REPUBLIC OF THE PHILIPPINES

THE FEASIBILITY STUDY FOR

MANILA RAPID TRANSIT RAILWAY LINE NO. 1

JUNE 1976

JAPAN INTERNATIONAL COOPERATION AGENCY

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PREFACE

In response to the request of the Government of the Republic of the Philippines, the Government of Japan has decided to cooperate in the execution of a Feasibility Study for the *Manila Rapid Transit Railway Line No. 1 Project* which is a part of the overall urban transportation plan for Manila, and the Japan International Cooperation Agency undertook the study.

In view of the importance of the study, the Japan International Cooperation Agency dispatched a prefeasibility study team in July, 1974 to define the objectives and scope of the study, and further sent, from February to May, 1975, a six-member supervisory team led by Mr. Kunizo Nishijima, Director of the Teito Rapid Transit Authority, Tokyo, as well as an eleven-member study team headed by Mr. Hiroshi Isono, to carry out the feasibility study. Moreover, teams were also dispatched for the discussion of the study process of the interim report as well as presentation of the findings of the draft final report.

The study team held discussions on the project with the Philippine authorities concerned and collected available information and data and implemented various field surveys necessary for the planning of the project in Manila. Basing on these investigations, and augmented by advices and opinions obtained from competent authorities of various Philippines Government departments, the team then engaged in the related analysis and studies after returning to Japan. The work is now completed and the results are compiled in this report.

I sincerely hope that this report would contribute to the socio-economic development in Metropolitan Manila Area and at the same time contribute towards the enhancement of the friendly relations now existing between the two countries.

I avail myself of this opportunity to express my heartful appreciation to the competent Philippine Authorities and other parties concerned for the cooperation and hospitality extended to the team during the study period.

June, 1976

Shinsaku Hogen
President
JAPAN INTERNATIONAL COOPERATION AGENCY

C O N T E N T S

SUMMARY AND CONCLUSIONS

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(A) CONCLUSIONS

1. In the light of the future traffic growth in the metropolitan Manila area it is necessary to build a mass transit system which can cater for heavy traffic demand along the corridor of RTR Line No. 1, and that the implementation should be initiated immediately.

2. A comparative study of various modes of mass transit systems has led us to conclude that there is a limit to the transport capacity of the road surface modes of public transport and that the transit system which should be adopted for RTR Line No. 1 as one which is capable of meeting future traffic demand is a two-rail type railway system.

3. Studies on the two-rail type railway had been made with due consideration to the soil condition, structure, and construction method including consideration on measures against flood during construction and after completion and it was concluded that the project is technically feasible.

4. Various alternative plans of a two-rail system have been studied from points of structure and construction schedule and it has been made clear that all the alternatives are feasible from the standpoint of the national economy of the Philippines.

5. The following are the main factors recommended for RTR Line No.1 from technical, economical and financial considerations:

   a) The section to be put into operation will be that between the University of the Philippines Station and Baclaran and Baclaran Station with length of about 21 km and a total of 21 stationss. The decision on the timing of extension of the section from Baclaran Station to the airport terminal should be made in due consideration of the future traffic growth of this section.

   b) From the point of environmental preservation, a railway should be mainly an underground structure. However for RTR Line No. 1 it was concluded that it should be partially elevated to reduce the cost of construction. That is, the railway should go underground between Baclaran Station and Santo Domingo Station and be elevated beyond Santo Domingo Station up to the University of the Philippines Station.

c) It will be more advantageous economically and financially if the railway is built from the side of the University of the Philippines, but the difference is not significant. In this respect, since the future passenger traffic in the metropolitan Manila area has been estimated in this study on the assumption that the Quezon city district will be developed in accordance with the master plan of the government, it is recommended that decision as to which end of the proposed route shall be implemented first should be made with due consideration on the pace of implementation of the regional development plan.

6. It is recommended that a zone fare structure be adopted. As for the fare level, assuming that the minimum fare for the existing modes of public transport should remian at 20 centavos, it is recommended that the minimum fare for the rapid transit railway system be 25 centavos.

7. The total project cost for the recommended alternative is estimated at US$547 million, of which foreign currency portion is estimated to be US$265 million (48%), and the construction period for the section according to the recommended schedule will be 7-1/2 years. It will not be possible to repay the entire capital investiment cost through only operation revenue within the analysis period assumed at 30 years after operation of the first stage of the line and the capital costs will have to be borne by the government during the stages of its construction. For the government investment plan, it is recommended that the examples of government financial investments and subsidies practiced in various countries be duly made reference to, and an investment plan most suited to the Philippines be established in the implementation of the project. In this respect, it is noted that the development of the land along the proposed route can be expected to bring about vast profit which may be considered as one of the financial sources. A rough estimate of the profit that may be derived from the development of the vicinity of U.P. had been made and it was estimated that for each one hectare of land developed, the profit comes to about one million US$.

A substantial portion of this profit may be used in the repayment of the capital cost of the rapid transit railway. It is therefore recommended that the government study the possibility of development along the entire route and vigorously promote the implementation of development.

8. The annual revenue and operating expenses in 1975 price for the recommended section for 1989 are estimated at US$18.1 million and US$20.2 million respectively, and are expected to increase to US$26.3 million and US$22.4 million respectively in 2000. Since the revenue is not expected to cover the operating expenses for the first several years of operation, it is recommended that the government subsidizes the transit system for the time the system operates below the break-even point. In this respect, a part of the above mentioned profit from the development of the land may be alloted as fund for subsidy of the operating deficit.

9. Should the fare rate of the existing modes of transport in Manila be increased, it will also be possible to raise the fares of the rapid transit system and obtain a consequent increase in annual revenues without resulting in a drop of passenger volume. Assuming a fare increase of fifty percent for the existing modes of transport and a propotional increase of the fares of the rapid transit railway, a trial calculation was made for the recommended alternative, and it was made clear that the whole amount of the capital costs and interest on foreign loan will be fully repaid through operating revenues on the 37th year after the completion of the whole section.

(B) SUMMARY

1. BASIC ITEMS OF THE SURVEY

1.1 Background

The metropolitan Manila area has been making remarkable progress and as a result, the traffic problem is acquiring serious proportion. To cope with this probelm, a study of the urban transport system of the metropolitan Manila area (UTSMMA) was made from 1971 to 1973, and a recommendation was made that a rapid transit system be built in the metropolitan Manila area.

According to the recommendation of UTSMMA, the Government of the the Philippines requested technical cooperation for conducting the feasibility study of Rapid Transit Railway Line No. 1 and submitted the Terms of Reference of the study to the Japanese Government in the fall of 1974.

The route specified in the Terms of Reference submitted by the Government of the Philippines for line No. 1 which connects Quezon Boulevard with Taft Avenue, has been selected in the light of the fact that the motor traffic congestion in these streets is conspicuous and that the passenger traffic is expected to grow rapidly in the future.

The primary objective of this survey consisted in the verification of the economic, financial and technical feasibility of implementation of the rapid transit railway Line No. 1 construction. A summary of the major items of the survey will be presented below.

1.2 Population and Land Utilization Plans

The plan of the population in the metropolitan Manila area projected by USTMMA was revised according to the Manila Bay Metropolitan Region Strategic Plan (MBMRSP). This revision was necessitated by the plan to redistribute the population and economic activities to the five satellite cities in the MBMR by dispersing the population and wealth excessively concentrated in the metropolitan Manila area and vigorously promoting the regional development of the peripheral region.

As a result, the planned population in the metropolitan Manila area has been revised downward from 7,460 thousand to 5,760 thousand for 1987 and to 7,450 thousand for 2000. On the basis of this revised population plan and the plan of land utilization under UTSMMA, a new plan of land utilization for 1987 and 2000 has been worked out.

2. ESTIMATION OF PASSENGERS OF RTR LINE NO. 1

2.1 Present Traffic Condition

(1) The chief modes of existing public transport in the metropolitan Manila area are the bus, jeepney and Philippine National Railways. Other modes of transport such as the kalesa, tricycle or taxi are of lesser importance.

(2) The PNR has recently initiated the commuter service for the Greater Manila area, and there are now four commuter lines.

a) Barrangca - Guadalupe Line
b) Carmona Line
c) College Line
d) San Fernando, Pampanga Line

The role of the PNR commuter service in urban transport is still very small and in 1974 the volume of passengers served came to a little less than 9,500 paid passenger trips per day.

(3) The bus and jeepney services play the most important role in the urban transport of the metropolitan Manila area. In 1971, it was recorded that there were about 2,500 buses and 15 thousand jeepneys providing services to an average of respectively 1,364 thousand and 3,839 thousand passenger trips per day.

(4) The fare rate for the various modes of public transport is very low, and the existing rates for both the bus and the jeepney are 4 centavos/km, and a jeepney or bus trip may usually be made at a minimum rate of 20 ct due to the passenger trip length being generally short.

(5) The average trip lengths of bus and jeepney passengers are presently 7.44 km/passenger for bus and 4.18 km/passenger for jeepney.

(6) The average walking time of passengers before reaching the existing means of public transport is about 5 - 6 minutes for both the bus and the jeepney passengers. The average waiting time required before taking a ride differs according to the time of the day, and the average is somewhere between 8 and 14 minutes.

(7) The drastically high peak ratio recorded for commuting passengers of major cities of industrialized countries is not seen in Manila, where the peak hour passenger volume comes to within 10% of the daily total.

(8) Taft Avenue and Quezon Boulevard are two of the major thoroughfares that are constantly in a state of congestion, and the congestion ratio which is the ratio between total traffic demand and total trafffic capacity of the road network is around 1.

(9) The results of an interview survey show that the three main factors that determine the choice of modes of transport by passengers are travel time, travel cost and safety. These considerations make the jeepney the first choice of means of public transport among citizens.

2.2 Estimation of Future Traffic Demand

2.2.1 Person Trip by Modes of Transport

(1) Since the mass transport network of the metropolitan Manila area which will be improved in the future is expected to have a great influence on RTR Line No. 1, the traffic demand of RTR Line No. 1 was estimated as an integral part of the overall traffic demand for the whole metropolitan Manila area.

(2) In the projection of passenger traffic the trip production, trip generation, trip concentration, inflow and outflow of traffic in the metropolitan Manila area, the O-D distribution of passenger traffic, the modal split of passenger traffic, and the assignment of passenger traffic to the railways were estimated, and the modal split of passenger traffic was performed by calculating the O-D trip time ratio and trip cost of various route alternatives in consideration of an improved network of motorways, rapid transit system, buses and jeepneys.

(3) The total number of person-trips in the metropolitan Manila area in 1971 was 6,735 thousand. The total number of person-trips in 1987 is estimated at 11,213 thousand, and that in 2000 at 14,883 thousand. The total number of person-trips in 1987 is thus forecast to be 1.66 times that in 1971 and the same in 2000 will be 2.21 times that in 1971.

(4) Classifying the trip generation and attraction by zones into the four rings of the metropolitan Manila area it is seen that trip generation and attraction in the CBD ring (within 2 km from urban center), in 1987 and 2000 will not increase in any great extent above the 1971 level, but trip generation and attraction in the 1st Ring (2 - 5 km from urban center), 2nd Ring (5 - 10 km from urban center) and 3rd Ring (10 - 15 km from urban center), with show an increasing trend. Particularly the growth in the 3rd Ring will be conspicuous.

(5) As the metropolitan Manila area expands, the average trip length will increase. The average trip length in 1987 is estimated to be 7.28 km and that in 2000 to be 8.35 km, being respectively 1.22-fold and 1.40-fold the average trip length of 5.98 km in 1971.

(6) The modal split of passenger traffic estimated for RTR Line No. 1 on the assumption that the PNR will be improved to rapid transit railway level, shows that the proportion of car passengers will show a slight increase, whereas the proportion of passengers of mass transit systems including the railways will decline to some extent.

2.2.2 Passenger Volume of RTR Line No. 1

(1) The O-D distribution of RTR passenger traffic derived from the modal split of passenger traffic was used to estimate the passenger volume of Line No. 1.

(2) On the assumption that the PNR is improved to rapid transit railway level, the daily passenger trip volume of RTR Line No. 1 is estimated to be 826 thousand in 1987 and 1,280 thousand in 2000.

(3) The passenger volume of RTR Line No. 1 is influenced by the improvement program of the PNR. Since the line along Taft Avenue in particular competes with the PNR, it is estimated that the passenger volume of RTR Line No. 1 will increase by 10% if the PNR is not improved to rapid transit railway level.

(4) The average trip length of passengers on RTR Line No. 1 is estimated at 5.89 km/passenger for 1987 and 6.27 km/passenger for 2000.

2.2.3 Passenger Volume by Stages of Railway construction

On the assumption that the PNR is improved, comparative calculalations were made of the daily passenger volume if only a portion of the recommended section should be implemented, and the results show that the traffic volume for 1987 is estimated to be 157 thousand persons if only partial construction is made for the section between Baclaran and Rizal Park (25 thousand persons per kilometer) 389 thousand persons for partial construction of the section between Baclaran and U.S.T. (31 thousand persons per kilometer), 427 thousand persons for partial construction of the section between U.P. and F.E.U. (44 thousand persons per kilometer), and 579 thousand persons for partial construction of the section between U.P. and Rizal park (39 thousand persons per kilometer). It is seen therefore that the passenger demand will be greater if construction is started from the University of the Philippines side, on the assumption that the development in Quezon City is implemented as planned.

3. PLANS OF IMPROVEMENT OF PUBLIC TRANSPORT SYSTEMS

From the point of effective investment in public transport sector, the improvement of the urban public transport system should start with the processes of efficient utilization of the existing system and expansion of its capacity. the introduction of a new transport system should be made only when the capacity of the existing system cannot further meet the demand, despite the improvement program.

In this study the demand-supply relation of the public transport system, including the road network was investigated to recommend an optimum plan of public transport system improvement. The demand-supply relation of the public transport systems was expressed in terms of traffic congestion rate, which is defined as the ratio between total tarffic demand and capacity. The demand-supply ratio of traffic in 1987 for the whole surface road network of the Metropolitan is estimated to be over 1.25, despite assuming that plans to improve the bus and jeepney service or plans to introduce the bus lanes on a large scale is put into practice. If the bus and jeepney system is relied on to meet the traffic demand, traffic congestion in the metropolitan Manila area will be unbearable and it is imperative that the construction of RTR Line No. 1 and the improvement of the PNR to rapid transit railway level should be implemented without hesitation.

After 1987, it is necessary to consecutively introduce other rapid transit railway lines proposed in the Master Plan in accordance with their priority.

4. ENGINEERING STUDIES

4.1 The Studied Route

The studied route of RTR Line No. 1 starts from the proposed the University of the Philippines in Quezon City and reaches Baclaran in Paraneque after proceeding along Quezon Boulevard, passing by Tutuban Station of the PNR, crossing the Pasig River, skirting the Rizal park, and running along Taft Avenue. The section between Baclaran and the future airport terminals may be extended in the future when necessary.

4.2 Route Distance and Number of Station

The proposed route of RTR Line No. 1 extends for approximately 21 km from U.P. Station to Baclaran Station and is planned to have 21 stations. If the route is extended to the domestic and international airport, the total route length will be about 25 km, and the number of stations will increase to 23. The average station spacing is about 1.1 km. The route of RTR Line No. 1 is so planned that it can have easy connection with other rapid transit railways when they are implemented in the future.

4.3 Comparative Study of System

In order to reach a decision on the type of rapid transit system to be adopted,a comparative analysis was made of "light guideway transit system," "heavy rapid transit system," "light railway system," and "bus transit sytem." As a result, the heavy rapid transit system presented itself as the most preferable system which would meet the traffic demand of RTR Line No. 1. A further comparative study is then made between the two-rail type and the mono-rail type railway of this system.

The comparative study should that the heavy rapid transit system of two-rail type is the most suitable for RTR Line No. 1 from the standpoint of environment protection, economy and traffic capacity.

An urban rapid transit railway should generally go underground in the highly built-up urban center area from the points of environment preservation and of avoiding interference with road surface traffic. The need to go undergound in the heart of the metropolis is obvious from the fact that the subways are adopted in the major cities of the world.

4.4 Railway Operation Planning

The rapid transit system was so planned as to afford great convenience to its passengers and to be attractive enough to make road vehicle users divert to the railway.

For Line No. 1 the train operation is proposed to start at 5 o'clock in the morning and terminate at 12 o'clock at midnight. The passenger load factor is planned at 190% of normal accommodation capacity during peak hours, and 130% or less for the one hour periods before and after peak hours. The train headway in the final stage is planned at 2'30" to 3' during peak hours and 3' to 5' during off peak hours. The scheduled travel time is about 12 minutes between Baclaran Station and Rizal Park Station, 23 minutes between Baclaran and the University of Santo Tomas, 39 minutes between Baclaran and the University of the Philippines, and 45 minutes between M.D.A. and the University of the Philippines. At the initial stage 4 car trains will be operated, and the train consist will be increased to 5 and eventually 6 cars per train as the passenger demand increase.

4.5 Construction Criteria

The construction criteria of RTR Line No. 1 have been established with reference to the railway construction standards currently in use in various cities of the world including Japan. The main specifications are as follows:

Dimensions of cars	2.8 m in width and 20 m in length
Power supply voltage	DC 750 V
Power collection system	Third rail
Track gauge	1,435 mm
Scheduled travel speed	Approx. 33 km/h
Train control system	CTC and ATC
Minimum curve radium	200 m
Maximum gradient	35/1000
Rail	50 kg N rail/m
Ventilation and air conditioning system	
Station	Air conditioning
Tunnel	Mechanical ventilation

4.6 Rolling Stock

Each train is made up of motored cars (M) and trailer cars (T). One unit of motored cares comprises two cars, one of which has a driver's cab and serves as a control car (Mc).

At the initial stage about 70 cars will be put in service. At the final stage the number of cars required will increase to about 300 cars.

The control system of rolling stock is as follows:

Control system:	Thyristor chopper control with regenerative brakes
Brake system :	Chopper regenerative brakes, electric and pneumatic

4.7 Power Supply

The power of RTR Line No. 1 is planned to be supplied from the Tegen Power Station and Malibay and Marikina substations.

The reasons are that first, these power sources are located near RTR Line No. 1, secondly, these power sources have a large installed capacity, and thirdly, to ensure that even in the event of a failure of any one power source, uninterrupted power supply may be maintained from the two remaining sources.

4.8 Signals

The signal facilities planned for RTR Line No. 1 comprise cab signals, ATC and CTC.

4.9 Communications

The communication facilities planned for RTR Line No. 1 comprise an exclusive telephone line, a direct telephone line, an RF train communication system, a power directive telephone line, and a train directive telephone line.

4.10 Elevated Structure

Part of the RTR Line No. 1 will be elevated in the suburban area. In making a decision on the section to be elevated, the following were the sections put under comparative studies.

1. From Santo Domingo to University of the Philippines
2. From Baclaran to Vito Cruz

However, the street between Baclaran and Vito Cruz is narrow and heavily built up with many buildings on either side of it. Pier erection at the center of the street will narrow down the width of the road and hinder road traffic. To maintain the existing width of the street, demolition and land acquisition will be necessary. With all these problems, the elevation of this section is not considered desirable. Thus only the section from Santo Domingo is proposed as an elevated section.

The elevated section is planned to be built with prestressed concrete girders and to have a standard span of 20 m. The bridge rests on one row of piers between stations but on three piers at the station to cross over the street.

4.11 Underground Structure

Should it be decided that the whole line of RTR Line No. 1 be constructed underground then Baclaran, Rizal Park, Tutuban, Far Eastern University, and University of the Philippines stations will be two-level underground station, and the other stations will be one-level underground stations from the point of economy. The underground stations will be built by the cut-and-cover method.

The tunnel will have a rectangular two-box shape cross section and will be built by the cut-and-cover method except for the section which crosses under the Pasig river. This section will be a circular tunnel and will be a compressed air shield-driven tunnel.

4.12 Stage Construction

(1) The recommended route of RTR Line No. 1 is planned to be constructed in three stages from such considerations as traffic congestion, finance, and balanced employment of mechanical and man-power.

(2) Two cases of stage construction of RTR Line No. 1 were considered as follows:

a) Recommended alternative(Construction from U.P. side)

Stage 1 University of the Philippines - Far Eastern University (F.E.U.)

Stage 2 F.E.U. - Rizal park

Stage 3 Rizal Park - Baclaran

b) Compared alternative (Construction starting from Baclaran side)

Stage 1 Baclaran - Rizal Park

Stage 2 Rizal Park - University of Santo Tomas

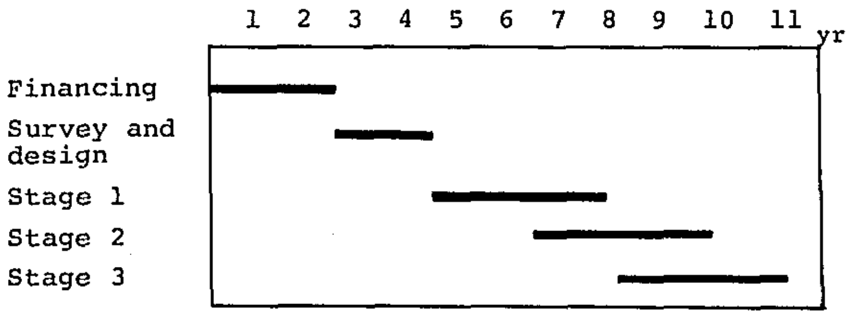
Stage 3 University of Santo Tomas - University of the Philippines

(Stage 4) In both cases, the section between Baclaran and the airport terminal may be extended in the future if traffic demand so warrants.

4.13 Implementation Schedule

The total implementation period for the three stages of RTR Line No. 1 including the preparatory period is estimated to be 10 years of which the construction works will take 6-1/2 years. The preparatory period of time required for establishment of organization, financial procurement, engineering works, and land acquisition is assumed to be about 4 years. The period of each stage of construction is estimated at 3 years to 3-1/2 years. The construction period does not differ from one case of stage construction to the other.

Implementation Schedule



(Note) The sections to be built at stages 1, 2, and 3 are the same as mentioned in Section 4.12.

4.14 Project Cost

The project cost of RTR Line No. 1 was estimated for both alternative structures of (a) all underground structure and (b) partial elevation for the section between Santo Domingo and the University of the Philippines.

(a) Recommended Alternative

(Partially elevated structure, construction starting from U.P. side)

Stage 1	(U.P. - F.E.U.)	221,660
Stage 2	(F.E.U. - Rizal Park)	153,840
Stage 3	(Rizal Park - Baclaran)	172,100
Subtotal		547,600
Stage 4	(Baclaran - Airport)	72,160
Total		619,680 thousand US$

(b) Compared Alternative

(i) Partially elevated structure; construction starting from Baclaran side

Stage 1	(Baclaran - Rizal Park)	225,320
Stage 2	(Rizal Park - U.S.T.)	173,410
Stage 3	(U.S.T. - U.P.)	149,290
Subtotal		548,020
Stage 4	(Baclaran - Airport)	71,660
Total		619,680 thousand US$

(ii) All underground structure; construction starting from U.P. side

Stage 1	(U.P. - F.E.U.)	286,810	
Stage 2	(F.E.U. - Rizal Park)	157,170	
Stage 3	(Rizal Park - Baclaran)	173,950	
Subtotal		617,930	thousand US$
Stage 4	(Baclaran - Airport)	72,270	
Total		687,280	

(iii) All underground structure; construction starting from Baclaran side

Stage 1	(Baclaran - Rizal Park)	226,280
Stage 2	(Rizal Park - U.S.T.)	173,930
Stage 3	(U.S.T. - U.P.)	215,620
Subtotal		615,830
Stage 4	(Baclaran - Airport)	71,450
Total		687,280

The project costs estimated above do not include the interest on the capital cost of construction, allowance for inflation, and survey, design and other engineering expenses but include prevailing rates of taxes and duties. The unit construction cost is estimated on the basis of the market prices of building materials and labor cost as of July 1975.

4.15 Operation and Administration

The personal requirements for smooth operation of RTR Line No. 1 at the final stage of operation is estimated to be between 2,000 and 2,500 persons, on the assumption that a policy of intensified mechanization and automation is not adopted.

4.16 Operating Expenses

The annual operating expenses of RTR Line No. 1 was respectively estimated for both alternatives of stage construction. The operating cost greatly differs according to whether electric power cost is estimated at the unit price of National Power Corporation (N.P.C.) or that of Manila Electric Company (MERALCO). For this reason, the operating expenses were estimated for both cases of unit price of electricity.

The operating expenses include labor cost, power cost, rolling stock maintenance cost, track maintenance cost, electric circuit maintenance cost and administrative expenses, but excludes the interest on capital cost and depreciation expenses. The annual operating expenses in thousand US$ for the various alternatives are as follows:

(a) Recommended Alternative

(Partially elevated structure; construction starting from U.P. side)

U.P. - F.E.U. section in operation		(Year 1983)	6,663	(5,313)
U.P. - Rizal Park	"	(" 1985)	11,043	(8,577)
U.P. - Baclaran	"	(" 1987)	16,563	(12,543)
Year 2000			22,159	(16,266)

(b) Compared Alternative

(i) Partially elevated structure; construction starting from Baclaran side)

Baclaran - Rizal Park section in operation		(Year 1983)	6,109	(4,393)
Baclaran - U.S.T.	"	(" 1985)	10,944	(7,954)
Baclaran - U.P.	"	(" 1987)	16,563	(12,543)
Year 2000			22,159	(16,266)

(ii) All underground structure; construction starting from U.P. side

U.P. - F.E.U. Section in operation		(Year 1983)	6,663	(5,313)
U.P. - Rizal Park	"	(" 1985)	11,043	(8,577)
Year 2000			23,362	(16,686)

(iii) All underground structure; construction starting from Baclaran side

Baclaran - Rizal Park section in operation		(Year 1983)	6,109	(4,393)
Baclaran - U.S.T.	"	(" 1985)	10,944	(7,954)
Baclaran - U.P.	"	(" 1987)	17,759	(12,963)
Year 2000	"		23,362	(16,686)

(Note) Figures in parentheses indicate the operating costs in the case of power supply calculated at NPC unit price.

4.17 Training of Personnel

It is necessary to provide training to train operators, signalmen and communication personnel prior to the opening of RTR Line No. 1. In this respect it is recommended that the key personnel be trained at the facility of an organization which is actually operating a rapid transit railway system.

5. ENVIRONMENTAL IMPACT STUDY

5.1 Environmental Problems

It is desirable to take into full account, and provide measures for mitigation of, the evil effects of the RTR Line No. 1 on the environments. The demerits resulting from the implementation of the project can be divided into two cagegories, the first being that occurring during construction and the other being that occurring after the operation of Line No. 1. These however may be reduced to a permissible level if proper measures are taken. On the other hand, the merits of the project are vast and great in physical, cultural, environmental and economic fields. In particular, the contribution of the project to the alleviation of the urban traffic is every so great. Namely, it is sure that the merits more than offset the demerits, and it can be said safely that the project is permissible from the environmental viewpoint. However, it is of course important to provide pertinent measures to minimize the demerits resulting from the implementation of the project.

5.2 Corridor Impact Study for Land Uses

An analysis of the impact of RTR Line No. 1 on land utilization suggests that the accessibility to the districts through which RTR Line No. 1 after its completion will pass will increase to a far greater extent than other districts. The completion of RTR Line No. 1 will have a great impact on the redistribution of population and attract a huge number of people to the neighboring areas along the route.

From the standpoint of environmental planning, it is desirable that the resident population density of the existing congested areas along RTR Line No. 1 should be reduced while that of the less congested areas should be maintained at a tolerable level.

To limit the excess concentration of population, legislative restrictions such as city planning law which qualifies the land use and limits the building height should be established. Furthermore, city development should bè implemented to improve the infrastructure of the city and to plan an efficient utilization of land.

If the development of the undeveloped areas along the projected line is promoted in keeping with the construction, large gains (such as rise of land price) will be brought about. The difference in land pirce between the case where the railway is constructed and the case where it is not is estimated at US$ 1 million per hactare of development around U.P. Station. If this value is multiplied by the underdeveloped area within a 500 m circle of the station, it will be found that the development benefits amount to as large as US$40 million.

If this is applied to also Quezon Station and Capital Center Station, the total benefits will reach some US$140 million, or over 20% of the capital cost.

6. EVALUATION OF THE PROJECT

6.1 Economic Analysis

6.1.1 Benefits Derived through Construction of RTR Line No. 1

Both the passenger traffic that is diverted to RTR Line No. 1 and the passenger traffic that is not diverted to the RTR Line No. 1 will benefit from the completion of RTR Line. The benefits include (1) saving in travel time, (2) saving in vehicle operating cost, (3) saving in vehicle capital cost, and (4) saving through a decrease in traffic accidents.

On the assumption that PNR will be improved to rapid transit level, the annual undiscounted benefits in 1975 prices of RTR Line No. 1 are estimated as follows:

a) Recommended Alternative (Construction starting from U.P.)

Stage 1	(Year 1983)	43,100	
Stage 2	(" 1985)	66,600	
Stage 3	(" 1987)	117,400	
Year 2000		185,100	million US$

b) Compared Alternative (Construction starting from Baclaran)

Stage 1	(year 1983)	16,900	
Stage 2	(" 1985)	44,900	
Stage 3	(" 1987)	117,400	
Year 2000		185,100	million US$

6.1.2 Discounted Costs and Benefits

The accumulative discounted economic costs and benefits for the recommended partially elevated structure over an economic life of 30 years at a discount rate of 12% is as follows:

a) Construction starting from U.P. side

Total discounted benefits = 468.3 million US$
Total discounted costs = 253.5 "

b) Construction starting from Baclaran side

Total discounted benefits = 441.8 "
Total discounted costs = 242.6 "

6.1.3 Benefit/Cost Analysis

Benefit/cost analyses are made for the cases that PNR be improved to rapid transit railway level basing on the assumption that the economic life would be 30 years and from the results, the following observations may be made.

(1) Both the alternative to construct RTR Line No. 1 from Baclaran side and that from U.P. side are economically feasible, and the benefit/ cost at 12% discount rate and the internal rate of return are 1.82 and 20.4% for the former alternative and 1.85 and 21.1% for the latter alternative in the case of the recommended partially elevated structure.

(2) The economic indicators for recommended alternative are more favorable than the all underground alternative because its construction cost is about 20% lower than that for the all underground alternative.

(3) The time of PNR improvement influences the economic feasibility of RTR Line No. 1, so that a delay in the improvement of PNR will favorably affect the economic indicators of RTR Line No. 1.

6.1.4 Economic Analysis by Section

The economic feasibility analysis has also been made for the case that only a section of the recommended alternative should be implemented and the following observations may be made from the results.

(1) Even if the PNR is improved to rapid transit railway level, the operation of only the competitive section between Baclaran and Rizal Park will be economically feasible. Moreover, if the operation is extended from Baclaran to U.S.T., the benefit/cost ratio and internal rate of return will increase to 1.31 and 15.6%, respectively, indicating that the operation of this section will be economically feasible regardless of the improvement of the PNR.

(2) The B/C ratio and IRR for the operation of only the sections between U.P. and F.E.U. or between U.P. and Rizal Park will be 1.81 and 19.8% and 1.61 and 18.9%, respectively. These economic indicators suggest that the operation of only these sections will be economically feasible.

(3) If the entire original studied route of U.P. - Airport section is put into operation, the B/C ratio and IRR will be respectively 1.65 and 19.9%, showing that the project will remain feasible even with the extention of the Baclaran - Airport section to the recommended route.

6.1.5 Sensitivity Analysis

(1) Project Cost

Even if the project cost increases by 20%, the project is still economically feasible, for the B/C ratio is over 1.36.

(2) Discount Rate
If a discount rate of 20% is used instead of 12%, the B/C ratio of the whole line of RTR Line No. 1 is reduced to 1.

(3) Project Life
If the project life is placed at 50 years, the B/C ratio will further be increased and the project feasibility is further enhanced.

(4) Time Benefit
Even if the time benefit is drastically reduced by 50%, the B/C ratio is 1.30 so that the project still remains feasible.

(5) Revision of the Population Estimate
Even if the population estimates in 1987 and 2000 are revised downward to 80% of planned population, the B/C ratio still reaches 1.47 and the project remains economically feasible.

(6) If the zone distribution of population should remain similar to the existing pattern for the years 1987 and 2000, the B/C ratio will be 1.50, indicating that the project is still economically feasible.

6.1.6 Risk Analysis

The main factors which affect the feasibility of the Project are the planned population, the population distribution pattern, and the level of overall improvement of existing transportation facilities. These factors, together with the estimated project costs, for which a 20% variation up and down was assumed, were taken into consideration together for a risk analysis. It was also assumed that the probability of occurrence of each combination of the adopted variations of factors would be the same.

The results of the analysis shows that the probability of the economic rate of return falling below 13% is a meagre 2%, while the probability of the rate of return reaching over 15% is 84%. Thus it can be concluded that from the economical point of view that the proposed project is amply feasible.

6.2 Financial Plan

6.2.1 Fare Determination

The following are recommended on the determination of fare of RTR Line No. 1.

(a) Fare Policy

Since the construction of a subway involves an enormous capital investment, it is hardly possible to repay the entire capital cost through operation revenues alone, especially because the fare rates of the subway must be suppressed in order to compete with other modes of transportation. It is therefore necessary to determine the fare rates in such a way that the revenues will be sufficient to cover the annual operating cost when the RTR line reaches a stage of stable operation, and the capital cost should be met with government subsidy. This is a general practice adopted by many cities in the world which operate rapid transit railway systems.

(b) Fare Structure

A zone fare structure is recommended for RTR Line No. 1. In this case, RTR Line No. 1 will be divided into three zones by setting up a zone boundary (1) between Rizal Park Station and General Hospital Station and (2) between Santo Domingo Station and Welcome Rotonda Station.

(c) Fare Level

On the assumption that the minimum fare rate of existing modes of mass transit reiamin at 20 ct, it is recommended that a minimum rate of 25 centavos be applied to intrazonal trips, 50 centavos to trips made between two adjacent zones, and 75 centavos to trips made across three zones, while a discount rate of 35 centavos or the minimum fare of 25 ct may be applied to the trips made between the adjacent stations on either side of the zone boundary.

6.2.2 Revenue

The annual fare revenue can be estimated as follows on the assumpiton that the fare structure and level recommended above are adopted.

a) Recommended Alternative (Operation starting from U.P. side)

Stage 1	(Year 1983)	2,355	
Stage 2	(" 1985)	6,424	
Stage 3	(" 1987)	16,159	
Year 2000		25,506	thousand US$

b) Compared Alternative (Operation starting from Baclaran side)

Stage 1	(Year 1983)	5,996	
Stage 2	(" 1985)	9,461	
Stage 3	(" 1987)	16,159	
Year 2000		25,506	thousand US$

6.2.3 Cash Flow Plan of Revenues and Expenses

On the assumption that the capital cost and interest thereon are borne by the government and the depreciation cost is not taken into account, the operation of RTR Line No. 1 is expected to be in a deficit for the first several years of partial operation. But the revenue will exceed the operating cost when the whole line comes into stable operation. The recommended partially elevated alternative would yield a profit 11 years after service inauguration (that is, 8 years after operation of the whole line), and the all underground alternative would record a profit three years later.

The accumulated profit over 30 years of line operation is estimated as follows:

a) Recommended Alternative
Partially elevated structure;
operation starting from U.P. — US$96.9 million

b) Compared Alternative
- (i) partially elevated structure, operation starting from Baclaran side — US$84.2 million
- (ii) All underground structure; operation starting from U.P. side — US$60.0 million
- (iii) All underground structure; operation starting from Baclaran side — US$52.9 million

From the results of the calculation of the various cases and alternatives, the following observations may be made.

(a) The number of passengers and fare revenue greatly differs according as whether the PNR is improved or not. If it is not improved, the accumulated profit of RTR Line No. 1 increases by about US$40 million.

(b) The partially elevated alternative is cheaper in operating expenses, so that the accumulated saving amounts to about US$35 million.

(c) If the line is first opened to traffic from U.P. side, the revenue during the period of partial line operation is slightly larger but this is partially offset by an increase in operating expenses so that the accumulated profit increases by only about US$8 to $12 million.

(d) The opening of the section between Baclaran and the airport terminal does not result in any substantial increase in passenger traffic volume, but involves an increase in operating cost. Accordingly, from the financial point the timing of construction of this section should be given careful consideration.

(e) If RTR Line No. 1 is not built beyond the second stage (that is, not extended beyond the section between U.P. and Rizal Park), the annual operating cost decreases by about 31%, but the revenue will also decrease by as much as 39%. However, the project cost will come to only US$375 million, or about 70% of the project cost for the entire recommended route.

6.2.4 Financial Investment Plan

The foreign currency portion of the project cost will account for about 50% of the total project cost. Assuming that this portion is procured from foreign source and that the loan is to be repaid in equal installments in 25 years after 7 years of deferment at an interest rate of 7.5% per annum, the period of repayment is 44 years after the initiation of the implementation of the project, and the maximum annual amount of repayment in foreign currency is about US$30 million.

If all the local currency portion is disbursed by the government, the annual repayment of both the foreign and local currency portions becomes the largest during the period of 6 to 11 years after the initiation of implementation, amounting to between US$40 and $80 million.

6.2.5 Financial Source through Development along the Route

Following the completion of the rapid transit railway, the accessibility along the route will be greatly improved and the land value greatly increased. Therefore, through vigorous development of the land along the route, a great profit can be expected. Through returning a portion of this profit to the public, alloting a portion of this for repayment of capital cost, and retaining the remaining portion for further development, continuous development will become possible, and an uninterrupted financial source may be secured for the rapid transit railway. It is recommended therefore that the government carefully study the possibility of development along the whole route and vigorously promote the implementation of development.

Should the fare rate of the existing modes of transport in Manila be increased, it will also be possible to raise the fares of the rapid transit system, and obtain a consequent increase in annual revenues, without resulting in a drop of passenger volumes. Assuming a fare increase of fifty percent for the existing modes of transport and a propotional increase of the fares of the rapid transit railway, a trial calculation was made for the recommended alternative, and it was made clear that the whole amount of the capital costs and interest on foreign loan will be fully repaid through operating revenues on the 37th year after the completion of the whole section.

PART I

INTRODUCTION

PART I. INTRODUCTION

CHAPTER 1. SCOPE OF STUDY

This report sums up the findings of the works on the "Feasibility Study for Manila Rapid Transit Railway Line No.1" executed by the Japan International Cooperation Agency.

The terms of reference prepared by the Philippine Government had stipulated that the Line No.1 of the Manila Rapid Transit Railway be the route joining Quezon Boulevard on the northeast of the Metro Manila and Taft Avenue on the South-west. With the general alignment of the line fixed, the study was proceeded in the following sequence.

(1) Analysis of the existing transport demand of the Metro Manila and forecast of future transport demand, with due consideration given to future pattern of population distribution, change in future economic activities and relevant future development plans;

(2) Estimation of the future traffic demand along the corridor of Line No.1;

(3) Comparative study of the various modes of transport to determine the most favorable mode of transport to be adopted for Line No.1; (Two-rail type railway was recommended)

(4) Comparative study of the most suitable structural type of two-rail type railway for Line No.1 and preliminary engineering design and rough cost estimates for the construction of the Line;

(5) Assessment of the environmental impact of the construction of Line No.1;

(6) Analysis of the economic feasibility and financial implication of the construction of Line No.1;

(7) Discussion was also made on the necessary improvement of the public transport system of Metro Manila.

CHAPTER 2. SITE VISITS

The feasibility study was carried out by a study team through the guidance and supervision of a Supervisory Committee composed of experts on the varied fields of urban rapid transit railway planning from the Japanese Government departments and public corporations. A team consisting of six supervisory committee members and eleven study team members were despatched to Manila in February 1975 for varied periods ranging from one to four months to commence the study. During this visit extensive discussions were held with the Philippine Panel on the scope of study and the methodology and work process to be adopted. Topographical and soil surveys as well as additional traffic and mass transit surveys were also carried out. The information and data collected were then processed and analysed, and the preliminary findings were compiled in a interim report. In August, 1975, a team formed of four supervisory committee members and four study team members was again sent to Manila to discuss the findings of the interim report and confirm the methodology and work process. Further works in Tokyo led to the completion of a draft final report which was presented to the Philippine Panel by a team consisting of three supervisory committee members and six study team members, who visited Manila in February, 1976. Necessary modifications and rectifications on the draft final report basing on the valuable suggestions and comments of the Philippine Panel lead to the production of this final report.

The following are the members of the teams which visit Manila during the course of the study.

(1) Commencement Visit (Febrary to May, 1975)

a) Supervisory Committee

Kunizo Nishijima	Teito Rapid Transit Authority, Tokyo
Yoshitomo Shido	Ministry of Transportation, Japan
Hifumi Tsuboi	" " "
Mitsuo Inaba	" " "
Takeshi Watanabe	Teito Rapid Transit Authority, Tokyo
Saburo Nakagawa	Ministry of Construction, Japan
Koh Mogi (Coordinator)	Japan International Cooperation Agency

b) Study Team

Hiroshi Isono	Pacific Consultants International
Toshiro Fukuyama	Japan Overseas Consultants
Kai-Chang Fan	Pacific Consultants International
Toshio Kimura	Japan Overseas Consultants
Takehiko Kocho	" "
Yoshihiro Hattori	" "
Tatsuo Kumagai	Pacific Consultants International
Kurando Murata	" " "
Ryojiro Murata	" " "
Hiroshi Kamiya	" " "
Shigeo Tajima	" " "

(2) Interim Report Visit (August, 1975)

a) Supervisory Committee

Kunizo Nishijima	Teito Rapid Transit Authority, Tokyo
Yoshiro Watanabe	Ministry of Construction, Japan
Mitsuo Inaba	Ministry of Transportation, Japan
Hikaru Kobayashi	Teito Rapid Transit Authority, Japan

b) Study Team

Toshiro Fukuyama	Japan Overseas Consultants
Tatuso Kumagai	Pacific Consultants International
Kai-Chang Fan	" " "
Toshio Kimura	Japan Overseas Consultants

(3) Draft Final Report Visit (February, 1976)

a) Supervisory Committee

Kunizo Nishijima	Teito Rapid Transit Authority
Mitsuo Inaba	Ministry of Transportation, Japan
Saburo Nakagawa	Ministry of Construction, Japan
Tomochika Uchida (Coordinator)	Japan Interantional Cooperation Agency

b) Study Team

Tatsuo Kumagai	Pacific Consultants International
Kai-Chang Fan	" " "
Hidetaka Miyake	Japan Overseas Consultants
Ryojiro Murata	Pacific Consultants International
Hiroshi Kamiya	" " "
Toshio Kimura	Japan Overseas Consultants

CHAPTER 3. ACKNOWLEDGEMENT

In the course of the study, much valuable assistance, advice, opinions, and convenience were received by the team from various government departments and public and private organizations. The Japanese Study Team would like to express their sincere appreciation for the kind cooperation extended by the Secretary and other officials of the Planning and Project Development Office, (PPDO) of the Department of Public Works, Transportation and Communications (DPWTC) and other agencies of the Government of the Philippines in the preparation of the Rapid Transit Railway Line No.1 Study, more particularly the following:

Planning and Project Development Office, Department of Public Works, Transportation and Communications.

1.	Teodoro T. Encarnacion	Assistant Secretary
2.	Jose R. Valdecanas	Project Coordinator
3.	Jesus P. Cammayo	Director, Programs Management Department
4.	Pedro Prado	Director, Programs Management Department
5.	Rene Santiago	Systems & Research Department
6.	Alexis Verzosa	Transport Sector
7.	Jose T. Virtucio	Transport Sector
8.	Orlino P. Tuzon	Transport Sector

Philippine National Railways

1.	Atty. Juan de Castro, Jr.	Assistant General Manager
2.	Dionisio B. Figueroa	Assistant General Manager
3.	Ramon T. Jimenez	Manager

National Economic and Development Authority (NEDA)

1.	Antonio Locsin	Deputy Director General
2.	Jesus Sunga	Director, Infrastructure Staff
3.	Jesse Evidente	Deputy Director

Department of Public Highways (DPH)

1.	Baltazar Aquino	Secretary
2.	Jose David	Director, Planning Service
3.	Antonio I. Goco	Executive Director, Special Projects Office
4.	Prudencio Baranda	Deputy Director, Planning Service

Bureau of Telecommunications

1.	Manuel Casas	

National Power Corporation (NPC)

1.	Ramon Ravanzo	General Manager
2.	Quirino Tiu	

United Nation Development Programme (UNDP)

1.	Toru Ida	Consultant

CHAPTER 4. BACKGROUND

Unless a rationalized urban traffic system is adopted, MMA will face a serious traffic problem as represented by traffic congestion which is likely to be ever-aggravating as a result of increase in population and the number of car ownership.

In 1971, the Government of the Republic of the Philippines requested the Japan International Cooperation Agency (JICA, then called the Overseas Technical Cooperation Agency - OTCA) through the Government of Japan to undertake transportation study in the Metropolitan Manila Area (MMA) for the purpose of finding effective measures to solve present and future traffic problems.

In response to the request, JICA conducted studies during the 1971 - 73 period and prepared a report titled "Urban Transportation Study in Manila Metropolitan Area (UTSMMA) in which the following master plans for the urban transportation facilities were proposed.

(1) Plan of major thoroughfare network system comprising ten radial roads and six circumferential roads.

(2) Plan of urban rapid mass transit system to be completed by the construction of five rapid transit railway line and the improvement of PNR commuter service to rapid transit railway level.

(3) Plan of expressway network system consisting of three branches.

UTSMMA recommended emphasis on the completion and improvement of the major thoroughfares within C-4 and the completion of urban rapid mass transit railways at the earliest time.

In 1973, the Philippine Government requested the Government of Japan to conduct a feasibility study on the radial road R-10, and again in August 1974 made an official request to the Government of Japan for a technical assistance in the feasibility study of the Manila Rapid Transit Railway Line No.1.

