two types of platform, the separate type and the island type. Generally the separate type which has a lower construction cost will be sufficient. For the stations in CBD and cross stations, the island type with a mezzanine should be employed. As a rule, it is best that the same platform: shade be used when transferring to other lines with different directions.

Stations must be equipped with various facilities required for operation depending on their size. The entrance, stairway, underpass and the widths of platform must be determined according to the estimated number of passengers at each station and the design of these facilities should provid the greatest convenience and efficiency in handling passengers.

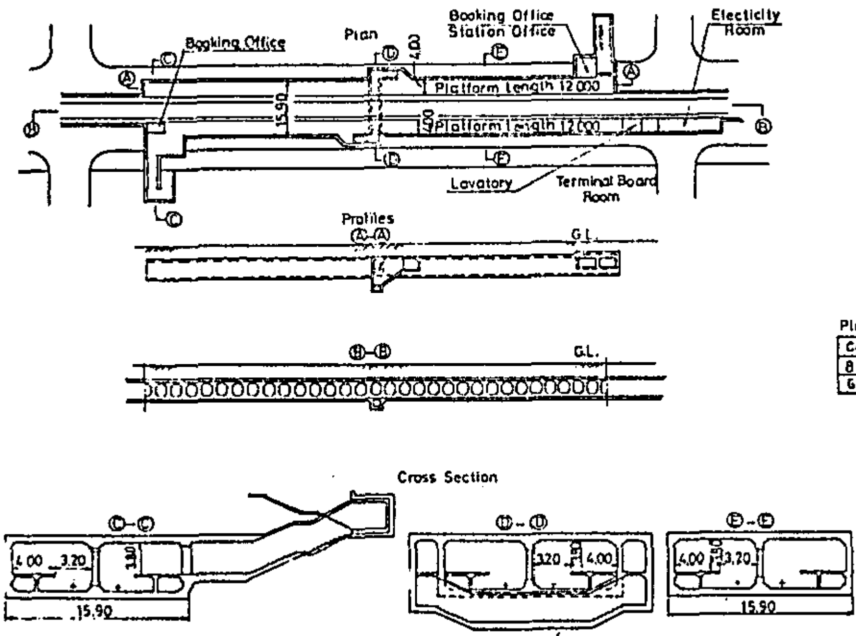
Sketch plans of stations are shown in Fig. 10.4-8 through Fig. 10.4-10.



Platform Length

Case	L^m
8cars	154
6cars	120

Fig. 10.4-8 General Plan .of Station (Type I)



Platform Length

Case	L^m
8cars	154
6cars	120

Fig. 10.4-9 General Plan of Station (Type II)

CONSULTING ENGINEERS NIKKEN CONSULTANTS. INC.

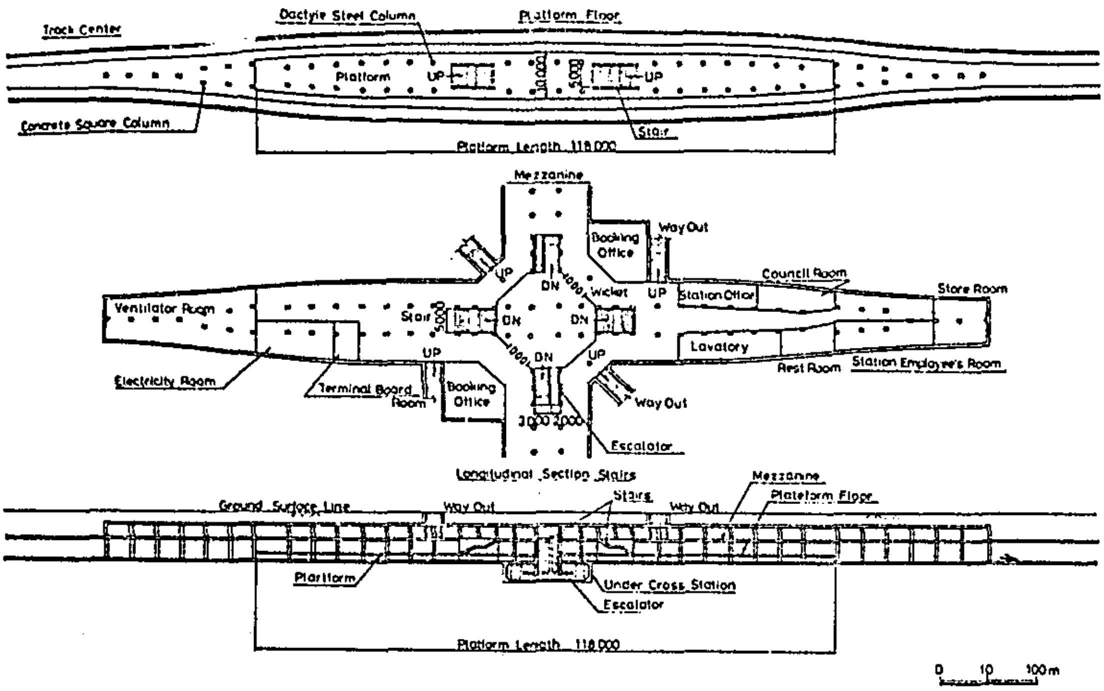


Fig. 10.4-10 General Plan of Cross Station

10.4.5 Types of electric facilities

Electric facilities includes the following;

(1) Electric substation

For a unit power consumption of 33 KWH/C-km for each line, an electric substation must be provided at intervals of about 5.0 km. This substation will receive high voltage electric power supplied from outside, rectify it to a 1,500 VDC with silicon rectifiers, feeding the DC power into feeding system. The substation will be automatic and will be under the centralized control of the control power station. Low voltage electric power supply for signals, communication facilities, lightings, drainage and ventilation system will be made from the power room of each station to which power of reduced voltage will be supplied separately.