A terms of reference as well as a Position Paper were also prepared by the Philippine Government and transmitted to the Government of Japan, in which the selection of RTR Line No.1 as the rapid transit railway line of top priority was verified. The findings of the Position Paper form the basis on which the feasibility study of the Manila Rapid Transit Railway Line No.1 was undertaken by the Government of Japan, with the Japan International Cooperation Agency acting as the executing agency.

CHAPTER 5. STUDY AREA

The impact of RTR Line No.1 on the urban transportation is not limited to the development of the corridor along the route, but is far-reaching, and the entire MMA is taken as the study area. MMA referred to here covers the following four cities and fifteen municipalities as defined in UTSMMA.

City:	Manila, Caloocan, Quezon, Pasay
Municipality:	Navotas, Malabon, Mandaluyomg, San Juan, Makati, Pasig, Pateros, Marikina, Taguig, Paranaque, Las Pinas (Rizal Province), Obando, Marilao, Meycauayan, Valenzuela (Bulacan Province)

These are divided into fifty-one zones, while the outlying area into six zones, as shown in Fig. 1.5.1. These zones were used in this study in the trip generation and attraction and trip distribution portion of the passenger projection process as well as the benefit calculation in economic evaluation.

After trip distribution in the passenger projection were made, these 51 zones were subdivided to 103 zones while keeping the number of external zones at six. (See Fig. 1.5.2.) The purpose of zone subdivision is to enable projection of the passenger volume of each station and the station-to-station traffic volume. The re-zoning process was carried out through the following criteria.

(1) No more than one station of RTR Line No.1 will be included in one zone.

(2) Each traffic zones was divided into walking zone (approximately 500 m radius from a station) and transport using zone.

Table 1.5.1 shows the original zones (51 zones), the subdivided zones (103 zones) grouped in 4 Rings and 15 Sectors. Of the 4 Rings, the First Ring is approximate 4 km from the center of MMA, the Second Ring and the Third Ring are respectively 7 km and 12 km away from the urban center.

Table 1.5.1 Zoning List

Ring	Sector	Original Zone	Sub-divided Zone	Ring	Sector	Original Zone	Sub-divided Zone
CBD	CBD-1	1	1	Second Ring	A - 4	14	29
		2	2			16	30
		12	3			15	31
		12	4			18	32
	CBD-2	19	5			18	33
		17	6		B - 1	20	34
		17	7			21	35
First Ring	A - 1	3	8			22	36
		3	9			40	37
		5	10		B - 2	23	38
		5	11			23	39
		6	12			25	40
		4	13			25	41
		4	14		B - 3	27	42
		7	15			27	43
	A - 2	8	16			27	44
		9	17			27	45
		11	18			29	46
		11	19			29	47
		11	20			29	48
		24	21			29	49
		24	22			28	50
		24	23			28	51
		24	24			28	52
	A - 3	10	25			28	53
		10	26			28	54
		10	27		B - 4	31	55
		13	28			33	56

Table 1.5.1 (Cont'd)

Ring	Sector	Original Zone	Sub-divided Zone
	B - 5	34	57
		34	58
		35	59
		35	60
		35	61
		37	62
		37	63
		37	64
		36	65
		36	66
Third Ring	C - 1	41	67
		42	68
		44	69
		43	70
		45	71
		47	72
		46	73
	C - 2	26	74
		58	75
		58	76
		58	77
		58	78
		26	79
		26	80
	C - 3	48	81
		30	82
		32	83
		49	84
Third Ring	C - 4	50	85
		50	86
		50	87
		50	88
		38	89
		38	90
		38	91
		39	92
		39	93
		39	94
		39	95
		39	96
		39	97
		39	98
		51	99
		51	100
		51	101
		51	102
		51	103
External Ring	E - 1	52	104
		53	105
	E - 2	54	106
		55	107
	E - 3	56	108
		57	109

PART II

PASSENGER PROJECTION

PART II. PASSENGER PROJECTION

This Part presents data concerning the present condition of traffic in the Manila Metropolitan Area to be used as input data for estimating passenger demand, the framework which will form the basis for estimating future passenger demand and the results of the estimate.

Chapter 1: "Existing Situation of Urban Transport in MMA" discusses the present condition of transport system in MMA and the existing fare system of public transportation. Also analysed are made on the characteristics of public transport and road using passengers to be used as input data for passenger projection, and the current condition of "split" among various transportation means and the users' likings of these means.

Chapter 2: "Framework Plan" treats overall plan in entire MMA concerning population, employed population and economy, makes clear related development projects involving land use plans, and discusses population distribution plans and land use plans in the years of 1987 and 2000.

Chapter 3: "Projection of Passengers on RTR Line No.1" describes the process whereby person-trip is estimated on the basis of Person Trip Survey in 1971 supplemented by data obtained from additional field surveys. Also, modal split of person-trip was determined basing on the development plan of urban transportation facilities for each key year and the passenger volume on RTR Line No.1 is estimated by passenger assignment.

CHAPTER 1 · EXISTING SITUATION OF URBAN TRANSPORT IN MMA

1.1 PUBLIC TRANSPORT SYSTEM

Until the recent introduction of the commuter service by the Philippine National Railways (PNR), urban railway transport was non-existent. The present PNR commuter train service is by no means adequately to cater for the urban transport demand, which is highly varied in direction, time and purpose. The road transport therefore is, in a practical sense, the sole means of urban public transport in Manila.

By far the most important modes of urban public transport are the bus and the jeepney. The taxi comes next in importance. Besides these, there are also the kalesas (horse drawn coaches) which ply the central down town area and the tricycle type motored vehicles which serve the more remote outskirt districts. The last two, however, are supplementary in characteristics, and are of minor importance.

In the past, taxis, buses and jeepneys used to ply freely over major roads of the urban area. There were no bus or jeepney 'stops' designated, and the vehicles could stop for boarding and unboarding of passengers at any point along the route. This caused great congestion and confusion of traffic along all bus and jeepney routes. In December 1972, the Board of Transport decided on the segregation of the bus and the jeepney. Under this policy, the main thoroughfares of the metropolitan were franchised to bus services, while jeepneys were to serve as feeder transport along the minor roads off the trunk roads. This complete segregation, however, proved inconvenient for passengers, and a modification was made in May 1973 whereby some of the major thoroughfares were opened to a limited number of authorized jeepneys. This system remains until today.

A more detailed description of the various modes of public transport shall be made below.

1.1.1 Philippine National Railways (PNR) Commuter Trains Service

The Philippine National Railways was established originally for the purpose of serving interprovincial passenger and freight traffic, and the part played by PNR in urban public transport was negligible. It was not until recent years that the commuter service was introduced for the metropolitan region of Manila, in pace with the establishment of new residential settlements at the outskirt of the metropolitan area.

There are as of 1975 four commuter service lines in the metropolitan, two running to the south, one to the north, and the remaining one in the south easterly direction. The four lines are as follows:

(a) Barrangca-Guadalupe Line

This line of 13 Km in total distance is the shortest of the four commuter lines, having its destination within the Manila Metropolitan. It starts from Manila and runs along the South Line before branching off at Sta. Mesa into a south-easterly direction to run generally along the Pasig River, and has its terminal at Barrangca-Guadalupe, by the river opposite the township of Guadalupe. There were as of 1975 seven trains per day in each direction, the seven Rosal commuter trains making the outbound trips while the seven Camia commuter trains making the inbound trips. The first outbound train left Manila at 4.50 am while the last train left at 6.35 pm. The first and last inbound trains left Barrangca-Guadalupe at respectively 5.40 am and 7.45 pm. The scheduled travel time for the whole trip was 42 minutes.

This line was formerly called the Hulo line with the terminal at Hulo. The extension of the line by one station to Barrangca-Guadalupe was accomplished on November 24, 1974. The statistics for a six month period shows that in July, 1974 the month of inauguration of the line, a total of 8,733 passengers were served, for an average of 474 passengers/day or 57 passengers/train. The number of passengers had increased by leaps and bounds so that in December, 1974, when service was extended to Barrangca-Guadalupe, the record had reached 73,324 passengers for the whole month, or 2,334 passengers/day and 155 passengers/train.

In terms of efficiency rating, this line ranked highest among all the commuter lines for the same half-year period. The percentage of delayed trips ranged from 5% for July to the highest of 14% for the month of November, and the average for the period came to 73%. The number of cancelled trips for the 6 month period came to a total of 20 trips or 1.2% of the total scheduled trips.

(b) Carmona Line

This is by far the most important of all the commuter lines,accounting for over 2/3 of the total commuting passengers served by the PNR. Starting from Caloocan, the line runs along the main South Line passing through Paco and Muntinlupa and branches off at St. Pedro, Laguna, to end in the new settlement of Carmona which is situated at the boundary of the Provinces of Rizal, Laguna and Cavite. The total distance of the route is 42.4 km, and the scheduled travel time is about 82 minutes.

Eight trips per day in each direction were scheduled for the line in 1975. The total number of passengers served for the July-December 1974 period was 1,082 thousand, for an average of 6,000 passengers/day or 371 passengers/train, a loading volume of nearly 4 times that for the Barrangca-Guadalupe Line. The monthly fluctuation of traffic volume was small, although a gradual increase was recorded from 174 thousand passengers for the month of July to 205 thousand for the month of December.

The efficiency rating of the Carmona Line for the half-year period was poorer than that for the Barrangca-Guadalup Line. A total of 51 trips were cancelled, while the percentage of delayed trips ranged from 32% for November to 57% for July for an average of 45% delayed trips for the whole 6-month period. It it worth particular note that about 16% of the actual trips made were delayed by more than half an hour. This lack of punctuality and reliability no doubt accounted partly for the sluggishness in the increase of passenger volume.

(c) College Line

This line is basically an extension of the Carmona Line. The route is the same for the two lines from Manila to San Pedro, where the College Line diverges from the Carmona Line to run general along the verge of Laguna de Bay to reach the College terminal which is about 3 km away from Los Banos in the Province of Laguna. The total distance of the line is 67.1 km and the scheduled travel time was about 2 hours.

Only one train in each direction was scheduled for the line in 1975. The inbound train started from College at 5.00 am. and was scheduled to arrive Manila at

7.00 pm, while the outbound train left Manila at 6.00 pm. to arrive at College at 8.04 pm.

During the July-December 1974 period, a total of 104 thousand passengers were served by the line, for an average of 574 passengers/day or 293 passengers/train. The average per day and per train passenger volumes have in fact shown a gradual trend of decrease from the July record of 652 passengers/day and 323 passengers/train to the December figures of 483 passengers/day and 237 passengers/train.

The efficiency rating of this line was comparatively poor, with 46% of the trips arriving later than schedule, and 3.5% of the trips cancelled. The percentage of trips delayed by more than 30 minutes came to a high 18.3%.

(d) San Fernando, Pampanga Line

This line runs northwards from Manila via Caloocan on the North Railway Line, passing Meycauayan, Balagtas and Calumpit before ending in San Fernando in the Province of Pampanga. The total distance of the line is 61.6 km, and the scheduled travel time was about 105 minutes.

As in the case of College line, only one train was scheduled in each direction everyday in 1975. The inbound train left San Fernando at 5.35 am to reach Manila at 7.25 am while the outbound train left Manila at 6.10 pm and arrived at the destination at 7.55 pm.

A total of 82 thousand passengers were served by the line during the July-December, 1974 period, for an average of 476 passengers/day or 236 passengers/train. There was no marked trend of increase or decrease during the period.

In terms of efficiency rating, the San Fernando, P. Line ranked together with the College Line on the poor side. Of the total number of trains scheduled, 3.5% were cancelled while a high 68% were delayed, of which the percentage for delay of over 30 minutes came to about 12%.

1.1.2 Taxi

Although the taxi cannot be classed as a menas of mass transport, it is one of the most convenient means of personal rapid transport, and its important role in the public transport mechanism of the Metropolitan of Manila cannot be overlooked. There were some eight thousand vehicles registered in the Greater Manila Area under the category of taxis in 1975. Other than a number of taxi companies on a large scale, many of the vehicles were operated by small operators, owning from one to several vehicles. These vehicles were chartered to taxi drivers either at a flat rate per day or on a commission basis whereby an agreed percentage of the revenue was paid to the driver.

No fixed routes or fixed schedules are set for the taxi, neither are there any taxi pools established for the centralization of passengers, so that the taxi usually picks up passengers by 'flowing' through the streets. Many taxis, however, are usually found waiting around hotels, major restaurants, night clubs, movie theaters, the air-port, or other public places. The first user/s has the monopoly of the vehicle so that an occupied vehicle may not subsequently pick up other passengers even if there are some vacant seats that remain. This is different from some other southeast Asian cities whereby it is proper for the taxi to pick up different groups of passengers travelling in the same direction.

The fare is incremental in proportion to the distance travelled, at a rate fixed by the Board of Transport. Tipping of the taxi driver is not compulsory but it is customary to let the driver keep the change of a small sum.

Almost all the vehicles used as taxis are small sedans with a capacity of five persons including the driver. Many of the vehicles in use are rather old and poorly maintained, and breakdown of taxis in the middle of the road is not an uncommon scene.

Besides the taxi, there are also many vehicles on hire. These hired vehicles, together with the driver, are usually airconditioned large vehicles, which cater to the hirer at a rate proportional to the time restricted, irrespective of the distance travelled. The hired vehicle, however, is of negligible importance as a means of public transport and the use is generally limited to foreigners or residents on special occasions.

1.1.3 Bus

Together with the jeepney, the bus form the mainstay of mass public transport in the Metrpolitan Area.

There were as of 1975 over two thousand five hundred operating buses in MMA, under the operation of about 180 operators. About four-fifths of the buses were owned by small operators with less than ten vehicles. These buses provided services to passengers along 64 bus routes over the Greater Manila Area. These bus routes are usually along major thoroughfares although there are some routes which also pass through minor roads.

Until lately, there were no bus stops designated for the boarding and unboarding of passengers and the buses could stop anywhere along the route at the passengers convenience. This was very convenient for passengers. On the other hand, the large number of stops at short intervals inevitably greatly reduced the travel speed of the buses. Subsequently bus-stop were established so that boarding and unboarding of passengers may now be carried out only at designated stops.

The bus does not run on a fixed schedule, and the starting of a bus from a bus terminal is usually decided by a controller at the terminal. Generally, a controller does not order the bus to proceed unless the bus is nearly full of passengers at the terminal. As a result, the passengers at the intermediate stops find that they have to squeeze themselves into crowded buses full of passengers from the terminal.

Each bus is operated by one driver and one or two conductors according to the size of the vehicle. A passenger boarding a bus pays the conductor the fare of the trip (20 ct, 25 ct, or 30 ct in accordance to the distance to the destination) and in return receives a ticket which the passenger retains until the end of the trip. Inspectors may board the bus anywhere along the route to check if the passengers are holding the proper tickets. For unboarding, the passenger signifies by either pushing a buzzer if available, or by vocally notifying the drive or the conductor. The ticket is not retrieved by the conductor when the passenger unboards. Also, there is no distinction between entrance and exit so that a passenger may board or unboard at any door most convenient to him.

A bus transport system with a large number of small scale operators independently operating without a fixed schedule is by no means satisfactory in terms of efficiency and economy for a metropolitan area such as the Greater Manila Area. For the purpose of making an overall improvement of the bus transport system, a Manila Transit Corporation was established last year through the Presidential Decree No. 492 dated 27 June, 1974. The by-laws of the Corporation were subsequently drafted and approved on 5 Agusut, 1974, and the Manila Transit Corporation officially came into being.

The main objectives of the establishment of the Corporation were for the rationalization and integration of public transportation services in the Metropolitan and all operators with existing franchise were encouraged to transfer their assets involved in the transport business in exchange for equity participation in the corporation. The corporation is therefore eventually expected to become the core of an integrated public transportation system in Metropolitan Manila, capable of providing convenient, efficient and economical services to the public through the elmination of destructive competition and service duplication, the rationalization of route allocation and provision of proper balance of commuter service in all routes, the effecting of economies in operations and overhead facilities, and the standardization of rolling stock equipment and other facilities.

Being in operation for only a few months, it will be too rash to give any judgement as to the degree of success of the corporation at this time. However, it may be said that the general positive response from the existing operators is not by any means spontaneous, as many are probably skeptical of the merit of relinquishing their own franchise in exchange for equity participation. Perserverance is necessary on the part of the Corporation to convince and prove to the operators that participation in the Corporation will in the long run be in the interest of the operators as well as the national economy on the whole.

1.1.4 Jeepney

The jeepney has a most extensive service network in MMA and is probably firmly rooted as an indispensable means of public transport, particularly in the field of feeder service.

There were in 1975 over fifteen thousand jeepneys plying the thoroughfares, roads, streets and lanes of the Metropolitan. Most of the operators of the jeepney are of very small scale so that with the said number of vehicles, there were as many as fourteen thousand operators. One or two vehicles per operator is the common case, and operators with over ten vehicles constitute only a very small percentage of the whole. The vehicles are generally operated in two shifts per day, and a total of about twenty four thousand jeepney drivers keep the vehicles on the move.

When the policy of segregating the bus from the jeepney was established in Dec. 1972, the jeepneys were shut out from the main thoroughfares and the sphere of activities of each jeepney was confined to any designated one of the 120 jeepney zones, which were divided by neighbourhood areas. Passengers travelling across the zone boundaries have therefore to transfer enroute to complete the journey. However, following the modification carried out in May 1973, 6,500 of the vehicles were authorized to merge with the bus routes and travel across boundary lines. The structure of the modified jeepney transportation system remains prevailing today. The jeepney that vie with the buses on major throughfares are mostly of the larger twelve-seater type vehicles, while those smaller vehicles of 6, 8 or 10 passengers in capacity are generally used for serving the feeder routes.

As in the case of bus transport, the many small scale operators operating independently on such a varied number of routes is by no means efficient or economical, and reform measures have been contemplated.

A committee on transport corporative was recently established for this purpose. Here a recommendation is made that corporatives be set up within the operating zones, so that all the jeepneys within each zone will be put under one management through the corporative in the zone.

The operators will participate in the corporatives through contribution of the vehicles owned, while the drivers will be paid their compensation through the corporatives. The gross profit through the operation of the vehicles will then be divided between the vehicle owners (operators) and the corporative at a rate agreed between the two. In this manner, the allocation of routes, vehicles and drivers may be rationally made, and maintenance of vehicles may be centrally controlled by the corporatives. Economy and efficiency can be greatly expected.

However, response from the jeepney operators, as in the case of the bus, is generally cold. So far, twelve corporatives have been organized within the metropolitan, but only two of these can boast of being successful to some extent, while the rest are virtually dormant. Here again, it is anticipated that great perserverance is required to make the concept of corporatives well understood and welcomed by the operators.

1.2 EXISTING FARE SYSTEM OF PUBLIC TRANSPORT

Generally speaking, the fare for the various modes of urban public transport facilities in Manila is cheap as compared to the same for other major cities of the world.

The fare rate for road transport is determined by the Board of transport and usually remains very stable. The last revision of the fare rate was carried out in February 1974, as a consequence of the increase in operating cost due to the oil crisis.

A description of the four existing major modes of public transport, namely taxi, PNR commuter train service, bus and jeepney shall be given below.

1.2.1 Taxi

The taxi is a minor form of public transport in Manila. According to the results of the traffic survey carried out in 1971 for the master plan of Manila at the screen line stations, the volume of traffic by taxi made up 10-15% of the total vehicle traffic volume, and was only about 1/4 to 1/2 of the total volume of jeepneys and buses. Moreover, while the taxi is undoubtedly a form of public transport, characteristically it does not sufficiently fulfil the role of a mass transit transport.

The fare rate of taxi until the year 1973 had for a long time been fixed as follows.

(1) 20 centavos (ct) for the first 300 m

(2) 10 ct for each additional 300 m

The old taxi fares at 1 km interval were therefore as follows:

distance (km)	1	2	3	4	5	6	7	8	9	10
fare (P)	0.5	0.8	1.1	1.5	1.8	2.1	2.5	2.8	3.1	3.5

The fare rate was revised in February 1974 after the oil crisis, and the current rate is as follows.

(1) 40 ct for the first 350 m

(2) 20 ct for each additional 350 m

The current taxi fares at 1 km interval, together with the percentage increase over the old fare are as follows.

distance (km)	1	2	3	4	5	6	7	8	9	10
fare (P)	0.8	1.4	2.0	2.6	3.2	3.8	4.2	4.8	5.4	6.0
% increase over old fare	60%	75	82	73	78	81	68	72	74	72

1.2.2 Philippine National Railways (PNR)

The Philippine National Railways (PNR) was established for the service of inter-provincial long-distance transport of goods and passengers, and is therefore not oriented to cater for urban public transport. The commuter train service in the Greater Manila region was rather recently initiated, with the aim of providing commuter transport facilities to the new residential housing subdivisions sprouting through the outskirt of the metropolitan. The existing commuter train services are provided on the following lines:

(1) Carmona Line: Caloocan -- Manila -- Carmona

(2) Barrangca-Guadalupe Line: Manila -- Hulo -- Barrangca-Guadalupe

(3) College Line: Manila -- Paco -- Los Banos -- College

(4) San Fermando, Pampanga Line: Manila -- Caloocan -- San Fernando, P.

The current fares on a commuter train trip from Manila or Caloocan to the major stops of the four lines are as shown below.

(1) Carmona Line (From Caloocan)

Station	Distance (km)	Fare(P)	Fare rate (ct/km)	Scheduled time (min.)
Sampaloc	7.0	0.35	5.0	15
Sta Mesa	8.6	0.35	4.1	20
Pandacan	9.9	0.35	3.5	25
Paco	11.5	0.35	3.0	30
Pio del Pilar	15.4	0.60	3.9	39
Highway	16.5	0.60	3.6	41
GMTFM	20.5	0.60	2.9	47
Gelmat (Pae)	22.8	0.60	2.6	51
Sucat	27.1	0.80	3.0	58
Alabang	30.8	0.80	2.6	64
Muntinlupa	34.1	0.80	2.4	69
San Pedro,L.	37.6	1.00	2.7	73
Carmona	42.4	1.00	2.4	82

(2) Barrangca-Guadalupe Line (From Manila)

Station	Distance (km)	Fare (P)	Fare rate (ct/km)	Scheduled time (min.)
San Lazaro	2.7	0.25	9.3	8
Sampaloc	4.9	0.25	5.1	15
Sta Mesa	6.5	0.25	3.8	38
Hulo	11.9	0.40	3.4	38
Barrangca-Guadalupe	13.0	0.40	3.1	42

(3) San Fernando, P. Line (From Manila)

Station	Distance(km)	Fare (P)	Fare rate (ct/km)	Scheduled time (min.)
Caloocan	5.8	0.20	3.4	11
Meycauayan	15.0	0.50	3.3	24
Balagtas	26.4	0.85	3.2	41
Malolos	37.1	1.20	3.2	58
Calumpit	46.0	1.50	3.3	78
San Fernando, P.	61.6	2.00	3.2	105

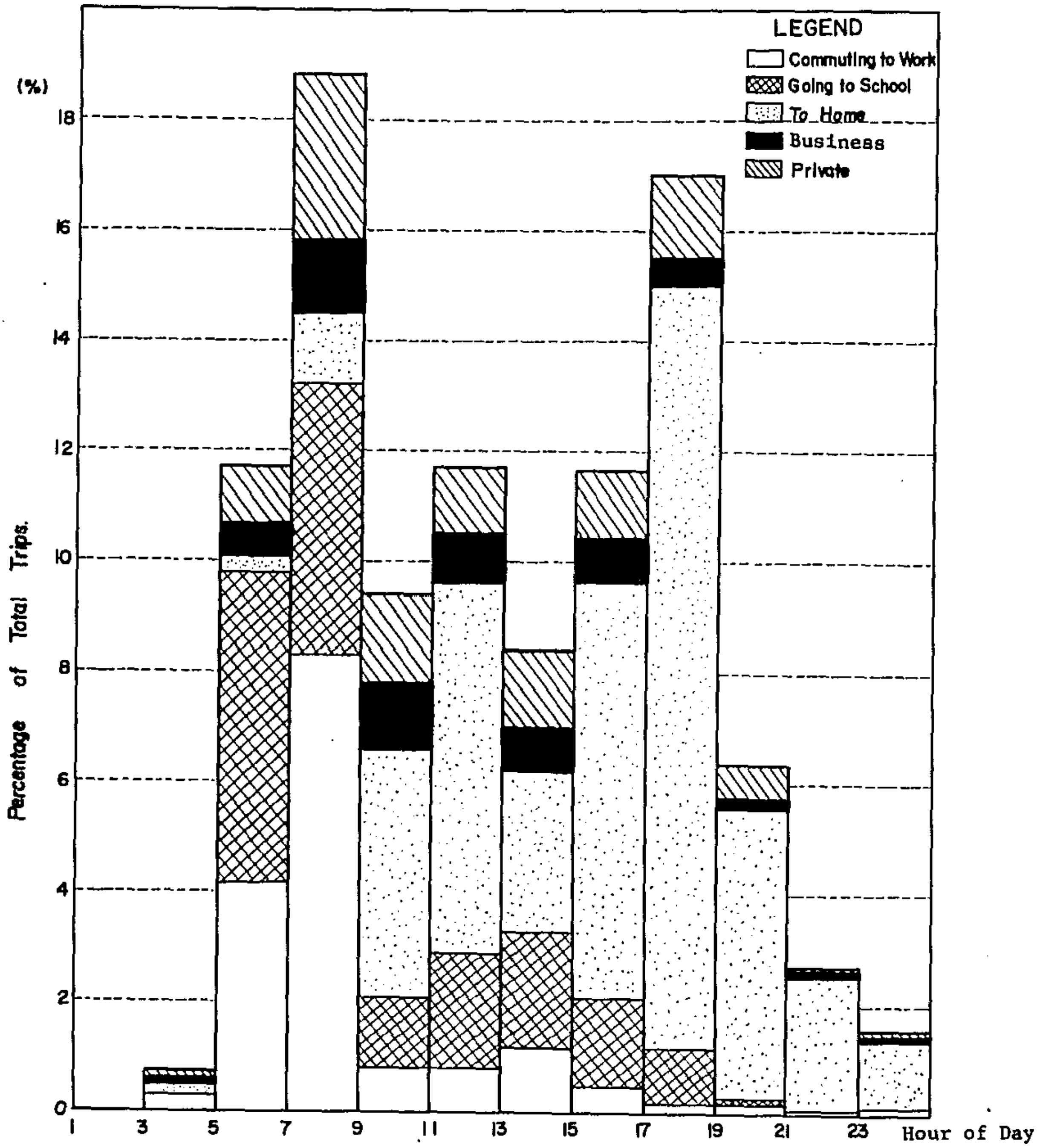
It will seen from the above that the absolute minimum fare for the PNR commuter service train is P0.20 which is applicable to the 5.8 km trip from Manila to Caloocan on the San Fernando, P. Line. However, it will be noticed that the minimum fare differs from line to line irrespective of the section distance. Thus the minimum fare for the 2.7 km trip from Manila to San Lazaro on the Barrangca-Guadalupe line comes to P0.25. More conspicuously, the fare from Caloocan to Manila on the Carmona Line comes to P0.25. We have therefore two different fare rates for the same section on different lines.

Except for the short-distance trips, the fare rate on the commuter service trains generally comes within the range of 2.5 - 3.5 ct/km. This fare rate is considerably lower than the flat rate of 4 ct/km for the bus and jeepney. Other than the Barrangca-Guadalupe Line which has an average scheduled travel speed of about 19 kph, the average scheduled travel speed of the remaining three lines comes to 30 - 35 kph. This again, is much higher than an average of below 15 kph recorded by buses and jeepneys in most of the urban road sections. It can be said, therefore, that if the train frequency can be increased, and the regularity and punctuality can be maintained, the PNR commuting train is in a very favourable position to compete with the buses and jeepneys in urban passenger transport in terms of both fare rate and travel speed.

1.2.3 Bus and Jeepney

The bus and the jeepney form the mainstay of the current urban public transport system in Manila. The extensiveness of the service networks, which enable users to travel to their respective destination either directly or through changing of bus or jeepney, is of course a great merit. However, the low fare rate undoubtedly makes the bus and jeepney more attractive.

Fig. 2.1.1 Hourly Variation of Person Trip by Trip Purpose 1971



Source: Person Trip Survey in 1971 under UTSMMA

The same fare rate is applicable to both the buses and the jeepneys plying the main thoroughfares and the secondary roads of the metropolitan. The fare rate had remained unchanged for many years until its last revision in February 1974. The fare rates before the 1974 revision were as follows:

(1) A minimum fare of 15 centavos for the first 5 km

(2) An additional 2.4 ct for each additional km

At the above fare rate, the fare for a trip by distance was therefore as follows:

Distance (km)	0-5	6	7	8	9	10
Fare (ct)	15	17	20	22	25	27

The oil cirsis in the winter of 1973 resulted in a drastic increase in the cost of fuels as well as other commodities and the operators found it difficult to maintain a healthy state of operation of the buses and the jeepneys at the old fare rates. A revision was consequently made in February 1974, and the revised fare rates are as follows:

(1) A minimum fare of 20 centavos for the first 5 km

(2) An additional fare of 4 ct. for each additional km

The prevailing fares by distance for buses and jeepneys are therefore as follows:

Distance (km)	0-5	6	7	8	9	10
Fare (ct)	20	24	28	32	36	40
% increase	33	41	40	46	44	48

It should be noted, however, that except for some routes along the main thoroughfares, the average route distance of most of the jeepneys are generally short, and in practice, the minimum rate of 20 ct. per trip is the general case for most jeepney trips. There are nevertheless, minor cases of 25 ct/trip or 30 ct/trip being charged on some longer routes.

The same case may be said for the buses, for which the minimum rate of 20 ct/trip is most common. 25 ct/trip or 30 ct/trip are minor cases for trips of longer distance.

Discounted fares for coupon tickets, season tickets or concession fares for children or students are not available.

1.3 THE CHARACTERISTICS OF PUBLIC TRANSPORT TRIPS

1.3.1 Hourly Variation

According to the person trip survey conducted in 1971, the hourly variation of person trip generation can be illustrated as in Fig. 2.1.1. As shown in this figure, there are outstanding peaks of person trip generation at periods 7:00 - 9:00 a.m. and 5:00 - 7:00 p.m. of a day, which occupy 18.8 per cent and 17.0 per cent respectively of all trips, with the morning peak time 1.8 per cent higher than the evening.

From the point of trip purpose according to this survey, "trip to work" is at peak at 7:00 - 9:00 a.m. and the peak for "trip to school" is earlier than this. The peak of "trip to home" is conspicuous at 5:00 - 7:00 p.m. As for "business trip" and "personal trip", the variation is almost even with the business trip remaining almost unvaried throughout 7:00 a.m. to 5:00 p.m. and personal trip almost constant throughout

Fig. 2.1.2 Hourly Variation of Vehicle Trip (Bus) - 1974

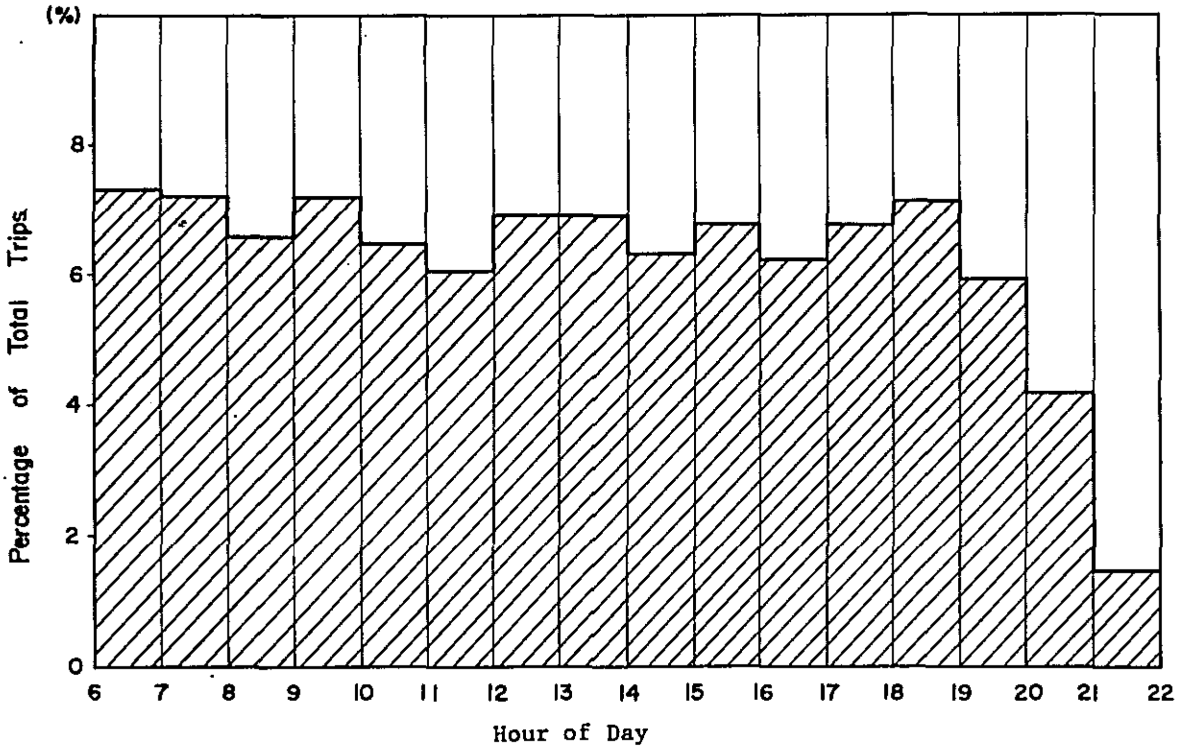
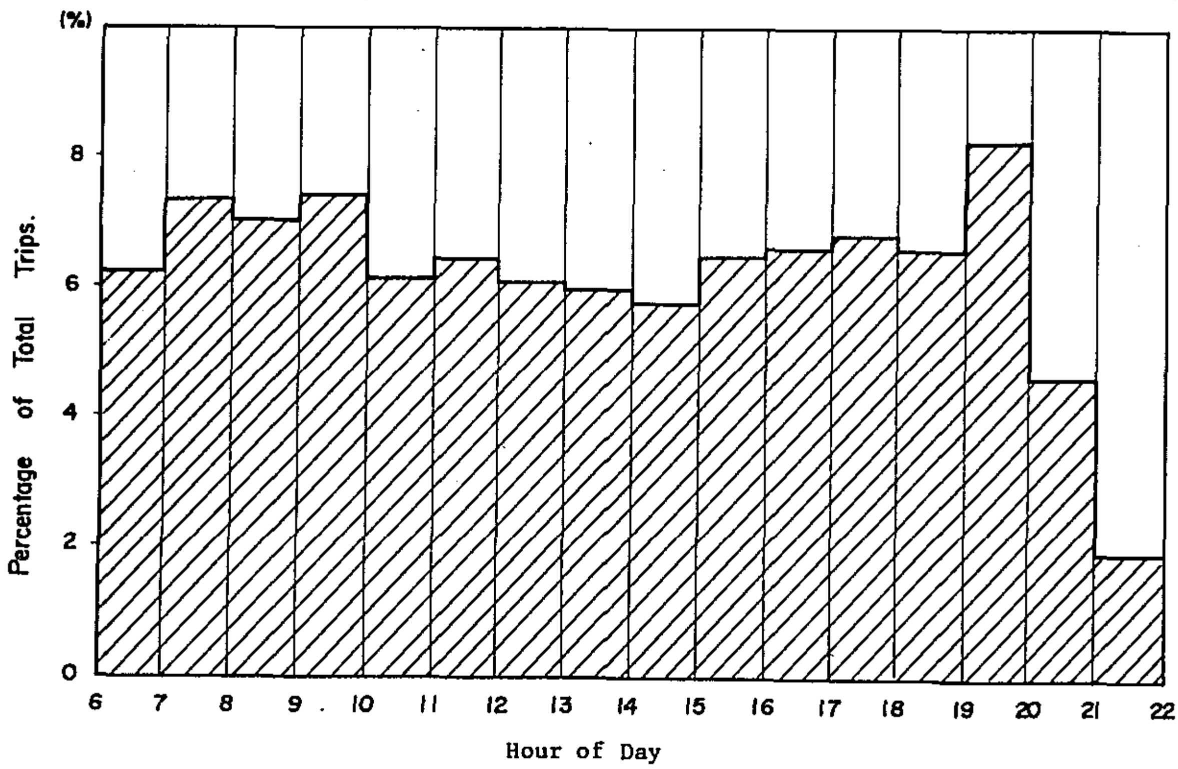


Fig. 2.1.3 Hourly Variation of Vehicle Trip (Jeepney) - 1974



Source: Traffic Survey by DPH in 1974

5:00 a.m. to 7:00 p.m.

In contrast to these figures for person trips, the trips by bus and jeepney do not have noticeable hourly variations throughout 6:00 a.m. and 8:00 p.m., as shown in Fig. 2.1.2 and 2.1.3.

The service frequency of bus and jeepney do not vary between peak periods and off-peak periods to any great extent, although from the point of hourly variation of bus and jeepney passengers, there are slightly noticeable peaks at 7:00 - 9:00 a.m. and 5:00 - 7:00 p.m. for both bus and jeepney, as shown in Fig. 2.1.4 and 2.1.5.

1.3.2 Variation in Trip Length

Fig. 2.1.6 and 2.1.7 illustrate the variation in trip length of passengers using bus and jeepney. The average trip length of bus passengers is 7.44 kms and that of jeepney passengers is 4.18 kms, the average trip length of bus passenger being 3.26 kms longer than that of jeepney passengers.

The percentage of bus passengers trip is highest at the trip length of 8 - 10 kms, with a share of 17.9% of all bus passengers trips and the second highest is at passengers trip length of 6 - 8 kms with a percentage of 16.6%. The total share of bus passengers trips of less than 14 kms in trip length is 85.6%. From this it may be said that most of the bus passengers trip length is less than 14 kms.

As for the trip length variation of jeepney passengers, the highest percentage of jeepney passenger trip is found at trip length of 2 - 4 kms, the percentage being 37.9, and the next highest, 24.3%, for trip length of 0 - 2 kms. The total percentage of jeepney passenger trip length that is less than 8 kms comes to 88.9%, showing that most of the jeepney passenger trips ends within 8 km distance.

It is found, therefore, that the trip length of jeepney passenger is much shorter than that of bus passenger. This is a natural outcome of the present status of route networks whereby the bus route serves as a trunk line haul and the jeepney provides services to feeder lines.

1.3.3 Variation in Walking Time

The results of the surveys on mass transit service conducted in April, 1975 are summarized in Fig. 2.1.8, which shows the walking times of bus or jeepney passengers from their home, work, or school to bus or jeepney stop, or vice versa.

It is found from this figure that the average walking time of bus passengers is almost a constant 6 minutes irrespective of trip purpose and that of jeepney passenger is 5 minutes for trip to work and 6 minutes for trip to school or home. As far as the walking time is concerned, there is almost no difference observed between bus passengers and jeepney passengers.

On analysing the variation of walking time, it is seen that the bus passengers show some slight variation only according to the the purpose of the trip, and the walking time of less than 10 minutes occupies 75 - 85% of all trips. The variation in walking time of jeepney users is almost identical to this.

Fig. 2.1.4 Hourly Variation of Bus Passenger

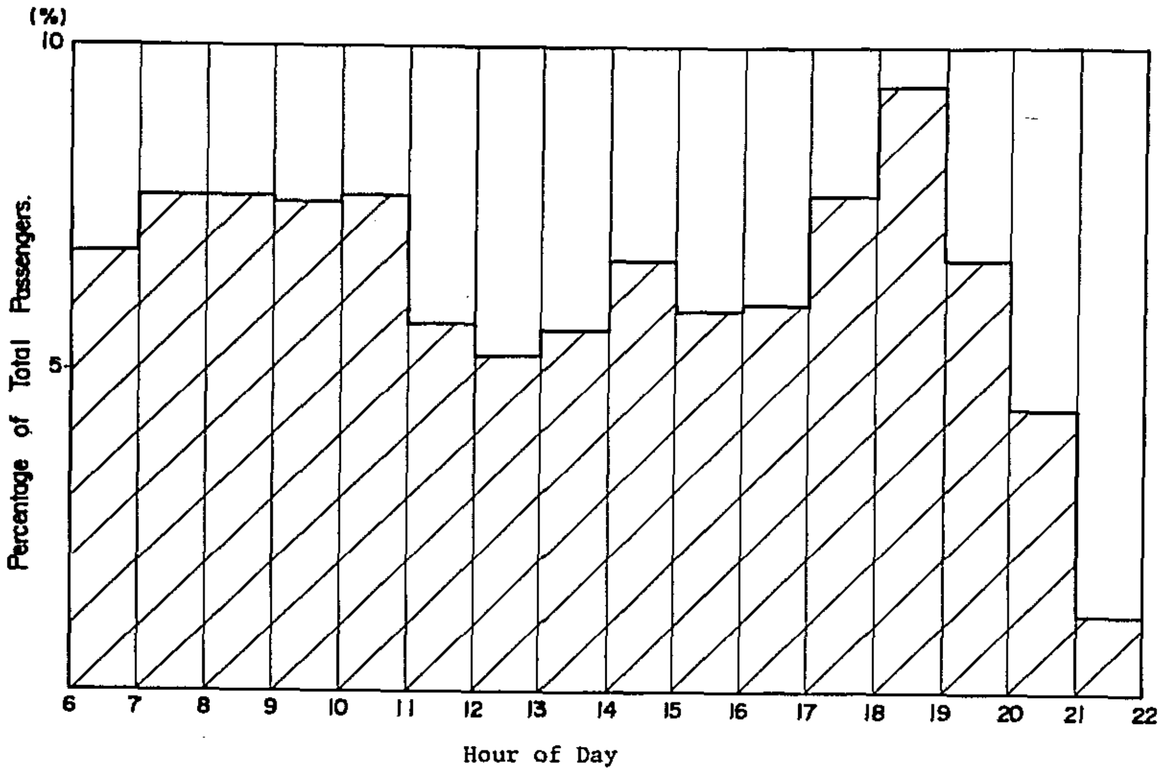
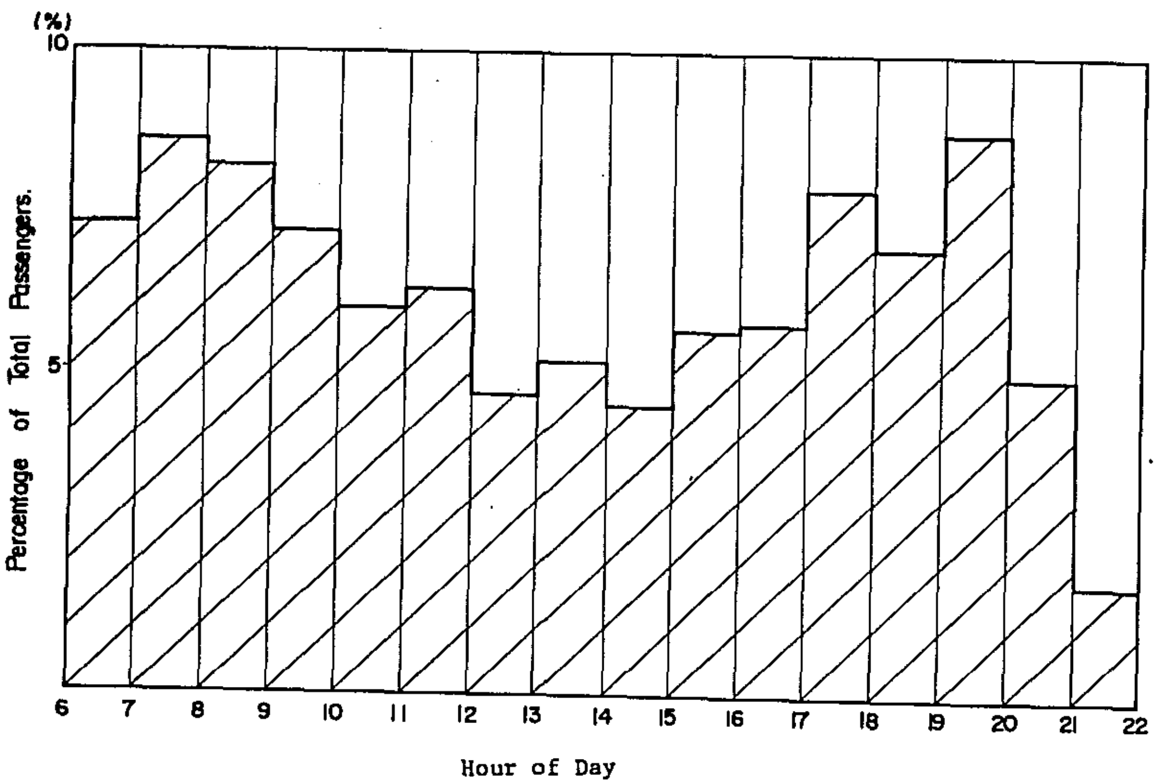
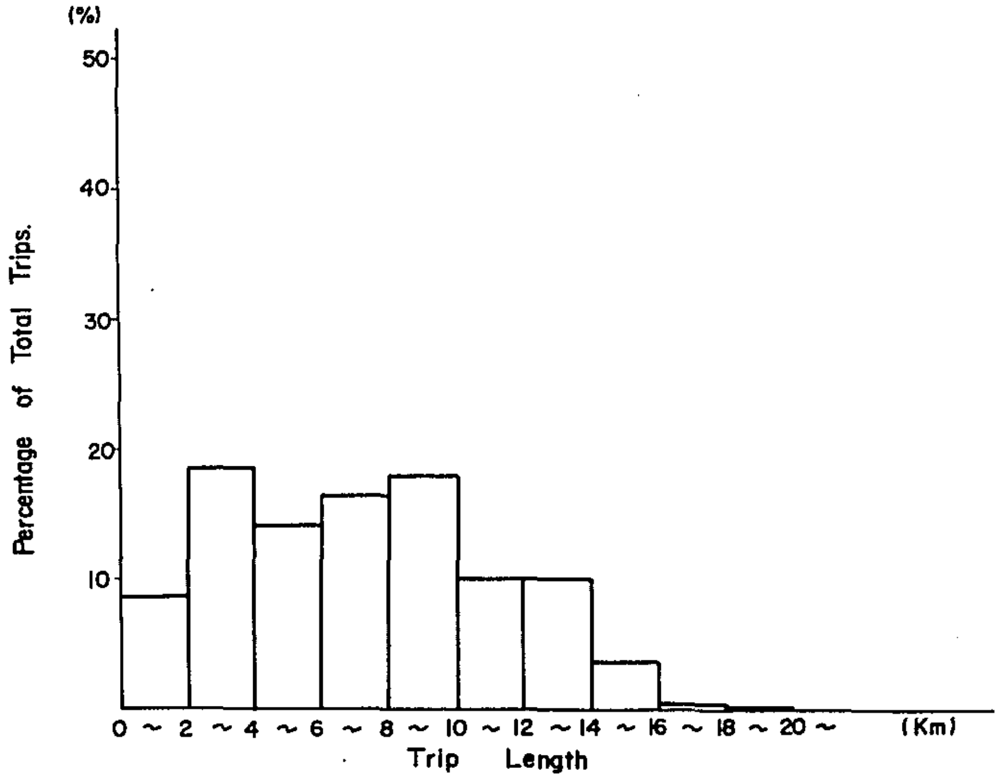