(2) Signals and communication system

For signal systems, the Cab Signal-Automatic Train Control System (CS-ATC) should be employed for safety, promptness and efficiency of train operations.

For communication system, the up-to-date system should be employed for rationalization of management.

(3) Drainage system

In the tunnel section waste water drained at stations, rain water leaking into the tunnel and seepage of groundwater must be collected at the drain pits at the bottom of slopes and pumped out by pumping station.

The size of pumping stations must be determined to provide a maximum pumping capacity while taking into account the effect of topography of the site, tunnel structure, construction method and the quantity of groundwater. In general at least three pumps are provided for each pumping stations.

It is necessary to provide special facilities to prevent the entry of rain-water through the ventilation ducts or the entrance to the station and also to prevent inundation by flood.

(4) Ventilation and air-conditioning systems

While the temperature inside tunnel is generally lower than that of the open air, both temperature and humidity inside a tunnel rises gradually through effect of radiation heat from the car with the increase of passengers and train operating frequency. Air-conditioning system to counter this problem require considerable space for installation and careful study must be made at the initial stage of construction for this requirement.

(5) Disaster prevention facilities

Possible disasters in subways include fires, flood, earthquakes, and power failures. In order to counteract these emergencies, sufficient preventative and protective equipment must be provided. In order to eliminate the possibility of collisions or other accidents in the tunnel, atmost care must be exercised in the maintenance of various security equipment.

10.4.6 Car and maintenance facilities

(1) Car

Cars for the proposed rapid transit must have modern equipment and high safety factors. The main features of rolling stock will be as follows.

Car type :	metallic, electric welded double-axle bogie car
Formation :	6 - 8 car formation, all electric car
Track gauge :	1,435 mm for subway
	1,065 mm for PNR improvement
Power supply :	1,500 V DC overhead contact wire type
Capacity :	120 passengers
Max operating speed :	100 km/H

Dimensions of car are as shown in Fig. 10.4-11.

(2) Inspection and maintenance facilities

Inspection and maintenance facilities for rolling stock consist of car shed and work shop which may be provided separately.

It is ideal to provide a car shed for each line to perform normal cleaning and a work shop at a location where rolling stock from all lines may be brought for maintenance and repair. However, the completion of each line of the subway differs in timing from one another and workshop and the car shed will have to be provided at the same location.

Construction of a car shed and a maintenance shop will require 45,000 m^2 of land and about 8,000 m^2 of floor space. A typical layout of car shed and workshop is shown in Fig. 10.4-12.

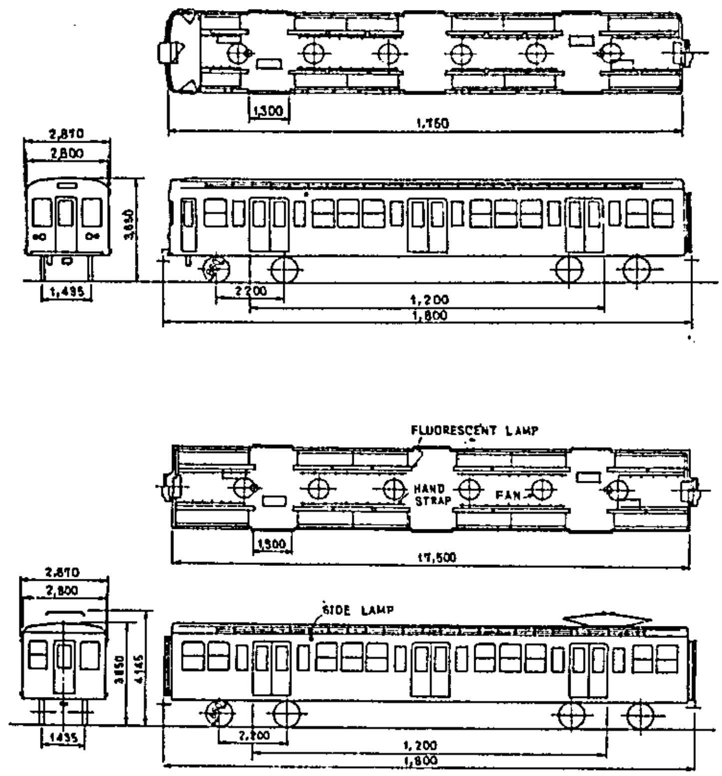


Fig. 10.4-11 Standard Electric Car

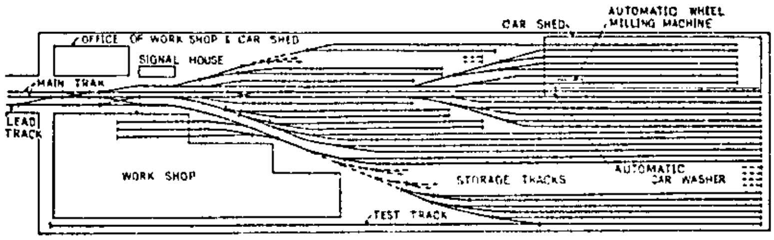


Fig. 10.4-12 Car shed and Work shop

10.5 Construction Schedule and Construction Cost

10.5.1 Construction schedule

The main element of construction of the network is civil engineering constructions. As the construction progress, track laying follows after which electrical materials and equipment will be installed.

Relatively early completion of tunnel may be expected in areas where the soil condition is favorable. In the delta areas of Pasig River, for route intersecting the river and other routes underground, and anywhere in CBD, construction will be complicated. These influences may delay the completion of construction.

On the basis that the route is diveded into construction sections of 500 m - 800 m in length, the estimated construction time for each method is as follows though a slight difference in construction time may be unavoidable between the ordinary section and the station section.

1. Cut and cover method (firm ground, H-pile used) - about 21 months
2. Cut and cover method (poor sub, sheet-pile used) - about 25 months
3. Caisson method and shield driving method - about 33 months
4. Elevated bridges - about 18 months

When the caisson method or the shield driving method is employed, it is important to initiate works by these methods prior to the start of work by other methods.

Construction time of the rapid transit system cannot be determined definitely since it is further influenced by the natural condition (especially rainfall) of the site, capacilities of constractors and the availability of construction materials apart from the previously mentioned standard construction time. As a reasonal construction time, four years should be expected to complete the first 10 km. However, the completion of the first 10 km will establish a firm construction method and should enable reduction of construction time for other routes.

10.5.2 Construction cost

The Philippines has never experienced the construction of a large scale rapid transit system such as this project. Therefore, calculation of construction cost will be based on the construction cost in Tokyo, with proper currency adjustment.

The urban rapid transit network has a total length of 183.4 km. Estimation of construction cost for the 121 km section which are inside C-4 (inclusive) near outside C-4 is relatively accurate and is shown in Table 10.5-1. Construction cost for the extensions to the suburbs was estimated at the rate of 37.4 million pesos/km. Construction cost of the entire network is shown in Table 10.5-2. Estimation was made on the following conditions.

(1) Construction work is within the scope described in this report and does not include future extensions.

(2) Expenses incurred with regards to the raising funds and importation of construction materials are not included.

(3) Compensation for land and buildings affected by the project was considered to be 5 - 6% of the total construction cost.

(4) Miscellaneous expenses including engineering fee, cost of survey and construction supervision etc, are to be 25% of the total cost.

(5) Estimation was made at the conversion rate of ₱ = ¥50 and at the present price and assuming that no fluctuation occurs at the time of construction.

Table 10.5 - 1 Construction Cost (Network inside C-4 and near to outside C-4 121.1 k'm)

Unit: million ₱

Line Nos. / Length	No. 1 / 21.7km	No. 2 / 25.6km	No. 3 / 24.3km	No. 4 / 19.0km	No. 5 / 8.0km	PNR / 22.5km	Remarks
Structural Works	1,296.0	1,530.0	1,870.0	1,560.0	480.0	360.0	
Tracks	63.6	75.0	74.2	56.4	24.2	26.4	
Buildings	82.6	83.6	106.4	70.6	33.0	70.0	
Electrical Facilities	148.8	175.4	197.8	136.8	57.6	148.8	
Mechanical Facilities	23.6	27.8	15.2	19.6	8.6	23.6	Drainage and Air-conditioning
Side expenses	94.4	139.2	152.2	87.6	40.8	-	(5% - 6%)
Administration	429.0	509.0	622.2	485.0	163.8	176.2	(25%)
Total Cost	2,138.0	2,540.0	3,032.0	2,416.0	608.0	805.0	
Average Cost	98.6	99.2	124.8	127.2	101.0	35.8	Million ₱/km

Table 10.5 - 2 Construction Cost (Entire network, 183.4 km)

Unit: Million ₱

Line Nos.	No. 1	No. 2	No. 3	No. 4	No. 5	PNR	
Length	27.1km	36.0km	24.3km	30.1km	17.6km	48.3km	183.4km
Total Cost	2,340.0	2,928.0	3,032.0	2,832.0	1,168.0	1,770.0	14,070.0
Average Cost	86.4	81.4	124.8	94.0	66.2	36.6	76.6 Million ₱/km

§ 10.6 Benefits

10.6.1 Estimation of benefits

The economic effect of the construction of urban rapid transit networks is represented by the development of sub-centers in the surrounding area and new towns in the suburbs. The reduction of travel time from CBD and sub-centers along C-4 will in turn accelerate the dispersal of urban population and decentralization of industries and other employment areas nearby promoting more rational expansion of the metropolis.

The benefits of such an economic effect based on the following assumptions:

1) Savings of travel time by passengers

Passengers of the urban rapid transit railway spend less time in travelling from the point of origin to the destination as compared with other transport systems and may utilize the time thus saved to improve the efficiency of production activities or allocate to other purposes. For example, demand/ supply relations of labor force may improve to some extent.

2) Savings of investment for road construction

Major roads in the downtown area have already reached the point of saturation and additional construction and improvement of roads are required to meet the ever increasing traffic demand. Under these circumstances, construction of an urban rapid transit system will contribute to some extent to the savings of investments for road construction.

3) Savings of investments for buses and their operating expenses

In the absence of the urban rapid transit passengers must be transported by bus. Construction of urban rapid transit will contribute to the savings of investments for buses and of their operating expenses.

4) Savings of expenses for handling accidents

The rate of accidents by urban rapid transit is generally very small compared with that for automobiles, and this difference in the rate of accidents contributes to the savings of accident expenses.

5) Increase in the land use value

The urban rapid transit will enable CBD to attract more customers and manpower from a wide range of area and will increase central area land values within reasonable limits of CBD expansion as presided by the accepted pattern of development postulated in chapter 5.