Fig. 2.1.5 Hourly Variation of Jeepney Passenger



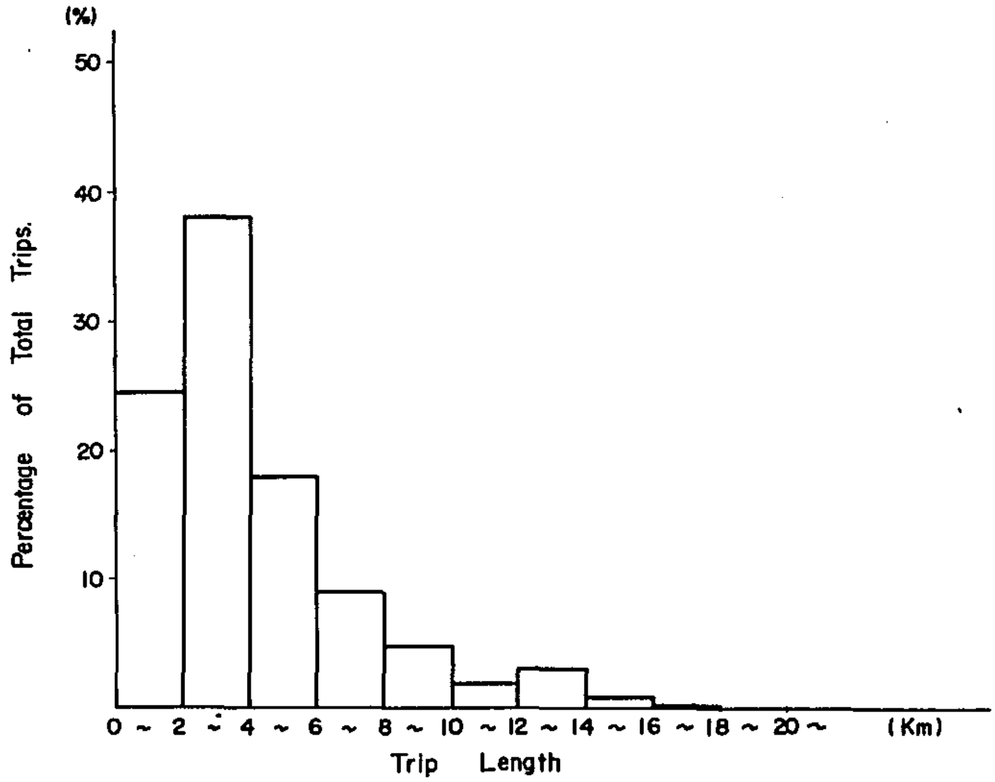
Source: Traffic Survey by DPH in 1974 & Mass Transit Services Survey in 1975

Fig. 2.1.6 Variation in Trip Length (Bus) -- 1974



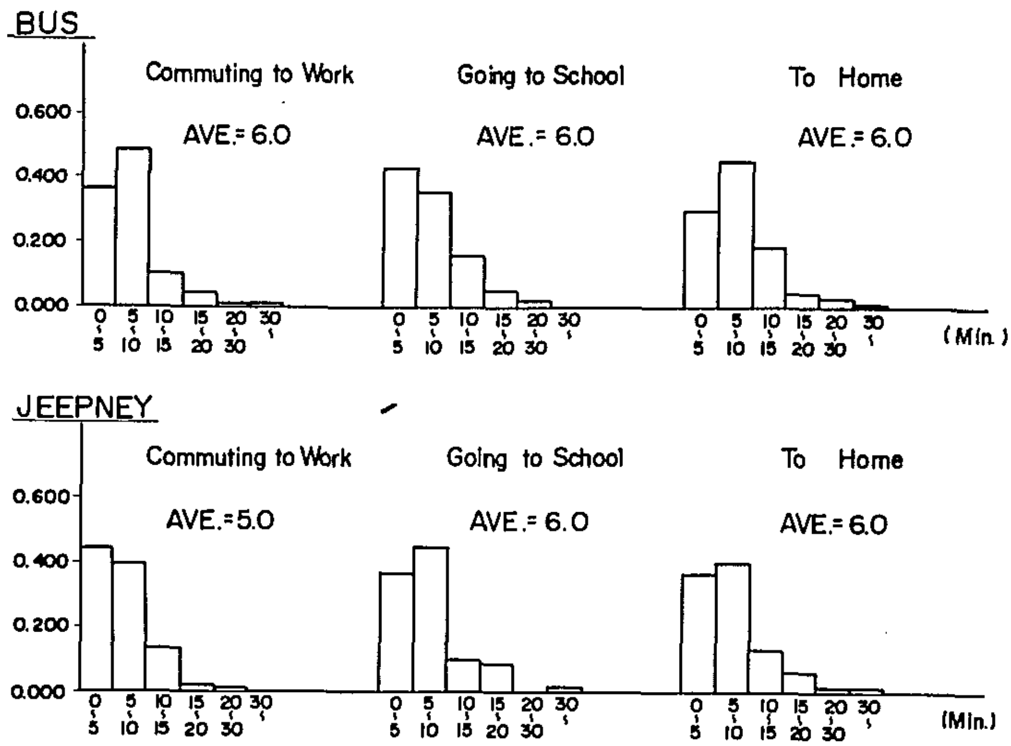
Source: Person Trip Survey in 1971 under UTSMMA

Fig. 2.1.7 Variation in Trip Length (Jeepney) - 1974



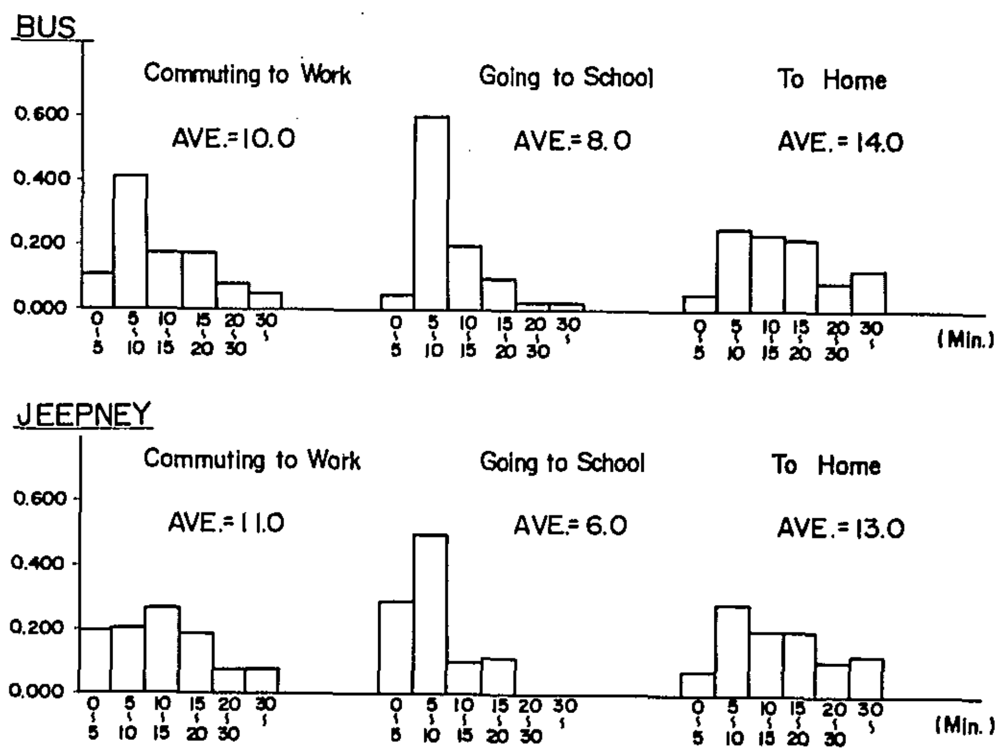
Source: Person Trip Survey in 1971 under UTSMMA

Fig. 2.1.8 Variation in Walking Time



Source: Mass Transit Services Survey in 1975

Fig. 2.1.9 Variation in Waiting Time



Source: Mass Transit Services Survey in 1975

1.3.4 Variation in Waiting Time

A survey similar to that referred to in 1.3.3 was conducted on the waiting time at bus or jeepney stops, the results of which are shown in Fig. 2.1.9.

As seen from this figure, the average waiting time of bus passengers at a bus stop varies slightly according to the trip purpose. For a trip to work the average waiting time is 10 minutes, while that for trips o school is 8 minutes and that of trip to home is 14 minutes. A variation quite similar to this is found with the waiting time of jeepney passengers. Thus, the average waiting time of jeepney passengers is 11 minutes for trip to work, 6 minutes for trip to school, and 13 minutes for trip to home.

The average waiting time of bus or jeepney passengers becomes longer for trip to home, and the waiting time of 20 - 30 minutes is experienced by 10% of bus or jeepney passengers on their way home and that of less than 30 minutes by 13%, as shown in Fig 2.1.9. The longer waiting time for trip to home is observed with bus as well as jeepney passengers.

The reason for the longer average waiting time for trip to home is that the trip generation is most concentrated in the early evening as indicated in Fig. 2.1.1 while the service frequency of bus and jeepney do not vary much between peak and off-peak periods as in Fig. 2.1.2 and 2.1.3. The result is that buses and jeepneys are always running at full capacity thus prolonging the average waiting time. This phenomenon is easily vindicated by the great number of people waiting at bus or jeepney stops in the urban centre during peak periods.

It is noteworthy that the waiting time for trip to work is longer than that for trip to school. The trip generation peak period of trip to school is found at 5:00 - 7:00 a.m. when the passenger volume of other trip purposes is not very high. However the time period of 7:00 - 9:00 a.m. which is the peak period for trip to work, also coincides with the peak period for other trips purposes and the service frequency of bus and jeepney is not adequate to fully cater to the demand at this period. From the point of service frequency of public transport means it can be said that the capacity is extremely small at peak periods in comparison with the generated volume of personal trips.

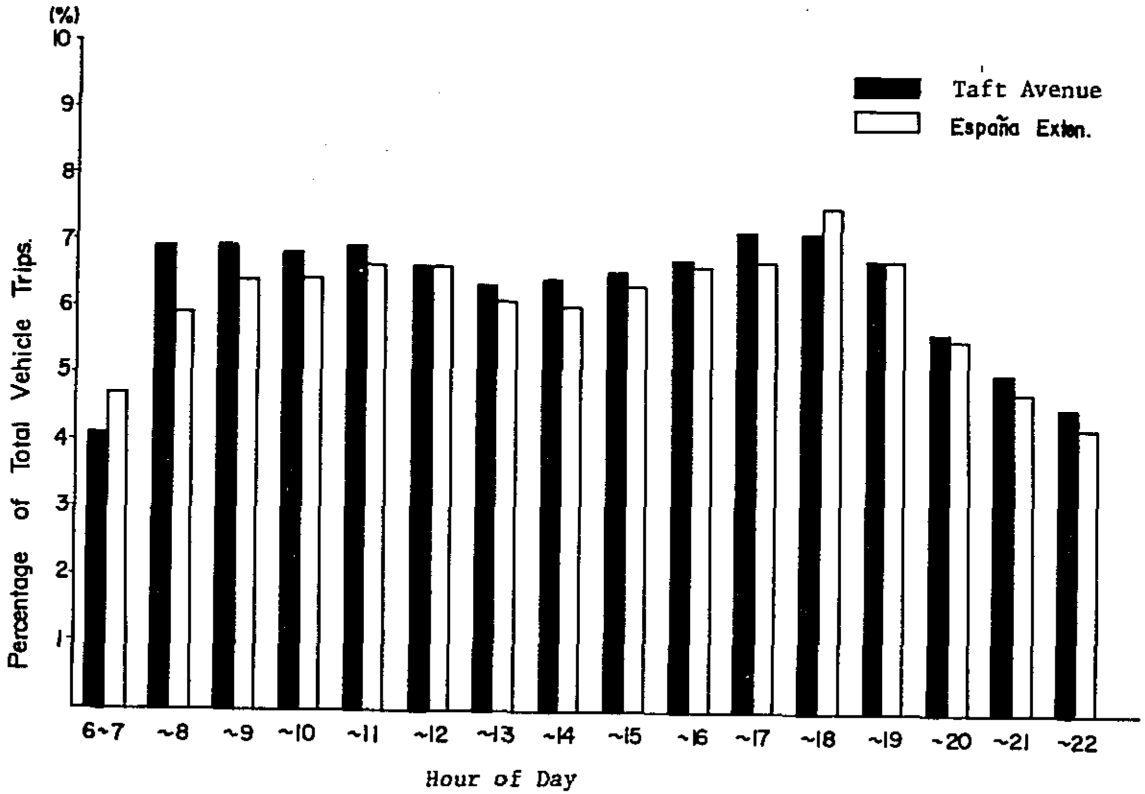
1.4 CHARACTERISTICS OF ROAD USING TRIPS

1.4.1 Hourly Variation

According to the results of a survey on automobile traffic volume that was conducted by the D.P.W.T.C. of the Philippine government in July and August of 1974, the hourly variation of the automobile traffic volume can be illustrated as in Fig. 2.1.10. It is noted that there are small peaks at 7:00 - 9:00 a.m. and 5:00 - 9:00 p.m. but that the hourly variation is not conspicuous throughout the 12 hours from 7:00 to 7:00 p.m.

It is considered that the coefficient of road congestion is around 1 and therefore the roads cannot accommodate any additional traffic volume at any time period with the result that the hourly variation is being levelled up. This will be discussed in more detail in the following section.

Fig. 2.1.10 Hourly Variation of Total Vehicle Trip. - 1974



Source: Traffic Survey by DPH in 1974

1.4.2 Traffic Volume and Congestion

Table 2.1.1 shows the average daily traffic volumes and coefficient of congestion at the main points along RTR Line No. 1.

In this table , the road capacity was computed from the following equation.

$$C_D = C_B \times Y_e \times Y_c \times Y_t \times Y_i \times Y_d \times Y_{ic} \times P$$

where

C_d ; Designed capacity (vehicle/day lane)

C_B ; Basic capacity

Y_e ; Adjustment factor for lane width

Y_c ; Adjustment factor for lateral clearance

Y_t ; Adjustment factor for composition of heavy trucks and buses

Y_i ; Adjustment factor for shoulder

Y_d ; Adjustment factor of heavy flow in one direction

Y_{ic} ; Adjustment factor for road intersections

P ; Peak ratio

According to this table, the congestion coefficient for the main roads, especially Quirino Ave., Taft Ave., C.M. Recto Ave. and Espana Boulevard are more than 1, which means that these roads are already heavily congested.

Although Bonifacio Drive and Quezon Boulevard are still capable of catering to an increased traffic volume, the traffic on the extention of Quezon Boulevard, i.e. Espana Boulevard, is extremely congested and considering that they must serve as a part of a network it will be almost impossible for these roads to meet with any increase of traffic volume from the present level.

Table 2.1.1 Traffic Congestion by Survey Station

Survey station	Survey Location & Name of Street	ADT[1)] Vehicles/Day	Design capacity Vehicles/Day	Congestion Coefficient
19	Quirino Ave. Paranaque	30,028	26,000	1.15
18	Quirino Ave. Baclaran	24,055	20,800	1.15
16	Taft Ave. Pasay Market	22,981	20,800	1.11
15	Taft Ave. General Hospital	68,516	66,300	1.03
285	Bonifacio Drive Intromuros	41,874	51,000	0.82
105	C.M. Recto Juan Luna	50,471	45,700	1.10
187	C.M. Recto Rizal Ave.	46,622	40,000	1.17
189	C.M. Recto Rizal Ave.	44,815	40,000	1.12
261	C.M. Recto Quezon Boulvard	57,499	45,700	1.26
32	Espana Boulvard Boundary Manila-Quezon	75,375	64,700	1.16
31	Quezon Boulvard Francisco River	66,179	74,400	0.89

Source of ADT: Traffic Survey by DPH in 1974

1.4.3 Vehicle Composition

The vehicle composition of daily average traffic volume for 1974 is shown in Table 2.1.2. There are notable differences of the vehicle composition among routes. Particularly for Quirino Ave. in Paranaque and Taft Ave. in Pasay, the composition of bus and jeepney against the total traffic volume was recorded at a high 74% and 59% respectively. The same is found in the section of C.M. Recto near Divisoria, where the share of bus and jeepney together reaches 55%. The share of bus and jeepney is less than 10% in only two places only, i.e. Bonifaico Drive and Quezon Boulevard whereas a share of between 20 and 40% was recorded for all the other places.

On the roads with such large shares of bus and jeepney, the congestion becomes extremely great. The congestion coefficient is 1.12 for Survey Station 18, 1.07 for Survey Station 16 and 1.03 for Survey Station 32, all exceeding congestion coefficient 1.

Table 2.1.2 Average Daily Vehicle Traffic Volume by Vehicle Type in 1974

Survey Station	Name of Street	Cars	Jeep-neys	Buses			Trucks	Total
				Light	Heavy	Total		
19	Quirino Ave. Paranaque	17,005 56.6	10,076 33.6	666 2.2	1,025 3.4	1,691 5.6	1,256 4.2	30,028
18	Quirino Ave. Baclaran	5,531 23.0	9,825 40.8	2,375 9.9	5,534 23.0	7,909 32.9	790 3.3	24,055
16	Taft Ave. Pasay Mart.	8,612 37.5	9,156 39.8	106 0.5	4,386 19.1	4,492 19.6	721 3.1	22,981
15	Taft Ave. General Hos.	42,184 61.5	15,606 22.8	145 0.2	9,704 14.2	9,849 14.4	877 1.3	68,516
285	Bonifacio Drive	35,523 84.8	615 1.5	78 0.2	1,051 2.5	1,129 2.7	4,607 11.0	41,874
105	C.M. Recto Juna Luna	21,294 42.2	24,434 48.4	637 1.3	2,534 5.0	3,171 6.3	1,572 3.1	50,471
187	C.M. Recto Rizal Ave.	29,376 63.0	13,387 28.7	567 1.2	2,381 5.1	2,948 6.3	911 2.0	46,622
189	C.M. Recto Rizal Ave.	28,993 64.7	11,800 26.3	656 1.5	2,390 5.3	3,046 6.8	976 2.2	44,815
261	C.M. Recto Quezon Bould.	37,540 65.3	16,199 28.2	677 1.2	2,294 4.0	2,971 5.2	789 1.3	57,499
32	Espana Bould. Boundary Manila and Quezon	58,611 77.8	9,801 13.0	241 0.3	5,284 7.0	5,525 7.3	1,438 1.9	75,375
31	Quezon Bould. Fransico River	59,212 89.5	1,245 1.9	129 0.2	3,873 5.8	4,002 6.0	1,720 2.6	66,179

Source: Data: Traffic Survey by DPH in 1974
Unit: Upper: Traffic Volume (Vehicles/day)
Lower: Percentage of Total Traffic Volume (%)

1.5 CHARACTERISTICS OF MODAL SPLIT

1.5.1 General Remarks

There are a great number of factors affecting a person's selection of traffic mode to make a trip. The factors may be concerned with the traffic mode in relation to the time and distance to the destination and the conditions of traffic network. At the same time, the factors may be about the individual person or the family with respect to car ownership, income standard, social status, etc. The modal split is to be analyzed in the next section by using the results of person trip survey in 1971 and mass transit service survey in 1975.

1.5.2 Modal Split

(1) Modal Split by Trip Purpose

Table 2.1.3 shows the modal split by trip purpose. The use of bus and jeepney as the existing means of public transport is the highest for trip purposes of going to school (74%), and the second highest for commuting to work (60%)

In contrast to this, the use of public transport for business purpose is very low (17%), and it is also rather low for private purpose (45%).

Table 2.1.3 Modal Split by Trip Purpose

Unit: %

	Bus	Jeepney	Car	Taxi	Total
. Commuting to Work	25	35	33	7	100
Goint to School	23	51	24	2	100
Private	12	33	45	10	100
Business	5	12	78	5	100
To Home	21	42	30	7	100

Source: Result of person trip survey under UTSMMA, 1971.

(2) Modal Split by Car Ownership

The modal split by car ownership is shown in Table 2.1.4. From this table a clear difference is shown in the selection of traffic mode by car owners and non-car-owners. In other words, the use of cars by car owners is excessively high in contrast to their low rate of using bus and jeepney. The reverse is found with non-car-owners. This means that the factor of whether or not one is in possession of a car, i.e. car ownership, cannot be disregarded in modal split.

Table 2.1.4 Modal Split by Car Ownership

Unit: %

	Bus	Jeepney	Car	Taxi	Total
Car Owner	9	15	72	4	100
Non-Car-Owner	25	51	17	7	100

Source: Results of person trip survey under UTSMMA, 1971

1.5.3 Passenger Volume along the proposed line

Table 2.1.5 shows the number of passengers on each survey station on the proposed line based on the DPH traffic survey in 1974 and the bus jeepney occupancy survey in 1975. The following characteristics were observed from the table.

(1) The number of passengers near Baclaran on Quirino Ave. was 478 thousand and the share of public transport was a particularly high 97.6 percent while that of private

transport is only 2.4%.

(2) The share of public transport near the boundary of Manila and Quezon on Espana Bouldvard was 78 percent while that of private transport is 22%.

(3) From the viewpoint of passenger volume, the passenger volume on Espana Bouldvard was larger than that on Taft Ave.

Table 2.1.5 Daily Passenger Volume by Vehicle Type

Unit: Passengers/day

Survey Station	Name of Street	Private Vehicles			Public Vehicles			Total
		Cars	Trucks	Sub-Total	Jeep-neys	Buses	Sub-Total	
19	Quirino Ave. Paranaque	30,609 14.7	2,512 1.2	3,121 15.9	100,760 48.4	74,357 35.7	175,117 84.1	208,238
18	Quirino Ave. Baclaran	9,956 2.1	1,580 0.3	11,536 2.4	98,250 20.5	368,495 77.1	466,745 97.6	478,281
16	Taft Ave. Pasay Market	15,502 4.4	1,442 0.4	16,944 4.8	91,560 26.0	244,092 69.2	335,652 95.2	352,596
15	Taft Ave. General Hospital	75,931 9.9	1,754 0.2	77,685 10.1	156,060 20.2	537,635 69.7	693,695 89.9	771,380
285	Bonifacio Drive	63,941 45.9	9,214 6.6	73,155 52.5	6,150 4.4	59,911 43.1	66,061 47.5	139,216
105	C.M. Recto Juna Luna	38,329 8.7	3,144 0.7	41,473 9.4	244,340 55.2	156,569 35.4	400,909 90.6	442,382
187	C.M. Recto Rizal Ave.	52,877 15.8	1,822 0.5	54,699 16.3	133,870 40.0	146,264 43.7	280,134 83.7	334,833
189	C.M. Recto Rizal Ave.	52,187 16.2	1,952 0.6	54,139 16.8	118,000 36.8	149,162 46.4	267,162 83.2	321,301
261	C.M. Recto Quezon Bould.	67,572 18.0	1,578 0.4	69,150 18.4	161,990 43.1	144,449 38.5	306,439 81.6	375,589
32	Espana Bould. Boundary Manila & Quezon	105,500 20.9	2,876 0.6	108,376 21.5	98,010 19.5	297,127 59.0	395,137 78.5	503,513
31	Quezon Bould. Fransico River	106,582 31.5	3,440 1.0	110,022 32.5	12,450 3.7	216,498 63.8	228,948 67.5	338,970

Source: Traffic Survey by DPH in 1974.

1.5.4 Factors of Traffic Mode Selection

This survey, conducted in March and April of 1975, requested the interviewees to mark the highest selective factor 1, the second highest selective factor 2, and so on when they select among traffic modes. In subsequent analysis, the 1st selective factor is given the score 8, the 2nd factor given the score 7, and so on, until the 8th factor which is given the score 1. The scores are weighed by the number of samples which respond on the factors.

The overall scores of a factor can be obtained by the following formula:

$$P^{ic} = \frac{\sum_N V_N^{ic} \times S_N^{ic}}{\sum S_N^{ic}}$$

P^{ic} ; the overall score of factor i with attribute c

V_N ; the score of rank N

S_N^{ic} ; the number of samples responding on rank N of factor i attribute c

According to the results of the above analysis shown in Fig. 2.1.11, "travel time" obtained the highest point of 5.90 among factors for modal split. This was followed by "safety" (5.46) and "fare" (5.37) to form the top three factors. Then came "precise scheduling", "availability of seats", "walking time to stops", "number of transfers required", and "weather".

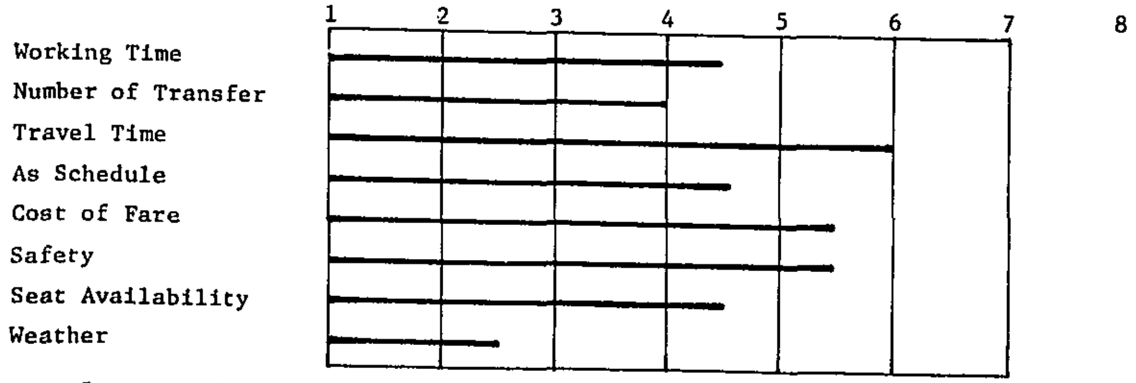
Table 2.1.6 shows the same data by sexes, age brackets and occupations. By sexes, the first three factors remain the same but the order of importance given was different. While men gave the highest point to "travel time", women gave it to "safety". Also characteristic of women was that they put a high priority on "availability of seats".

By age brackets, "travel time" was given the highest point by under 19 year old group and the point given became smaller as the age brackets went higher. Scheduling did not obtain very high points though it is essentially much related to travel time.

By occupations, professional workers gave very high points to "travel time", followed by "safety", and scheduling". Other worker groups put priorite on "safety", then "fare" and "travel time".

In summary, it can be concluded that most commuters and passengers want a shorter travel time as well as safety, security and lower fares.

Fig. 2.1.11 Overall Values of Factors for Choice of Modes of Transport



Source: Mass Transit Service Survey in 1975

Table 2.1.7 indicate people's ideas for traffic modes. From these data the following can be concluded:

(1) In general, they want to own an automobile;

(2) By sexes, age brackets and occupations, jeepneys are preferred to buses; and

(3) The existing state of the railway is the least wanted means.

The reason for (3) is perhaps due to the fact that existing PNR does not operate effectively.

Table 2.1.6 *Values of Factors for Choice of Mode of Transport*

By Sexes

Factor	Walking Time	Number of Transfer	Travel Time	Schedule	Cost of Fare	Safety	Seating	Weather
Average	4.31	3.99	5.90	4.74	5.37	5.46	4.38	2.59
Male	4.45	4.15	5.66	4.96	5.30	5.26	4.06	2.50
Female	3.94	3.56	5.32	4.29	5.56	5.84	5.17	2.87

By Age Brackets

Factor	Walking Time	Number of Transfer	Travel Time	Schedule	Cost of Fare	Safety	Seating	Weather
0 - 19	4.68	3.86	6.48	4.31	5.82	5.44	3.70	2.79
20 - 29	4.47	3.99	5.87	4.77	5.24	5.30	4.52	2.48
30 -	3.27	4.16	5.52	5.13	5.46	5.91	4.53	2.84

By Occupations

Factor	Walking Time	Number of Transfer	Travel Time	Schedule	Cost of Fare	Safety	Seating	Weather
Profes-sional	3.76	4.15	6.35	5.20	4.85	5.40	4.55	2.39
Other Worker Group	3.27	4.05	5.21	4.39	5.62	5.88	4.78	2.82
Students	4.77	3.86	6.12	4.66	5.53	5.12	3.86	2.58

Table 2.1.7 Values of Factors of Mode of Transport

By Sexes

Factor	Bus	Jeepney	Commuter Train	Taxi	Private Car
Average	3.46	3.71	2.03	2.82	3.23
Male	3.61	3.75	2.11	2.66	3.09
Female	3.17	3.66	1.76	3.12	3.86

By Age Brackets

Factor	Bus	Jeepney	Commuter Train	Taxi	Private Car
0 - 19	3.84	3.90	2.27	2.54	2.64
20 - 29	3.38	3.62	1.93	2.90	3.38
30 -	3.53	3.91	2.25	2.67	3.06

By Occupations

Factor	Bus	Jeepney	Commuter Train	Taxi	Private Car
Professional	3.26	3.38	2.00	2.98	3.55
Other worker group	3.27	3.88	1.95	2.86	3.47
Students	3.76	3.81	2.14	2.63	2.79

Source: Mass Transit Service Survey in 1975

CHAPTER 2 FRAMEWORK PLAN

2.1 GENERAL

The proposed Rapid Transit Railway Line No. 1 is an important part of the MMA public transit system, which in turn is an integral part of the overall transport system proposed by the UTSMMA. This proposed line is expected to exert a strong influence and have comprehensive impacts on both the present and the future development of the entire MMA.

The land use development plans in the MMA which will provide the inputs for forecasting passengers on the proposed line will be discussed in this chapter. Three major development plans for the MMA were taken into consideration in this chapter. They are (a) Manila Bay Metropolitan Region Strategic Plan (MBMRSP) b) Manila Development Plan for Land Use based on the UTSMMA, and (c) Other major individual development plans in MMA.

The MBMRSP which establishes the framework of the MMA as a higher-ranked priority plan was prepared under the United Nations Development Programme (UNDP) sponsorship in 1971 - 1975. The land use plan in the MMA has been identified by the Japanese assisted 1971 - 1973 Urban Transport Study of the Metropolitan Manila Area (UTSMMA). Several major projects on the MMA level within this framework and which are presently being planned and implemented will be discussed.

2.2 MANILA BAY METROPOLITAN REGION STRATEGIC PLAN

The original MBMRSP population plan was based on following the natural trends of development in the MBMRSP Study Area and the MMA. However, a revised MBMRSP population plan was subsequently prepared on the basis of attaining planned targets of controlled population growth in the MMA.

Hence, the original plan projected MMA population in 1987 to be 7.5 million based on past trend of population growth, while the revised plan projects the population to reach the same figure of 7.5 million by the year 2000 and only 5.8 million by 1987.

The change from the original population figure of 7.5 million to 5.8 million by 1987 was made in order to avoid overconcentration which would necessitate large investments in infrastructure. Dispersal of population to the areas ourside the MMA will be accomplished by fostering the intensive development of the five regional cores while maintaining the total population in the Manila Bay Metropolitan Region (MBMR). The population growth rate in the MBMR is therefore expected to be higher than the MMA's.

2.3 FRAMEWORK IN THE MMA

The study team of this project analysed the past trends of economic activities and reviewed the MBMRSP report and the other related reports. As a result, the framework that has been determined by MBMRSP Group was adopted in this report.

2.3.1 Population Plan

AS is illustrated in Table 2.2.1, the population frame work of MMA are estimated on two levels, 7.45 million and 5.76 million. The years when these levels are reached are

2000 for the former and 1987 for the latter, according to the estimation.

Table 2.2.1 Population Framework Plan

(Thousand persons)

Years	Area (1,000 sq. km)	1970 Population	1987		2000	
			Population	1987/1970	Population	2000/1970
Philippines	300	36,684	58,380	1.59	71,591	1.95
MBMR	18	8,625	15,581	1.81	20,900	2.43
MMA (1)	1.6	4,363	6,300	1.44	8,320	1.91
MMA (2)	0.6	3,996	5,758	1.44	7,452	1.86

Notes:

MBMR - Manila and Provinces of Rizal, Cavite, Batangas, Laguna, Bulacan, Pampanga, Bataan and Zambales.

MMA (1) - 29 Cities & Municipalties (NCSO Definition)

MMA (2) - 19 Cities & Municipalities (UTSMMA Definition)

Source: Manila Bay Metropolitan Region Strategic Plan

Under this population framework plan, population sizes of 1.44 times and 1.86 times as much as the population of 1970 are estimated. According to this plan, the average population density of MMA will be 95 persons/ha at 5.76 million level and 123 persons/ha at 7.45 million level.

2.3.2 Employed Population

Shown in Table 2.2.2 is the employed population in MMA at present and the same in the future at population levels of 5.76 million and 7.45 million.

The growth rate of employed population in future is made slightly higher than that of the total population. This adjustment is based on the consideration that the age composition of population will change in future due to the family planning of the government now under way, resulting in an increase in employment rate.

Table 2.2.2 Employed Population

	Employed Population (1,000)	Ratio of Employed Population (%)
1970	1,291	32.3
1987	2,187	37.7
2000	2,831	38.0

Source: Estimated by the MBMRSP Group

Table 2.2.3 shows the labor composition by industry. As compared with 1970, the ratio of labor force in the primary industry against the total employed population is notably lowered in the future.

Table 2.2.3 Labor Composition by Industry

Unit: %

Industry / Year	Primary	Secondary	Tertiary	Total
1971	3.0	26.7	70.3	100.0
Future (1987 & 2000)	3.0	15.3	81.7	100.0

Estimated by the MBMRSP Group

On the basis of the differences between daytime and nighttime populations at present, the future daytime employed population can be estimated, the results of which are shown in Table 2.2.4.

Table 2.2.4 Number of Employed Population

(Thousand persons)

Years	Day time (A)	Night time (B)	Difference (A) - (B)
1987	2,376	2,187	189
2000	3,076	2,831	245

Estimated by the MBMRSP Group

2.3.3 Number of Students

Table 2.2.5 shows the number of students in MMA. The change of age composition in future was taken into account for estimation of future student population.

Table 2.2.5 Students Population

(Persons)

Years	Number of Students
1971	1,435,100
1987	2,020,400
2000	2,397,200

Source: 1971's figure was obtained from results of Home-Interview Survey under UTSMMA.

Future figure was estimated by the MBMRSP Group.

2.3.4 Economic Activities

GNP, GDP and per capita GNP are estimated as in Table 2.2.6. According to this estimation, the net annual average growth rate of GNP and GDP is 7% in 2000 and the growth rate of per capita GNP is 4.5%, which is at a relatively medium rate.

Table 2.2.6 GNP, GDP and Per Capita GNP

	FY 1972	FY 1987	FY 2000	Average Growth Rates FY1972 - 2000 (%)
Cross National Product (million Pesos)	56,869	156,890	378,073	7.0
Gross Domestic Product (million Pesos)	55,200	152,286	366,977	7.0
Per Capita GNP (in Pesos)	1,454	2,687	5,281	4.5

Estimated by the MBMRSP Group

Table 2.2.7 shows the distribution of family income of MMA as against the whole country. The family income of MMA comes to twice that of the whole country, and the regional gap of family income is remarkably conspicuous. On the assumption that growth rate of per capita GNP will be 4.5% in future, the family income in MMA is estimated to be ₱9,613 in 1987 and ₱18,848 in 2000, as shown in Table 2.2.8.

Table 2.2.7 Family Income in 1971

Family Income Bracket	Philippines	Manila & Suburbs
Under ₱500	5.2%	0.2%
₱ 500 - ₱ 999	12.1	0.9
₱ 1,000 - ₱ 1,499	12.2	1.7
₱ 1,500 - ₱ 1,999	11.8	4.0
₱ 2,000 - ₱ 2,499	9.6	6.9
₱ 2,500 - ₱ 2,999	8.1	8.6
₱ 3,000 - ₱ 3,999	12.5	15.3
₱ 4,000 - ₱ 4,999	7.5	10.9
₱ 5,000 - ₱ 5,999	5.0	7.6
₱ 6,000 - ₱ 7,999	6.4	13.3
₱ 8,000 - ₱ 9,999	3.6	9.1
₱ 10,000 - ₱14,999	3.7	12.2
₱ 15,000 - ₱19,999	1.1	4.3
₱ 2,000 -	1.3	4.9
Average family income	₱2,454	₱5,202

Source: NCSO

Table 2.2.8 Family Income in MMA

	Family Income
1971	P 5,202/year
1987	P 9,613
2000	P18,848

Estimated by the MBMRSP Group

2.3.5 Car Ownership

The future car ownership is estimated as in Table 2.2.9. The rate of car ownership per 1,000 persons was 60 cars in 1971, and this will increase of 120 cars in 1987 and 189 cars in 2000. The details are as shown in Table 2.2.10.

Table 2.2.9 Car Ownership in MMA

		1970 - 1971	1987	2000
Ratio of Non-Owner		0.799	0.706	0.576
Ratio of Owner	One Car	0.151	0.187	0.221
	Two or More cars	0.050	0.107	0.200

Estimated by the MBMRSP Group

It is estimated that the ratio of ownership of 2 or more cars will increase considerably in future.

Table 2.2.10 Present & Future Vehicle Registration

Vehicle Type	Year	Present 1970 - 1971	Future 1987	2000
1. Passenger Cars (Incl. Jeeps & Vans)				
1-1 Privately owned		149.693	499,046	1,151,967
1-2 A.C.		4,485	5,786	7,986
1-3 Tourist Bus		29	97	223
Sub-Totals		154,207	504,998	1,160,176
2. Passenger Cars (Incl. Jeeps & Vans)				
2-1 Owned by Private Enterprises & Governmental Organization ...		6,246	9,522	12,093
2-2 Taxis & Carriage		7,339	11,189	14,209
Sub-Totals		13,585	20,711	26,302
3. Trucks				
3-1 Trucks		54,551	130,590	234,184
3-2 P.U.J.		12,983	16,748	20,513
3-3 Buses		2,820	6,751	12,106
Sub-Totals		70,354	154,189	266,803
Grand Total		238,146	679,898	1,453,281

Source: Futures estimated by MBMRSP Group

2.4 DEVELOPMENT PROJECTS

The major development projects which would directly affect the future land use in the MMA are enumerated as follows.

(1) The National Government Center Project
- (i) Quezon Memorial Park Site
- (ii) Constitution Hill Site
- (iii) Republic Avenue Site
- (iv) Camp Agunaldo Site
- (v) Manila-Cavite Reclamation Site
- (vi) Fort Bonifacio Site
- (vii) Bicutan Site

(2) The Tondo Urban Renewal Project

(3) The Dagat-Dagatan Resettlement Project

(4) The Manila-Cavite Road and Reclamation Project

(5) The Manila International Marine Port Project

(6) The Navotas Fisheries Port Project

(7) The Vitas Industrial Complex Project

(8) The Manila International Airport Project

2.5 BASIC CONCEPTS FOR LAND USE AND POPULATION PLAN

2.5.1 Analysis of existing data.

The trend of population growth and existing land use were analysed in order to establish the population distribution plans. Table 2.2.11 shows the past trend of population growth within MMA which suggests very important factors for forecasting the direction of future plans.

(1) The urban center of the MMA had a high population density of 348 persons/ha in 1970, but its population growth had presently almost ceased due to the existing high population density.

(2) On the other hand, Quezon City recorded a high population annual growth rate of 10% for the period of 1930 to 1970 and the population density in 1970 was 45 persons/ha. A further population growth is expected in the future.

(3) Showing high population growth like Quezon City are Makati, Marikina, Mandaluyong, Las Pinas, etc. These are cities and municipalities located along and/or outside the Circumferential Road C-4, and a continuous high population growth is expected in the future because of their comparatively small population density.

(4) Pasay City, Navotas, San Juan, and Pasig which show comparatively high population densities like Manila City are naturally expected to have a smaller population growth rate, though not so small as in Manila City.

The existing land use pattern of the Metropolitan Manila area is highly diversified and the following observations may be made.

(1) The area within the Circumferential Road C-4 has almost entirely been developed and the regions having future developmental potentials will be outside the said road.

(2) Land development occured along transportation corridors especially, as may be seen from the large-scale land development along the South Diversion Road.

(3) Large commercial and business districts are concentrated in Manila and Makati. The places of commercial and business development in Manila include Santa Cruz, Binondo and Quiapo which are the urban center of MMA, and other places located along the transportation corridors. Along C-4, there are Makati, Cubao and others growing large-scale commercial and business areas.

(4) Industries are sited along the Pasig River, and are also seen along C-4. These are for the most part light industries for consumer goods situated in and around the large urban areas, and there are not many large-scale mechanical-intensive industries.
From the above observations on the trend of population growth and the present pattern of land use, the following conclusions may be made.

(1) The preference of residents in the MMA is more for a satiable place with good environment rather than for an over concentrated city or municipality center.

Table 2.2.11 a) Comparative Table on Population, Land Area and Density of the MMA by Region, Province and Municipality: 1970, 1960, 1948 and 1939

Region, Province and Municipality	Population				Area (Km^2)	Density in Km^2				Annual Growth Rate (%)			
	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	32,017.2	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	62,310	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
Paranaque	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 Pinas	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 2.2.11 b) Comparative Table on Population, Land Area and Density of the MMA by Region, Province and Municipality: 1970, 1960, 1948 and 1939

Region, Province and Municipality	Population				Density per Km^2					Annual Growth Rate (%)			
	1970	1960	1948	1939	Area	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	11,975	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	2,274.4	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	122.3	90.3	64.1	53.3	3.1	2.9	2.1	2.7

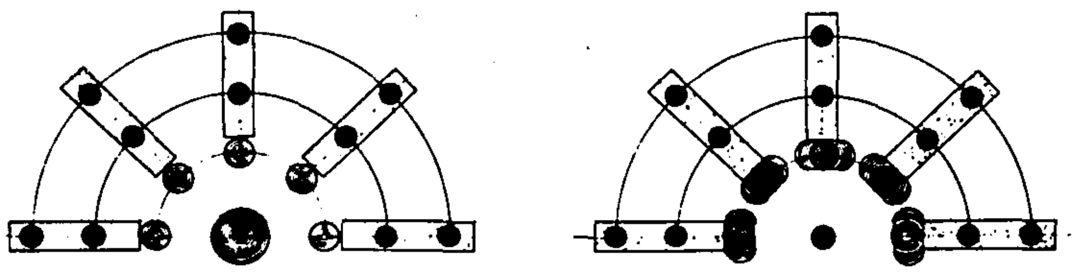
(2) Unless development is put under proper control, sprawl phenomenon of population which is seen as in New York, London, and Tokyo may occur in MMA in the near future. Statistically, Manila City has been almost saturated with population, and will possibly turn towards trend of population decline as seen in central Tokyo. The population will flow into new urban areas with good transportation services, and the most promising areas in this sense lie outside C-4 but along the radial road corridors.

2.5.2 Development patterns to be adopted

The future development pattern has been studied in detail in UTSMMA and MBMRSP, which pattern is also adopted in this study.
An analysis of the existing urban development pattern has revealed that the pattern of overconcentration in the existing urbanized area should not be adopted for the city, but that a pattern should be adopted so that overcongestion of of traffic in the metropolitan may be avoided. It is therefore recommended that the establishment of subcenters for the metropolitan along the Highway No. 54 to prevent the concentration of population in the central MMA should be considered, as seen Fig. 2.2.1.

In this figure, the growing populations is posted along the transportation corridors to form new urban areas, and at the same time, subcenters of the metropolitan are established along the Highway No. 54 in order to prevent the population from being dispersed extraordinarily.

Fig. 2.2.1 Development Pattern of Metropolitan Manila Area



A - 3   B - 3

2.6 LAND USE PLAN AND POPULATION DISTRIBUTION PLAN

2.6.1 Land use plan

The land use plan should be determined according to the basic concepts of the city structure mentioned in the preceeding section and the existing circumstances of land use and also along following policies:

1) Allocation of industrial districts

Industrial districts already distributed inside the existing built-up area which are of relatively large-scale but do not create hazards to the neighboring residences may generally be allow to maintain their operation in such area in future, with some ground for future industrial expansion.

Industrial development 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 along the Laguna de Bay.

Industries to be established alongside the water should be located at sites where no population growth is anticipated.

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.

It is desirable to allocate the predicted increase in the demand for commercial and business districts, mainly in the existing urban center and along the Highway No. 54. In this case, the question of great importance is distribution between the commercial and business districts in the existing urban center and those along the Highway No. 54. However, it is predictable that the extent of expansion of the commercial and business districts in the existing urban center is restricted by the capacity of the future transportation facilities there.

As for the centers of the commercial and business districts along the Highway No. 54, it is desirable that they should be placed in Quezon, Caloocan and Makati districts where the nodes of mass transit routes are planned.

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

3) Allocation of goods circulation centers

Since the areas behind the existing harbors are situated at a short distance to the urban center, it is not appropriate to maintain the existing harbors as cores of goods circulation which is anticipated to expand in the near future. Therefore, it is required that new goods circulation harbors should be planned 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.