The reduction in travel time from CBD to the suburbs will also result in increases of the land value in the suburbs. Reference is made elsewhere to the possible recovery of all or part of such increases for the public benefit.

6) Lessening of air pollution problems

Air pollution caused by automobile exhaust is posing a serious problem in advanced countries. The future total running kilometers of all vehicles and the consequent air pollution will be less with rapid transit than without.

Of these benefits, the ones that can be measured in monetary term will be the savings of travel time, savings of investments for road construction, savings of investments for buses and of their operating expenses and the increase in the land use value. The total of these benefits amounts to an enormous figure of 64 billion pesos with a breakdown as follows.

1)	Savings of travel time	-	₱36,347 million
2)	Savings of investments for roads	-	₱ 4,770 million
3)	Savings of investments for buses and operating expenses	-	₱15,265 million
4)	Increase of land use value	-	₱ 7,320 million
	Total	-	₱63,702 million

The benefits are estimated by item as follows:

(1) Savings of travel time (ΔT_s)

$$\Delta T_s = P_r \cdot Q_r \cdot (T_b - T_r) \cdot R_1$$

where P_r : Time value of railway passengers (1.1071 ¢ /min. same as that of bus and jeepney passengers)

Q_r : Total passengers for 30 years (87,230 million persons from Table 10.1-1)

T_b : Travel time by bus (10 kms./hr. based upon the traffic assignment)

T_r : Travel time by railway (33 kms./hr. same as that in Japan)

R_l : Length of railways used by a passenger (9 kms. based upon the traffic assignment)

$$T_s = 1.1071 \text{ ₵ } \times 87,230 \text{ million persons } \times (\frac{60}{10} - \frac{60}{33}) \times 9 \text{ kms.}$$

$$= 36,347 \text{ million Pesos}$$

(2) Savings of investments for roads (ΔR_s)

$$\Delta R_s = N_r \cdot N_c$$

where N_r : Land area for additional roads without railways

N_c : Unit cost for road construction

$$N_r = \frac{T_p}{P_h} \cdot \frac{1}{Q_b \cdot B_s} \cdot W. R_w \cdot R_l$$

where T_p : Railway passengers per day (4,304 thousand persons from Table 6.7-4)

P_h : Peak ratio (10%)

Q_b : Passengers per bus (36 persons)

B_s: Frequency of bus services during peak hour (120 times/hr.)

W : Directions of roads (2)

R_w: Width of a road (3.5 ms)

R_l : Length of a road (9 kms. same as that of a railway used by a passenger)

$$N_r = \frac{4,304 \text{ thousand persons}}{10\%} \times \frac{1}{36 \times 120} \times 2 \times 3.5 \times 9 \text{ kms.}$$

$$= 6,276,665 \text{ m}^2$$

$$N_c = L_p + R_c$$

where L_p : Cost for land acquisition (₱ 300/m² x 1.2)

R_c : Cost for road construction (₱400 /m²)

$$N_c = 300 \text{ ₱/m}^2 \times 1.2 + 400 \text{ ₱/m}^2$$

$$= 760 \text{ ₱/m}^2$$

$\Delta R_s = 6,276,665\ m^2 \times 760\ P/m^2$

$= 4,770$ million pesos

(3) Savings for buses and operating expenses (ΔB_s)

$\Delta B_s = Q_r \cdot Q_b \cdot R_1 \cdot Bc$

where Q_r : Do.

Q_b : Do.

R_1 : Do.

B_c : Unit cost of bus operation (0.7 Pesos/km. considering that the unit cost is 2.4 Pesos/km. in Japan and the personnel expenses and the fuel cost in Manila are from 30% to 40% of those in Japan)

$\Delta B_s = 87,230$ million persons $\times \frac{1}{36} \times 9$ kms. $\times$ 0.7 ₱/km.

= 15,265 million Pesos

(4) Increase of land use value (ΔU_s)

$\Delta U_s = S_l \cdot I_w \cdot L_p \cdot U_r$

where S_l : Length of railways (183 kms.)

I_w : Areas served by a railway line (500 ms. in a side)

L_p : Unit land price of the above areas (200 ₱/m^2)

U_R : Increasing rate of land price (20%)

ΔU_s = 183,000 m x (500 m + 500 m) x 200 ₱ x 20%

= 7,320 million pesos

10.6.2 Estimation of expenses

Operating schedule will have to be established on the basis of the master plan of the urban rapid transit project, from which the required manpower and expenses will be estimated using recent data in Japan as a comparative basis.

For operation and management, the following conditions have been established.

a) Train operating schedule keeping the loading efficiency in rush hours in the most congested section below 150% is to be maintained but loading efficiency may exceed 200% in some short sections.

b) Train formation will be uniform all day.

c) Operation of stations will be automated to the extent as possible. Staff of ordinary stations limited to maintenance and security personnel. Such sales promotion activities as the sale of season tickets and handling of groups of passengers taken up by administrative stations.

d) Train operation controlled by operation center.

e) Calculation of personnel expenses is based on the five-day working system.

The master plan of Manila Rapid Transit System is shown in Table 10.6-1.

Table 10.6-1 Basis for Operating Cost

Line No.	No. 1	No. 2	No. 3	No. 4	No. 5	PNR	Totals
(A) Length	27.1	36.0	24.3	30.1	17.6	48.3	km 183.4
(B) Number of admi-strative stations	2	2	2	2	1	3	12
(C) Number of ordinary stations	16	20	14	17	10	24	101
(D) Operation center	1	1	1	1	1	1	6

Calculation on the basis of the foregoing train operating schedule provides:

a) Train and car running mileage as shown in Table 10.6-2.

b) Number of employees required for management as shown in Table 10.6-3.

c) Operating cost as shown in Table 10.6-4.