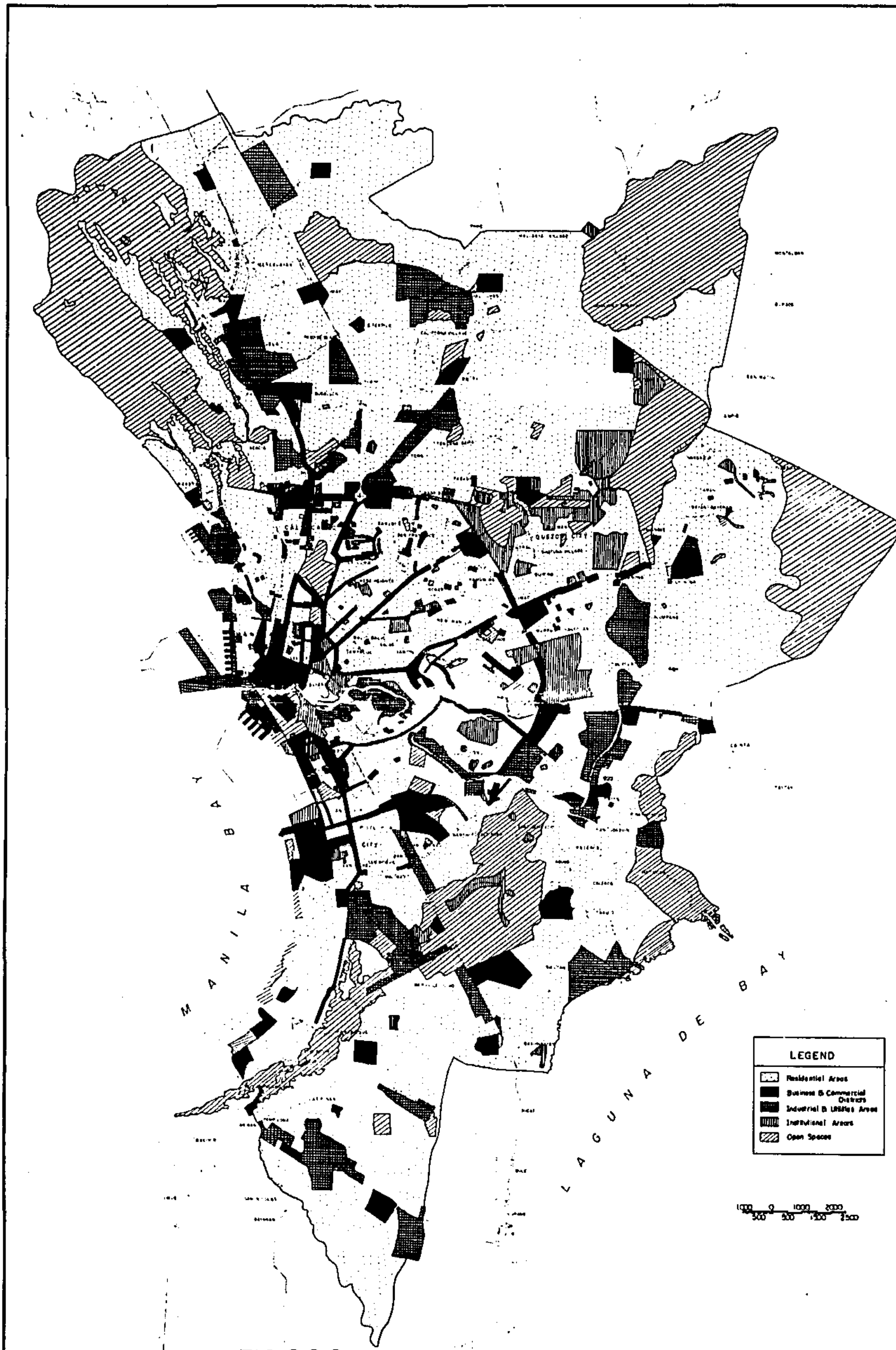


FIG.2.2.2 LAND USE PLAN BY 2000

Regarding the business districts for goods circulation related to these harbors, it is desirable 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 towards the outside of Highway No. 54.

4) Allocation of residential districts

Densely populated residential areas require the improvement of their environments and in some cases this may mean a reduction of population density. Any land thus vacated 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 newly developed, for which the whole suburban area excluding the damp and low-altitude part has the potentiality, gradual and well planned development should be conducted in the districts where a harmonious coordination can be achieved between the development plan of employment places and the plan for transportation facilities. For these areas it is important to lead development under a definite plan by implementation of simultaneously the development of mass transit means and large-scale residential areas development since it can be predicted that in the outer area rapid urbanization will be accelerated by the increase in population in years to come.

5) Allocation of public open land and others

The public vacant land which is under utilization or planning at present should be successively used or be constructed in the near future. It is desirable to build all-purpose parks, each covering an area of more than 50 ha., in different directions and at several places in the areas outside the Highway No. 54 where new urbanization is predicted. Moreover, efforts must be made in placing tracts of green belts along river, lakes and seashores as much as possible and also in restraining the development of the steep slopes of the hills in the eastern part of the Manila Metropolitan Area in order to reserve the hilly region for the future use as recreation area.

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

6) For environmental reasons, the area south of the Manila International Airport should be changed from a residential district in the original plan to an open space for the year 2000.

On the basis of above mentioned basic concepts, land use plan in the year 2000 was carried out by the MBMRSP Group as shown in Fig. 2.2.2.

2.6.2 Population Distribution Plan

(1) Resident population

The resident population plan was determined according to the land use plan in the

Table 2.2.12 Resident Population and Employed Population by Industries by Zones in 2000

(Persons)

Ring	Sector	Zone	Resident Population	Employed Population: Primary	Employed Population: Secondary	Employed Population: Tertiary	Employed Population: Total	Number of Students & School Children
CBD	CBD1	1	550	0	0	105,180	105,180	220
		2	0	0	4,500	53,150	57,650	0
		12	27,500	0	3,450	154,290	157,740	125,300
		S.T	28,050	0	7,950	312,620	320,570	125,520
	CBD2	17	6,050	0	4,050	86,570	90,620	2,500
		19	14,300	0	6,150	60,660	66,810	5,910
		S.T	20,350	0	10,200	147,230	157,430	8,410
		Total	48,400	0	18,150	459,850	478,000	133,930
1st Ring	A-1	3	63,200	0	6,150	27,820	33,970	36,940
		4	51,150	0	0	44,760	44,760	21,160
		5	29,150	0	5,250	7,350	12,600	12,070
		6	56,650	0	0	10,110	10,110	23,440
		7	47,300	0	300	14,910	15,210	19,580
		S.T	247,450	0	11,700	104,950	116,650	113,190
	A-2	8	19,800	0	0	110,640	110,640	190,470
		9	26,400	0	0	30,610	30,610	10,930
		11	80,200	0	0	50,780	50,780	35,640
		24	161,100	0	0	55,030	55,030	63,400
		S.T	287,500	0	0	247,060	247,060	300,440
	A-3	10	219,450	0	0	104,240	104,240	182,000
		13	40,700	0	15,300	39,120	54,120	16,840
		S.T	260,150	0	15,300	143,360	158,660	198,840
	A-4	14	40,150	0	15,750	15,990	31,740	16,590
		15	74,250	0	4,350	31,920	36,270	30,720
		16	45,650	0	450	17,360	17,810	18,900
		18	58,300	0	0	94,550	94,550	24,120
		S.T	218,350	0	20,550	159,820	180,370	90,330
		Total	1,013,450	0	47,550	655,190	702,740	702,800
2nd Ring	B-1	20	149,810	0	2,100	30,690	32,790	43,000
		21	94,890	0	30,700	26,710	57,410	12,570
		22	85,000	340	13,600	23,450	37,390	16,030
		40	52,400	1,750	1,900	4,400	8,050	10,190
		S.T	382,100	2,090	48,300	85,250	135,640	81,790

foregoing section. The population density was determined based on the results of analysis and processing of the home-interview survey data, pilot survey data, and other relevant data.

1) A guideline for the population density as classified into iso-travel time to CBD in the central MMA has been prepared basing on the data obtained by the analysis of existing situation and revision made according to specific characteristics of each traffic zone or traffic sector.

2) At present, the regions of CBD and the first Ring have an extremely high population density of about 500 to 1,000 persons per hectare of residential area. In order to rectify this over-concentrated condition and also to reform these areas to achieve functional commercial and business activities, the population densities was limited to 550 persons per hectare of residental area.

3) In the 2nd Ring population density is now about 200 to 400 persons per hectare of residential area. This level of population density should preferably be maintained in view of living environment. For this reason, the population density for the future was set at 200 to 300 persons/ha.

4) In the 3rd Ring, most of the area is in the process of urbanization. Although the population density is less than 20 to 50 persons/ha of residential area, the population growth for the 1960-70 period has been extremely high. This trend will continue in the future, and the population density is therefore set at 100 to 150 persons/ha of residential area.

(2) Daytime Employed Population

Allocation of daytime worker was also carried out with the same method as that for the residential population as follows.

1) It was found from the analysis of existing situation of the tertiary employed population in the commercial and business areas that the density of employed population in CBD in Ring 1 is extremely high. Since the employed population is expected to further increase with decline in the resident population, the density of employed population was set at 1,000 persons/ha of commercial and business area, a little larger than the existing density.

2) The employed population densities in 2nd and 3rd Rings were set at 500, 400 and 300 persons/ha in consideration of the coverage of the commercial and business activities and also of the size of residential population covered.

3) In the institutional area, the tertiary employed population was also determined at 500 to 300 persons per hectare.

4) The secondary employed population in the industrial area was set at 200 persons per hectare for the traffic zones in CBD and 1st Ring and around 150 persons per hectare for other zones.

As a result of the above computation, the resident population and daytime employed population for each zone for year 2000 was estimated by MBMRSP and the results are as shown in Table 2.2.12.

Table 2.2.12 Cont'd

(Persons)

Ring	Sector	Zone	Resident Population	Employed Population				Number of Students & School Children
				Primary	Secondary	Tertiary	Total	
	B-2	23	160,880	0	24,400	62,150	86,550	45,400
		25	288,250	0	38,700	38,400	77,100	111,140
		S.T	449,130	0	63,100	100,550	163,650	156,540
	B-3	27	144,300	0	2,250	31,540	33,790	57,450
		28	148,000	0	100	91,850	91,950	126,860
		29	201,300	0	1,800	64,480	66,280	80,540
		S.T	493,600	0	4,150	187,870	192,020	264,850
	B-4	31	242,100	0	2,550	79,870	82,420	46,140
		33	120,600	0	20,550	24,750	45,300	14,620
		S.T	362,700	0	23,100	104,620	127,720	60,760
	B-5	34	118,800	0	7,200	32,850	40,050	14,410
		35	112,200	0	4,350	155,710	160,060	13,600
		36	70,400	0	4,100	7,120	11,220	8,530
		37	89,700	0	0	52,360	52,360	36,640
		S.T	391,100	0	15,650	248,040	263,690	73,180
		Total	2,078,630	2,090	154,300	726,330	882,720	637,120
3rd Ring	C-1	41	218,800	28,690	0	15,980	44,670	57,360
		42	58,000	4,210	7,800	5,960	17,970	14,820
		43	106,800	0	24,000	18,590	42,590	28,000
		44	59,400	1,800	1,400	12,00	15,230	15,570
		45	177,900	0	9,600	10,270	19,870	46,220
		46	328,800	29,570	900	18,450	48,920	86,820
		47	317,100	0	16,100	16,980	33,080	82,710
		S.T	1,266,800	64,270	59,800	98,260	222,330	331,500
	C-2	26	584,420	0	34,600	99,260	133,860	239,800
		S.T	584,420	0	34,600	99,260	133,860	239,800
	C-3	30	125,600	0	300	44,320	44,620	39,150
		32	99,400	0	10,400	17,890	28,290	24,000
		48	674,250	0	30,300	78,450	108,750	81,580
		49	162,750	0	40,500	51,340	91,840	19,490
		S.T	1,062,000	0	81,500	192,000	273,500	164,220
	C-4	38	83,000	0	500	9,980	10,480	35,530
		39	396,600	6,670	4,500	107,000	118,170	42,340
		50	260,400	10,250	27,700	103,820	141,770	32,930
		51	649,200	10,520	40,700	61,710	112,930	77,230

Table 2.2.12 Cont'd

(Persons)

Ring	Sector	Zone	Resident Population	Employed Population				Number of Students & School Children
				Primary	Secondary	Tertiary	Total	
3rd Ring		S.T	1,389,200	27,440	73,400	282,510	383,350	188,030
		Total	4,302,420	91,710	249,300	672,030	1,013,040	923,150
MMA		G.T	7,442,900	93,800	469,300	2,513,400	3,076,500	2,397,200

Source: MBMRSP Group

2.7 PLAN FOR POPULATION DISTRIBUTION AND LAND USE FOR THE YEAR 1987

2.7.1 Purposes and Objectives

The total population in MMA and residental population by zone for the year 1987 were estimated in the Radial Road R-10 feasibility study. This population plan by zone was made without assuming the construction of the urban rapid transit railway (RTR), and it is expected that the population and land use patterns will change when RTR is constructed. Assuming that RTR line No. 1 will be put into operation by the year 1987, the possible change in the land use and in the distribution of resident and employed populations should be revised accordingly. For this reason, an impact study of RTR Line No. 1 for land uses and population distribution was made, taking into consideration the strong influence of this new RTR Line.

2.7.2 Assumptions and Conditions for the Impact Study

The assumptions and conditions set for the future estimates of population distribution and land use plans in 1987 are as follows.

(1) The total resident population and employed population by industries in MMA in 1987 were already estimated in this chapter.

(2) The number of primary and secondary industry employed population by zone in each key year was determined according to the distribution plan of the Government of the Philippines. Institutional workers of the tertiary industries were also determined by the said planned distribution plan.

(3) The network of transport system assumed in section 3.3 was respectively adopted for each key year.

(4) The impacts by the transport systems were assumed to take their respective forms fully in each key year.

(5) In the zones along RTR Lines which are expected to be affected by the impact of RTR Lines, the level of population might go beyond the optimal level from the environmental viewpoints. A proper level of population density will be set after due consideration on sectoral characteristics are made, and superfluous population will be redistributed to other zones.

(6) For the measurement of impacts through the development of RTR Lines, method of estimation based on the accessibility concept was applied.

(7) As regards the travel time which was used for the assessment of accessibility, the possible future increase in travel time due to congestion was duly taken into consideration.

2.7.3 Methodology

The analysis approach comprised the following six setps. In the first step, it is assumed that the secondary, the institutional the tertiary industry employed population will be determined from plans determined at a higher level. Namely, it is assumed to be determined according to the industrial and institutional areas allocated in a planned manner and in consideration of the existing densities of employed population. In the second step, the location of commercial and service industries which are most strongly influenced by the completion of RTR Lines was determined by a potential model. That is, travel time between zones for the year 1987 was computed for the transport network which include RTR Line No. 1, and the potential for commercial and service industries estimated with the resident population in R-10 feasibility report adopted as an attraction index. Then, the commercial and service employed population excluding institutional population, which was already distributed in the 1st step, was distributed according to the size of the potential.

The potential model used here is mathematically represented by the following formula.

$$Ei = \sum_{j=1}^{n} \frac{Pj}{tij^{\gamma}} + \frac{Pi}{tii^{\gamma}}$$

$$B_{Si} = \frac{Ei}{\sum_{j=1}^{n} Ej} \cdot B_S$$

where

Ei	:	potential of zone i
Pi	:	resident population of zone i
Tij	:	time distance between zone i and zone j
B_{Si}	:	commercial and service employed population of zone i
B_{St}	:	total number of commercial and service employed population
γ	:	coefficient
n	:	number of zones

Ater the distribution of employed population has been determined, the area required for the employed population could be calculated just as in the 1st step.

After the areas for the secondary and commercial and service employed population are determined in the above steps, open spaces are added in the 3rd step and the residential areas available is determined by subtracting the commercial and service area from the total buildable area. In this way, the land use for the year 1987, in which the effects of RTR Line No. 1 are considered, is computed.

From the distribution of the commercial and service employed population determined in the 1st and 2nd step, as well as the residential areas determined in the 3rd step, the resident population increase is estimated by the Hansen Model. In this case, the location of residents can be determined according to the accessibility, using the secondary and commercial and service employed population as an attraction index.
The Hansen Model employed here is given below.

$$Ai = \sum_{j=1}^{n} \frac{Si}{tij^{\gamma}}$$

$$d_{Pi} = \frac{Ai\ Fi}{\sum_{j=1}^{n} Aj \cdot Fj} \cdot d_{p}$$

where

- Ai : accessibility of zone i
- Si : total employed population of zone i
- d_{pi} : increase in residential population of zone i
- d_{p} : total increase of residental population
- Fi : residential area of zone i

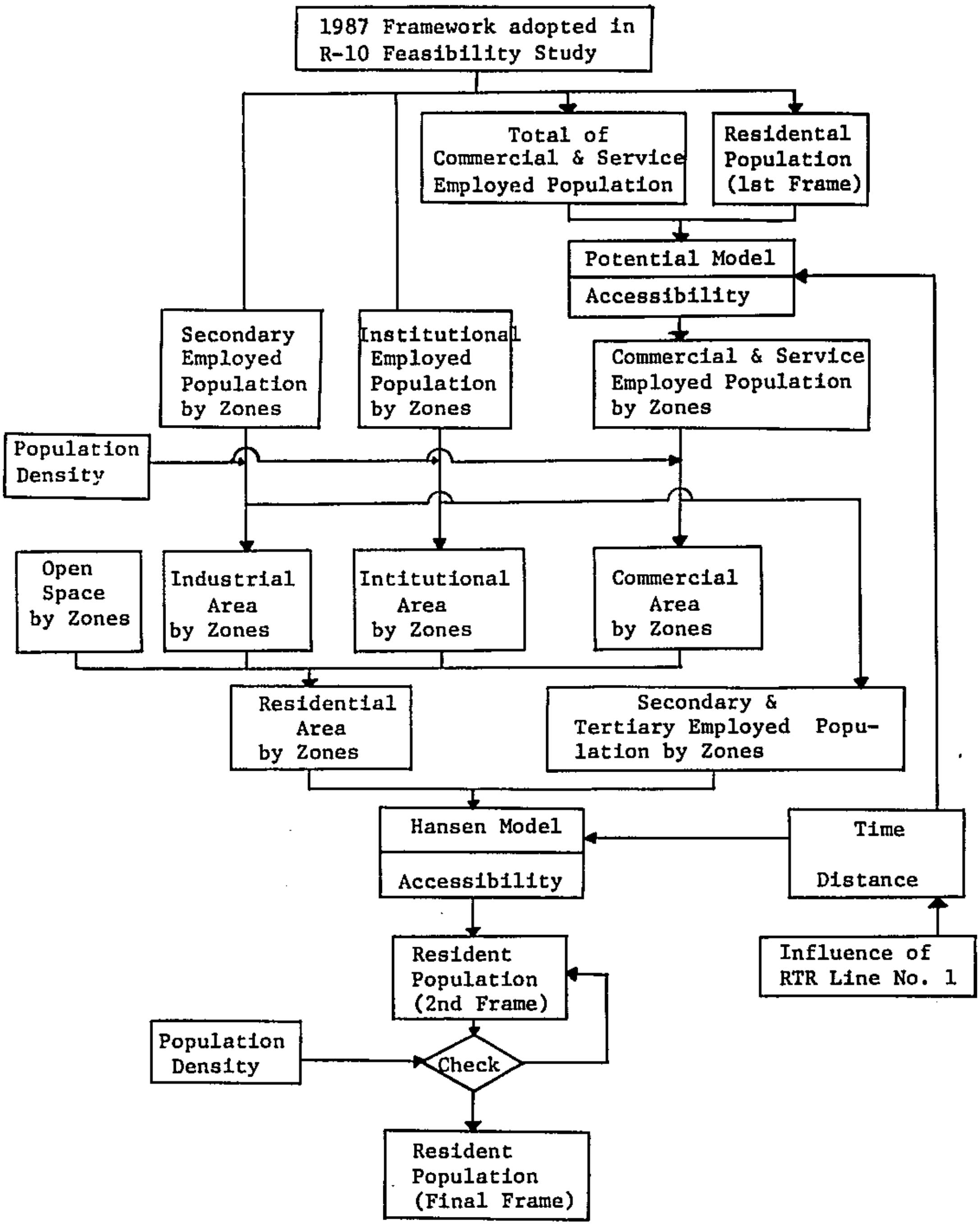
In this way, the distribution of population in the residential area for the year 1987, the 2nd frame, is determined to taking full account of the influence of RTR Line No. 1.

In 5th Step, Since the distribution of resident population calculated in the 4th step may not always be compatible to environmental conditions or in accordance with master plan for the year 2000, it is required to determine the optimal resident population density for the year 1987 and to modify the population distribution accordingly, to form the 3rd frame.

The 3rd frame obtained in the 5th step is, if necessary, again put into reiterated calculation until there is little or no change in the values in the 6th step. In this final step, the tertiary employed population and residential population are determined as the final frame.

The above steps are summarized into the flow chart shown in Fig. 2.2.3.

Fig. 2.2.3 Flow of Analysis of Population Distribution



2.7.4 Employed Population and Land Uses Distributed by Government Policy

The employed population of the secondary industry and the institutional sector of the tertiary industry is usually decided by Government policy. This is because the secondary industry has a great bearing on the surroundings and also is largely dependent on the infrastructural factors, including availability of water and electricity. Moreover the institutional sector includes central and local governmental agencies, universities and other educational institutions.
In many case, these are sited in a planned manner by government policy. Consequently, the land use areas of these industries were estimated on the basis of the 2000 pattern with reference made of the existing patterns. For this reason, the land areas by industry estimated in the foregoing and the existing area of land use form the basis for the calculation of the land use areas for the year 1987. From the land use areas as well as the employed population densities, the employed population of the secondary industry and institutional sector of the tertiary industry were estimated as shown in Table 2.2.13
The public open space is also assumed to be determined by policy.
Again, the existing public open areas and those estimated necessary for the year 2000 were the basis for estimating the area of the public open space for the year 1987.

2.7.5 Results of Computation and Examination

Basing on the assumptions and methodology described in the foregoing, the results of computation are described as follows.

(1) Distribution of Accessibility

Fig. 2.2.4 shows the distribution of accessibility with the secondary and tertiary employed population as an attraction index.From the figure it is seen that the maximum accessibility is noted in CBD-2, which is thus the central area of MMA in terms of accessibility. However, the central area pointed out here does not always fall in with the geometrical center of the metropolis, since it only means that the area is the zone having the highest accessibility to other zones. This finding is vindicated by the fact that CBD-2 lies almost midway between the two large business areas of CBD-1 and B-5 (Makati). The accessibility diminished by degrees from the center of CBD-2 reaching the lowest toward the outskirts.
A comparison between B-3 which is traversed by RTR Line No. 1 and B-4 which lies away from the RTR Line reveals that the former was higher in accessibility than the latter, indicating that the former will receive much more influence from RTR than the latter.

(2) Distribution of Tertiary Employed Population

The commercial and service employed population were projected by the potential model explained under section 2.7.2 and were added to the institutional employed population. The result of this calculation are shown in Table 2.2.13 and the following observations can be made.

(1) *The tertiary employed population in CBD-1 (downtown) is likely to increase* more and more in the future, and the zone will prosper as a central business area in *the Metropolitan Manila Area.*

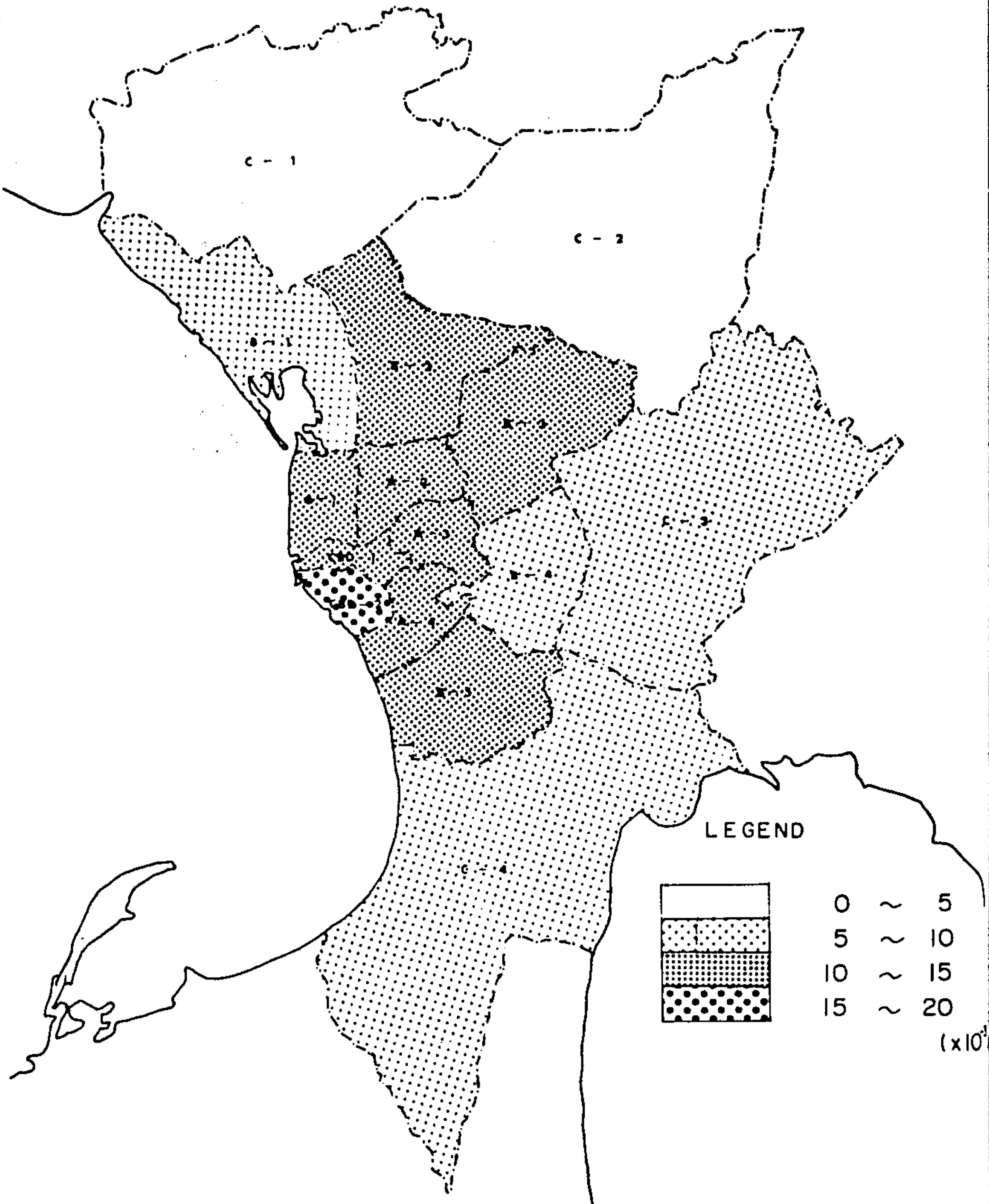


Fig. 2.2.4 Accessibility

(2) The tertiary employed population in CBD-2, on the other hand, is likely to show only a slight increase, because a sharp rise in employed population will not be expected if the Government Center Project planned elsewhere should be implemented.

(3) Along RTR Line No. 1, the tertiary employed population of both A-2 Sector and A-4 Sector are increasing at a high pace, indicating that RTR Line No. 1 will underlie the commercialization of the areas along it.
The same will hold true with B-3 Sector and B-5 Sector.

(4) In this way, the construction of RTR Line No. 1 will be accompanied by the increase of accessibility, which in turn will attract tertiary employed population in the future.

(3) Distribution of Resident Population
Hansen Model is employed to determine the distribution of resident population. This model uses the accessibility of each zone and the undeveloped potential residential area of the zone as parameters.
The accessibilities are combined with the residential areas obtained by subtracting the industrial areas, institutional areas, open spaces and commercial areas from the total zone areas in order to distribute the resident population among the zones.

Table 2.2.13 Resident and Employed Population by Zones in 1987

(Persons)

Sector	Zone	Resident Population	Employed Population				Number of Students & School Children
			Primary	Secondary	Tertiary	Total	
CBD-1	1	6,000	0	0	108,400	108,400	2,600
	2	22,400	0	3,300	53,250	56,550	3,070
	12	46,200	0	6,900	89,850	96,750	110,210
	S.T	74,600	0	10,200	251,500	261,700	115,940
CBD-2	17	8,000	0	3,150	74,100	77,250	3,350
	19	10,000	0	5,400	57,100	62,500	4,540
	S.T	18,000	0	8,550	131,200	139,750	7,890
A-1	3	102,600	0	6,150	27,200	33,350	33,130
	4	57,000	0	0	48,600	48,600	25,060
	5	31,500	0	5,250	6,100	11,350	14,040
	6	52,800	0	0	8,600	8,600	21,110
	7	59,200	0	300	13,400	13,700	19,960
	S.T	303,100	0	11,700	103,900	115,600	113,300
A-2	8	28,800	0	0	61,700	61,700	164,240
	9	29,200	0	0	27,100	27,100	12,400
	11	80,500	0	0	41,100	41,100	38,060
	24	140,800	0	0	49,000	49,000	49,640
	S.T	279,100	0	0	178,900	178,900	264,340

Table 2.2.13 Cont'd

(Persons)

Sector	Zone	Resident Population	Employed Population				Number of Students & School Children
			Primary	Secondary	Tertiary	Total	
A-3	10	214,600	0	0	51,200	51,200	159,580
	13	55,000	0	11,400	30,600	42,000	17,890
	S.T	269,600	0	11,400	81,800	93,200	177,4 70
A-5	14	62,400	0	14,400	9,300	23,700	18,080
	15	94,200	0	4,350	20,700	25,050	31,610
	16	45,240	0	450	14,000	14,450	17,230
	18	74,000	0	0	69,900	69,900	25,410
	S.T	275,840	0	19,200	113,900	133,100	92,330
B-1	20	156,000	0	3,150	27,400	30,550	48,040
	21	136,800	0	27,400	23,700	48,400	19,930
	22	75,600	260	12,700	17,500	30,460	14,230
	40	27,800	1,350	1,900	3,800	7,050	7,890
	S.T	396,200	1,610	42,450	72,400	116,460	90,090
B-2	23	157,500	0	16,600	49,300	65,900	42,650
	25	235,800	0	32,550	31,600	64,150	90,830
	S.T	393,300	0	49,150	80,900	130,050	133,480
B-3	27	133,200	0	2,550	26,200	28,750	49,910
	28	139,600	0	100	71,700	71,800	105,160
	29	129,400	0	2,850	51,600	54,450	66,410
	S.T	402,200	0	5,500	149,500	155,000	221,480
B-4	31	219,100	0	3,600	65,700	69,300	38,990
	33	120,000	0	16,050	26,600	42,650	15,530
	S.T	339,100	0	19,650	92,300	111,950	54,520
B-5	34	117,900	0	6,600	26,200	32,800	18,960
	35	110,400	0	4,300	138,200	142,500	10,040
	36	66,200	0	4,100	12,500	16,600	7,670
	37	100,000	0	0	54,800	54,800	41,270
	S.T	394,500	0	15,000	231,700	246,700	77,940
C-1	41	133,650	22,150	0	13,600	35,750	38,150
	42	25,200	3,250	5,400	4,900	13,550	10,110
	43	43,500	0	14,600	16,800	31,400	18,630
	44	25,400	1,390	1,300	9,300	11,990	11,160
	45	75,100	0	7,100	7,500	14,600	30,240
	46	199,050	22,820	900	13,200	36,920	58,390
	47	177,450	0	9,600	8,500	18,100	53,140
	S.T	679,350	49,610	38,900	73,800	162,310	219,820

Table 2.2.13 Cont'd

(Persons)

Sector	Zone	Resident Population	Employed Population Primary	Secondary	Tertiary	Total	Number of Students & School Children
C-2	26	420,900	0	23,800	57,500	81,300	174,100
	S.T	420,900	0	23,800	57,500	81,300	174,100
C-3	30	120,900	0	300	45,400	45,700	33,360
	32	82,200	0	6,600	17,100	23,700	32,310
	48	314,310	0	13,600	62,000	75,600	56,460
	49	145,800	0	35,200	33,600	68,800	16,110
	S.T	663,210	0	55,700	158,100	213,800	138,240
C-4	38	58,600	0	500	8,000	8,500	26,920
	39	293,540	5,150	4,000	69,400	78,550	32,410
	50	244,200	7,910	20,600	54,000	82,510	25,720
	51	252,660	8,120	26,500	32,000	66,620	54,010
	S.T	849,000	21,180	51,600	163,400	236,180	139,060
MMA		5,758,000	72,400	362,800	1,940,800	2,376,000	2,020,000

The results are shown in Table 2.2.13. From this table it is noticed that there is a tendency for the resident population to diverge from the central to the peripheral areas - the so-called sprawling. Namely, CBD and A will maintain the present level of population or will decline gradually while B and C will grow sharply. This sprawl phenomenon is more seriously seen in Europe, U.S.A., Japan and other developed countries and the Metropolitan Manila will soon experience it.

2.7.6 Determination of Disposition of Population and Land Uses

The results of computation for the populating plan and land use plan according to the foregoing procedures are summed up in Figs. 2.2.5 to 2.2.7.

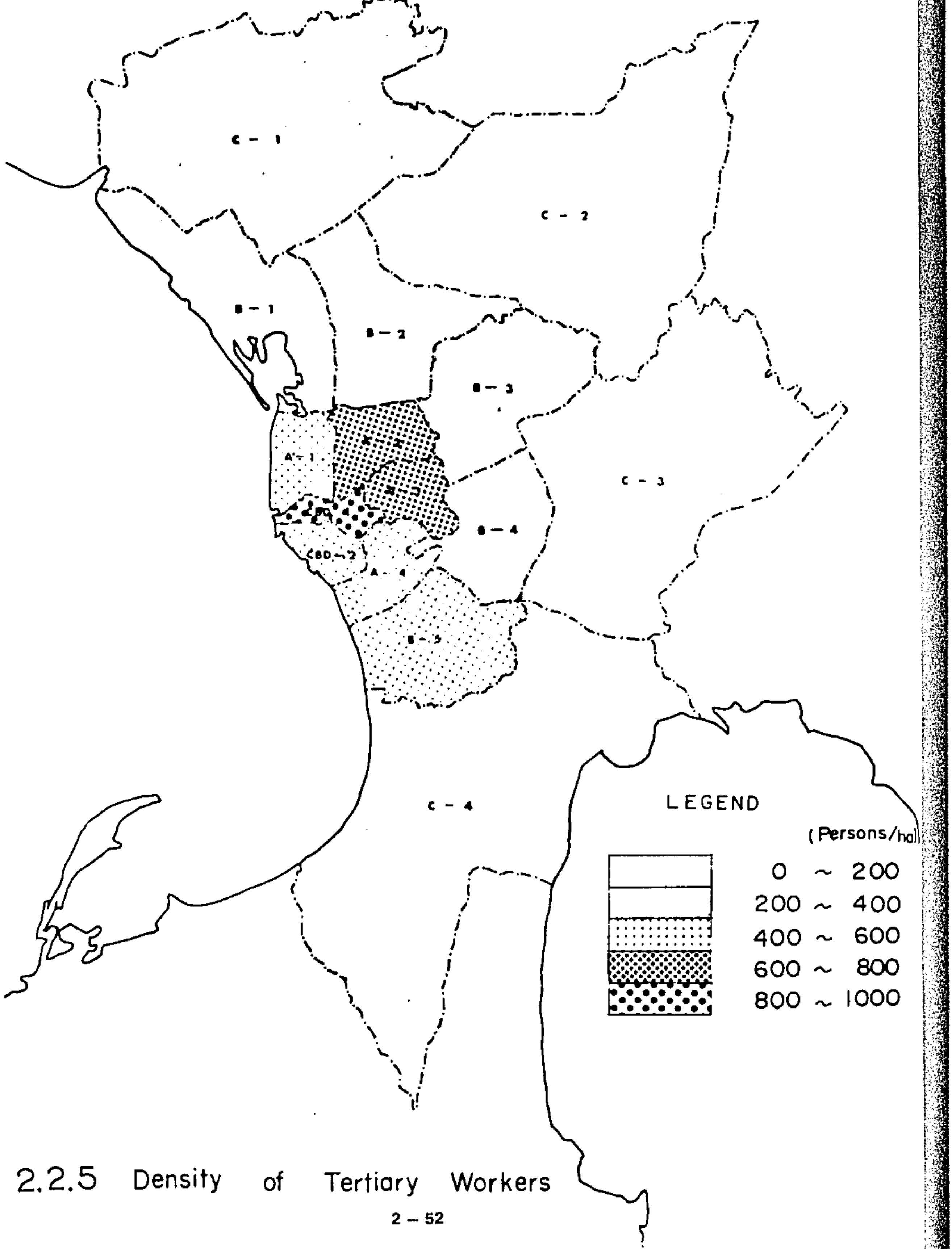


Fig. 2.2.5 Density of Tertiary Workers

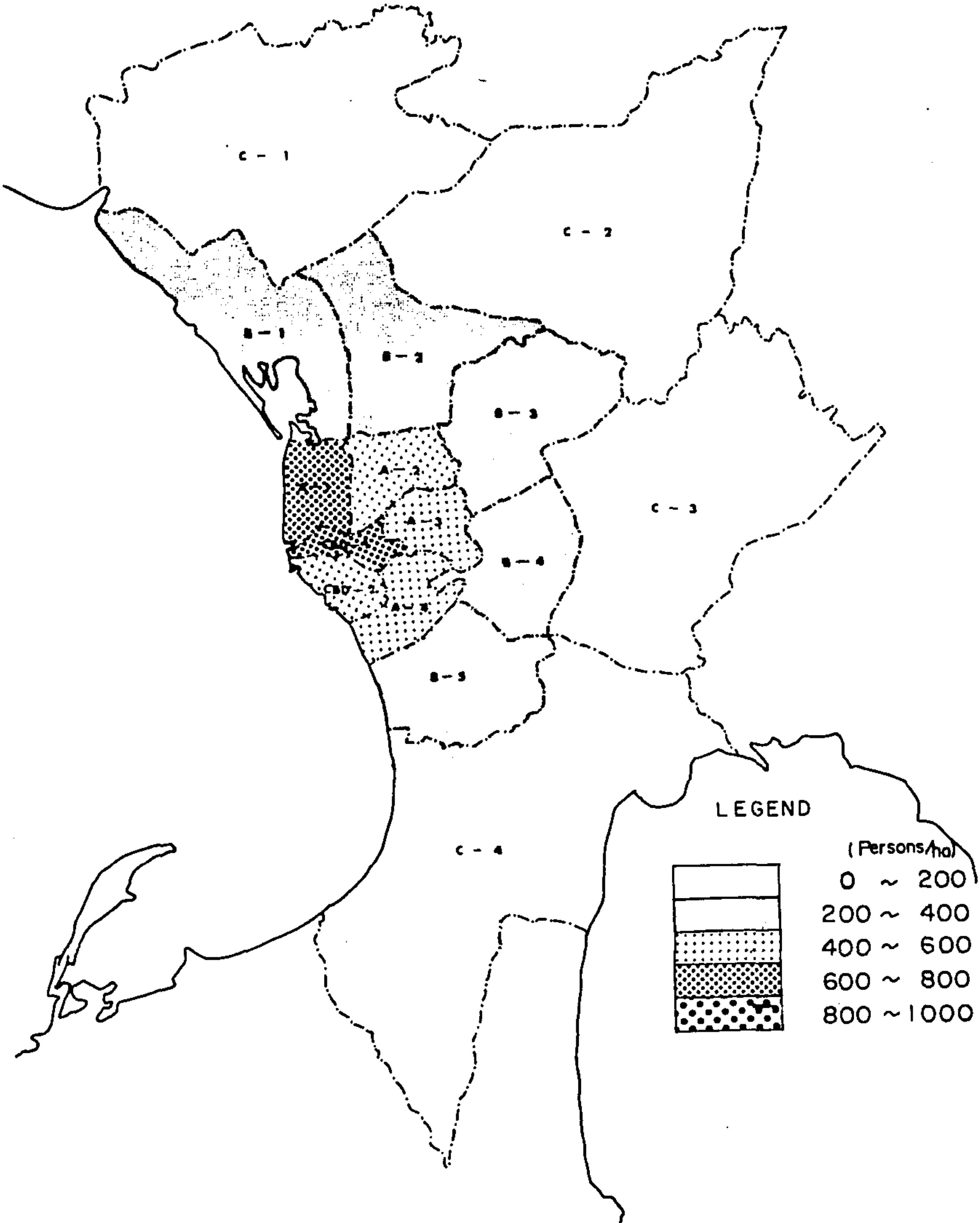


Fig. 2.2.6 Density of Residential Population

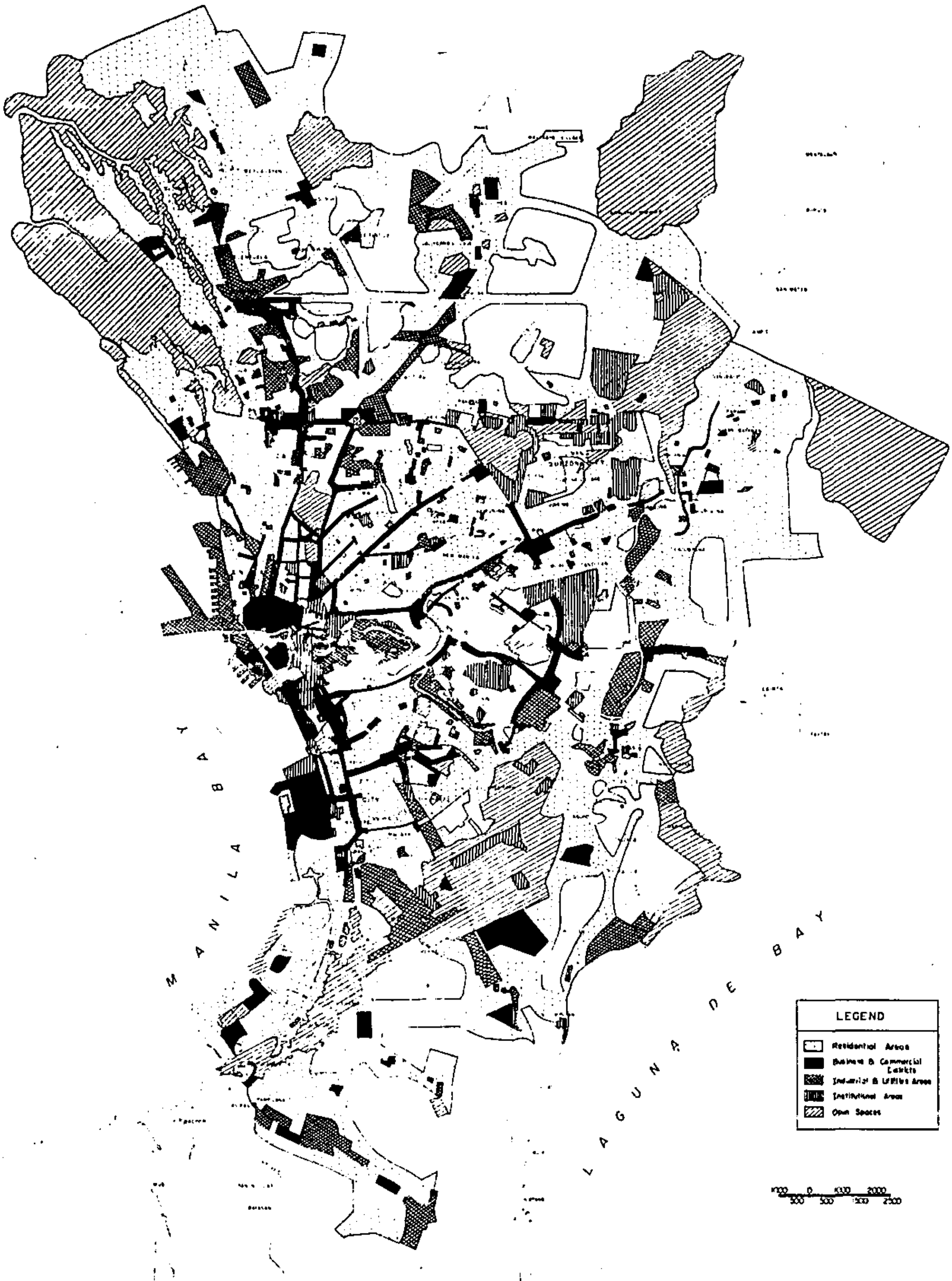


FIG.2.2.7 LAND USE PLAN BY 1987

CHAPTER 3 · PROJECTION OF PASSENGER DEMAND ON RTR LINE NO. 1

3.1 BASIC DATA

The data used for the projection of traffic demand of RTR Line No. 1 was those obtained through the home-interview survey and related surveys conducted in 1971 by the Government of the Philippines, and mass transit services survey also conducted by the Government of the Philippines in 1975. The home-interview survey was carried out for the Urban Transport Study in the MMA (UTSMMA), and covered four cities and fifteen municipalities. The number of samples obtained in this survey covered 35,084 persons of above 7 years in age from 6,184 households. In connection with this, cordon line interview, screen line traffic survey, travel speed survey and other related surveys were conducted. These data were adopted for the projection of the passenger demand on RTR Line No. 1. These data composed mainly of individual characteristics, trip characteristics in relation to individual characteristics, and trip characteristics by zones. In addition to these surveys, the mass transit services survey in the year 1975 has offered useful data including characteristics of use of public transport facilities, passengers propensity in selection of mode of transport and others.

3.2 GENERAL PROCEDURES

The passenger demand for RTR Line No. 1 should be estimated as an integral part of the overall transport systems of not only the existing road transport network but also of the rapid transit network to be introduced in future. For this reason, the projection of passenger demand was made by estimating the overall person trip demand. The general procedure for passenger projection is shown in Fig. 2.3.1.

The major inputs were obtained from the person trip surveys previously conducted for the UTSMMA, while the projections were based on trip purpose which is the principal factor used in the projection process. In this connection, the same trip purpose classifications used for the UTSMMA were also adopted in this Study, namely:

- Commuting to work
- Going to school
- Private
- Business
- Returning home

According to the above classification, the passenger projection was carried out in the following steps.

- Trip production
- Trip generation and attraction
- External trip
- OD distribution
- Zone subdivision
- Modal split
- Passenger assignment to rapid transit system

Trip production in the MMA was obtained by multiplying the trips per person with the total population, while trip generation and attraction were estimated on the basis of the distribution of the resident, employed and student population as related to each trip purpose.

The O-D distribution of trips was determined by the entropy method incorporated with the gravity model.

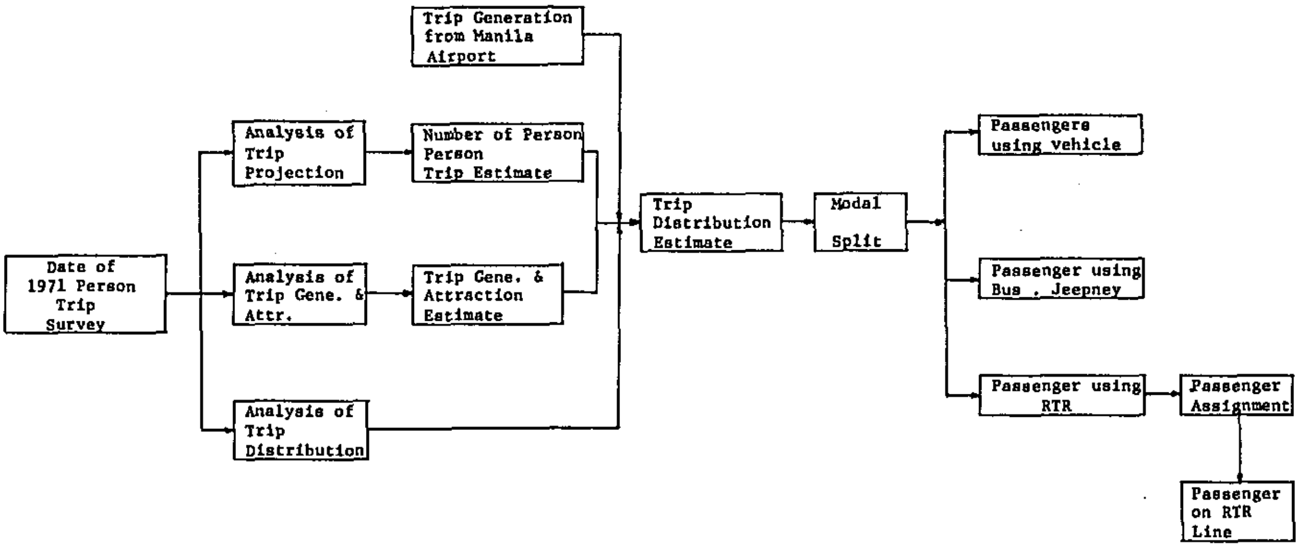


Fig. 2.3.1 Procedure for Passenger Projection

After determination of O-D distribution, the 51 zones was subdivided into 103 zones in order to prepare a refined O-D distribution suitable for estimation of passenger demand of RTR Line No. 1.

The trip generation in Manila International Airport was estimated separately, and was superimposed on this O-D table.

In the modal split, the trip interchange model was used because this model can be adopted to the introduction of urban rapid transit railway in the future. The modal split was determined by taking into account relative travel times between the two modes, i.e., mass transit and private cars. Mass transit users were further subdivided into bus and jeepney users and rapid transit railway users by the same method.

The rapid transit railway users were further subdivided into PNR and RTR users in the process of traffic assignment. As a result of above mentioned calculations, future passenger demand on RTR Line No. 1 was obtained.

2.3 PROJECTION OF PERSON TRIPS

2.3.1 Trip Projection

The number of person-trips and first trips per person classified by car ownership and occupation were obtained from the results of person-trip surveys under the UTSMMA as shown in Tables 2.3.1 and 2.3.2. The ratio of car owner and occupation to total population were determined by the MBMRSP Team. Basing on these data, the population by occupation and by car ownership was determined as shown in Table 2.3.3. The number of first trips was projected through multiplying the classified population with the first trip per person.

The estimated first trips were broken down into internal and external trips using the results of the person-trip surveys. (Table 2.3.4)

2.3.2 Trip Generation and Attraction

In estimating trip generation and attraction, it is necessary to establish the relationship of trip generation and attraction with relative activity indicators.

The trip generation of commuting-to-work trips and going-to-school trips are proportional to the resident population, and the attraction of these trips are proportional to the number of employed and student population, respectively. The trips generated for private purposes are proportional to the resident population while attraction of these trips are proportional to the number of tertiary employed population.

As far as work-trips are concerned, the generated and attracted trips are proportional to the number of employed population. This study follows the analysis made by UTSMMA which uses the multiple correlation analysis to establish a suitable parameter relating trip generation and attraction with resident population and employed population, as shown in Table 2.3.5.

Resident population and employed population were determined in accordance with the land use plan of the MBMRSP as shown in Chapter 2.

Trip generation and attraction by zones was estimated by the following equation.

Table 2.3.1 Number of Linked Trips per Head (Trip Purpose/Occupation/Car Ownership)

Car Owner-Ship	Occupation \ Trip Purpose	(1) Commuting to Work	(2) To School	(3) To Home	(4) Work	(5) Private	(6) Un-Known	Tot[illegible]
Owner	1. Professional, Administrative, Clerical Workers	1.12	0.05	1.34	0.57	0.68	0.00	3.[illegible]
	2. Sales Workers, Farmers, Craftsmen, Service Workers	0.32	0.01	0.61	0.73	-.29	0.00	1.[illegible]
	3. Workers in Transport	0.49	0.01	1.68	3.60	0.27	0.00	4.[illegible]
	Average 1, 2, 3	0.62	0.03	0.94	0.83	0.44	0.00	2.[illegible]
	4. School Children	0	0.80	0.88	0	0.06	0.02	1.[illegible]
	5. Students	0	1.13	1.30	0	0.20	0.03	2.[illegible]
	Average 4, 5	0	0.99	1.12	0	0.14	0.02	2.[illegible]
	6. Housewives	0	0.01	0.62	0	0.96	0.02	1.[illegible]
	7. Joblesses	0	0.00	0.38	0	0.58	0.00	0.[illegible]
	Average 6, 7	0	0.00	0.51	0	0.77	0.01	1.[illegible]
	Average 1, 2, 3, 4, 5, 6, 7	0.29	0.36	0.93	0.39	0.39	0.01	2.[illegible]
Non Owner	1. Professional, Administrative, Clerical Workers	1.12	0.06	1.21	0.36	0.21	0.00	2.[illegible]
	2. Sales Workers, Farmers, Craftsmen, Service Workers	0.57	0.02	0.78	0.49	0.17	0.00	1.[illegible]
	3. Wokers in Transport	0.90	0.02	0.96	1.01	0.14	0.00	2.[illegible]
	Average 1, 2, 3	0.75	0.03	0.91	0.49	0.17	0.00	2.[illegible]
	4. School Children	0	0.33	0.36	0	0.02	0.00	0.[illegible]
	5. Students	0	0.96	1.08	0	0.09	0.02	2.[illegible]
	Average 4, 5	0	0.63	0.71	0	0.05	0.01	1.[illegible]
	6. Housewives	0	0.00	0.40	0	0.50	0.00	0.[illegible]
	7. Joblesses	0	0.00	0.23	0	0.33	0.00	0.[illegible]
	Average 6, 7	0	0.00	0.32	0	0.41	0.00	0.[illegible]
	Average 1, 2, 3, 4, 5, 6, 7	0.26	0.25	0.67	0.17	0.19	0.01	1.[illegible]
Total	1. Professional, Administrative, Clerical Workers	1.10	0.06	1.25	0.47	0.36	0.00	3.01
	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	2.3[illegible]
	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. Joblesses	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 2.3.2 First Trip Production

(Trips/Person)

Occupation \ Car Ownership \ Trip Purpose		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 Sector		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. Jobless		0.634	0.304	-	-
Correlation coefficient	Partial	Occu-pation	Car Ownership	Occu-pation	Car Ownership
		0.98	0.89	0.92	0.70
	Multiple	0.98		0.93	

Table 2.3.3.(A) Future Population of MMA by Occupation and Car Ownership (1987)

(1,000 Persons)

Occupation \ Car Ownership	Owners	Non-Owners	Total
Professional Workers	123	132	255
Administrative Workers	44	24	68
Clerical Workders	78	172	250
Sales Workers	77	152	229
Farmers	12	60	72
Workers in Transport Sector	76	212	288
Craftsmen	65	448	513
Service Workers	267	245	512
Sub-Total	742	1,445	2,187
School Children	248	770	1,018
Students	315	687	1,002
Sub-Total	563	1,457	2,020
Housewives	161	574	735
Jobless	164	652	816
Sub-Total	325	1,226	1,550
Grand Total	1,630	4,128	5,758

Source: Estimation of population by occupation by MBMRSP Group and broken down by car ownership by Japanese Team.

Table 2.3.3 (B) Future Population of MMA by Occupation and Car Ownership (2000)

(1,000 Persons)

Occupation \ Car Ownership	Owners	Non-Owners	Total
Professional Workers	227	103	330
Administrative Workers	81	7	88
Clerical Workers	144	180	324
Sales Workers	143	153	296
Farmers	22	72	94
Workers in Transport Sector	140	233	373
Craftsmen	120	544	664
Service Workers	495	168	663
Sub-Total	1,372	1,460	2,832
School Children	422	786	1,208
Students	536	653	1,189
Sub-Total	958	1,439	2,397
Housewives	333	730	1,063
Jobless	330	830	1,160
Sub-Total	663	1,560	2,223
Grand Total	2,993	4,459	7,452

Source: Estimation of population by Occupation by MBMRSP Group and broken down by car ownership by Japanese Team

Table 2.3.4 Ratio of First Trips by Area

Trip Purpose \ Area	Internal	External	Total
Commuting to Work	0.985	0.015	1.000
Going to School	0.998	0.002	1.000
Private	0.975	0.025	1.000
Business	0.938	0.062	1.000

Note: Calculated from the present trip distribution of the persons trip survey.

Table 2.3.5 Factors for Estimating Trip Generation and Attraction of First Trip

Trip Purpose / Generation & Attraction / Factors		Commuting to Work		Going to School		Private		Work	
		Generation	Attraction	Generation	Attraction	Generation	Attraction	Generation	Attraction
Resident Population		○		○		○			
Numbers of Workers at Work Place	Totals		○						
	Primary								
	Secondary							○*	○*
	Tertiary						○	○*	○*
Number of Students & School Children at Daytime					○				

* The equation to 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 Secondary Industry Employed Population

X_2: Number of Tertiary Industry Employed Population

R : Multiple correlation coefficient

Source: As analyzed under UTSMMA

Table 2.3.6 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
Business	0.000	0.000	0.039	0.275

Remark: * As analyzed under UTSMMA

Table 2.3.7 Total Number of External Trip per Day in MMA

Unit: 1,000 trips/day

	1987			2000		
	External	Internal	Total	External	Internal	Total
Commuting to work	189.0	33.0	222.0	245.0	42.0	287.0
Going to school	3.0	3.0	6.0	3.0	3.0	6.0
Private	144.4	28.0	172.4	204.1	40.0	244.1
Business	60.4	53.0	133.4	85.3	85.0	170.3
Returning home	336.4	64.0	400.4	452.1	80.0	532.1

$$W_j = L^{(1)} (1 - y)^{-1} V_j$$

$$U_i = L^{(1)} U_i + L^{(1)} (1 - y)^{-1} V_j y$$

where U_i = Total trip generation by zones

W_j = Total trip attraction by zones

$L^{(1)}$ = Number of first trips

U_i = Ratio of trip generation by zones

V_j = Ratio of trip attraction by zones

y = Transition probability between trip purposes (See Table 2.3.6)

3.3.3 Estimation of External Trips

External trips consist of two parts, namely:

- Trips generated by residents of MMA as projected in this Study.
- Trips generated by residents in the outlying areas.

The former was projected in Section 3.3.1, while the latter was estimated by multiplying the result of the Cordon Line Survey for the UTSMMA with the future population growth in the outlying areas. The results of the total external trips are shown in Table 2.3.7.

3.3.4 Estimation of Traffic Volume Generated by Manila International Airport

Trip generation by Manila International Airport was estimated according to "Manila International Airport Review of Traffic Forecasts and Findings as to Facility Requirements", Reneardet Sauti-Transplan Inc., Oct. 1974 (Sauti Report) and "Manila International Airport Master Plan",Airways Engineering Corporations (AEC Report). According to AEC Report, the estimated airport passenger volume for the target year 1983 are as shown in Table 2.3.8. The traffic demand of the domestic and international passengers was estimated also for the years 1987 and 2000 by adopting the logistic curve. The domestic passengers was estimated to reach 10,930 persons/day in 1987 and 13,730 persons/day in 2000, and the international passengers 8,710 persons/day in 1987 and 10,400 persons/day in 2000. The growth rate for the years beyond 1983 onward was made lower than before 1983 in consideration of the capacity of the airport facilities.

Table 2.3.8 Number of Air Passenger of Manila International Airport

Unit: person

	1972	1983	1987	2000
Domestic	134,000	3,523,600	3,990,000	5,010,000
Passenger	3,679	9,650	10,930	13,730
International	678,500	2,780,000	3,780,000	3,810,000
Passengers	1,876	7,620	8,710	10,440

Note: Upper row: Annual number of passengers
Lower row: Daily number of passengers

These passengers are often accompanied by well-wishers for seeing off or receiving the passengers. These well-wishers are also analysed in AEC Report. According to the report, the number of well-wishers per passenger is estimated as follows

For domestic passengers: 1.10 well-wishers/passenger

For international passengers: 3.62 - 4.04 well-wishers/passenger

Thus, the trips generated by well-wishers were estimated as shown in Table 2.3.9.

Table 2.3.9 Number of Well-wishers per Day

(Persons)

	1987	2000
For domestic passengers	10,931	13,726
For international passengers	30,492	36,533

The number of trips generated by the airport is summed up in Table 2. 3.10. These figures were superimposed over the generated and attracted estimated for the zones around the Airport.

Table 2.3.10 Number of Trips Generated by the Airport

(Persons/day)

	Domestic			International			
	Passenger	Well-wisher	Subtotal	Passenger	Well-wishers	Subtotal	Total
1987	10,930	21,860	32,790	8,710	60,980	69,690	102,480
2000	13,730	27,450	41,180	10,440	73,060	83,500	124,680

Table 2.3.11 Daily Person-trip Estimates by Trip Purpose

	Commuting to Work	Going to School	Private	Work	To Home	Total
1971 (Base Year)	1,046	1,060	909	843	2,836	6,735
	15.5	15.7	13.5	12.5	42.1	100.0
1987	1,719	1,568	1,640	1,591	4,695	11,213
	15.3	14.0	14.6	14.2	41.9	100.0
2000	2,266	1,980	2,234	2,198	6,206	14,883
1987/1971	1.64	1.48	1.80	1.88	1.66	1.66
2000/1971	2.17	1.87	2.46	2.61	2.19	2.21

Notes: Upper Figure; Number of trips per (1,000 trips)

Lower Figure; Share of trips; %

Including external trips and generated trips by MIA and MDA

3.3.5 Results and Evaluation of Person-trip Estimates

Table2.3.11 shows the purpose-wise volume of person-trips for the key years in MMA. Compared with the base year of 1971, the key year 1987 saw a increase of trips to 1.66 times, and the key year 2000 to 2.21 times. On the other hand, the resident population was 5.76 million for the key year 1987 and 7.45 million for the key year 2000, or 1.44 times and 1.86 times that of 1970. Thus, the person-trips growth is a little larger than that of population. This is attributable to the factors of (a) increase in the number of car owners, (b) rise in the employment ratio in the future, and (c) a sharp increase in population of the outlying area. The most conspicuous increase was seen in private trips and business trips.

Trip generation and attraction in the five rings in the MMA was shown in Fig. 2.3.2. It is noticed that for both key years 1987 and 2000, the trip-ends rise conspiciously in the 3rd Ring and in the external Ring, while the growth of trip-ends in CBD Ring is very low. This is due to the fact that the decrease in resident population of the CBD Ring is very large so that although an increase in tertiary employed population is anticipated, the growth in overall trip-end volume is limited. The density of trip-ends by zone is shown in Fig. 2.3.3 and Fig. 2.3.4. It is noticed that the zones belonging to CBD-1 have the highest density, followed by A sector and B sector. It is also found that the density of trip-ends along RTR Line No.1 is conspicuously high.

3.4 ASSUMED TRANSPORT SYSTEMS

3.4.1 Transport Network

The analysis has so far only concerned the trip generation and attraction by zones and trip distribution between zones. No consideration has been given to the modal split and assignment of transport network.

In this section, therefore, transport systems was determined for each key year, along with characteristic values for the computation of travel times.

The transport systems are composed of the following.

(a) Road system (excl. bus and jeepney systems)

(b) Rapid transit railway system with the bus/jeepney system serving as access transport system

(c) Bus and jeepney systems

For each key year, the above three systems are determined as follows. The transport system proposed for 1987 for the UTSMMA was assumed to be the plan for the year 2000 in this study, since planned population for 1987 under UTSMMA was put back so that it comes to be similar to that for the year 2000 in this study. Although this is an ideal plan from the long-term viewpoint, it will be financially and technically difficult to complete all the RTR Lines by the year 2000. The implementation of RTR Line No.1 only, for example, is estimated to take 10 to 12 years including preparation works, if the implementation schedule recommended in Part IV of this report were adopted. For this reasons, the following transport plans were assumed for the year 2000.

Plan 1 for the year 2000

Roads: Construction and improvement of six circumferencial roads and ten radial roads.

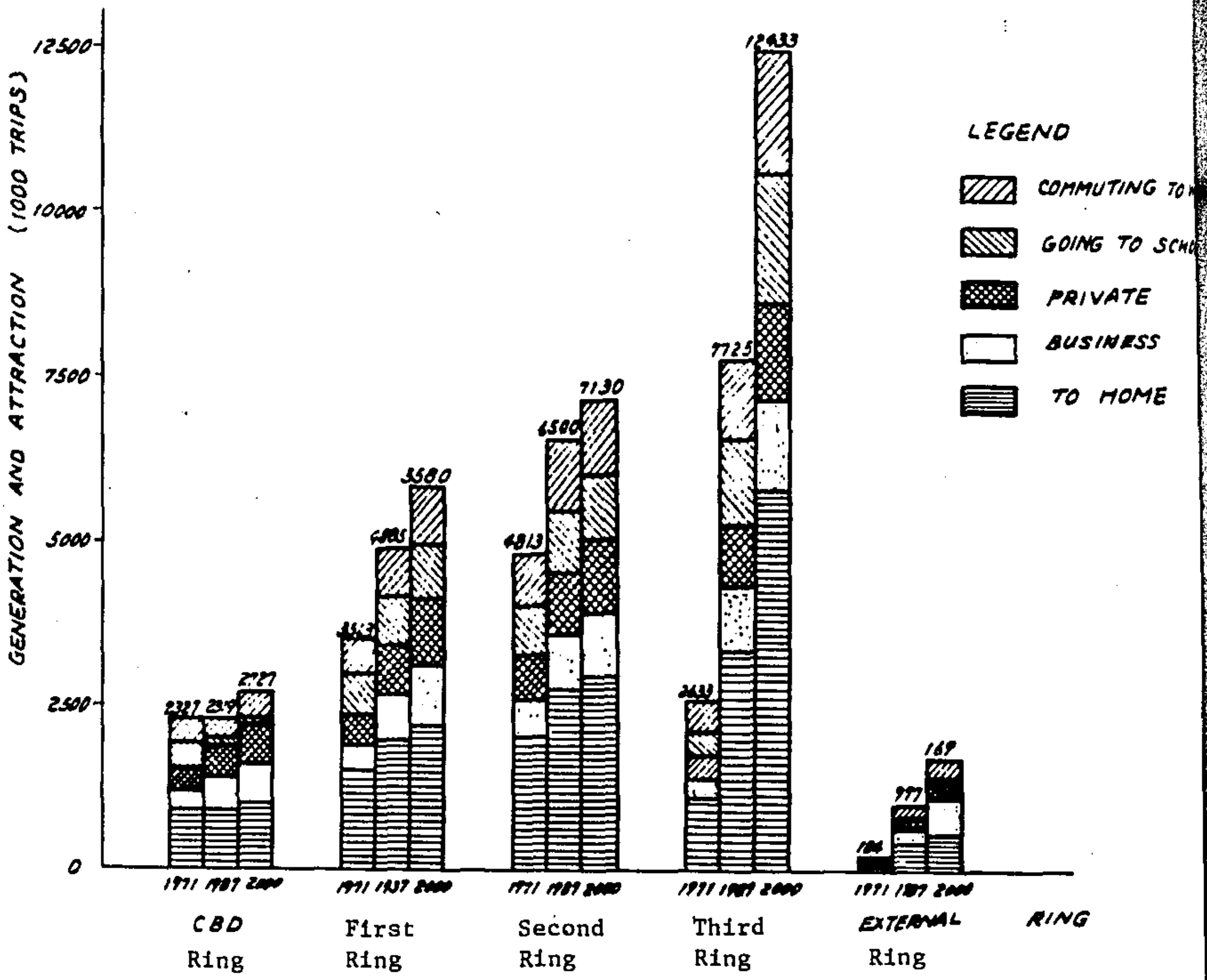


Fig.2.3.2 Generation and Attraction by Ring by Trip Purpose

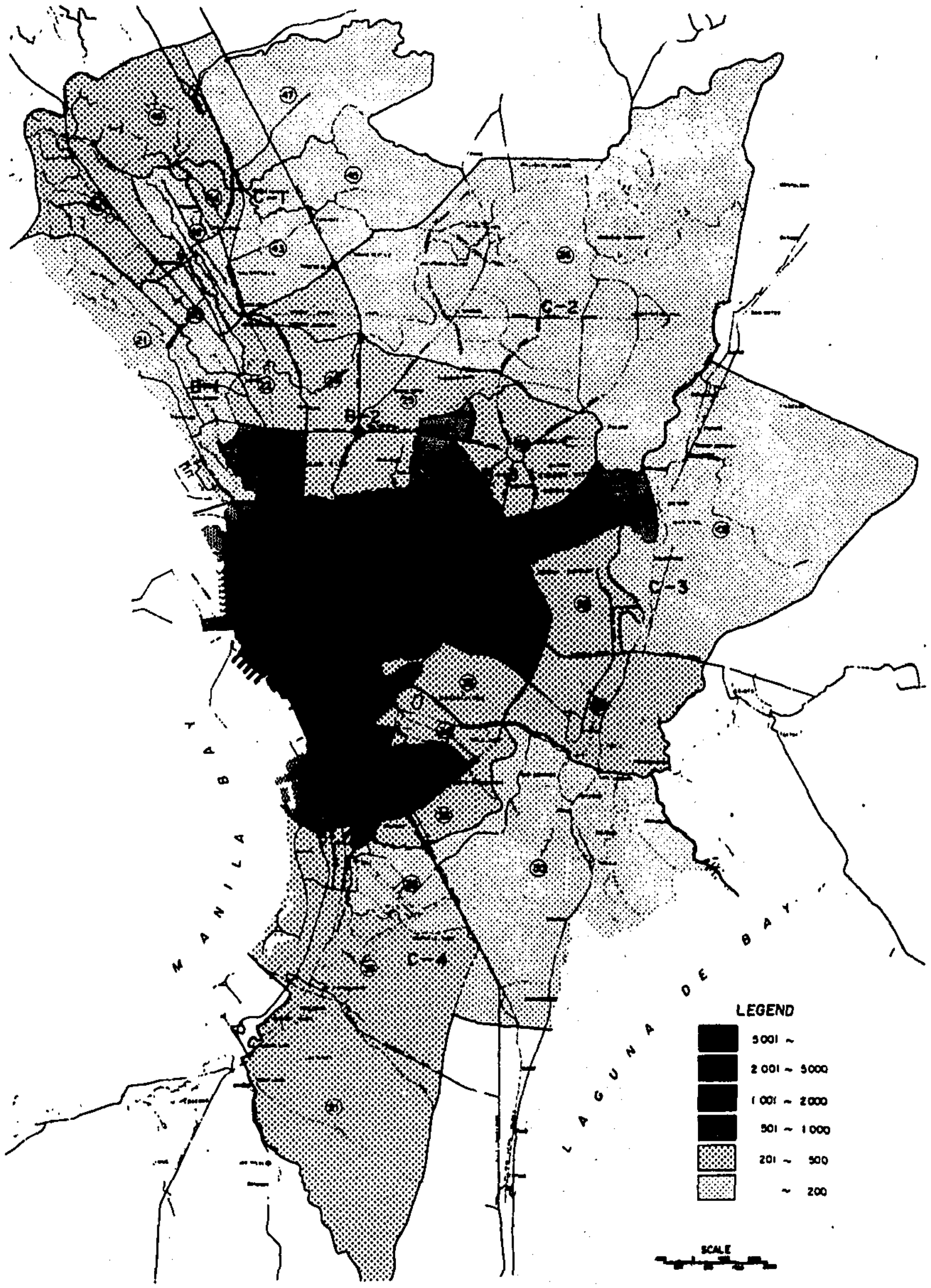


Fig. 2.3.3 Trip-End Density by Zones in 1987

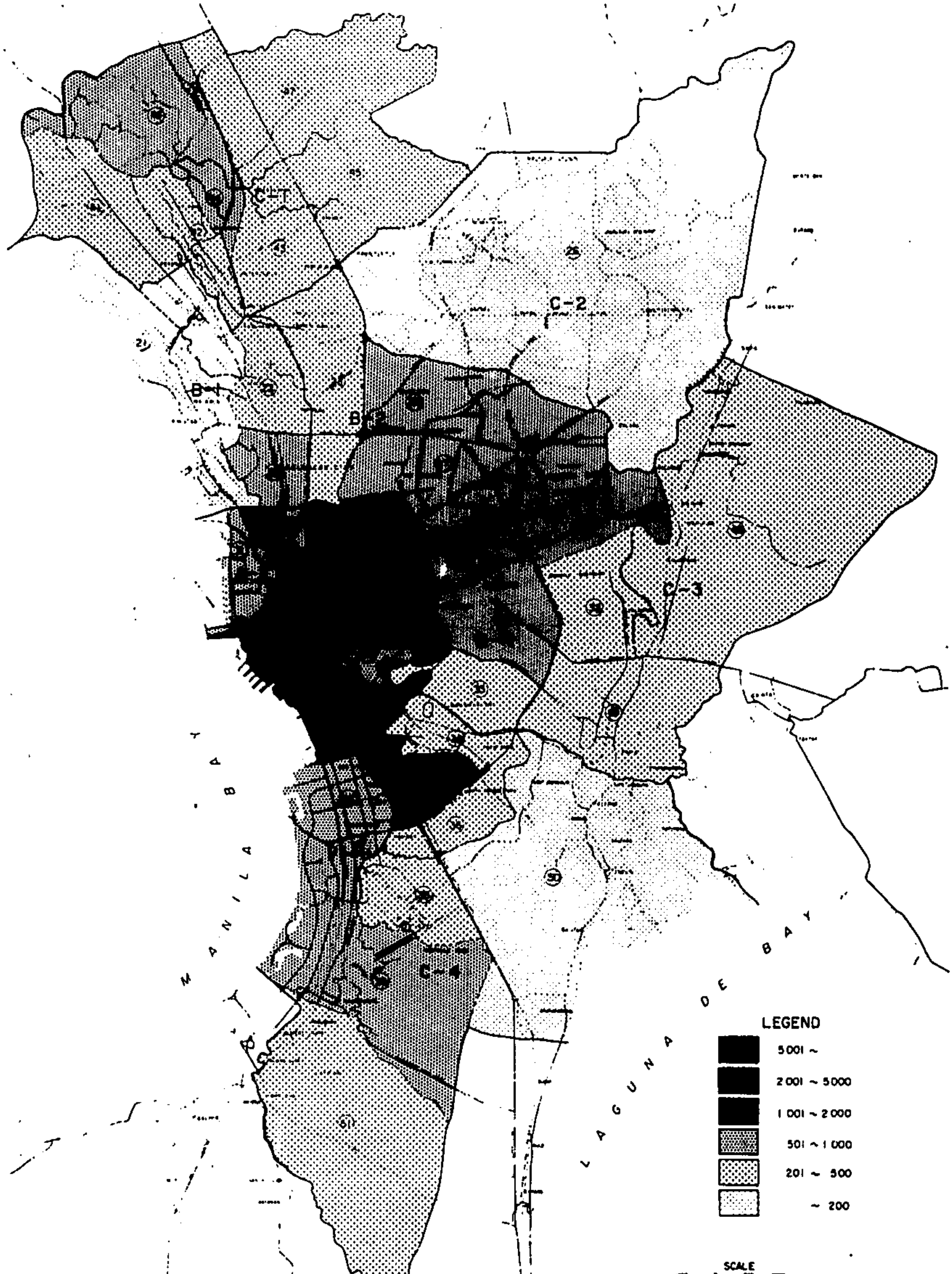


Fig. 2.3.4 Trip-End Density by Zones in 2000

Railways:	Improvement of PNR to rapid transit railway level and construction of Rapid Transit Railway Line No.1.
Bus and Jeepney:	Newly constructed roads to provide services to newly urbanized areas in coordination with the existing network.

Plan 2 for the year 2000

· Transport system proposed under the UTSMMA as shown in Fig. 2.3.5.

For the key year 1987, on the other hand, the urban transport systems will assume a compromise between the existing and the 2000 system. Here again, two alternative plans are assumed for the transport systems.

Plan 1 for the year 1987

Roads:	Extension of Radial Road R-1 within MMA
	Improvement and construction of Radial Road R-4
	Construction of Radial Road R-10
	Completion of Circumferential Road C-2
	Completion of Circumferential Road C-3
	Improvement of Circumferential Road C-4
	Almost all planned major thoroughfares within C-4 will be constructed.
Railways:	Improvement of PNR to rapid transit railway level
Bus and Jeepney:	Offering services to newly urbanized areas in coordination with the existing network.

Plan 2 for the year 1987

Road:	Same as Plan 1
Railways:	Completion of RTR Line No.1 and completion of Phase III of existing improvement program of PNR. (Minor improvement)
Bus and Jeepney:	Same as Plan 1

All the above transport systems are incorporated into a network, and the nodes and links are numbered and the node and link data are loaded into a computer for the computation of OD distribution, modal split and passenger assignment.

3.4.2 Characteristic Values of Transport System

The respective characteristic values such as travel speed, waiting time, transfer time, walking time from/to station or stop, terminal time of car user, and fares are converted into link values for the network by the following process.

(1) Travel Speed of Transport

The travel speed of the Rapid Transit Railway is assumed to be 33 km/hr, considering the distance between stations, stopping time and performance of motored cars and trailer cars proposed.

The travel time of PNR is assumed to be increased up to 30 km/h from the existing

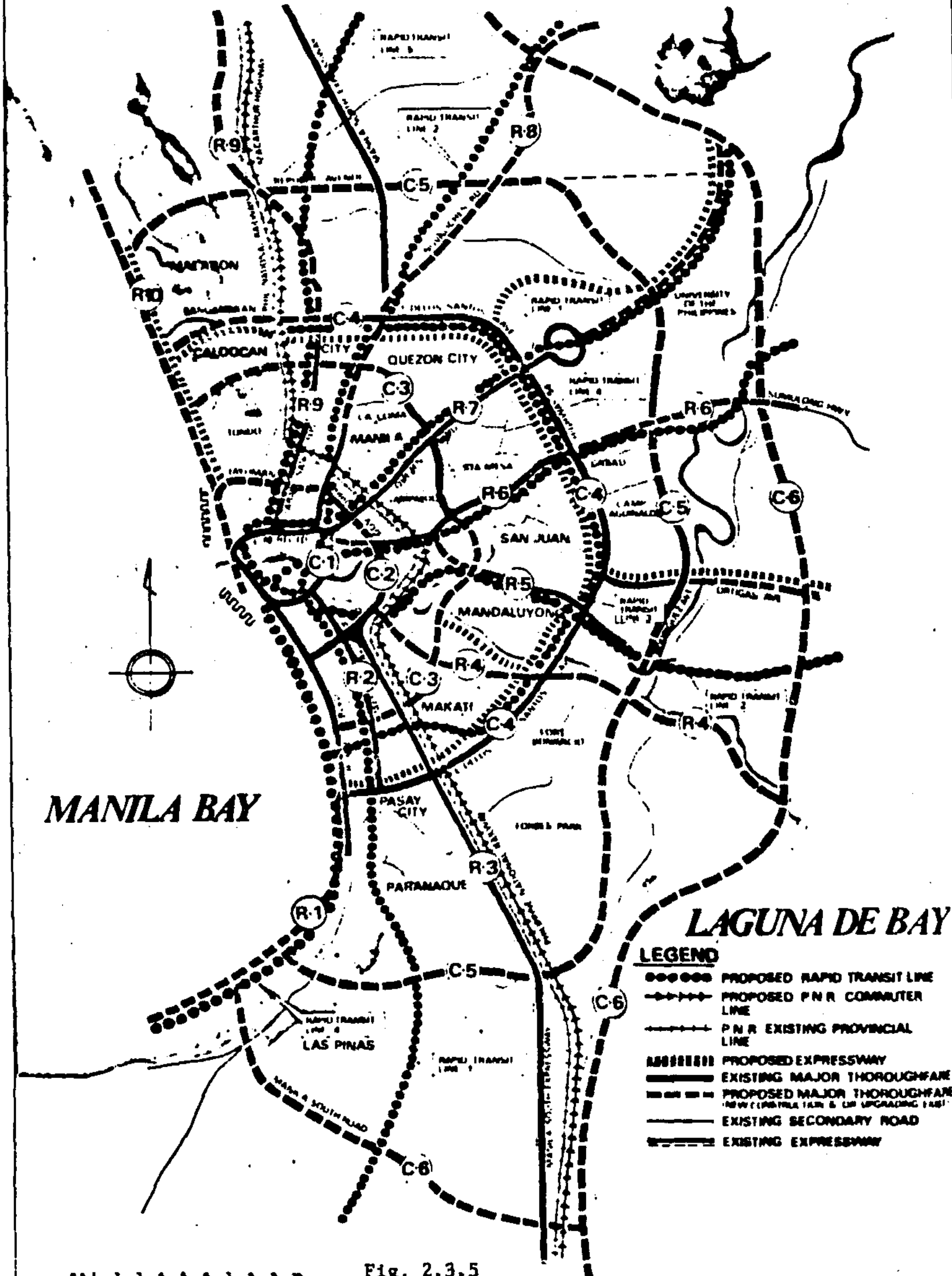


Fig. 2.3.5

PROPOSED TRANSPORTATION NETWORK FOR MANILA METROPOLITAN AREA UNDER UTSMMA.

20 to 25 km within MMA through the improvement of track and other facilities.

The travel speed of the road vehicles was calculated in the following way.

(1) The roads were classified into the following seven types with reference made of the AASHO Standards and the Japanese law concerning the road structures.

Type A: applicable to expressways between principal localities, such as Manila North-South Expressway.

Type B: applicable to urban expressways proposed in UTSMMA.

Type C: applicable to major thoroughfares in the suburban areas such as C-4, C-5 and C-6, of which most of the intersections are grade separated.

Type D: applicable to major thoroughfares located in suburban areas with at-grade intersections.

Type E: applicable to multi-lane roads within C-4 which have many at-grade intersections.

Type F: applicable to two-lane roads in the urban areas.

Type G: applicable to two-lane roads in the suburban areas.

(2) According to the 1971 and 1975 road traffic survey and travel speed survey, the relationships between traffic volume and the travel speed were analysed as shown in Fig. 2.3.6.

(3) The travel speed of road vehicles for the years 1987 and 2000 adopted was the critical speed in Fig. 2.3.6.

The travel speed of the Bus/Jeepney was calculated as follows:

(1) The roads were also classified into seven types same as for the road vehicles.

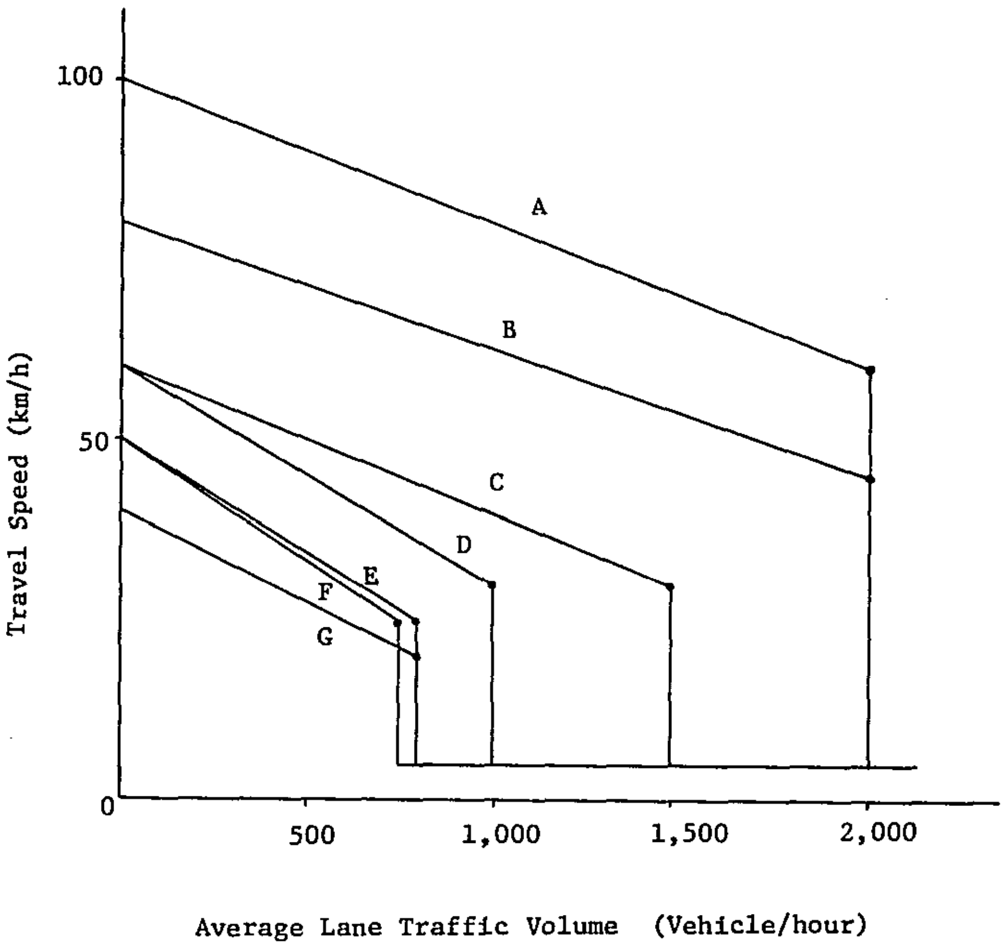
(2) According to the 1971 and 1975 traffic survey and travel speed survey, the rate of decrease in travel speed between road vehicles and bus/jeepney was analysed.

(3) The travel speed of bus/jeepney for the key years was calculated basing on the critical speed adopted for road vehicles and the rate of decrease in travel speed determined above.

(2) Walking Time, Waiting Time and Transfer Time

The walking time and waiting time are determined basing on the analysis of the mass transit services survey conducted in 1975 as shown in Tables 2.3.12 and 2.3.13. The waiting time for railway is determined on the basis of the preliminarily pre-determined operating frequency of trains. The transfer time between various modes of transport is set at 5 minutes for the railway-to-railway transfer and at 7 minutes for the railway-to-bus transfer.

Fig. 2.3.6 Typical Relationship Between
Average Lane Traffic Volume & Travel Speed



Notes: • Denotes Critical Speed
Road types A to E are multi-lane roads
Road types F & G are 2-lane roads

Table 2.3.12. Walking Time by Transport-System and by Area

Ring	CBD & 1st	2nd	3rd
R.T.R.	6	8	10
P.N.R.	6	8	10
Bus/Jeepney	4	6	8

Note: The walking time from/to the station of RTR and PNR was only within their influenced zone (Approximate 500 m radius of the station)

Table 2.3.13. Waiting Time by Transport System and by Area

Ring		CBD, 1st	2nd, 3rd
R.T.R.	Peak	1.5	1.5
	Off-peak	3	3
	Average	2	2
P.N.R.	Peak	3	3
	Off-peak	5	5
	Average	4	4
Bus/ Jeepney	Peak	5	6
	Off-peak	10	12
	Average	7	19

(3) Terminal Time for Car Users

Every car user requires some time for seeking their parking lot and walking time to go to their destination. These add up to the terminal time. The terminal time is assumed at 6 min. in CBD and the 1st Ring, 3 min. in the 2nd Ring and 2 min. in the suburbs.

(4) Fares for RTR, PNR and Bus / Jeepney

For PNR, bus and jeepney, current fares are adopted and for RTR, the recommended fare system is applied.

(5) Time Value

The time value for mass transit system users determined in Chapter 1, Part VI of this report is adopted.

3.5 TRIP DISTRIBUTION

3.5.1 Procedure

The Entropy Method incorporated with the Gravity Model was adopted in determining trip distribution. This is the probability model which decides the transition probability of the most probable trip distribution.

The equations are as follows:

$$X_{ij} = T\, U_i\, P_{ij}$$

$$P_{ij} = a\, U_i\, V_j\, t_{ij}^{-r}$$

where,

X_{ij} : Trips between zones i and j

T : Total trips

$U_i\ V_j$: Ratio of trip generation and attraction by zones

P_{ij} : Transition probability

t_{ij} : Travel time between zones i and j

r : Parameter

Exponent of travel time shown in Table 2.3.14 under the UTSMMA was adopted. Trip generation and attraction was already estimated in section 3.3. The travel time between zones used was the average of road transport and public transports.

Table 2.3.14. Exponent of Travel Time

	Commuting to work	Going to school	Private	Business
Exponent of Travel Time	2.00	2.65	1.66	1.56

Notes: 1) As analysed under the UTSMMA
2) a = 1

3.5.2 Results and Evaluation of Trip Distribution

Figs. 2.3.7 and 2.3.8 show the desired line of person trip in each key year and Fig. 2.3.9 shows the trip length distribution.

The average trip length in the year 1987 is computed at 7.28 km/person and that in the year 2000 is 8.34 km/person as against 5.98 km in 1971. This increase in trip length is due to population expansion towards the suburbs of MMA.