The project cost consists of construction cost and cost of rolling stock. A breakdown of project cost is shown in Table 10.6-5.

Table 10.6 - 2 Train and Car Running Mileage

Line Nos.		No. 1	No. 2	No. 3	No. 4	No. 5	PNR	Totals
(E)	Nos. of round trip operations (trains)	604	604	604	604	604	604	3,624
(F)	Daily Train running mileage (A x E) (kms.)	16,368	21,744	14,677	18,180	10,630	29,173	110,774
(G)	Car training (cars)	8	8	8	8	8	8	-
(H)	Daily car running mileage (F x G) (kms.)	130,947	173,952	117,418	145,443	85,043	233,386	886,189
(I)	Annual car running mileage (H x 353) (1,000 kms.)	46,224	61,405	41,448	51,341	30,020	82,385	312,825
(J)	Numbers of cars (cars)	352	453	320	389	245	603	2,362

Note: (I) 353 = 365 days - (52 days x 0.25)

Table 10.6 - 3 Number of Railway Personnels

(persons)

Line Nos.		No. 1	No. 2	No. 3	No. 4	No. 5	PNR	Totals
(K)	Administrative Stations (B x 19 persons)	38	38	38	38	19	57	228
(L)	Ordinary Stations (C x 8 persons)	128	160	112	136	80	192	808
(M)	Operation Centers (D x 11 persons)	11	11	11	11	11	11	66
(N)	Track Maintenance (A x 4.869 persons)	132	175	118	147	86	235	893
(O)	Power Maintenance (A x 7.020 persons)	190	253	171	211	124	339	1,288
(P)	Car Maintenance (J x 1.124 persons)	396	509	360	437	275	678	2,655
(Q)	Train Operating Personnels	498	634	457	544	351	822	3,303
(R)	Sub-totals	1,393	1,780	1,264	1,521	946	2,334	9,238
(S)	Administrative (R x 0.559 persons)	78	100	71	85	53	131	518
(T)	Totals	1,471	1,880	1,335	1,606	999	2,465	9,756

Note: The unit figure for each category is based on data in Japan

Table 10.6 - 4 Annual Operating Cost

(1,000 Pesos)

Line Nos.	No. 1	No. 2	No. 3	No. 4	No. 5	PNR	Totals
Personnel Expense	12,356	15,792	11,214	13,490	8,392	20,706	81,950
Power Cost	12,625	16,771	11,320	14,022	8,199	22,501	85,438
Maintenance Cost (for cars)	2,339	3,107	2,097	2,598	1,519	4,169	15,827
Maintenance Cost (for others)	1,988	2,641	1,783	2,208	1,291	3,543	13,454
Other Expenses	5,032	6,685	4,512	5,589	3,268	8,968	34,054
Totals	34,340	44,996	30,926	37,907	22,669	59,887	230,723

Notes: Personnel Expense = (T) x 8,400₱
Power Cost = (I) x 0.273₱
Maintenance Cost (for cars) = (I) x 0.0506₱
Maintenance Cost (for others) = (A) x 73.36₱
Other Expenses = (A) x 185.68₱

Table 10.6 - 5 Project Cost

(million Pesos)

Line Nos.	No. 1	No. 2	No. 3	No. 4	No. 5	PNR	Totals
Construction Costs	2,340.0	2,928.0	3,032.0	2,832.0	1,168.0	1,770.0	14,070.0
Costs of Cars	457.6	588.9	416.0	375.7	318.5	783.9	3,070.6
Totals	2,797.6	3,516.9	3,448.0	3,207.7	1,486.5	2,553.9	17,140.6

Notes: 1. Construction cost is based on the estimation made in 10.5.
2. Cost of a car is estimated at 1.3 million ₱/car.

Table 10.6 - 6 Comparison of Benefit and Cost of Railways

(million Pesos)

Benefit	Savings of travel time	36,347
	Savings of investments for roads	4,770
	Savings of investments for buses and operating expenses	15,265
	Increase of land use value	7,320
	Total	63,702
Cost	Construction cost	14,070
	Vehicle cost	5,118
	Operating cost	6,992
	Total	26,110
Balance (Net benefit)		37,592

Remarks: The period for comparison is 30 years.
The price is fixed as of 1970.
The life span of a vehicle is 18 years.

10.6.3 Comparison of cost and benefit

A comparison of cost and benefit as estimated so far shows a social benefit amounting to more than 37 billion pesos for 30 years as shown in Table 10.6-6.

§ 10.7 Construction Priority

The order of priority for construction of the proposed lines of urban rapid transit must be considered on the basis of the following conditions.

a) Top priority must be given to the section which fulfills the requirement of mass rapid transit, the prime mission of the rapid transit system, as practically as possible.

b) Top priority must be given also to the section in which the effect on the alleviation of surface traffic, one of the prime objects of the rapid transit system, is greatest.

c) Rapid transit system must be operated on the sections and distances from which some operating results can be expected. Therefore, the route must be selected in CBD and the length of an operating section must be over 5 km.

d) Construction must begin with the section which renders the least difficulty in the progress of work.

When a comparison is made between the proposed lines on the basis of the above requirements, it is considered best to start with Line No. 1. This line originates in the new capital city of Quezon, passes through CBD and extends southward to the airport.