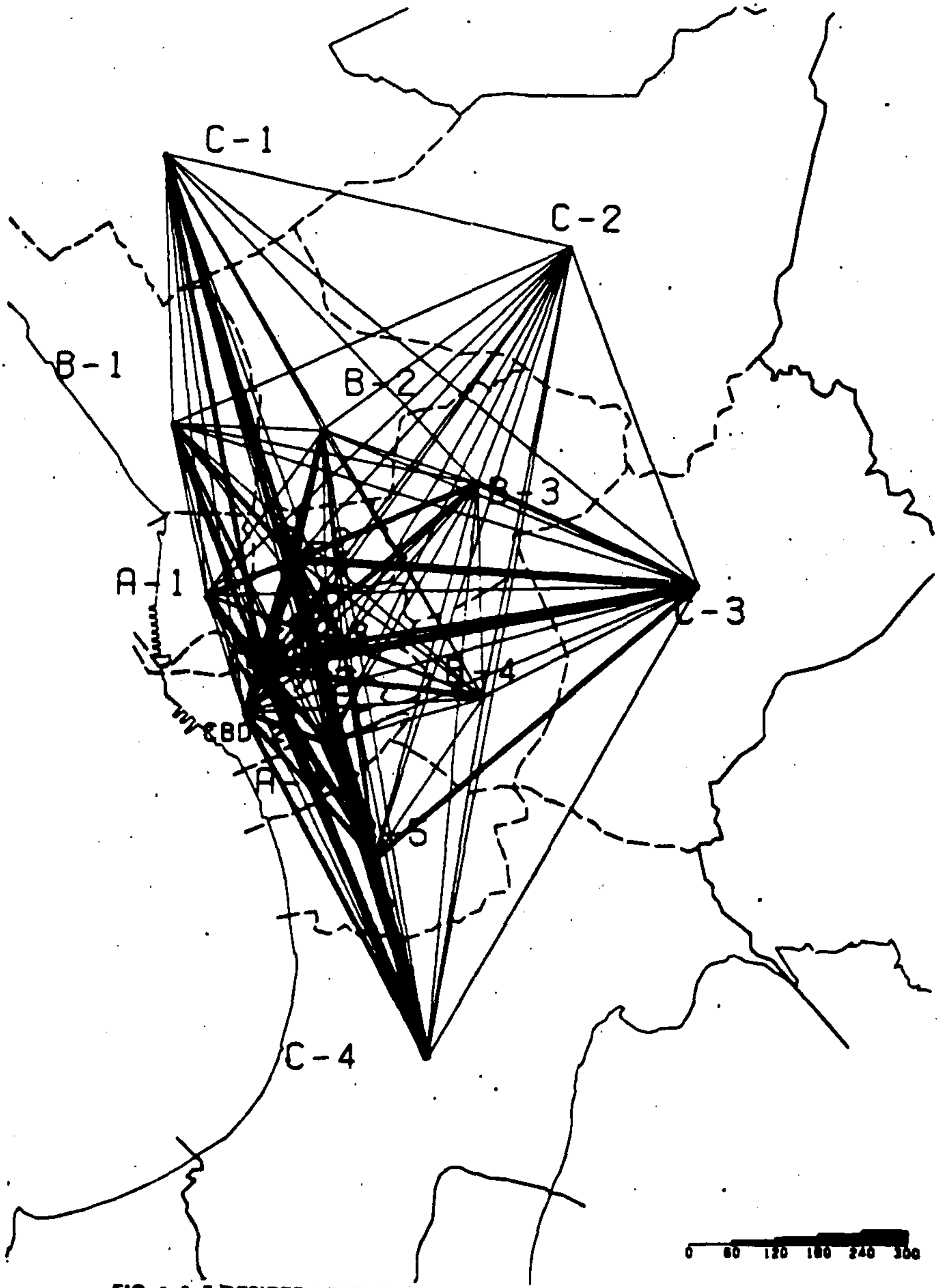


FIG. 2.3.7 DESIRED LINES OF PERSON TRIPS IN 1987 UNIT; 1,000 TRIPS

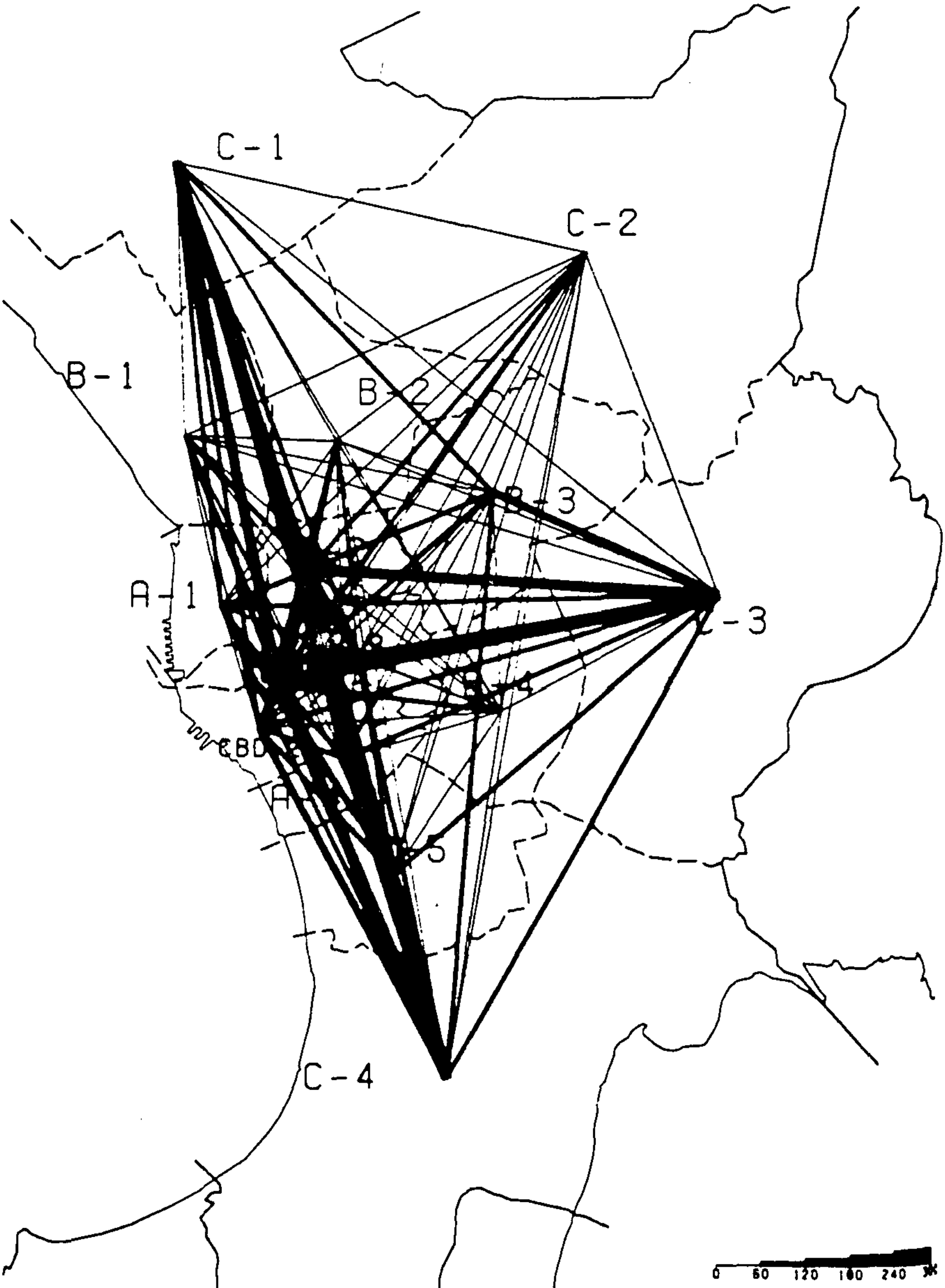


FIG. 2.3.8 **DESIRED LINES OF PERSON TRIPS IN 2000** **UNIT; 1,000 TRIPS**

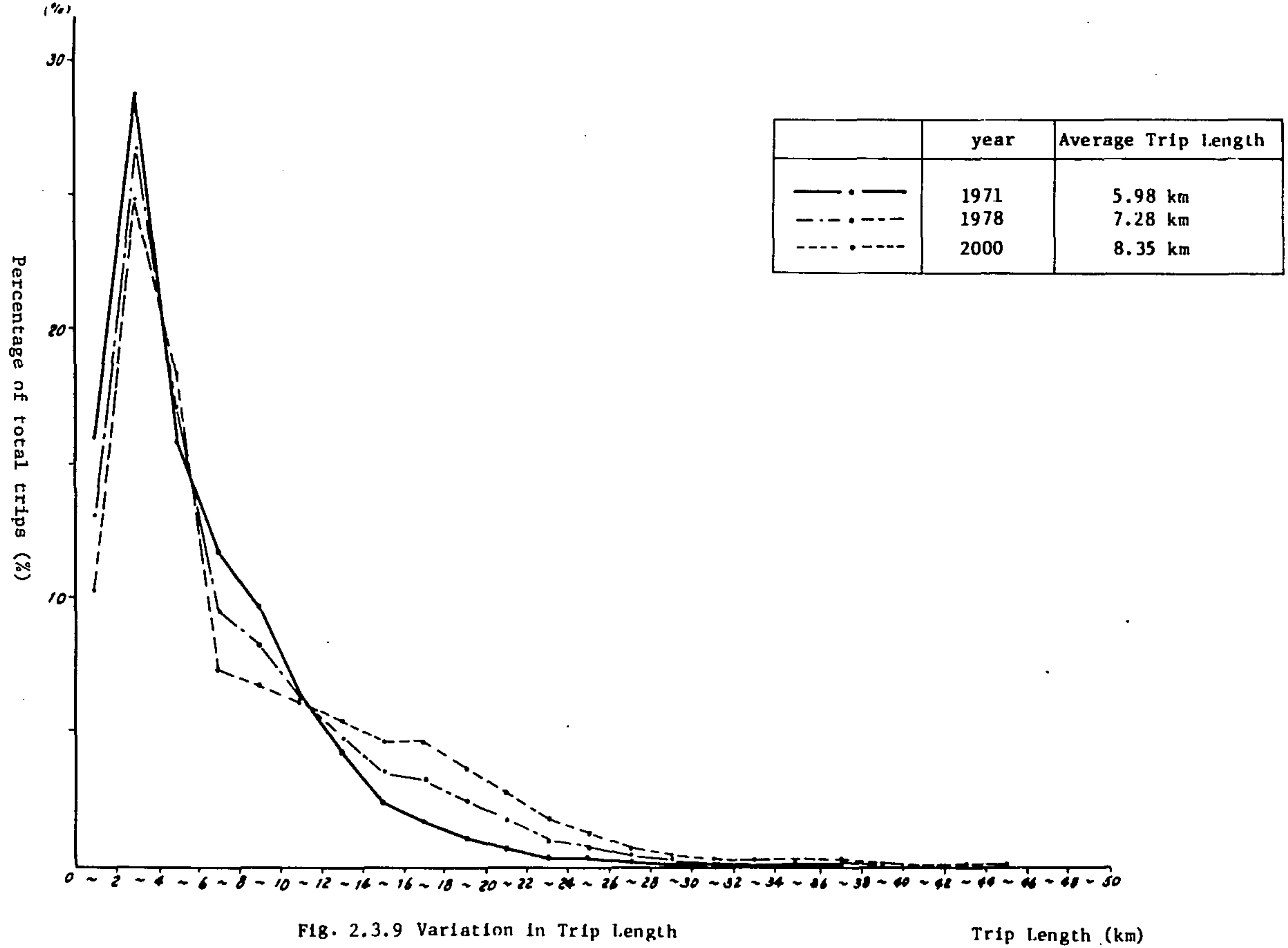


Fig. 2.3.9 Variation in Trip Length

3.5.3 Subdivision of Trip Distribution

The trip distribution obtained in 3.5.1 refers to that for the 51 zones. The zoning, however, has not followed the one-station one-zone principle. For this reason, the area along RTR Line No.1 was redivided into 103 zones as described in Part I.

The redivision was made according to the following equation, whereby the travel time was not taken into account, but the geographical conditions and area ratios were considered.

$$X_{ik.jl} = X_{ij} \cdot U_{ik} \cdot V_{jl}$$

where,

$$\sum_k U_{ik} = 1$$

$$\sum_l V_{jl} = 1$$

$X_{ik.jl}$: traffic volume between zones ik and jl after subdivision

X_{ij} : traffic volume between zones i and j before subdivision

U_{ik} : generation ratio

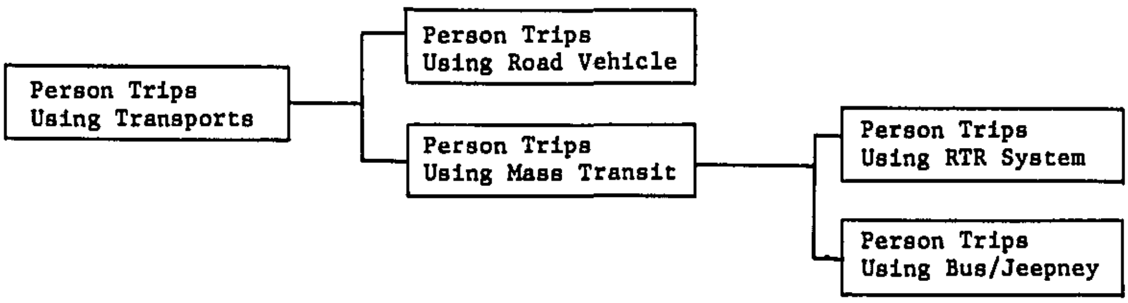
U_{jl} : attraction ratio

3.6 MODAL SPLIT

3.6.1 Methodology

In this study, the trip interchange method was applied, because the introduction of RTR Line No.1 will cause a large change in the inter-zonal travel time this greatly affecting the pattern of modal split.

According to the interchange model, the modal split was carried out as shown below.



The variable factor used was travel time, which included walking time, waiting time, transfer time and terminal time. To subdivide the mass transit trip into RTR trip and bus and jeepney trip, fares were also used as an input.

The ratio of the modal split by travel time ratio changes with trip purpose and car ownership; thus, the modal split ratio curves were prepared as classified by the trip purpose and by car ownership.

A modal split ratio curve representing a medium-sized city (population: 800 thousand) in Japan was modified with the results of the 1971 person trip survey in MMA.

The modification was made in the following way.

(1) Comparison study of the statistical modal split ratio in Japan and 1971 modal split ratio in MMA.

(2) Where a large discrepancy exists in the analytical results, the median of both is to be taken. This is because the discrepancy is considered attributable to the degree of repletion of the mass transit system in MMA, particularly rapid transit railway.

The modified modal split ratio curves are given in Figs. 2.3.11 and 2.3.12.

The following transport networks, which have been set in 3.4, were applied.

(1) Road vehicle network

(2) Bus & jeepney network

(3) RTR network reinforced with feeder network of bus and jeepney

The details of the modal splitting process are shown in Fig. 2.3.10.

3.6.2 Results and Evaluation of Modal Split

The results of modal split between the private car and the mass transit system is summarized in Tables 2.3.15 and 2.3.16 by key years. From the table, it is seen that Plan 1 for the year 1987 shows that the share of private car is 46% while that of mass transit system is 54%. If PNR is only partially improved, the share of private car will be increased 2% more than in Plan 1 to 48%.

In Plan 1 for the year 2000 the share of the car will be 47% and that of the mass transit system 53%. In Plan 2 for the year 2000, the share of the private car will be 33%, while that of the mass transit system will be 67%, increasing the private car using rate sharply. Considering the present car using rate of 43% and the mass transit using rate of 57%, it is evident that in the future, the modal split can be maintained at nearly the same level as it is now, depending on whether RTR Line No.1 is implemented or not.

Tables 2.3.17 and 2.3.18 show the assignment of mass transit passengers between railway and bus/jeepney for the key years for respective plans. The results indicate that bus/jeepney will still maintain the most important place as a means of mass transport within the entire MMA. The railway system will have a modal split ratio of 12% in Plan 1 and 8% in Plan 2 for the year 1987, 12% in Plan 1 and 26% in Plan 2 for the year 2000.

Figs. 2.3.13 and 2.3.14 show the trip-end density by railway passengers for both 1987 and 2000.

3.7 PASSENGER ASSIGNMENT FOR RAPID TRANSIT SYSTEM

3.7.1 *Method of Assignment*

The railway-using passengers are assigned to the railway network prepared under section 3.3 by means of a computer to determine the passenger volume of the railway system. Each link of the railway network is rated with a fare-added travel time.

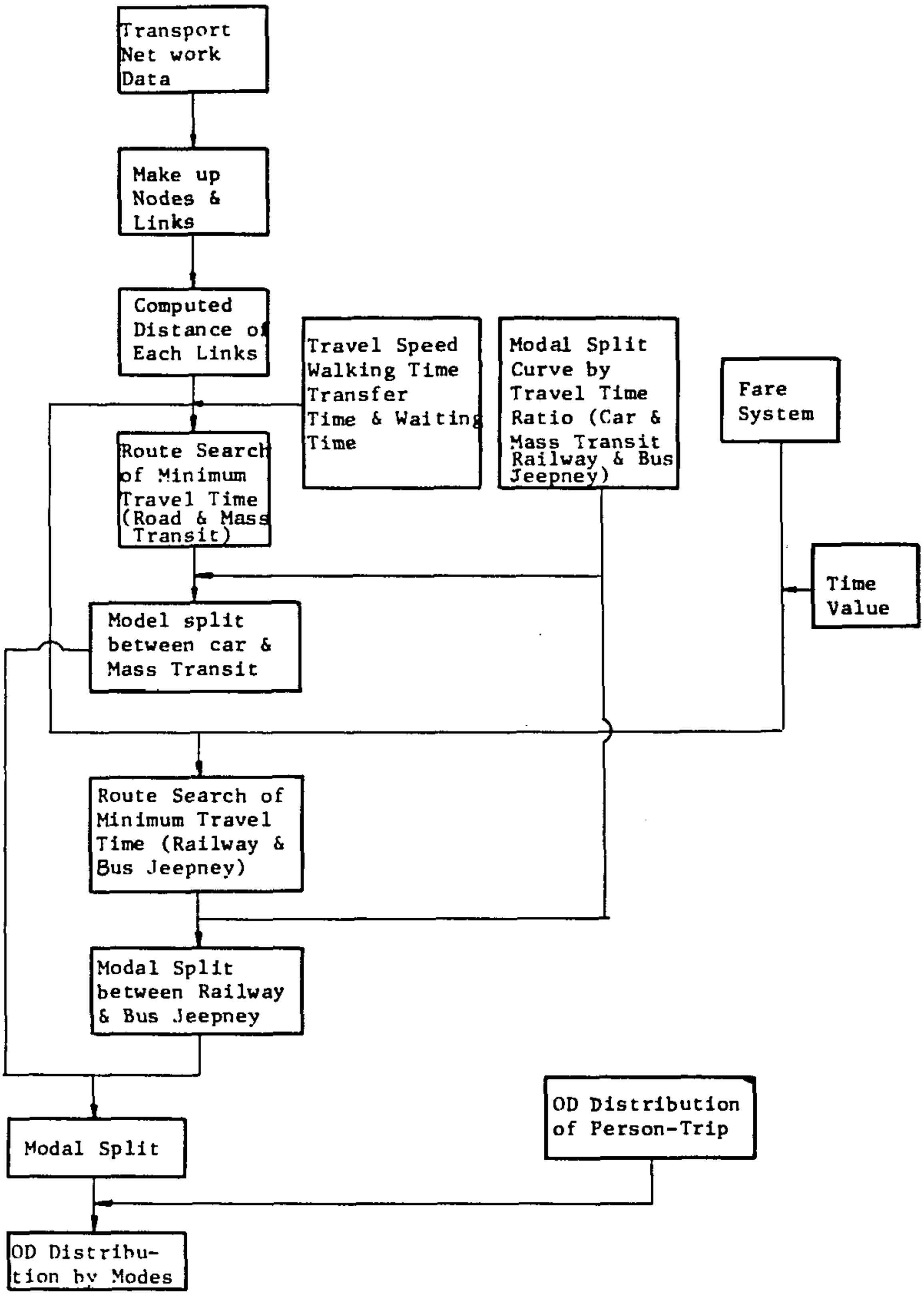


Fig. 2.3.10 Procedure for Modal Split

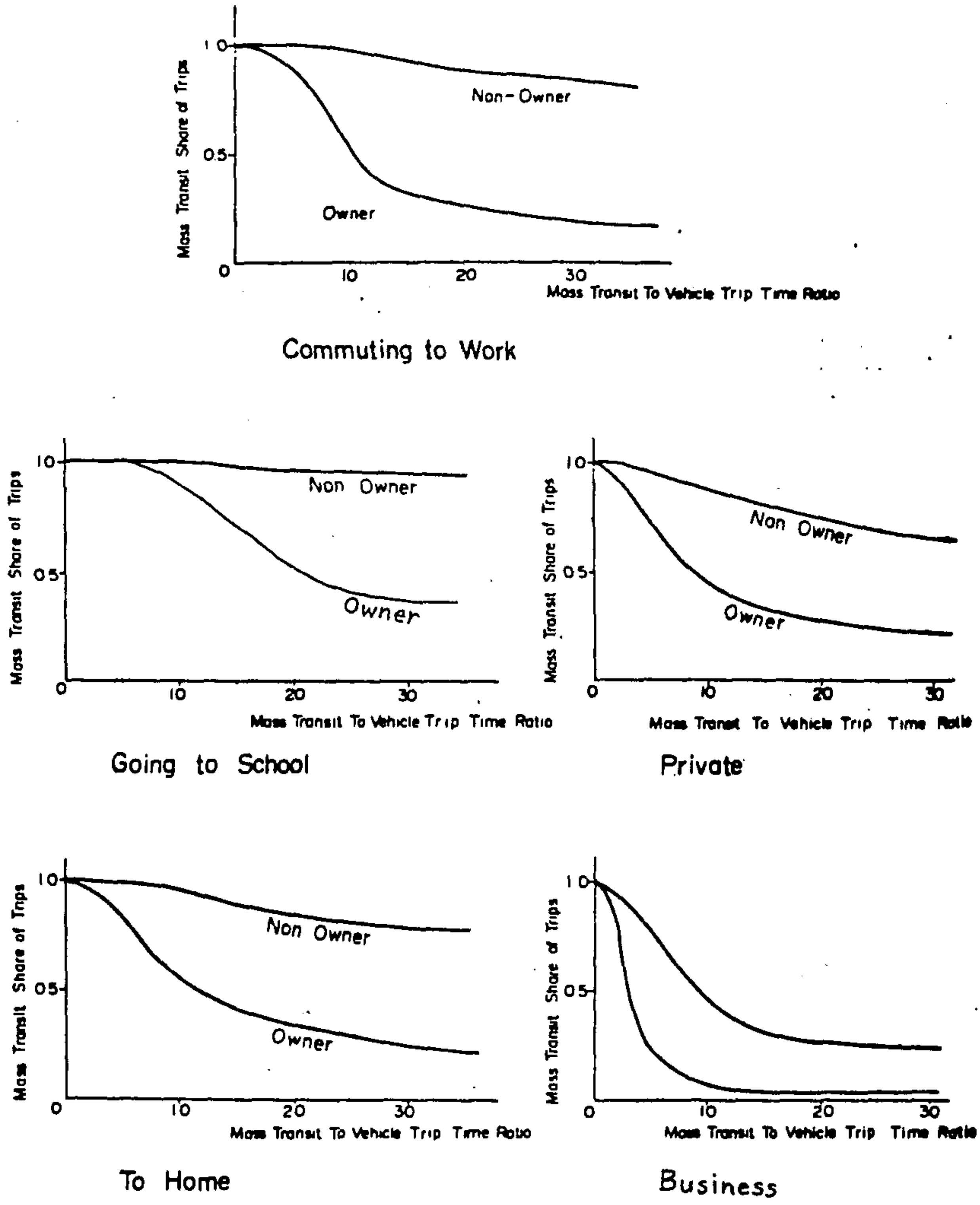
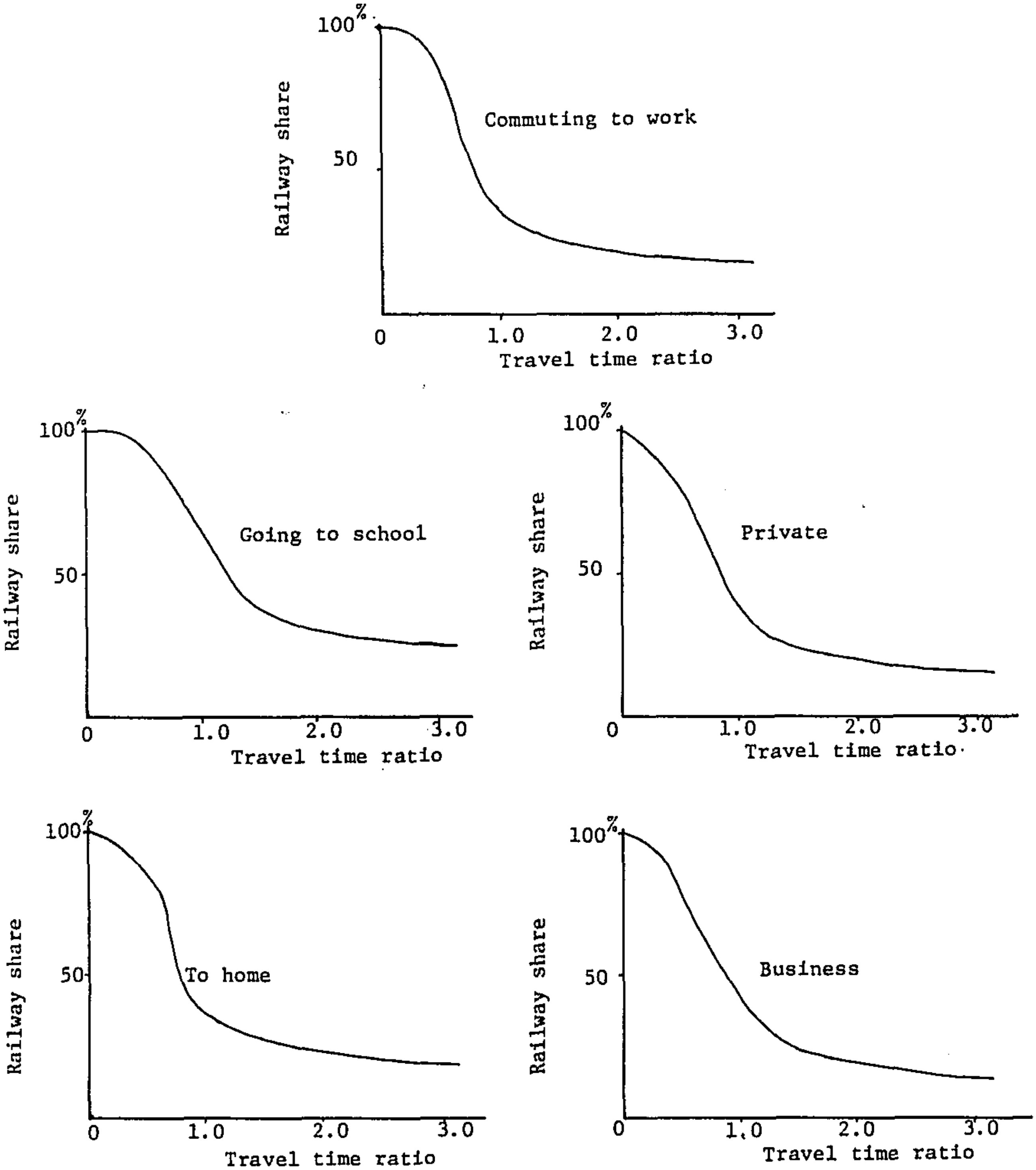


Fig. 2.3.11 MASS TRANSIT SHARE OF TRIPS BY TRAVEL TIME RATIO

Fig. 2.3.12 Railway Share of Trips by Travel Time Ratio



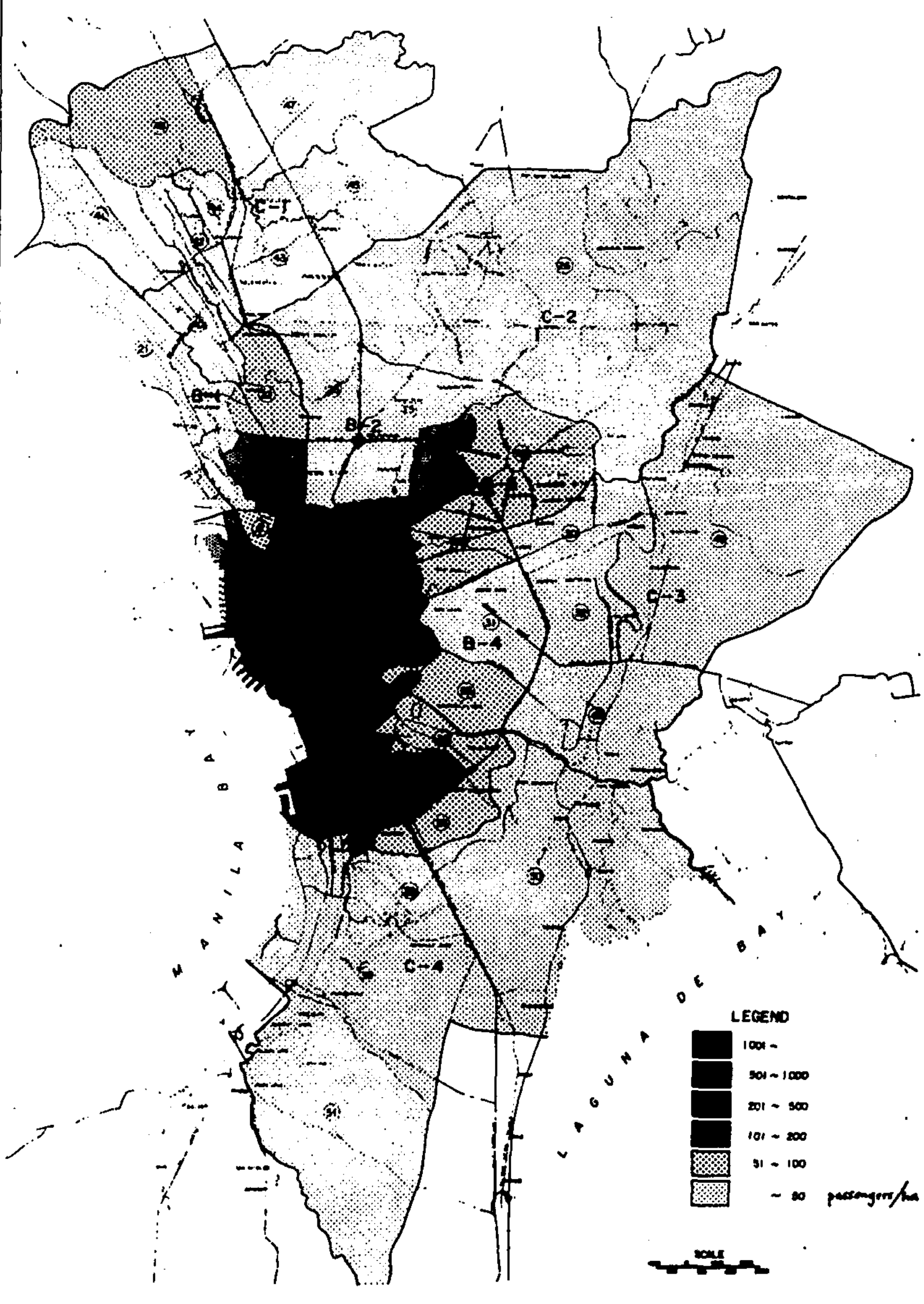


Fig. 2.3.13 Trip-End Density by Railway Passengers in 1987 (Plan 1)

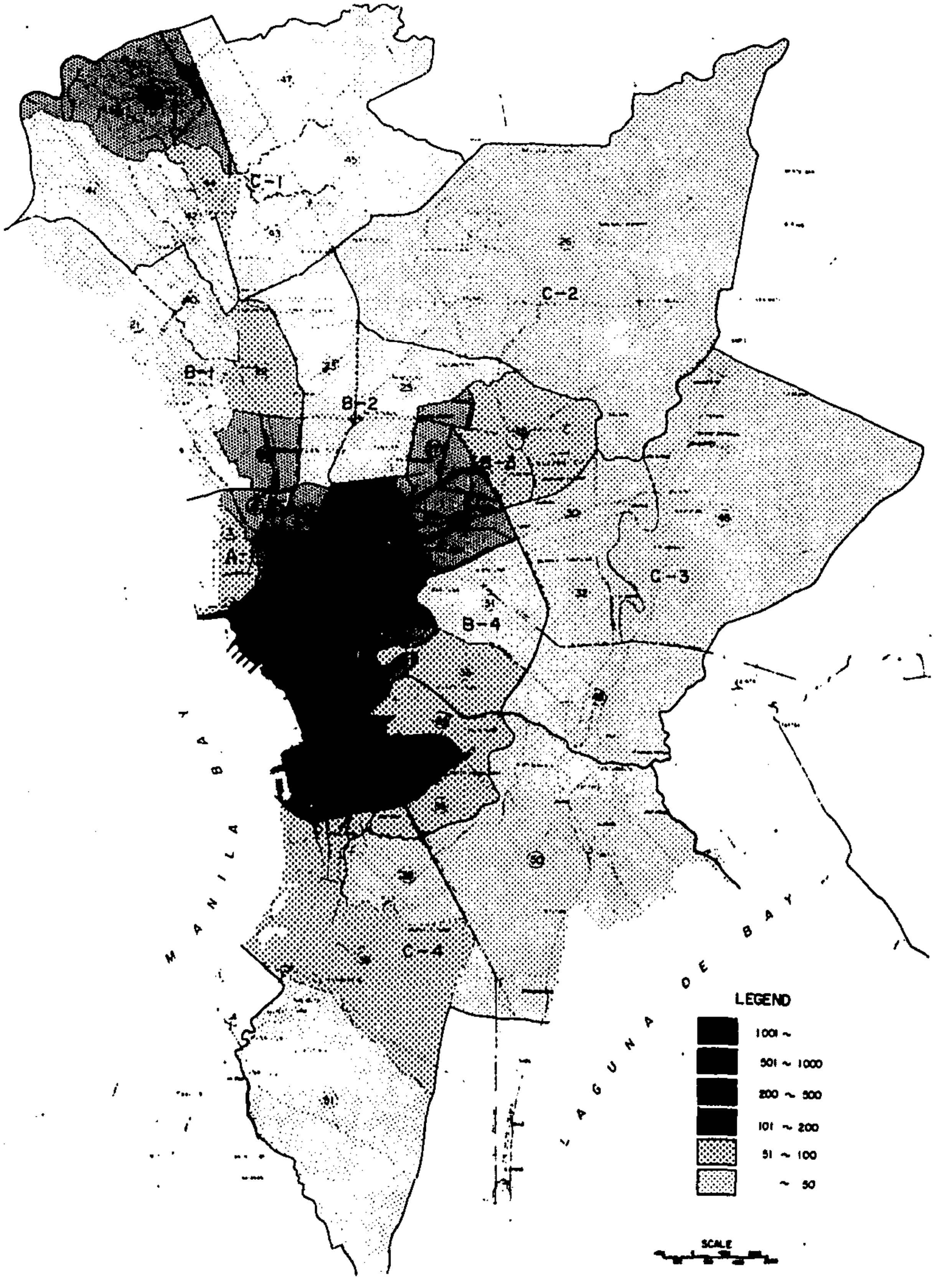


Fig. 2.3.14 Trip-End Density by Railway Passengers in 2000 (Plan 1)

Table 2.3.15 Modal Split by Trip Purpose in 1987

	PNR improved to RTR level (Plan 1)			PNR not improved to RTR level (Plan 2)		
	Car	Mass Transit	Total	Car	Mass Transit	Total
Commuting to work	705 (41)	1,014 (59)	1,719 (100)	739 (43)	980 (57)	1,719 (100)
Going to school	408 (26)	1,160 (74)	1,568 (100)	433 (28)	1,135 (72)	1,568 (100)
Private	902 (55)	738 (45)	1,640 (100)	936 (57)	704 (43)	1,640 (100)
Business	1,289 (81)	302 (19)	1,591 (100)	1,308 (82)	283 (18)	1,591 (100)
To home	1,878 (40)	2,817 (60)	4,695 (100)	1,960 (42)	2,735 (58)	4,695 (100)
Total	5,182 (46)	6,031 (54)	11,213 (100)	5,376 (48)	5,837 (52)	11,213 (100)

Upper - Number of trips per day in 1,000 trips
Lower - Rate of modal split in %

Table 2.3.16 Modal Split by Trip Purpose in 2000

	PNR improved to RTR level (Plan 1)			PNR not improved to RTR level (Plan 2)		
	Car	Mass Transit	Total	Car	Mass Transit	Total
Commuting to work	963 (42)	1,303 (58)	2,266 (100)	680 (30)	1,586 (70)	2,266 (100)
Going to school	497 (25)	1,483 (75)	1,980 (100)	297 (15)	1,683 (85)	1,980 (100)
Private	1,203 (54)	1,031 (46)	2,234 (100)	715 (32)	1,519 (68)	2,234 (100)
Business	1,762 (80)	436 (20)	2,198 (100)	1,539 (70)	659 (30)	2,198 (100)
To home	2,645 (43)	3,561 (57)	6,206 (100)	1,620 (26)	4,586 (74)	6,206 (100)
Total	7,070 (47)	7,815 (53)	14,884 (100)	4,851 (33)	10,003 (67)	14,884 (100)

Upper - Number of trips per day in 1,000 trips

Lower - Rate of modal split in %

Table 2.3.17 (A) Modal Split by Trip Purpose in 1987 (Plan 1)

	Commuting to work	Going to school	Private	Business	To Home	Total
Railway	223 (13)	251 (16)	185 (11)	79 (5)	610 (13)	1,349 (12)
Bus/Jeepney	791 (46)	909 (58)	553 (34)	223 (14)	2,207 (47)	4,683 (42)
Car	705 (41)	408 (26)	902 (55)	1,289 (81)	1,878 (40)	5,182 (46)
Total	1,719 (100)	1,568 (100)	1,640 (100)	1,591 (100)	4,695 (100)	11,213 (100)

Upper: Number of trips per day in 1,000 trips

Lower: Rate of modal split in %

Table 2.3.17 (B) Modal Split by Trip Purpose in 1987 (Plan 2)

	Commuting to work	Going to school	Private	Business	To Home	Total
Railway	145 (8)	166 (10)	146 (9)	59 (4)	419 (9)	935 (8)
Bus/Jeepney	835 (49)	969 (62)	558 (34)	224 (14)	2,316 (49)	4,902 (44)
Car	739 (43)	433 (28)	936 (57)	1,308 (82)	1,960 (42)	5,376 (48)
Total	1,719 (100)	1,568 (100)	1,640 (100)	1,591 (100)	4,695 (100)	11,213 (100)

Upper: Number of trips per day in 1,000 trips

Lower: Rate of modal split in %

Table 2.3.18 (A) Modal Split by Trip Purpose in 2000 (Plan 1)

	Commuting to work	Going to school	Private	Business	To Home	Total
Railway	339 (15)	382 (19)	309 (14)	125 (6)	927 (15)	2,082 (14)
Bus/Jeepney	964 (43)	1,1101 (56)	722 (32)	311 (14)	2,634 (42)	5,732 (39)
Car	963 (42)	497 (25)	1,203 (54)	1,762 (80)	2,645 (43)	7,070 (47)
Total	2,266 (100)	1,980 (100)	2,234 (100)	2,198 (100)	6,206 (100)	14,884 (100)

Upper: Number of trips per day in 1,000 trips

Lower: Rate of modal split in %

Table 2.3.18 (B) Modal Split by Trip Purpose in 2000 (Plan 2)

	Commuting to work	Going to school	Private	Business	To Home	Total
Railway	1,092 (48)	988 (50)	890 (40)	362 (16)	2,830 (46)	6,162 (41)
Bus/Jeepney	494 (22)	695 (35)	629 (28)	297 (14)	1,756 (28)	3,871 (26)
Car	680 (30)	297 (15)	715 (32)	1,539 (70)	1,620 (26)	4,851 (33)
Total	2,266 (100)	1,980 (100)	2,234 (100)	2,198 (100)	6,206 (100)	14,884 (100)

Upper: Number of trips per day in 1,000 trips

Lower: Rate of modal split in %

The all-or-nothing method is adopted for the assignment of passengers to RTR Line No.1 and PNR within the network in Plans 1 and 2 for the year 1987, and in Plan 2 for the year 2000, since in these cases little competition is expected between the two railway lines. In Plan 1 for the year 2000, the all-or-nothing method adopted is modified by taking into consideration the transport capacity of the lines.

The following are the outputs obtained from this passenger assignment process.

(1) The volume of passengers by trip purpose, direction and section

(2) The volume of boarding and unboarding passengers at each stations by trip purpose

(3) The RTR Line No.1 inter-station OD matrices by trip purpose

(4) The average passenger-kilometers

(5) The passenger volume by trip purpose, station and originating and destinating zones.

3.7.2 Results and Evaluation of Assignment

From the results of railway passenger assignment, it is seen that in Plan 1 for the year 1987, RTR Line No.1 passenger volume comes to 826 thousand per day and the passenger volume per unity length of line is 33 thousand per day per kilometer.

In Plan 2, RTR Line No.1 passenger volume will amount to 908 thousand, and the passenger volume per unit length will be 35 thousand per day per kilometer. In Plan 1, the average passenger trip length on Line No.1 will be 5.99 km, while in Plan 2 it will be 5.89 km. The total passenger volume of RTR Line No.1 for 2000, as shown in Table 2.3.19 will be 1,152 thousand per day in Plan 1, and 1,280 thousand per day in Plan 2, nearing the capacity of RTR Line No.1. Figs. 2.3.15 to 2.3.20 and Tables 2.3.20 to 2.3.23 show the RTR Line No.1 inter-station passenger volume, and the volume of boarding and unboarding passenger at each station for both years in the two plans. The inter-station through-passenger volume is largest in the section between Antipolo station and Welcome Rotonda station in Plan 1 for the year 1987, registering 306 thousand of passengers per day. The same section also ranks first with a total of 503 thousand passengers per day in Plan 2 for the year 2000. Tutuban, FEU and Antipolo are the stations having the largest volume of boarding and unboarding passengers, followed by the terminal stations of Baclaran and U.P.

Table 2.3.19 Daily Passenger Volume on the RTR Line No.1

	1987		2000	
	Plan 1	Plan 2	Plan 1	Plan 2
Total Passenger Volume (1,000 persons/day)	826.4	908.6	1,280.0	1,152.0
Average Number of Passengers per Length (1,000 persons/km/day)	33.0	35.5	51.1	45.9
Total Passenger-kilometers (1,000 persons/km)	4,946.8	5,349.4	8,022.0	6,818.7
Average Passenger-kilometers per Length (1,000 persons.km/km)	197.4	209.0	320.0	272.0
Average Trip Length per Passenger (km)	5.99	5.89	6.27	5.92

Table 2.3.20 Number of Passenger by Stations by Direction in 1987

(Unit: persons)

	Plan 1 (PNR improved)					Plan 2 (PNR not improved)				
	U.P. to Baclaran		Baclaran to U.P.			U.P. to Baclaran		Baclaran to U.P.		
	Boarding	Unboarding	Boarding	Unboarding	Total	Boarding	Unboarding	Boarding	Unboarding	Total
(M.D.A.)	0	5,816	6,120	0	11,936	0	5,778	6,120	0	11,898
(M.I.A.)	0	12,359	13,005	0	25,364	0	12,278	13,004	0	25,282
Baclaran	123	35,873	42,269	136	78,401	123	35,992	42,270	136	78,521
North Baclaran	1,774	17,528	15,932	2,272	37,506	1,774	43,193	47,385	2,272	94,624
Libertad	5,567	20,483	18,393	6,673	51,116	11,862	38,802	39,793	13,581	104,038
Buendia	6,810	8,209	6,682	8,270	29,971	6,810	8,209	6,682	8,270	29,971
Vito Cruz	8,096	14,875	15,256	7,440	45,667	16,434	22,490	25,214	16,379	80,517
San Andres	11,009	20,615	20,182	11,192	62,998	11,009	20,615	20,182	11,192	62,998
General Hospital	4,239	5,334	8,426	3,120	12,119	36,084	17,949	16,967	44,743	115,743
Rizal Park	15,263	14,032	19,705	12,115	61,115	19,887	11,015	15,081	15,132	61,115
Aduana	12,729	13,848	23,530	8,869	58,971	18,694	9,926	17,565	12,786	58,971
Divisoria	9,275	22,530	23,183	11,528	66,516	11,793	19,998	20,665	14,060	66,516
Tutuban	34,096	36,314	43,426	37,880	151,716	23,320	31,578	37,437	23,516	115,851
F.E.U.	29,442	44,236	46,216	29,027	148,921	31,200	43,146	45,356	30,935	150,637
U.S.T.	20,335	26,255	25,346	26,171	98,107	22,278	23,601	23,403	28,007	97,289
Antipolo	35,240	40,431	39,238	41,222	156,131	22,596	34,029	32,202	27,323	116,150
Welcome Rotonda	26,062	27,322	24,258	30,168	107,810	26,062	27,322	24,258	30,168	107,810
Santo Domingo	17,509	15,644	14,869	19,198	67,220	17,509	15,644	14,869	19,198	67,220
Roosevelt	8,489	4,903	4,779	9,600	27,771	8,489	4,903	4,779	9,600	27,771
Delta	35,052	5,270	5,224	35,546	81,092	35,052	5,270	5,224	35,546	81,092
Quezon	23,325	3,385	3,164	25,807	55,681	23,325	3,385	3,164	25,807	55,681
Capital Center	3,951	6,298	5,597	3,552	19,398	3,951	6,298	5,597	3,552	19,398
U.P.	93,169	0	0	95,014	188,183	93,169	0	0	95,014	188,183
Total	401,555	401,555	424,800	424,800	1,652,710	441,421	441,421	467,217	467,217	1,817,276

Table 2.3.21 Number of Passenger by Stations by Direction in 2000

	U.P. to Baclaran		Baclaran to U.P.		Total
	Boarding	Unboarding	Boarding	Unboarding	
(M.D.A.)	0	8,024	8,567	0	16,591
(M.I.A.)	0	16,292	17,393	0	33,685
Baclaran	313	91,546	106,466	326	198,651
North Baclaran	2,458	19,765	17,735	3,846	43,804
Libertad	8,395	21,966	19,872	10,569	60,802
Buendia	9,012	9,946	8,250	11,763	38,971
Vito Cruz	13,105	19,206	20,398	12,363	65,072
San Andres	16,786	24,190	25,593	17,119	83,688
General Hospital	6,667	8,016	12,171	4,846	31,700
Rizal Park	20,960	18,369	26,518	17,256	83,103
Aduana	17,191	19,589	30,451	12,937	80,168
Divisoria	10,459	27,589	27,234	14,091	79,373
Tutuban	46,124	42,917	50,828	51,832	191,701
F.E.U.	52,285	82,979	86,909	54,326	276,499
U.S.T.	22,061	38,778	37,440	26,513	124,792
Antipolo	55,042	66,836	70,037	60,188	252,103
Welcome Rotonda	42,056	42,477	37,673	49,276	171,482
Santo Domingo	30,345	21,430	20,809	34,579	107,163
Roosevelt	14,127	8,731	8,780	16,446	48,084
Delta	47,368	9,745	10,179	49,602	116,897
Quezon	37,241	6,929	6,007	42,200	92,377
Capital Center	10,765	12,798	12,659	11,468	47,690
U.P.	155,358	0	0	160,423	315,781
Total	618,118	618,118	661,969	661,969	2,560,174

Table 2.3.22 Number of Interstation Through Passenger by Direction in 1987

	Plan 1 (PNR improved)			Plan 2 (PNR not improved)		
	U.P. to Baclaran	Baclaran to U.P.	Total	U.P. to Baclaran	Baclaran to U.P.	Total
(M.D.A. - M.I.A.)	5,816	6,120	11,936	5,778	6,120	11,898
(M.I.A. - Baclaran)	18,175	19,125	37,300	18,056	19,124	37,180
Baclaran - North Baclaran	53,925	61,258	115,183	53,925	61,258	115,183
North Baclaran - Libertad	69,679	74,918	144,597	95,344	106,371	201,715
Libertad - Buendia	84,595	86,638	171,233	122,284	132,583	254,867
Buendia - Vito Cruz	85,994	85,050	171,044	123,683	130,995	254,678
Vito Cruz - San Andres	92,773	92,866	185,639	129,739	139,830	269,569
San Andres - General Hospital	102,379	101,856	204,235	139,345	148,820	288,165
General Hospital - Rizal Park	103,474	107,162	210,636	121,210	121,044	242,254
Rizal Park - Aduana	102,243	114,752	216,995	112,338	120,993	233,331
Aduana - Divisoria	103,357	129,413	232,770	103,570	125,772	229,342
Divisoria - Tutuban	116,612	141,068	257,680	111,775	132,377	244,152
Tutuban - F.E.U.	118,830	146,614	265,444	120,033	146,298	266,331
F.E.U. - U.S.T.	133,624	163,803	297,427	131,979	160,719	292,698
U.S.T. - Antipolo	139,544	162,978	302,522	133,302	156,115	289,417
Antipolo - Welcome Rotonda	144,735	160,994	305,729	144,735	160,994	305,729
Welcome Rotonda - Santo Domingo	145,995	155,084	301,079	145,995	155,084	301,079
Santo Domingo - Roosevelt	144,130	150,755	294,855	144,130	150,755	294,885
Roosevelt - Delta	140,544	145,935	286,478	140,544	145,934	286,478
Delta - Quezon	110,762	115,612	226,374	110,762	115,612	226,374
Quezon - Capital Center	90,822	92,969	183,791	90,822	92,969	183,791
Capital Center - U.P.	93,169	95,014	188,183	93,169	95,014	188,183

Table 2.3.23 Number of Interstation Through Passengers by Direction in 2000

Section	U.P. to to Baclaran	Baclaran to U.P.	Total
(M.D.A. - M.I.A.)	8,024	8,567	16,591
(M.I.A. - Baclaran)	24,316	25,960	50,276
Baclaran - North Baclaran	115,549	132,100	247,649
North Barclaran - Libertad	132,856	145,989	278,845
Libertad - Buendia	146,427	155,292	301,719
Buendia - Vito Cruz	147,361	151,779	299,140
Vito Cruz - San Andres	153,462	159,814	313,276
San Andres - General Hospital	160,866	168,288	329,154
General Hospital - Rizal Park	162,215	175,613	337,828
Rizal Park - Aduana	159,624	184,875	344,499
Aduana - Divisoria	162,022	202,389	364,411
Divisoria - Tutuban	179,152	215,532	394,684
Tutuban - F.E.U.	175,945	214,528	390,473
F.E.U. - U.S.T.	206,639	247,111	453,750
U.S.T. - Antipolo	223,356	258,038	481,394
Antipolo - Welcome Rotonda	235,150	267,887	503,037
Welcome Rotonda - Santo Domingo	235,571	256,284	491,855
Santo Domingo - Roosevelt	226,656	242,514	469,170
Roosevelt - Delta	221,260	234,848	456,108
Delta - Quezon	183,637	195,425	379,062
Quezon - Capital Center	153,325	159,232	312,557
Capital Center - U.P.	155,358	160,423	315,781

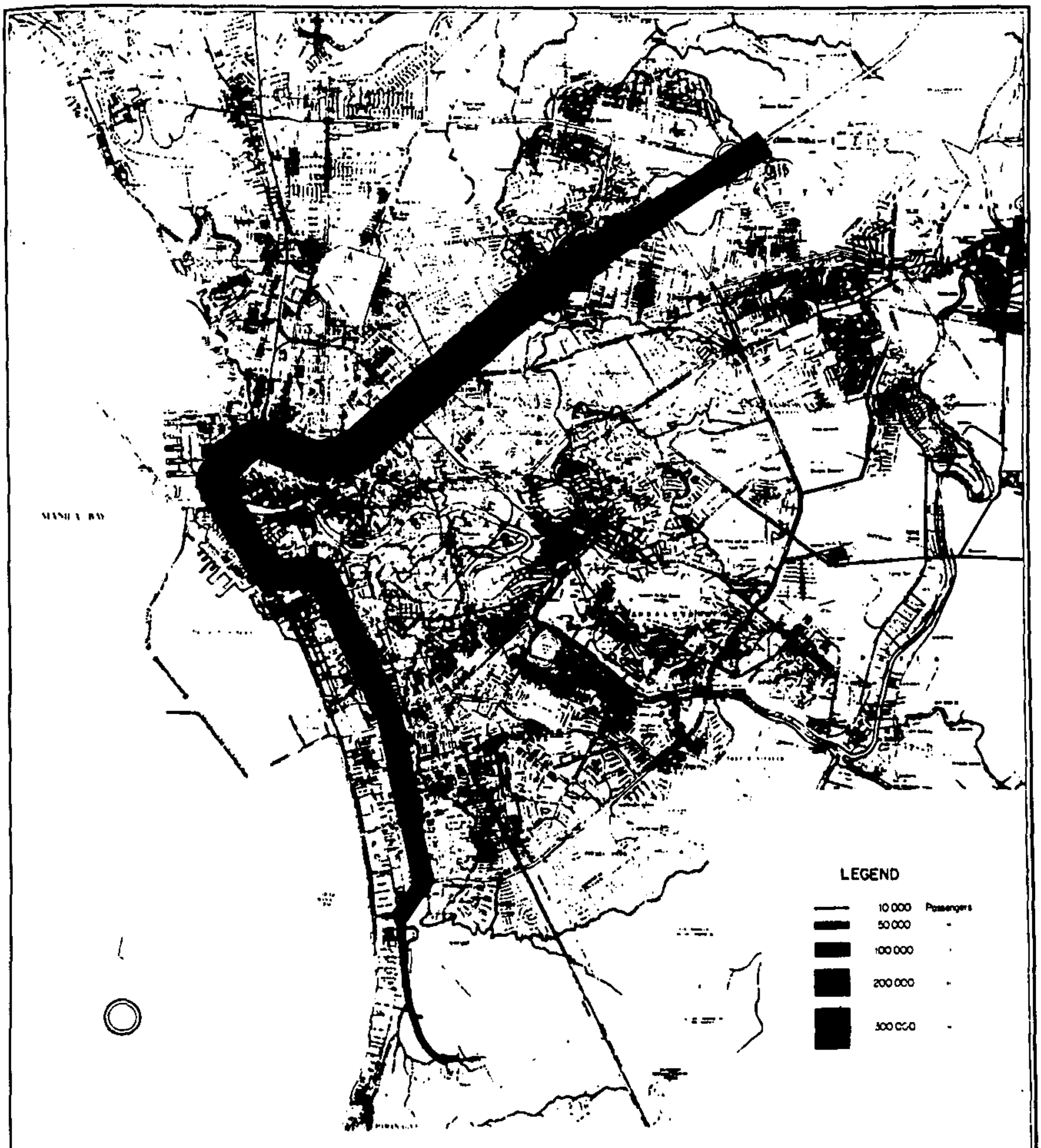


Fig. 2.3.15 Passenger Volume on RTR Line No. 1 in 1987 (Plan 1)

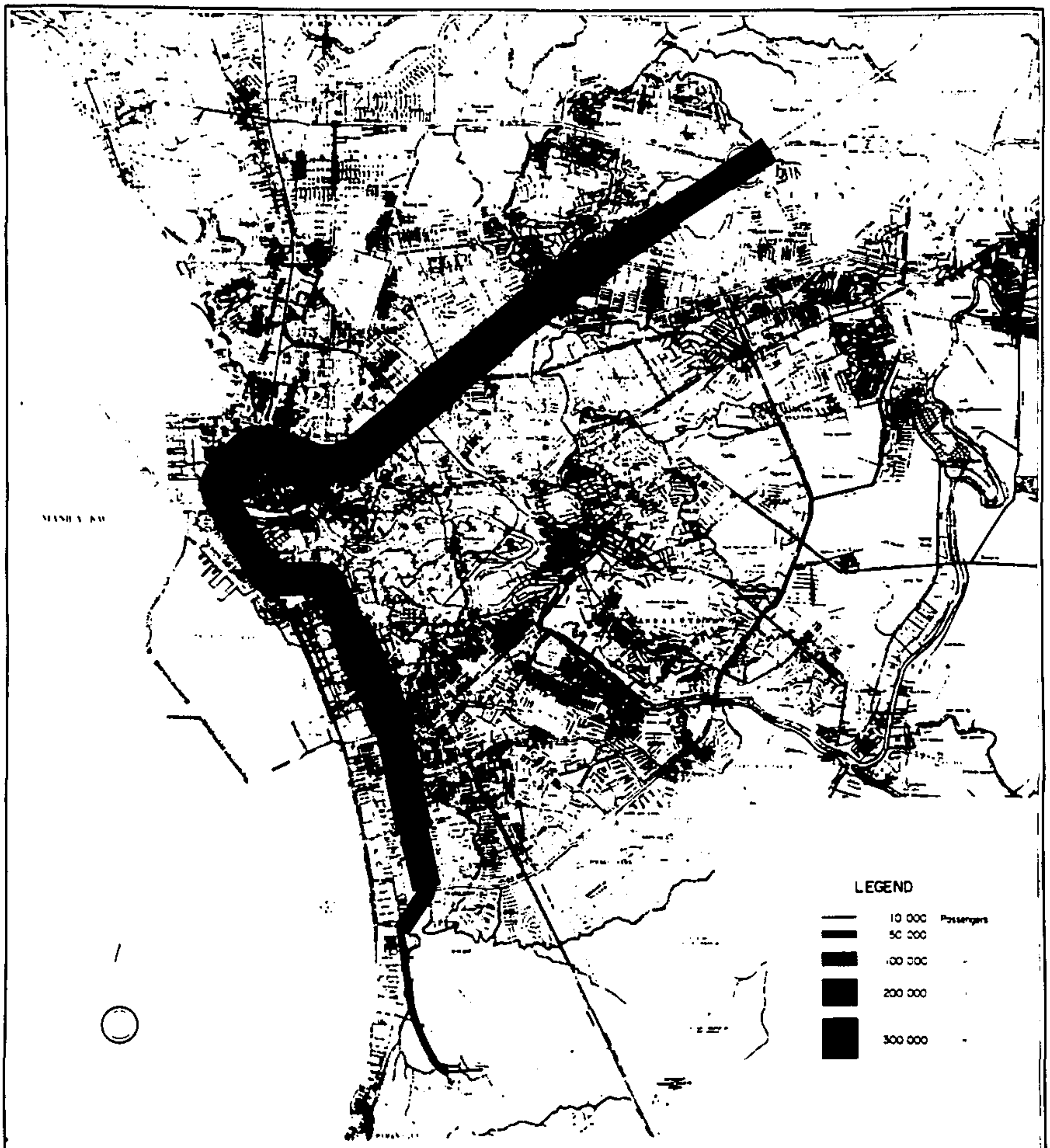


Fig. 2.3.16 Passenger Volume on RTR Line No. 1 in 1987 (Plan 2)

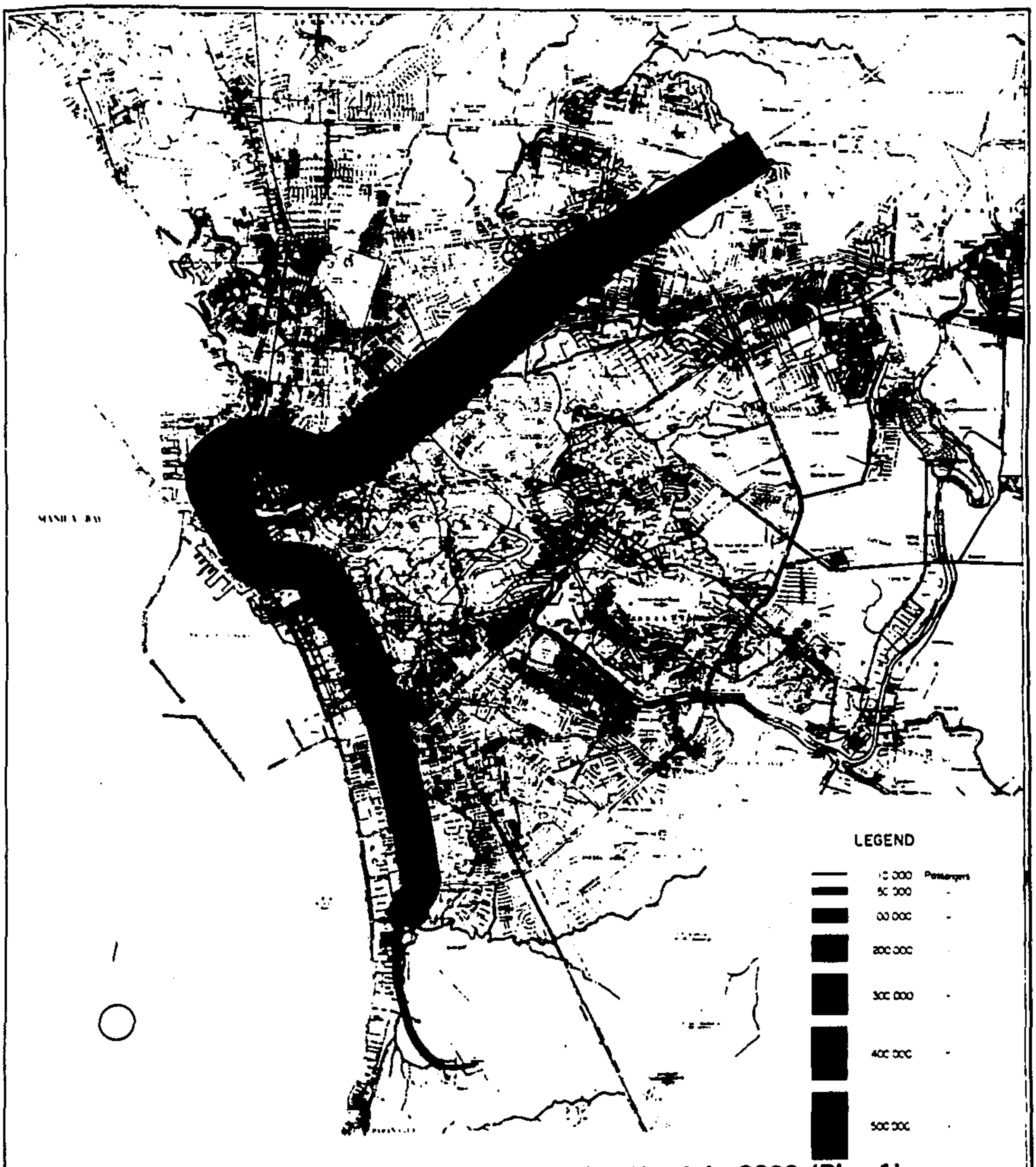


Fig. 2.3.17 Passenger Volume on RTR Line No. 1 in 2000 (Plan 1)

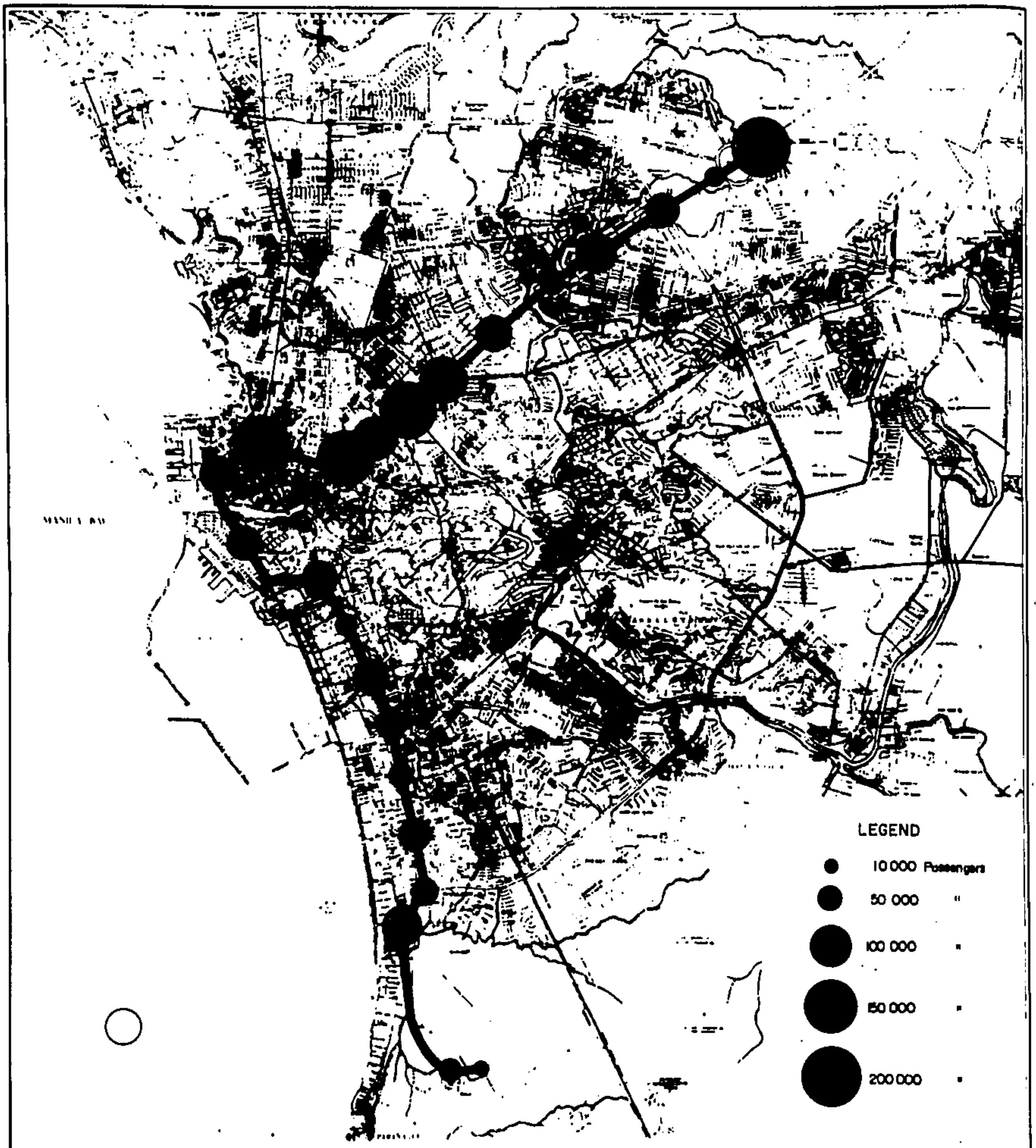


Fig. 2.3.18 Passenger Volume on Stations in 1987 (Plan 1)

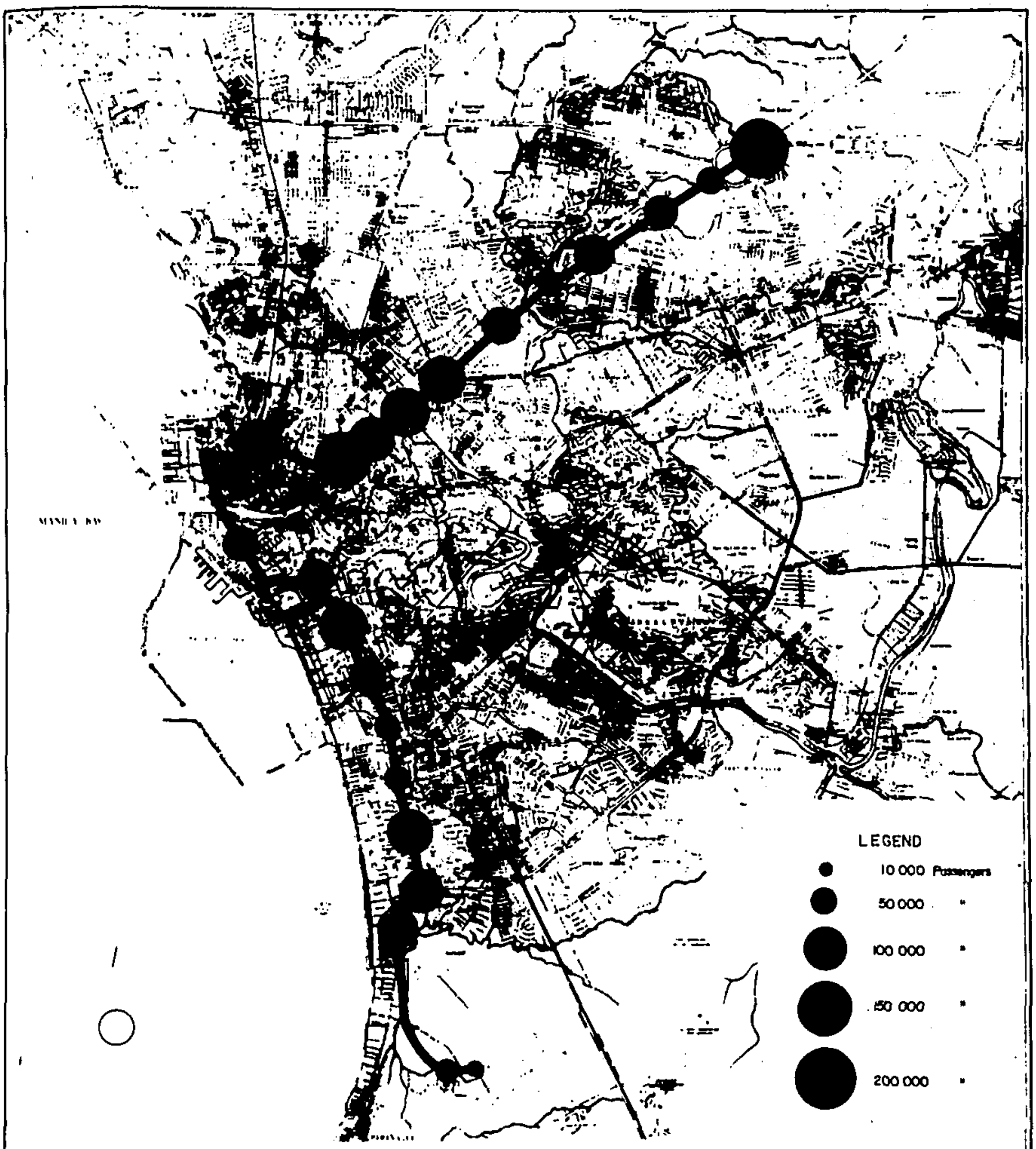


Fig. 2.3.19 Passenger Volume on Stations in 1987 (Plan 2)

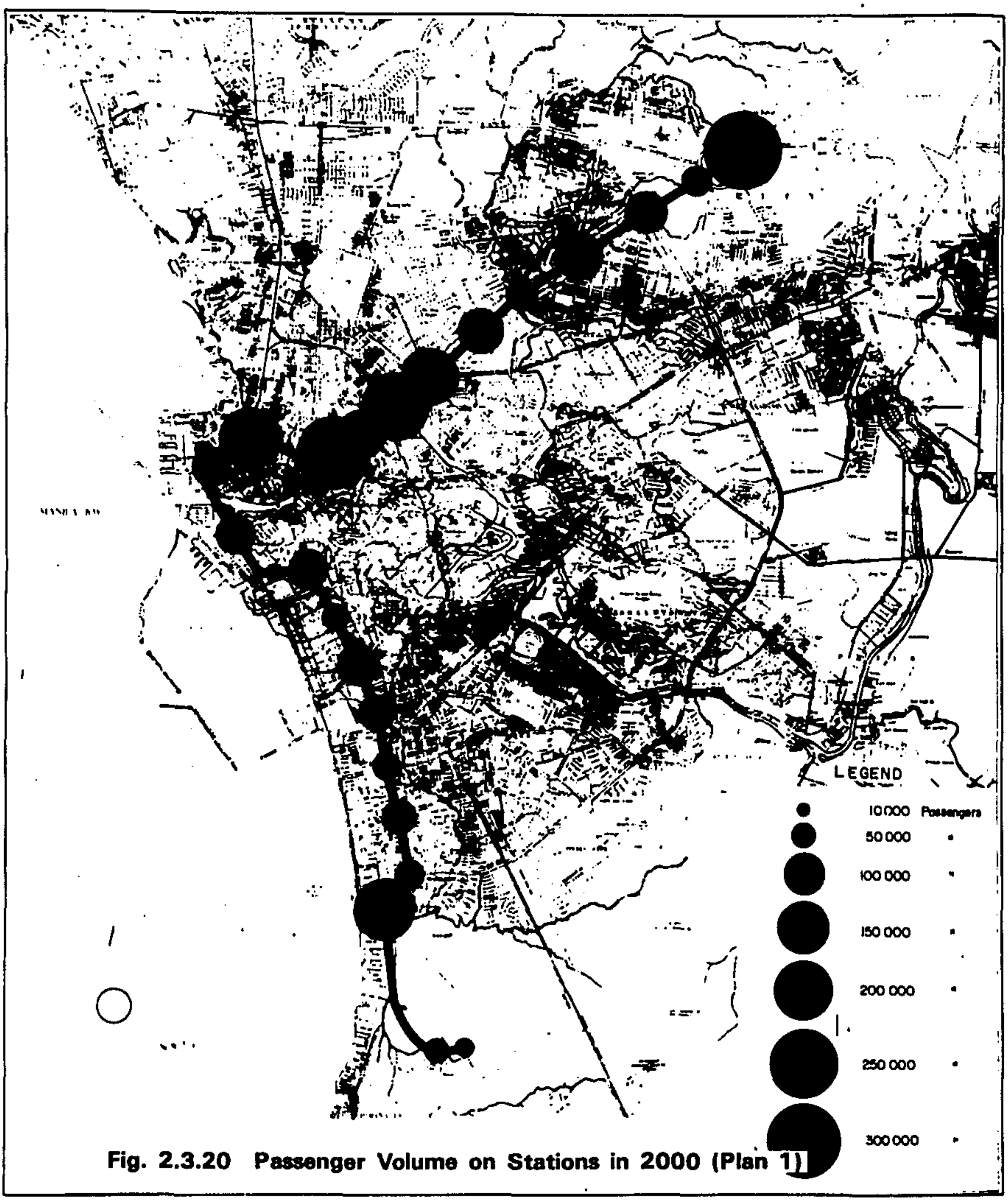


Fig. 2.3.20 Passenger Volume on Stations in 2000 (Plan 1)

3.8 PASSENGER VOLUME BY STAGES

In this study, a recommendation has been made for the stage implementation of RTR Line No.1. To assess the operation and equipment requirements for each stage and also to make revenue forecasts, it was necessary to estimate and analyse the passenger that would use the RTR Line at each stage of completion of the line. Passenger volumes of each station and on inter-station through passenger volume for each section of the RTR was projectd for this purpose. These estimates were based on the same modal split and assignment method but uses the modified transport network according to each stage of completion of RTR Line No.1. The estimates of the total volume and the volume per kilometer of the recommended alternative for the key years are shown in Tables 2.3.24 and 2.3.25.

Table 2.3.24 Estimated Daily Passenger Volume of RTR Line No.1 by Stages in 1987 for Plan 1
(PNR improved to rapid transit railway level)

Operation Starting from U.P. Side		Operation Starting from Baclaran Side	
Stage and Section	Passenger Volume	Stage & Section	Passenger Volume
Stage 1 (U.P. - F.E.U.)	427.6 45.3	Stage 1 (Baclaran - Rizal Park)	156.9 25.3
Stage 2 (U.P. - Rizal Park)	579.4 38.8	Stage 2 (Baclaran - U.S.T.)	389.2 30.6
Stage 3 (U.P. - Baclaran)	820.5 38.9	Stage 3 (Baclaran - U.P.)	820.5 38.9
Stage 4 (reference) (U.P. - M.D.A.)	826.4 33.0	Stage 4 (reference) (M.D.A. - U.P.)	826.4 33.0

Upper Figure: Number of passengers (1,000 passengers)

Lower Figure: Number of Passengers per kilometer (1,000 passengers)

Table 2.3.25 Estimated Daily Passenger Volume of RTR Line No.1 by Stages in 1987 for Plan 2
(PNR not improved to rapid transit railway level)

Operation Starting from U.P. Side		Operation Starting from Baclaran Side	
Stage & Section	Passenger Volume	Stage & Section	Passenger Volume
Stage 1 (U.P. - F.E.U.)	415.1 44.0	Stage 1 (Baclaran - Rizal Park)	251.6 40.6
Stage 2 (U.P. - Rizal Park)	623.4 41.8	Stage 2 (Baclaran - U.S.T.)	516.2 40.5
Stage 3 (U.P. - Baclaran)	902.8 42.8	Stage 3 (Baclaran - U.P.)	902.8 42.8
Stage 4 (reference) (U.P. - M.D.A.)	908.6 35.5	Stage 4 (reference) (M.D.A. - U.P.)	908.6 35.5

Upper Figure: Number of passengers (1,000 passengers)

Lower Figure: Number of passengers per kilometer (1,000 passengers)

3.9 HOURLY VARIATION OF PASSENGERS

The hourly variation of passengers on RTR Line No.1 was determined basing on the results of person trip survey under the UTSMMA. It is expected that the future peak hour ratio will be higher than the existing because passengers on the proposed RTR system may reach their destination on schedule and quickly comparing to travelling by the existing bus/jeepney system. In this report, the peak hour ratio of 'commuting to work' and 'going to school' was therefore raised by 20% higher than the existing ratio. The results of peak hour ratio adopted are as shown in Tables 2.3.26 to 2.3.29.

Table 2.3.26 Peak Hour Number of Passenger by Stations by Direction in 1987

	U.P. to Baclaran		Baclaran to U.P.		
	Boarding	Unboarding	Boarding	Unboarding	Total
(M.D.A.)	0	293	953	0	1,296
(M.I.A.)	0	624	2,026	0	2,650
Baclaran		1,305	7,398	16	8,733
North Baclaran	110	1,557	2,273	376	4,316
Libertad	448	1,990	2,541	1,067	6,046
Buendia	768	751	918	1,104	3,541
Vito Cruz	689	1,451	1,978	1,227	5,345
San Andres	1,133	1,764	2,750	1,608	7,255
General Hospital	209	991	412	621	2,233
Rizal Park	742	2,147	1,303	2,275	6,467
Aduana	825	2,904	1,176	1,756	6,661
Divisoria	626	3,702	1,456	1,708	7,492
Tutuban	3,788	6,444	2,108	4,097	16,437
F.E.U.	2,064	7,981	1,524	4,584	16,153
U.S.T.	3,214	4,221	1,512	1,804	10,751
Antipolo	6,339	3,628	4,902	1,445	16,314
Welcome Rotonda	3,401	3,482	2,443	2,909	12,235
Santo Domingo	2,274	1,805	1,558	1,647	7,284
Roosevelt	1,205	542	597	778	3,122
Delta	4,797	579	623	2,985	8,984
Quezon	3,276	361	386	2,229	6,252
Capital Center	363	748	612	398	2,121
U.P.	12,985	0	0	6,815	19,800
Total	49,270	49,270	41,449	41,449	181,438

Table 2.3.27 Peak Hour Number of Passenger by Stations by Direction in 2000

	U.P. to Baclaran		Baclaran to U.P.		
	Boarding	Unboarding	Boarding	Unboarding	Total
(M.D.A.)	0	443	1,282	0	1,725
(M.I.A.)	0	900	2,604	0	3,504
Baclaran	34	3,137	18,855	36	22,062
North Baclaran	179	1,646	2,694	616	5,135
Libertad	580	2,120	2,847	1,778	7,325
Buendia	914	042	1,162	1,718	4,736
Vito Cruz	864	2,153	2,506	2,254	7,777
San Andres	1,392	2,599	3,134	2,802	9,927
General Hospital	331	1,538	595	972	3,436
Rizal Park	1,010	3,222	1,557	3,269	9,058
Aduana	1,252	3,924	1,665	2,404	9,245
Divisoria	649	4,669	1,728	2,303	9,349
Tutuban	5,692	7,509	2,895	5,396	21,492
F.E.U.	3,071	15,462	2,780	9,021	30,334
U.S.T.	3,128	6,711	1,886	2,370	14,095
Antipolo	9,775	6,928	8,193	2,482	27,378
Welcome Rotonda	5,353	6,210	3,028	5,110	19,701
Santo Domingo	4,254	2,713	1,956	2,795	11,718
Roosevelt	2,102	978	1,077	1,315	5,472
Delta	6,969	1,015	1,239	3,878	13,101
Quezon	5,248	846	601	3,700	10,395
Capital Center	902	1,621	1,273	1,474	5,270
U.P.	23,587	0	0	9,864	33,451
Total	77,286	77,286	65,557	65,557	285,686

Table 2.3.28 Peak Hour Number of Interstation Through Passengers by Direction in 1987

Section	U.P. to Baclaran	Baclaran to U.P.	Total
(M.D.A. - M.I.A)	293	953	1,246
(M.I.A. - Baclaran)	917	2,979	3,896
Baclaran - North Baclaran	2,208	10,365	12,573
North Baclaran - Libertad	3,655	12,260	15,915
Libertad - Buendia	5,198	13,735	18,933
Buendia - Vito Cruz	5,181	13,549	18,730
Vito Cruz - San Andres	5,941	14,300	20,241
San Andres - General Hospital	6,572	15,441	22,013
General Hospital - Rizal Prak	7,353	15,232	22,585
Rizal Park - Aduana	8,759	14,259	23,018
Aduana - Divisoria	10,837	13,677	24,514
Divisoria - Tutuban	13,914	13,425	27,339
Tutuban - F.E.U.	16,570	11,438	28,008
F.E.U. - U.S.T.	22,488	8,348	30,872
U.S.T. - Antipolo	23,495	8,091	31,586
Antipolo - Welcome Rotonda	20,786	11,551	32,337
Welcome Rotonda - Santo Domingo	20,865	11,083	31,948
Santo Domingo - Roosevelt	20,398	10,996	31,393
Roosevelt - Delta	19,733	10,812	30,545
Delta - Quezon	15,515	8,450	23,965
Quezon - Capital Center	12,600	6,603	19,203
Capital Center - U.P.	12,985	6,815	19,800

Table 2.3.29 Peak Hour Number of Interstation Through Passengers by Direction in 2000

Section	U.P. to Baclaran	Baclaran to U.P.	Total
(M.D.A. - M.I.A.)	443	1,282	1,725
(M.I.A. - Baclaran)	1,343	3,886	5,229
Baclaran - North Baclaran	4,447	22,705	27,152
North Baclaran - Libertad	5,913	24,784	30,697
Libertad - Buendia	7,451	25,851	33,302
Buendia - Vito Cruz	7,481	25,293	32,774
Vito Cruz - San Andres	8,860	25,545	34,405
San Andres - General Hospital	9,976	25,875	35,851
General Hospital - Rizal Park	11,183	25,449	36,682
Rizal Park - Aduana	13,395	23,787	37,182
Aduana - Divisoria	16,069	23,047	39,116
Divisoria - Tutuban	20,090	22,474	42,564
Tutuban - F.E.U.	21,909	19,974	41,883
F.E.U. - U.S.T.	34,295	13734	48,029
U.S.T. - Antipolo	37,881	13,250	51,131
Antipolo - Welcome Rotonda	35,036	18,960	53,996
Welcome Rotonda - Santo Domingo	35,891	16,878	52,769
Santo Domingo - Roosevelt	34,349	16,040	50,389
Roosevelt - Delta	33,224	15,803	49,027
Delta - Quezon	27,270	13,164	40,434
Quezon - Capital Center	22,868	110,066	32,934
Capital Center - U.P.	23,587	9,864	33,451

PART III

PUBLIC TRANSPORT DEVELOPMENT PROGRAMME

PART III. PUBLIC TRANSPORT DEVELOPMENT PROGRAMME

CHAPTER 1. INTRODUCTION PROGRAMME FOR RAPID TRANSIT RAILWAY

1.1 GENERAL

The augmentation of public transport system to meet the future traffic demand in the MMA must start with more efficient use of the currently available buses, jeepneys and PNR for increased transportation capacity. Construction of new lines or systems can come later. In this respect, from the point of efficiency of transport investment and of convenience to the users, it is necessary that a new urban rapid transit system be introduced before the future traffic demand exceeds the capacity of the present transportation facilities.

Following this principle, the yearly change of supply and demand of urban transport system including roads will be discussed in this chapter and the transport policy that should be adopted by the Government of Philippines in relation to such change will also be broadly discussed.

The broad conceptual discussions cover the following:

(1) Overall examination of the whole MMA on the requirements of urban transport facilities from the viewpoint of future traffic demand at every stage of planned population growth.

(2) Examination of the requirements of the urban transport facilities on the assumption of some changes in the future population framework.

(3) Examination of urban transport policies for promoting the effective use of urban transport facilities.

Microscopic considerations are not made since this will be out of the scope of this study.

1.2 METHODOLOGY

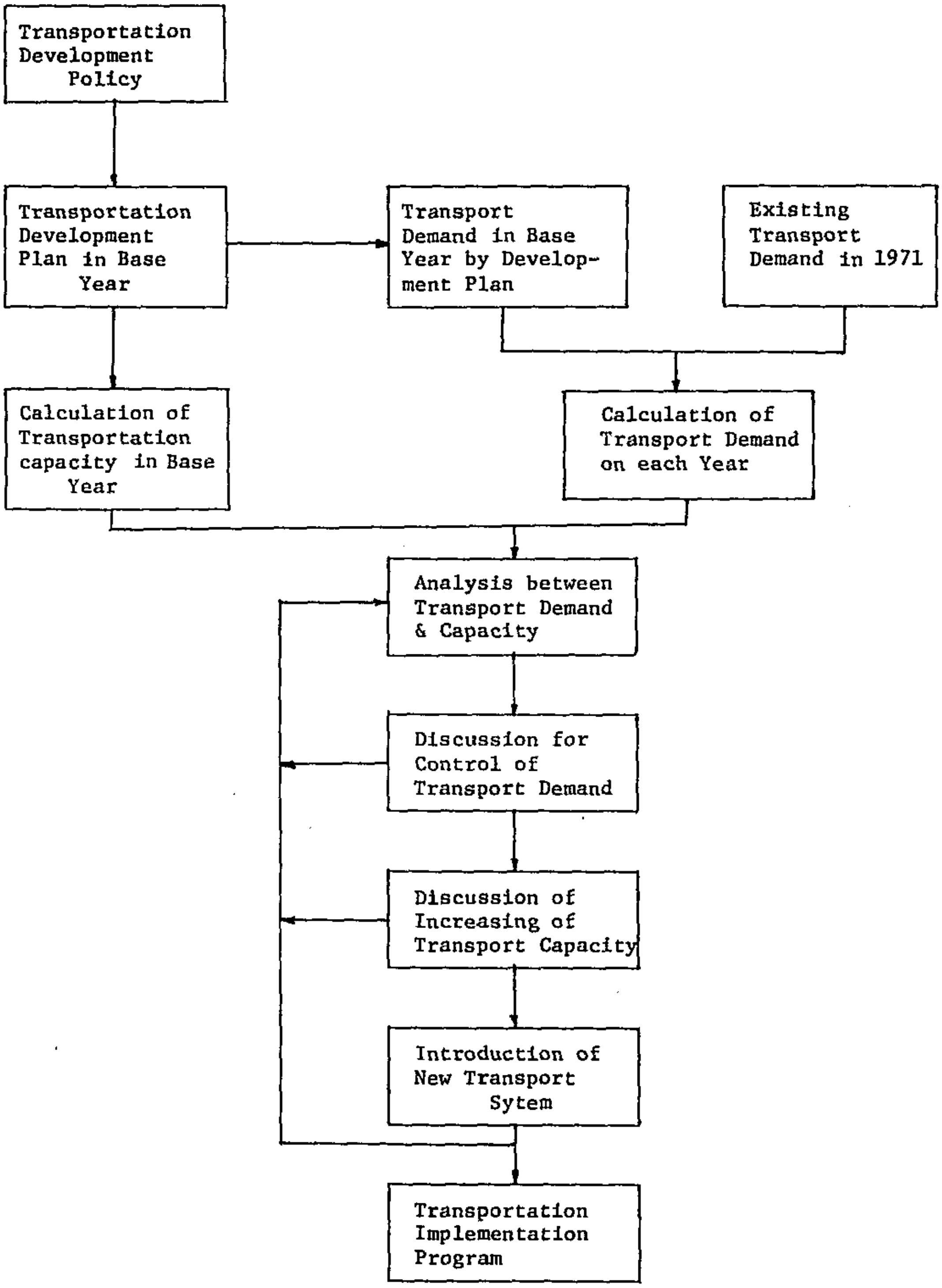
A flow diagram for the preparation of the transport system augmentation plan is given in Fig. 3.1.1.

In the first step, the basic policy for augmentation of the transport system is established and then tentative plans for the key years (1987 and 2000) are outlined. Two to three alternative plans are studied in this study for each key year. Basing on these plans, the transport capacity of each transport system by year from 1975 to 2000 is calculated.

In the second step, the traffic demand corresponding to the augmentation and improvement plans of transport system for the key years is determined. Since traffic demand forecast for the key years has already been made in Part II, the results of the forecast will be adopted and the traffic demand of intermediate years determined through interpolation.

In the third step, the relationship between transport capacity and demand is analysed. Where the transport demand is undoubtedly in excess of the capacity, the possibility of control over the transport demand should first be examined. Then, mitigation should be

Fig. 3.1.1 Flow Chart of Transportation Improvement Program



prepared for increasing the transport capacity. The increase of transport capacity referred to herein means not the construction of new transit systems, but the improvement of the exisitng transport facilities for increased operating efficiency.

The fourth stop will then consider the introduction of new transportation systems to meet the traffic demand in case that this is not solved in the third step.

In the fifth step, analysis made in the third and the fourth step will be carried out on a year-by-year basis in order to map out a plan for the transportation facilities necessary to meet ultimate requirements.

1.3 COMPARATIVE STUDY OF TRANSPORT CAPACITY AND DEMAND

1.3.1 Supply of Urban Transport Facilities

In the UTSMMA a Transport Master Plan was proposed as follows:

(1) A trunk road network consisting of ten radial and six circumferential roads.

(2) An urban rapid transit railway network consisting of five rapid transit lines and complemented by the improvement of PNR to rapid transit railway level.

(3) An urban expressway system consisting of a main line with three branch lines.

Basing on these recommendations, the Government proceeded with the improvement and construction of major trunk road networks. Some minor improvement of PNR is also underway. As regards the integration of the bus/jeepney system, the Manila Transit Corporation has been established and new buses introduced to improved efficiency of bus operation. A "Feasibility Study for Integration of the Bus-Jeepney Mode of Mass Transit System for the MMA" was also being carried out, and its implementation is now under consideration.

All these projects are in line with the program for immediate action, but there is no program yet for the implementation of the long-term plan. For this reason, the study team has established the following assumptions for the improvement and augmentation of urban transportation systems.

These assumptions are based on the survey of the actual progress in road construction in MMA and on the discussions with officials of PPDO-DPWTC in charge of the construction and improvement of the urban transportation facilities. Four or five alternative plans are prepared for the key years.

1. Urban Transportation Facilities to be improved and constructed by the year 1987.

   Plan A

   Road;
   1. Improvement of major intersections with C-4
   2. Construction of uncompleted sections of C-1 & C-2
   3. Construction of C-3
   4. Extension of Radial Road R-1
   5. Construction of Radial Road R-4
   6. Construction of Radial Road R-10 and related roads

   Public Transport;
   1. Completion of Phase III of PNR Improvement Program
   2. Existing Bus/Jeepney System maintained

Table 3.1.1 Road Transport Capacity by Year

(1,000 Vehicle.KM)

	Road Transport		
	Case 1, Plan A-D	Case 2, Plan A-D	Plan E
1974	19,000		
75	19,585		
76	20,178		
77	20,767		
78	21,356		
79	21,945		
80	22,534		
81	23,122		
82	23,711		
83	24,300		
84	24,889		
85	25,478		
86	26,067		
87	26,656		
88	27,245	28,104	
89	27,834	28,963	
90	28,424	29,822	
91	29,012	30,682	
92	29,601	31,541	
93	30,190	32,399	
94	30,779	33,259	
95	31,368	34,118	
96	31,957	34,977	
97	32,546	35,837	
98	33,135	36,696	
99	33,724	37,555	
2000	34,902	38,414	46,083

Case 1 assumes that road capacity will be increased by about 600 thousand vehicle-kilometers annually.

Case 2 assumes that road capacity will be increased by about 900 thousand vehicle-kilometers annually.

Plan B

Road: Same as Plan A

Public Transport:

1. Completion of Phase III of PNR improvement program.
2. Improvement and integration of Bus/Jeepney modes. (Partially improved Bus/Jeepney exclusive lanes).

Plan C:

Road: Same as Plan A

Public Transport:

1. Completion of Phase III of PNR improvement program.
2. Construction of Rapid Transit Railway Line No. 1.
3. Improvement and integration of Bus/Jeepney modes. (Partially improved Bus/Jeepney exclusive lanes)

Plan D:

Road: Same as Plan A

Public Transportation:

1. Improvement of PNR to rapid transit railway level.
2. Construction of RTR Line No. 1
3. Improvement and integration of Bus/Jeepney Modes. (Partially improved Bus/Jeepney exlusive lanes).

2. Urban Transport Facilities to be improved and constructed by the year 2000.

Plan A

Road: In addition to Plan A for the year 1987:

1. Construction of Circumferential Roads C-5 and C-6.
2. Extension of Radial Roads up to C-5 and C-6.

Public Transport: Same as Plan A for the year 1987.

Plan B

Road: Same as Plan A for the year 2000.

Public Transport: Same as Plan B for the year 1987.

Plan C

Road: Same as Plan A for the year 2000.

Public Transport: Same as Plan C for the year 1987.

Plan D

Road: Same as Plan A for the year 2000.

Public Transport: Same as Plan D for the year 1987.

Plan E:

Completion of Proposed Transport System recommended in UTSMMA.