Since the construction of a subway requires an investment twice to three times greater than that for an expressway, construction of a longer section at a time is not possible also from a financial point of view. It is advisable, therefore, to complete the 14 km section of Route No. 1 between CBD and Quezon first.

On the other hand, operation of an urban rapid transit must be preceded by the establishment of a fairly large organization. For the establishment of an organization, effective use of the present PNR as a guideline is considered advisable. In this context, construction of the 5.7 km section of the PNR improvement extending from

Tutuban Station toward the north simultaneously with the construction of the subway is advisable. While the construction of a subway between CBD and Quezon requires about four years for completion, improvement of the PNR involves mostly the elevated type or surface type utilizing the existing right of way and enables operation in about two and half years. It is advisable to use this one and a half year, the gap between the two, for the establishment of an organization required for the operation of a subway (including training of motormen and administrative personnel) to prepare for the inauguration of efficient operation immediately upon completion of the subway.

In any event, the first requirement is to plan for early completion of the sections mentioned above in order to establish a construction method, an operating organization and the habits of residents in the use of the subway for commutation, and thereafter the order of construction priority will be determined automatically by traffic demand and other conditions. Since the positive cooperation of the residents is indispensable to the construction work in CBD, it is important that the benefit of the urban rapid transit is fully recognized by the residents.

All railway lines proposed in this report should be opened for transportation as early as possible, judging from the existing traffic demand for the mass transit system.

The improved sections of the above 5.7 kms. of PNR and Subway Line No. 1 are desired to be open for the transportation within five years to come. The remaining sections and lines should be completed within fifteen years to come.

§ 10.8 Operating Plan

10.8.1 Operating organization

The operating organization of an urban rapid transit railway may be a private enterprise wholly owned by private sectors or a public corporation wholly owned by the central government or local government.

Because of financial burdens such as high construction cost and maintenance and operating cost, the business performance of the urban rapid transit railway in Japan is not favorable and shows a deficit even with financing aids from the central government and local governments. Under these circumstances, management of a railway by a private enterprise is considered extremely difficult except for special cases in which the enterprise also engages in other businesses such as the development of new towns and is able to count in the profit of such an undertaking.

It would be appropriate, therefore, to place the Manila Urban Rapid Transit System under the management of a public corporation in any of the following forms.

a) Corporation invested by such municipalities as Manila, Caloocan Quezon, Pasay, Rizal or Bulacan in which the urban rapid transit is constructed.

b) Corporation invested jointly by the local governments concerned and the central government.

c) Corporation invested wholly by the central government
A fourth alternative is that of operation by a relevent government agency.

Appropriateness of the form of public corporation is not merely because the management of urban rapid transit has to depend on the financial aid of the central or local governments but also because the rapid transit system is closely related to urban planning and is indispensable to the development of a metropolis, and moreover, the central government or local governments will be able to gain benefits of development indirectly by the increase of tax revenue.

10.8.2 Fare system

The fare system that obtains passengers' compliance and is most rational and economical from the management point of view is desirable.

a) Regular passenger fare

(1) Block fare system

Since the mileage fare system for each station will only complicate the work at stations and the flat fare system will make the fare generally high and may not be fair to all passengers, it would be appropriate to divide the network into blocks and adopt the flat fare system for each block.

(2) Separate fare system for adults and children

This system is presently employed for bus and will be applied to the proposed rapid transit railway.

Adults	-	Over 12 years of age
Children	-	Over 6 years and under 12 years of age .... Half of the fare for adults.
Infants	-	Under 6 years of age - Free

b) Commuters' fare

It is better to adopt the commutation ticket system which is very convenient for handling efficiently a large number of commuters going to work and school in a limited time.

An unreasonably high discount rate of commutation ticket may result in a decrease of operating revenue. A low discount rate lessens the merit of the commutation ticket system and encourages commuters to buy regular tickets as required with resultant congestion at the ticket office. It would be appropriate, therefore, to determine the discount rate as follows with a view to maintaining the balance between the two.

Commutation tickets for workers - 30% discount
(Round trip fares for 21 days a month)
Commutation tickets for students - 40% discount
(Round trip fares for 18 days a month)

c) Early morning discount rate

Congestion during the morning and evening rush hours is expected to reach 200% loading efficiency in some sections even when the trains are operated at two-minute headway. Otherwise the system is idle in the time zone other than rush hours. In order to make good use of such idling facilities and contribute to the alleviation of congestion during rush hours, it may be necessary to take such measures as the reduction of off-peak fares for by up to 50% to attract passengers.

d) Rate of passenger fare

The rate of passenger fare should be kept to the minimum in order to attract passengers from the surface transport system. Since the urban rapid transit travels faster than busses and jeepneys and operates on schedule, a slightly higher rate than bus fare may be justified.

For profitability study, the rate of oneway fare is set at 50¢ for an average trip distance of 9 km.

e) Joint fare adjustment with P N R

Since the Manila Urban Rapid Transit network includes improvement of part of P N R , the joint fare adjustment system should be employed to eliminate inconvenience of passengers using both systems.

10.8.3 Profitability

A profitability study is made for Manila Urban Rapid Transit on the following conditions.

a) Project cost and operating expense as estimated in Section 10.6.

b) Service life of rolling stock, 18 years.

c) Operating expense for the first year of operation twice that for other years since it includes expense required for training of employees.

d) Number of passengers as estimated in Section 6.7.

e) Revenue per passenger is estimated to be ($50 ¢ \times \frac{8}{10} = 40 ¢$) on the average in view of the proposed discount for commuters.

f) Interest rate of 4 %.

On the basis of the above conditions, the term of repayment will be 49 years as shown in Table 10.8-1.

If construction cost increases by 30% and the operating expense and revenue remain the same, repayment would not be possible at an interest rate of 4% and would last for 62 years at an interest rate of 3 %.

Table 10. 8 - 1 Repayment Program of Railways

Years		A	B	C	D
in Calendar	from Opening	Annual Passengers (million persons)	Annual Revenue (A x 40c) (million pesos)	Repayment (B-Annual Operation Cost) (million pesos)	Balance incl. Interest (million Pesos)
1987	1	2310	924. 0	462. 0	17364. 2
1988	2	2438	975. 2	744. 2	17314. 6
1989	3	2575	1030. 0	799. 0	17208. 2
1990	4	2703	1081. 2	850. 2	17046. 3
1991	5	2816	1126. 4	895. 4	16832. 8
1992	6	2876	1150. 4	919. 4	16586. 7
1993	7	2911	1164. 4	933. 4	16316. 8
1994	8	2932	1172. 8	941. 8	16027. 7
1995	9	2945	1178. 0	947. 0	15721. 8
1996	10	2959	1183. 6	952. 6	15398. 1
1997	11	2974	1189. 6	958. 6	15055. 4
1998	12	2989	1195. 6	964. 6	14693. 0
1999	13	"	"	"	14316. 1
2000	14	"	"	"	13924. 1
2001	15	"	"	"	13516. 5
2002	16	"	"	"	13092. 6
2003	17	"	"	"	12651. 7
2004	18	"	"	"	12193. 2
2005	19	"	"	"	14909. 6*
2006	20	"	"	"	14541. 4
2007	21	"	"	"	14158. 5
2008	22	"	"	"	13760. 2
2009	23	"	"	"	13346. 0
2010	24	"	"	"	12915. 2
2011	25	"	"	"	12467. 2
2012	26	"	"	"	12001. 3
2013	27	"	"	"	11516. 8
2014	28	"	"	"	11012. 9
2015	29	"	"	"	10488. 8
2016	30	"	"	"	9943. 8
2017	31	"	"	"	9377. 0
2018	32	"	"	"	8787. 5
2019	33	"	"	"	8174. 4
2020	34	"	"	"	7536. 8
2021	35	"	"	"	6873. 7
2022	36	"	"	"	6184. 0
2023	37	"	"	"	8660. 1*
2024	38	"	"	"	8641. 9
2025	39	"	"	"	7399. 0
2026	40	"	"	"	6730. 4
2027	41	"	"	"	6035. 0
2028	42	"	"	"	5311. 8
2029	43	"	"	"	4559. 7
2030	44	"	"	"	3777. 5
2031	45	"	"	"	2964. 0
2032	46	"	"	"	2118. 0
2033	47	"	"	"	1238. 1
2034	48	"	"	"	32. 3
2035	49	"	"	"	628. 7

Remarks (million Pesos)

Construction Cost		17, 140. 6
Operation Cost	1st year	462
	2nd & followings	231
* Replacement of Vehicles		3, 070. 5

CHAPTER 11 QUESTIONS FOR FUTURE SOLUTION

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§ 11.1 Projects for Immediate Feasibility Study

For each of the projects covered by this report, a continuous study must be made to work out more definite and detailed plans. In particular, feasibility studies should be initiated as soon as possible for the following transport facilities.

Improvement of existing intersections between major thoroughfares *

Circumferential major thoroughfare	C - 2*
Circumferential major thoroughfare	C - 3*
Circumferential major thoroughfare	C - 4
Radial major thoroughfare	R - 1
Radial major thoroughfare	R - 4
Radial major thoroughfare	R - 6* (claro M. Recto Extension, between C-1 and C-2)
Radial major thoroughfare	R - 10
Expressway	Route No. 1 (Over C-4)
Expressway	Route No. 2 (Over R-10)
Improvement of PNR	(Meycauyan - Tutuban Station - near Lagna De Bay)
Subway Line No. 1	(Center of Quezon city - CBD - near Manila International Airport)
Subway Line No. 2	(Outside C-4 - CBD - Pasig)
Subway Line No. 3	(Along C-4)

* Urgent projects. The detailed design and the construction work should go immediately after the preliminary feasibility study without the detailed feasibility study.

§11.2 Emergency Improvements of Surface Roads

The projects shown above are only the large scale ones. As far as roads are concerned, relatively small projects such as partial improvement of roads, which do not fall under the category of large projects are also important. Without these small projects, the effect of large projects may be very little in some cases. While these small projects must be planned systematically, the most urgent projects will be the following.

Improvement of intersections -- Signal control (major intersections inside C-4) and grade separation (about 15 most important intersections inside C-4)

Improvement of existing roads -- Separation of travelled ways and sidewalks, division of lanes(especially lanes exclusively for turning) and shoulders and pedestrians' crossings.

Strict enforcement of traffic regulations -- No stopping or parking near intersections, no Parking (especially in CBD), no U-turns, and one-way traffic (especially on small streets in CBD).

§11.3 Other Problems

While the importance and the need of immediate planning of the following are recognized in relation to the city planning and urban transport planning, the team was not able to propose a detailed plan due to limited time and only the basic concept will be discussed hereinafter.

(a) Secondary road network

A road network cannot consist of major roads alone. In order to meet a rapid growth of traffic demand in the future, construction and improvement of secondary roads are indispensable. However, there is almost no plan for secondary roads at present. Therefore, a continued study must be made to work out a definite plan as soon as possible.

(b) Parking facilities

Parking facilities in CBD must be augmented on a large scale. Since the on-street parking causes an obstacle to the functions not only of small streets but also of major roads, a strict rule should be enforced to eliminate on-street parking by resorting to such measures as heavy lines and towing of vehicles which violate regulations. However, the demand for parking space is not likely to diminish in future and the effect of such a traffic regulation cannot be expected unless backed by the expansion of parking spaces.

If the "park and ride" system in the use of automobiles is to be introduced as an urban transport pattern following the opening of a railway, it will be necessary to provide parking facilities of a sufficient space at stations in the suburbs. In some cases, encouragement of the "park and ride" system through construction and improvement of parking facilities may help construction and improvements and check the growing demand for vehicular traffic in CBD.

(c) Bus and jeepney terminals and routes

In places where the service of buses and jeepneys is quite frequent, it is necessary to construct terminals specially for buses and jeepneys in order to achieve an uninterrupted flow of vehicles and passengers' safety in getting on and off the vehicles. CBD and main railway stations are considered to need such terminals. As for ordinary stops of buses and jeepneys, it will be recommended to construct bays as far as possible.

Consolidation, abolition or establishment of bus and jeepney routes will have to be considered in relation to the improvement of PNR and construction of subways. Routes competing with the railway will have to be abolished or reduced in operating frequency to make effective use of road spaces for other traffic and secure passengers for the railways. It is natural that new routes of jeepney or bus must be opened from a residential district to a station.

(d) Auxiliary transport systems

Other transport systems having a function of feeder service besides bus and jeepney include monorail or a new transport system which has been under study in recent years. For these auxiliary transport systems, a study must be made of such factors as development method, traffic demand and economic effect from all angles.

(e) Ports and harbors

The port of Manila is presently handling a large volume of coastal and overseas cargo and passengers. Because of its geographical location being in the center of the city, however, passengers and cargo to and from the port must be passed through the central district of the city.

Although such traffic measures as the designation of lanes and time zone for the traffic of trucks are being taken in the city area in an effort to avoid traffic jams for inland transport, construction of a new port or expansion of the existing ports in the Manila Bay Region should be considered.

(f) Airpotts

The increase of flights and in the size of aircraft for both domestic and international services at Manila Airport may require expansion of the existing facilities in the not too distant future. More efficient use of the existing air port should be considered urgently.

For the future, a new international airport should be planned outside the Metropolitan Area even though the distance from CBD will increase Linkage with the CBD by an urban expressway (such as extension of R-10) and on a rapid transit rail connecting the new airport with two satellite terminals may be necessary. In any case, relocation of the international airport should be planned in parallel with the metro-region transport system.

(g) Reclamation

In the coastal area of Manila Bay various projects, such as expansion of port facilities and construction of coastal roads center on reclaimed land.

In order to reorganize city functions strategically and promote orderly development of the city so as to make the existing city area and newly reclaimed areas supplement and complement with each other, reclamation providing mainly transport and traffic facilities may need to be promoted positively.

(h) Urban renewal

Urban renewal is extremely difficult under present politcal and economic conditions as a project of the central government or local government and priority should be given to the improvement of the basic city functions (roads, waterworks and sewerage).

For the time being, such measures as the removal of squatters in the water may land and within the right of way of the PNR should be taken to restore the original functions of these facilities in the city.

To attain the object of urban renewal, systematic inducement of private capital is most effective and indispensable, and preparation of a master plan for such a program is advisable, in due course.

(i) Open space and recreational facilities

There is a considerable shortage of open space in the Metropolitan Area. Open space available to youths is so scarce that they use roads as their playground. Systematic arrangement of playground-parks for youths should be planned in each locality. From a long-range viewpoint, use of a reclaimed land for recreational facilities should be considered.

(j) Improvement of sewerage

As is generally known, one of the causes of traffic delays in Manila Metropolitan Area is road surface drainage and repairs caused by unsatisfactory conditions of drainage system. While the importance of drainage and sewerage is recognized and priority is given to its improvement, further efforts should be made in this respect.

(k) Environmental pollutions

In Manila Metropolitan Area where urbanization is occurring at a relatively high pace, it is feared that various environmental pollutions will pose a serious problem in the near future. It is important, therefore, to establish a basic policy in the course of development to counter such environmental disruptions as air pollution, water pollution and settlement of the ground.

For the time being, transport of waste materials and construction of waste disposal plants and areas will be the most urgent and pressing need. Prevention of water pollution in Manila Bay and Laguna De Bay is also important and for this purpose, construction of a waste water treatment plant is required urgently.

Nevertheless, the increasingly adverse effects on the environment caused by noise, dust; fumes and the like should not be overlooked. These are components of any transport system.

(1) Government agency

There is a great variety of plans related to various transport facilities required for the Metropolitan Area. In addition to the government agencies specifically responsible for each of these plans, establishment of a government agency vested with sufficient powers to handle these matters integrally and systematically will be required.

§ 11.4 Interim Mass Transit Improvements

Many immediate and short-term improvements to the road system are discussed and recommended in this report. These will improve the transport system in general. However, they will not necessarily result in mass transport improvement unless other measures are taken. Also, the major elements of the proposed mass transportation system may not be in use for at least five years. Consequently, every possible action should be taken to increase mass transport capacity in the interim. This means that special attention should be given and expansion and improvement of bus routes, services and facilities, as far as possible in patterns which will fill and complement the successive stages of the total transportation plan.