On the basis of the above policy, a network of urban transportation systems is prepared. The network is composed of nodes and links, and the distance, travel speed, number of lanes or width (road), service frequency (railway), capacity, and other pertinent factors of each link are compiled and computed by a computer to determine the capacity of various urban transportation facilities. Table 3.1.1 shows the capacity of the

Table 3.1.2 Modal Split by Transport Plan

Year	Plan	Railway		Bus Jeepney	Car	Total
		PNR	RTR			
1987	Plan A	26 (0.2%)	0	5,462 (48.7%)	5,725 (51.1%)	11,213 (100%)
	B	26 (0.2%)	0	5,644 (50.5%)	5,525 (49.3%)	11,213 (100%)
	C	26 (0.2%)	909 (8.1%)	4,882 (43.5%)	5,392 (48.2%)	11,213 (100%)
	D	516 (4.6%)	826 (7.4%)	4,689 (41.8%)	5,182 (46.2%)	11,213 (100%)
2000	Plan A	40 (0.3%)	0	5,788 (38.9%)	9,056 (60.8%)	14,885 (100%)
	B	40 (0.3%)	0	6,296 (42.3%)	8,548 (57.4%)	14,885 (100%)
	C	40 (0.3%)	1,280 (8.6%)	6,054 (40.7%)	7,511 (50.5%)	14,855 (100%)
	D	803 (5.4%)	1,280 (8.6%)	5,732 (38.5%)	7,070 (47.3%)	14,885 (100%)
	E	6,162 (41.3%)		3,871 (26.2%)	4,581 (32.5%)	14,885 (100%)

Unit: 1,000 Trips

Table 3.1.3 Passengers per Vehicle

Vehicle Type	Existing	Future
Car 1)	1.7	1.7
Bus 2)	40	20 (Average)
Jeepney 2)	10	

Source: 1) Survey Data under UTSMMA, 1971
2) Bus/Jeepney Occupancy Survey, 1975

whole road network for each year.

1.3.2 Projection of Transport Demand

The urban transport Plans in 1987 described may be summarized as follows:

Plan A — Existing transport system will be maintained and for 1987 without introduction of new transport facilities.

Plan B — No new transport facilities will be introduced up to year 1987, but improvement on bus system will be implemented.

Plan C — RTR Line No. 1 will be introduced

Plan D — RTR Line No. 1 will be introduced and PNR will be improved to RTR level.

These same plans for 1987 are also adopted in year 2000 with the additon of Plan E which is the case that the entire transport system recommended in UTSMMA is completed.

The passenger volume by modes of transport for each of the Plans C and D for the year 1987, Plans D and E for the year 2000, explained previously, have already been closely projected in Part II.

In this section, the passenger volume by modes of transport concerning the Plan A and B for the year 1987 and the Plan A and B for the year 2000 will be projected. In the Plan A for the years 1987 and 2000, any new transportation system will not be introduced, and it is expected that the current modal split will continue to apply. The pattern of the current modal split is as follows.

(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.

(2) The difference of the share of the cars is obvious among trip purposes but not so large.

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 modal split for the plan B is as follows.

Many cases to be adopted the bus priority lane system and/or exclusive bus lane system are the times for the traffic congestion. Traffic of commuting to work, going to school and returning to home concentrate in that times, so that traffic of these purposes was reduced 20 percentages less than that in plan A on the basis of statistical data in Japan.

Table 3.1.2 shows the passenger volume by mode. An assumption on the average number of passengers per car is made as shown in Table 3.1.3 and thus vehicle-trip is calculated.

Based on the calculated vehicle trips and the average trip lengths of car and bus/jeepney, the future vehicle-kilometers are calculated as shown in Table 3.1.4. The yearly traffic demand is stochastically projected by a linear interpolation of the 1971 vehicle-kilometers and Pattern A vehicle-kilometers for the years 1987 and 2000.

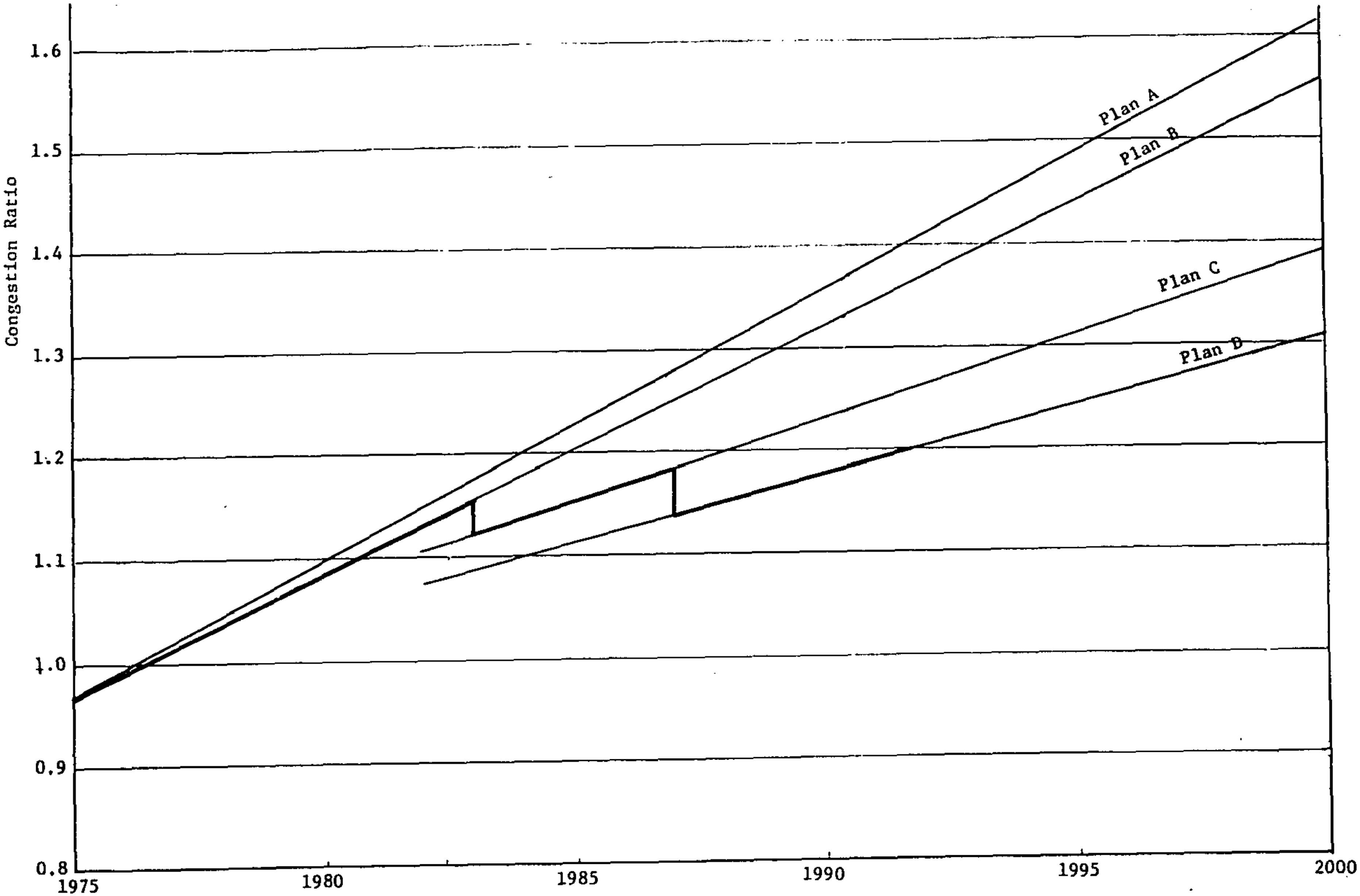


Fig. 3.1.2 Traffic Congestion Degree by Year

Table 3.1.4 Traffic Demand by Transport Plan

		Vehicle Trip (1000 Trips)		Average Trip Length	Vehicle.Kilometers (1000 Veh. km)		
		Car	Bus Jeepney	(km)	Car	Bus Jeepnty	Total
1987	Plan A	3,368	273	8.94	30,110	2,441	34,992
	" B	3,249	283	"	29,046	2,530	34,106
	" C	3,172	244	"	28,358	2,181	32,900
	" D	3,048	234	"	27,249	2,092	31,433
2000	Plan A	5,327	289	9.64	51,352	2,786	56,924
	" B	5,028	315		48,472	3,037	54,545
	" C	4,418	302	"	42,590	2,911	48,421
	" D	4,159	287	"	40,093	2,767	45,627
	" E	2,854	201	"	27,513	1,938	31,389

1.3.3 Comparative Analysis

For the comparative analysis, a concept of the traffic congestion ratio defined as the ratio of traffic demand to traffic capacity was adopted. The traffic congestion ratio of a network is quite different from that of a signle traffic link. Namely, the traffic demand is expressed by accummulative products of link traffic volume multiplied by link distance (total running vehicle-kilometers), while the traffic capacity is expressed by accummulative products of link traffic capacity and link distance (total capacity vehicle-kilometers). The traffic congestion ratio is expressed by the result of division of the above two. Table 3.1.5 and Fig. 3.1.2 show the overall traffic congestion ratio of the whole road network.

From Fig. 3.1.2, it is seen that the traffic congestion ratio for Plan A was 0.97 for the year 1975, and increased every year to reach 1.28 in year 1987 and 1.63 in year 2000. As regards the tolerable traffic congestion ratio of road network, there are many ways of view, and it cannot be said decisively. For instance, the road users may be desirous of a road network of high service standards with a traffic congestion ratio of something like 0.5 or 0.6, far below 1.0. But this will call for vast sum of investment cost for road improvement and maintenance.

In this study, tolerable road traffic congestion ratio is assumed at 1.1. From this assumption, it is foreseen that in 1980 the tolerable level will be exceeded, and the introduction of some new transport system will be necessary.

The reduction of the traffic congestion ratio by 0.1 calls for increase in traffic capacity by approximately 500 thousand to 600 thousand trips per day. If the RTR Line No. 1 proposed in this report is partially constructed, 300 thousand to 400 thousand passengers can be diverted to RTR Line No. 1, reducing the traffic congestion ratio by 0.05 to 0.07.

Even if the entire RTR Line No. 1 becomes operational by 1989, the traffic congestion ratio will remain at a high 1.20 in 1990. Thus, the early improvement of PNR to RTR level is necessary.

When RTR Lines 1 through 5 proposed in UTSMMA are completed, the traffic congestion ratio will be reduced to an ideal level of 0.9.

Table 3.1.5 Comparative Analysis between Traffic Demand and Traffic Capacity

Year	Plan	Overall Network Traffic Demand (A)	Overall Network Traffic Capacity (B)	Congestion Ratio (A/B)
1987	Plan A	34,992	27,245	1.28
	" B	34,106	"	1.25
	" C	32,900	"	1.21
	" D	31,433	"	1.15
2000	Plan A	56,924	34,902 38,414	1.63 1.48
	" B	54,545	"	1.56 1.42
	" C	48,412	"	1.39 1.26
	" D	45,627	"	1.31 1.19
	" E	31,389	46,083	0.68

Unit: Traffic Demand and Capacity 1000 vehicle.kms.

Notes: Traffic Capacity for year 2000.

Upper : Case 1 in Plan A - D
Lower : Case 2 in Plan A - D

1.3.4 Comparative Analysis of Other Factors

(1) Comparison of planned population

Under the comparative study made in item 1.3.3, the planned population has been assumed at 5,700 thousand for the year 1987 and 7,500 thousand for the year 2000. This population plan has been established by policy.

If the population is assumed at a lower level of 5,000 thousand for the year 1987 and 6,000 thousand for the year 2000, the traffic volume will be reduced proportionally as shown in Table 3.1.6.

As a result, the traffic congestion ratio will be reduced as compared with the original population plan. On a long-term basis, however, rapid transit railway system will still be necessary by the year 1987.

Table 3.1.6 Comparative Analysis - Reduction of Planned Population

Year	Plan	Traffic Demand (1,000 Veh. km)	Traffic Capacity (1,000 veh. km)	Congestion Ratio
1987	Plan A	30,793	27,245	1.13
	B	30,013	"	1.10
	C	28,952	"	1.06
	D	27,661	"	1.02
2000	Plan A	45,539	34,902	1.31
	B	43,636	"	1.25
	C	38,730	"	1.11
	D	36,502	"	1.05
	E	25,111	"	0.82

Notes: 1987 Planned Population assumed at 5,000 thousand.
2000 Planned Population assumed at 6,000 thousand.

(2) Comparison of Population Distribution

As pointed out in "Population Distribution Plan" in Part II, the population in the MMA has a tendency to leave Central Manila and disperse towards the outskirts. This trend will tend to increase the traffic volume.

This fact is comfirmed by the results of analysis carried out for this study. It is forecast that person-trip length of 6.0 km in 1971 will be increased up to 7.3 km in 1987 and then up to 8.4 km in 2000.

If city planning measures are so taken as to control the dispersion of population toward the outskirts, the traffic demand will decline accordingly.

Assuming that population distribution is so changed that the person-trip length is reduced to 6.7 km, or the average of that for 1971 and that orginally estimated for 1987, the traffic congestion ratio will be considerably reduced as shown in Table 3.1.7. Nevertheless, the congestion ratio will steadily rise with time, and the introduction of a new transport system such as the proposed RTR Line No. 1 will be a natural consequence.

Table 3.1.7 Comparative Analysis - Reduction of Trip Length by Changing the Population Distribution Pattern

Year	Plan	Overall Network Traffic Demand (1,000 trips)	Overall Network Traffic Capacity (1,000 trips)	Congestion Ratio
1987	Plan A	31,878	27,245	1.17
	B	31,017	"	1.14
	C	29,972	"	1.10
	D	28,635	"	1.05
2000	Plan A	49,523	34,092	1.45
	B	47,454	"	1.39
	C	42,126	"	1.24
	D	39,695	"	1.16
	E	27,308	"	0.80

Note: Passenger trip length assumed to be 6.7 km.

1.4 CONCLUSIONS

The following conclusions are derived from the comparative studies between Overall network traffic demand and supply for the entire MMA.

(1) The existing public transport systems will not be adequate to cope with the ever-increasing volume of traffic demand of MMA if only partial improvement or rehabilitation is implemented.

(2) Even if exclusive lanes are provided for buses and jeepneys, the demand will outweigh the supply soon in 1985. On a short-term basis, however, this measure will work to alleviate traffic congestion.

(3) In mid-1980 a large-capacity rapid transit system will be necessary. In this case, it is required to improve the PNR to rapid transit railway level and to construct the RTR Line No. 1.

From 1987 on, RTR Lines proposed in UTSMMA should be constructed in the order of priority keeping in pace with the increase in traffic demand.

(4) If the planned population could be held to levels of 5 million and 6 million respectively for the years 1987 and 2000, the congestion ratio will be reduced to some extent. Even in this case, the traffic congestion ratio will remain at a high level of 1.13 and 1.31 respectively for 1987 and 2000 and the construction of a large capacity rapid transit system will still be necessary.

(5) In this study, no microscopic analysis is made on the traffic demand and supply of the entire transport network, and careful study about endemic or regional characteristics and impact has yet to be made.

CHAPTER 2 PLAN FOR REORGANIZATION OF BUS/JEEPNEY NETWORK

2.1 GENERAL

On the completion of RTR Line No. 1, the reorganization of bus/jeepney network will be necessary. This is because the bus/jeepney passengers will almost divert to RTR Line No. 1 owing to shorter travel time and consequently buses and jeepneys should be reallocated to avoid futile competition with RTR Line No. 1. This is desirable in view of effective use of buses and jeepneys. If buses and jeepneys are reallocated to serve as a feeder transit system to RTR Line No. 1, the transit potentials of RTR Line No. 1 will be enhanced, thus increase the convenience to the passenger.

Projection of bus/jeepney traffic demand and analysis of bus/jeepney traffic flows along RTR Line No. 1 are carried out in this report to prepare a plan for reorganization of bus/jeepney network, and also to study how many buses and jeepneys each station on RTR Line No. 1 will require.

2.2 FEEDER TRANSPORT PASSENGERS

The number of passengers boarding and unboarding the RTR Line No. 1 at each station has been given in Part II. Here, the resultant feeder traffic volume is projected as classified by the transport means. With the O-D distribution breakdown of passengers in each station as a basis, it is assumed that the trips within the station's influence area will reach the station on foot and those out of the area will arrive by bus, jeepney, car or by PNR via the transfer stations of Tutuban and Antipolo.

With the number of boarding and unboarding passengers estimated for the year 2000 as a basis, it is seen that sucy terminal stations as Baclaran, Welcome Rotonda, and UP, will have 60 to 80% of their passengers making this access to the stations by buses and jeepneys, which is a very high rate. Other stations will have 20 to 30% of the same, but their trip length will not be so long. (Table 3.2.1)

General Hospital and Aduana will not generate demand for bus and jeepney; namely, almost all the passengers will be generated within the station's influence area on foot.

2.3 PROJECTION OF BUS/JEEPNEY TRAFFIC FLOWS AND EXAMINATION

The bus/jeepney OD table obtained in "Traffic Demand" in Part II and the network for buses/jeepneys were the two elements for making route assignment for buses and jeepneys.

The route assignment of buses/jeepney carried out is only for the purpose of making a macroscopic forecast of the overall traffic demand along the route, and no detailed planning of routing of the bus/jeepney service route is attempted here. The method employed for the assignment is the "all-or-nothing method", and the resultant volume of flow of buses/jeepneys along RTR Line No. 1 are illustrated in Figs. 3.2.1 and 3.2.2.

It may be observed that the flow of buses/jeepneys on completion of RTR Line No. 1 will be quite different from the existing pattern of flow.

The major differences are as follows.

(1) As anticipated, the traffic flow of buses and jeepneys running parallel with RTR Line No. 1 is sharply reduced. This is because the travel time by RTR Line No. 1 is much shorter than that by bus or jeepney.

Table 3.2.1 Passenger Volume by Transport Modes to RTR Station

unit: 100 Trips

		Number of Passenger through RTR Station	Means of Access to RTR Stations		
			Walking	Bus/Jeepney	PNR
1.	MDA/MIA	96	96	0	0
2.	Baclaran	2,380	496	1,884	0
3.	North Baclaran	438	290	148	0
4.	Libertad	608	363	245	0
5.	Buendia	390	313	77	0
6.	Vito Cruz	651	498	153	0
7.	San Adnres	837	713	124	0
8.	Gen. Hospital	317	317	0	0
9.	Rizal Park	831	670	161	0
10.	Aduana	802	802	0	0
11.	Divisoria	794	523	271	0
12.	Tutuban	1,917	1,168	242	507
13.	FEU	3,150	2,835	315	0
14.	UST	862	603	259	0
15.	Antipolo	2,521	559	196	1,766
16.	Welcome Rotonda	1,715	374	1,341	0
17.	Santo Domingo	1,072	674	398	0
18.	Roosevelt	481	385	96	0
19.	Delta	1,169	966	203	0
20.	Quezon	924	647	277	0
21.	Government Center	477	382	95	0
22.	UP	3,158	793	2,365	0
	TOTAL:	25,590	14,467	8,850	2,273
		(100%)	(100%)	(100%)	(100%)

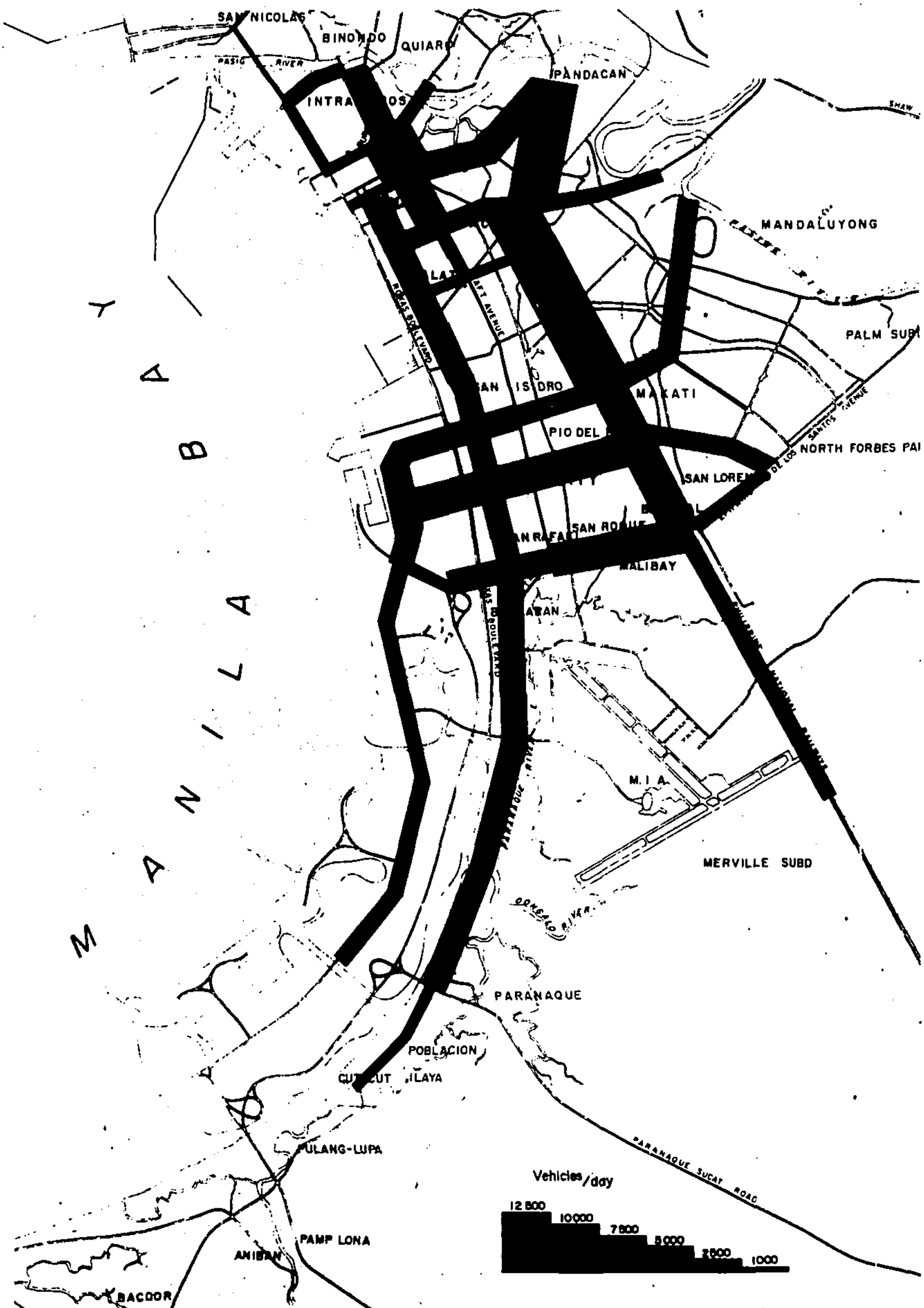


Fig. 3.2.1 **Bus Jeepney Traffic in 1987 (Baclaran Side)**

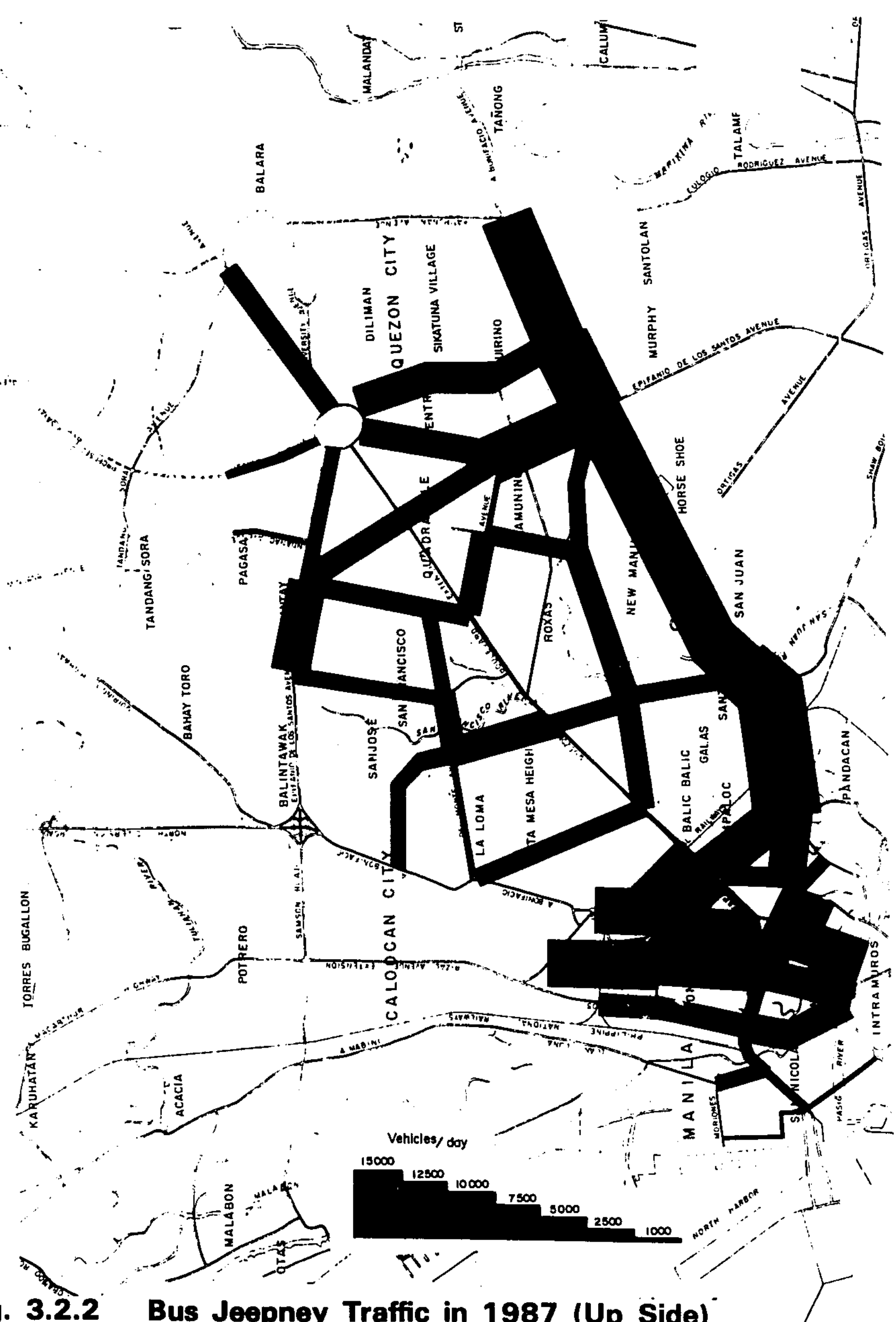


Fig. 3.2.2 Bus Jeepney Traffic in 1987 (Up Side)

It is also noted that trips of comparatively short trip lengths are still mainly borne by buses and jeepneys, accounting for the small portion of bus/jeepney passengers remaining on the route parallel to RTR Line No. 1.

(2) The access traffic volume to stations will increase sharply. This is because access trips by RTR Line No. 1 passengers add up to the ordinary trips.

Since the traffic flows of buses and jeepneys show quite a different pattern from those at present, route reorganization for bus/jeepney system should be made to meet such changes.

2.4 CONCLUSIONS

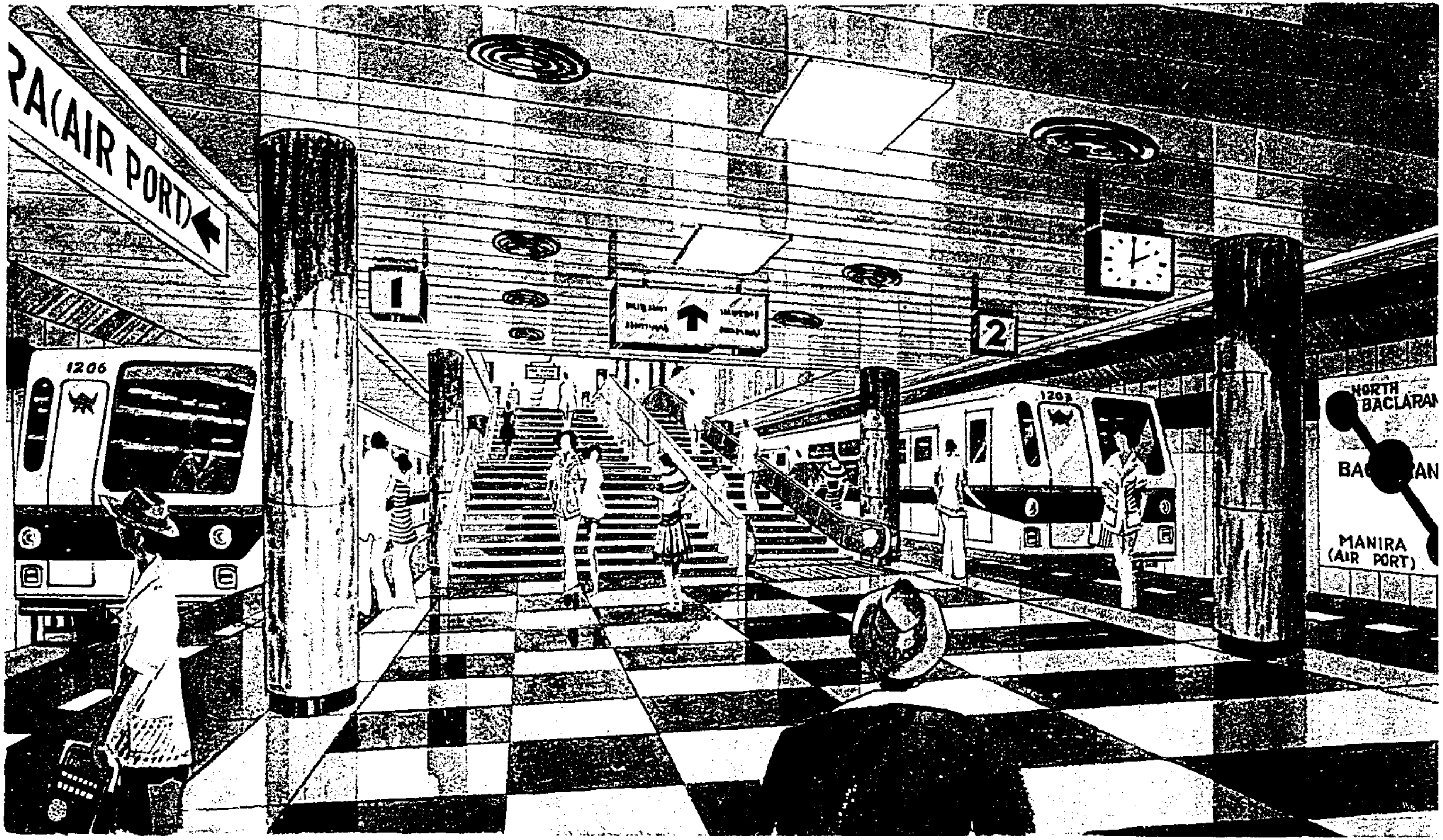
A few discussions have been made in the foregoing, and the following conclusions may be made.

(1) The existing bus/jeepney routes running along RTR Line No. 1 should be reduced, and the resulting surplus buses and jeepneys be assigned to other districts or for feder services.

(2) Bus/jeepney routes providing access to stations on RTR Line No. 1 should be maintained for increasing the effectiveness of RTR Line No. 1.

(3) The connecting stations between RTR Line No. 1 and bus/jeepney routes should be provided with adequate transfer facilities. This will be further discussed in Part V.

(4) The present study has not attempted to make detailed investigations of bus/jeepney system in relation to the zoning, but this will be necessary for the implementation of the reorganization of the bus/jeepney system.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1
2
1206
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NORTH BACLARAN
MANIRA (AIR PORT)

PART IV

ENGINEERING STUDIES

PART IV ENGINEERING STUDIES

CHAPTER 1. GENERAL CONCEPT OF ALTERNATIVE PLANS

1.1 SELECTED LINE

The Urban Transport Study (UTSMMA) report recommended the construction of a network of five new rapid transit railway lines and the expansion and improvement of the existing lines of the Philippine National Railways (P.N.R.) in order to establish a new network of railways in the metropolitan Manila area. This report contains the results of an engineering study being conducted to make suggestions and recommendations for the implementation of RTR Line No.1 in accordance with the Terms of Reference prepared by the Government of the Philippines. The future implementation of the other four lines will also require a similar study as to passenger traffic demand as well as the economic, engineering and financial factors.

1.2 ALTERNATIVE PLANS

Several alternative plans to construct Line No.1 have been studied from various angles to recommend an optimum mass transit system in the metropolitan Manila area, before a final recommendation on the optimum alternative was made. The alternatives being studied are summarized as follows:

(a) It is anticipated that the PNR will eventually be upgraded to rapid transit level in pace with the future increase in traffic demand of the PNR commuter service. The recommended alternative has been made basing on this assumption. However, to evaluate the effect of non-implementation of the PNR improvement program, comparative study was also made of the case where PNR is not improved. Thus, the following cases were put under comparative study.

Case 1: When PNR is improved to rapid transit railway level
Case 2: When PNR is not improved to rapid transit railway level

(b) For each of the above cases, two alternatives were studied in terms of the sequence of implementation as follows:

Alternative 1: Construction starting from U.P. side
Alternative 2: Construction starting from Baclaran side

(c) From the point of type of structure to be adopted, each alternative was again studied for the two following cases:

Alternative A: Partially elevated (i.e. The section from U.P. to Santo Domingo will be elevated).
Alternative B: The whole route will be underground.

For the above alternatives, analyses were also made of the partial construction and operation in different stages of the entire route.

The engineering studies were made basing on the results of traffic demand forecast made in the previous chapters. The following table summarizes the resultant traffic demand at different stages.

Table 4.1.1 Estimated Traffic Demand of RTR Line No.1

	Year	Section	Case I		Case II	
			Daily Traffic Volume (Persons)	One Peak Hour Line Passenger Volume in the Most Crowded Section (One-way)	Daily Traffic Volume (Persons)	One Peak Hour Line Passenger Volume in the Most Crowded Section (One-way)
Alt.1	1983	U.P. - F.E.U.	363,525	15,318	366,555	14,829
	1986	U.P. - Rizal Park	554,926	21,310	599,108	23,833
	1987	U.P. - Baclaran	820,538	23,370	902,840	22,707
	2000	U.P. - M.D.A.	1,280,087	37,881	1,368,989	42,353
Alt.2	1983	Baclaran - Rizal Park	133,670	7,065	222,356	12,840
	1986	Baclaran - U.S.T.	372,741	13,286	496,087	19,825
	1987	Baclaran - U.P.	820,538	23,370	902,840	22,707
	2000	M.D.A. - U.P.	1,280,087	37,881	1,368,989	42,353

As is obvious from Table 4.1.1, traffic demand will be heavier in case 2 where the assumption is made that the P.N.R. will not be improved. It is also seen from the table that a greater number of persons will use the line, if stage operation should start from the side of the University of the Philippines. From the engineering point of view it has been estimated through calculation of the one peak hour through-passenger volume in the most crowded section that the number of cars required, the train consist, the service level and the operating cost do not differ much for the two comparative cases.

From the financial point of view, however, case 2 alternative 1 is the most favourable, because revenue will be largest under this alternative.

Structural Comparison

A mass transit system to be constructed in the built-up area of a big city should basically go underground, and, in point of fact, the railways have been built underground in the majority of big cities of the world.

In the case of RTR Line No. 1, it is desirable that the railway should go underground all the way from Baclaran to the University of the Philippines, since the underground line can carry a large volume of passengers without disturbing street traffic and raising environmental problems. On the other hand, underground system has a major drawback in that its construction is very costly. This consideration made it necessary to study an alternative plan elevating the line where possible, while maintaining the policy of having the railway underground at least in the highly built-up urban area of Manila city. In other words, the elevated system was considered for the suburban area only.

1.3 CONSTRUCTION STANDARD

The construction standard for RTR Line No.1 has been established with reference to the representative construction standards by which railways are built in various cities of the world including Japan.

1.4 POWER SUPPLY

The operation of a mass transit system calls for an adequate supply of electric power. This study is based on the assumption that sufficient power to operate the system will be supplied locally without the necessity of constructing any new source of power supply specifically for the system.

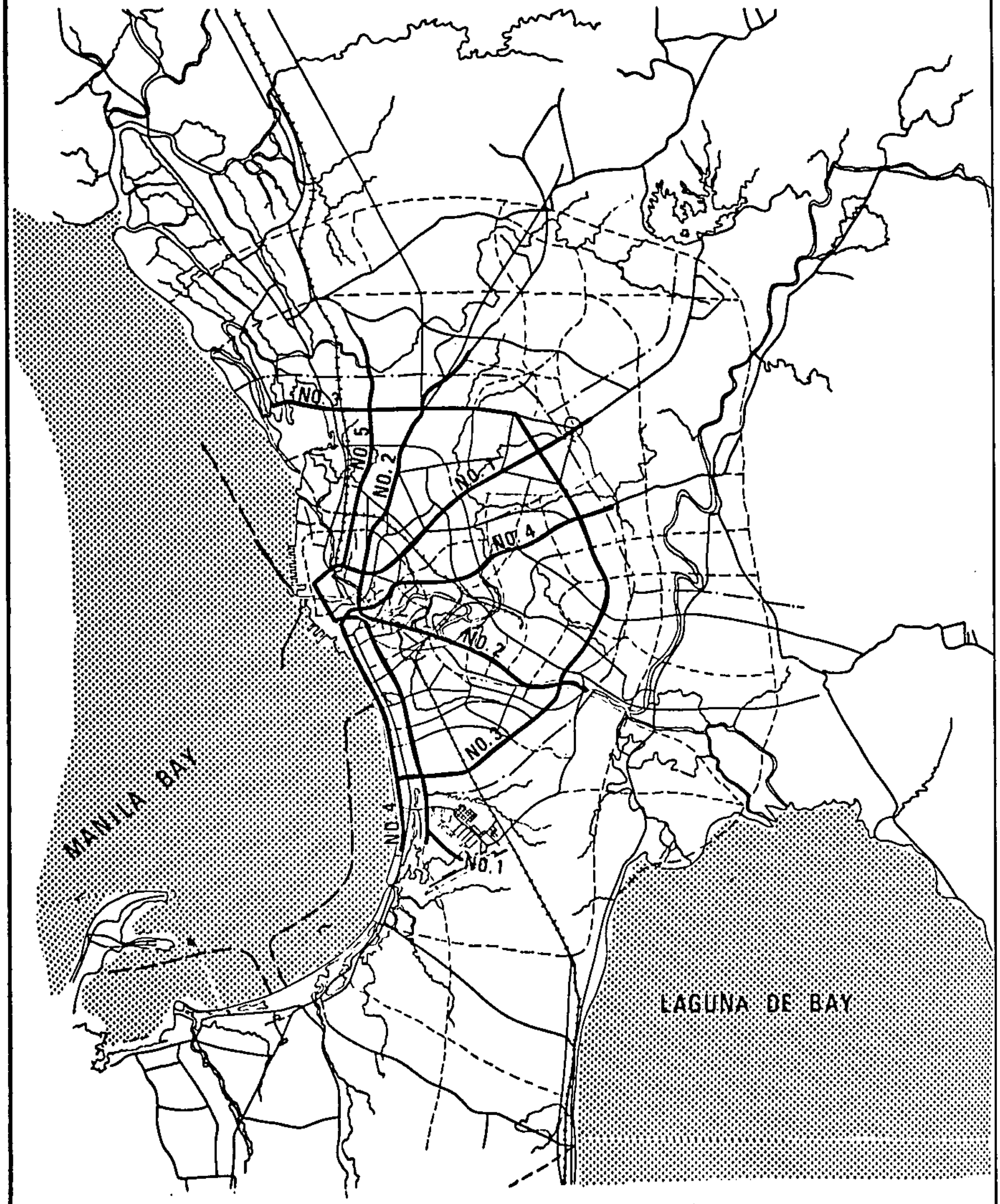


Fig. 4.2.1 Proposed Rapid Transit Railway Network for RTR

CHAPTER 2 ROUTE PLANNING

2.1 PLANNING OF THE FUTURE MASS TRANSIT RAILWAY NETWORK

In recent years the city of Manila has been developed to a great extent, attracting a huge number of people so that the traffic demand in the metropolitan area cannot be met by the existing transport facilities.

To maintain orderly development of the metropolitan Manila area, therefore, it is necessary to organize various projects of city development which will help redistribute the population in the suburban area and promote land utilization in the suburban area. These projects, however, require the existence of an efficient mass transit system which can carry a vast number of commuters.

In 1973 the Government of Japan submitted to the Government of the Republic of the Philippines a master plan of the future mass transit railway network in the metropolitan Manila area in compliance with the request for cooperation in the search for means to meet the rising transportation needs of the city. The master plan contained an analysis of the rapidly increasing traffic demand and modes of transportation in the metropolitan area, and the Government of Japan recommended in its report that a new railway network comprising five mass transit railways be built in the metropolitan area and the existing lines of the Philippine National Railway (P.N.R.) commuter service be improved to rapid transit level.

The recommended network of five mass transit railways comprises the following lines, as shown in Fig. 4.2.1.

Line No. 1:	Manila Airport - Center of the city - Quezon
Line No. 2:	Balintawak - Center of the city - Pasig
Line No. 3:	Caloocan - Quezon - Cubao - Makati - Baclaran
Line No. 4:	Cubao - Center of the city - Baclaran
Line No. 5:	Bulacan - Binondo
P.N.R.:	Improvement of existing lines of the P.N.R. commuter service

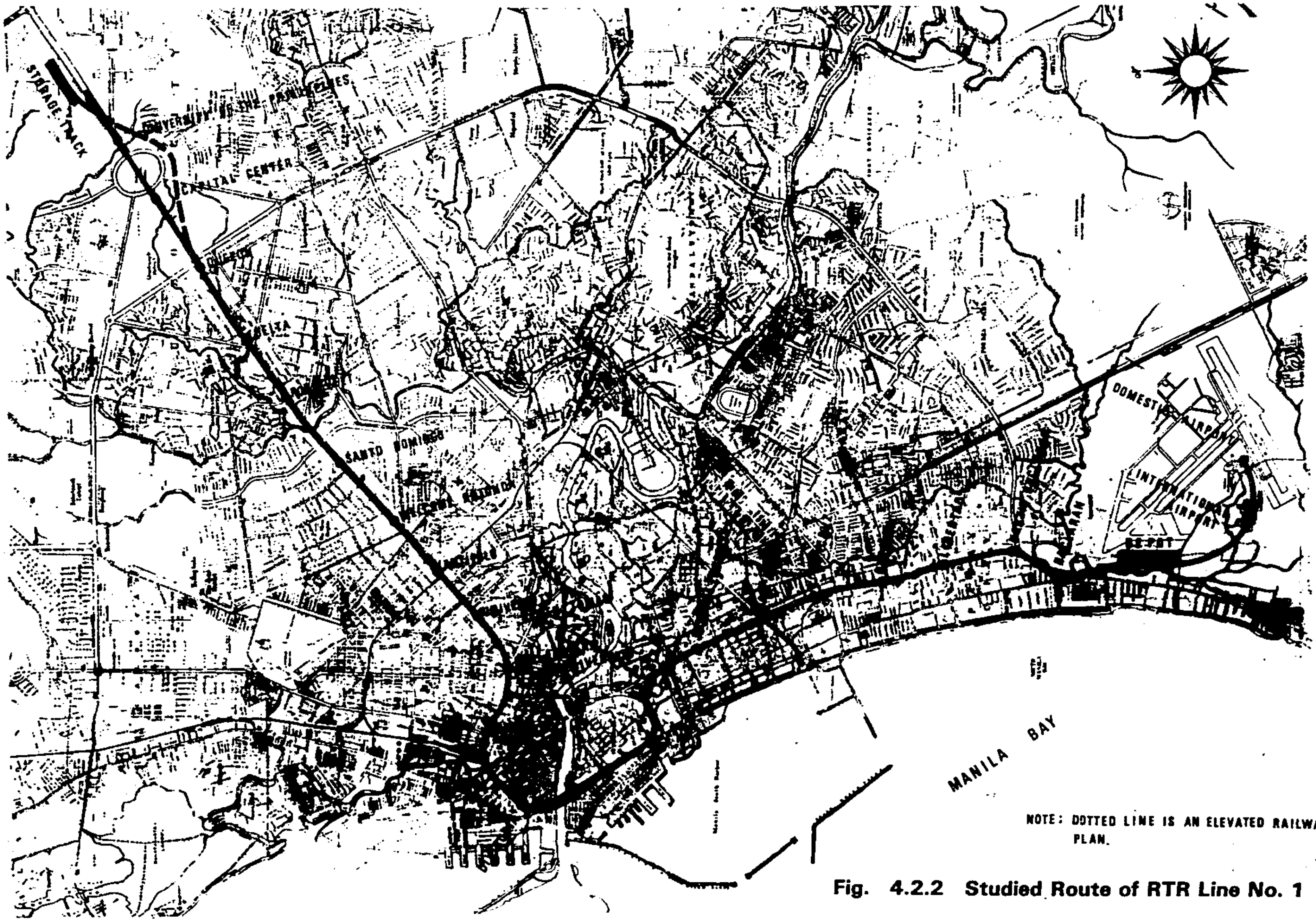
RTR Line No. 1 which will connect Quezon with Baclaran will provide the best means to ease traffic congestion of Taft Avenue and service the commuters who are forecast to grow rapidly in conjunction with the proposed development of Quezon city and its implementation at an early date is desirable.

As estimated in the previous chapters, the traffic demand of RTR Line No.1 is expected to be 820 thousand persons per day in 1987 and 1,280 thousand persons per day in 2000, and the implementation is shown to be economically feasible.

In this study the route of Line No.1 has been so planned that it can be easily connected with the other rapid transit lines, when they are implemented in the future.

2.2 ROUTE OF RTR LINE NO. 1

The studied route of RTR Line No.1 will extend for about 25 km. As shown in Fig. 4.2.2, this route starts at the Manila international airport, runs through Baclaran along Taft Avenue, crosses Rizal Park at the center of Manila city, and turns into Bonifacio Drive where, after crossing the Pasig river,it skirts Tutuban Station of the PNR, further extending along Quezon Boulevard to end near the University of the Philippines in Quezon city.



NOTE: DOTTED LINE IS AN ELEVATED RAILWAY PLAN.

Fig. 4.2.2 Studied Route of RTR Line No. 1

This entire route will have 22 stations if the whole line is constructed underground, and 23 stations if it is partially elevated.

The following were the major considerations in planning the route of Line No. 1:

1. Passenger traffic volume is heavy along the planned route.
2. Allowance should be made for future extension of the route to the areas where city development will take place in the future.
3. The route should be conveniently connection with other RTR lines at transfer stations.
4. The route should be so planned as not to disturb the traffic of main roads.
5. The route should be so planned that the line does not conflict with city planning.
6. The route should be so planned that it connects major parts of the city area along the corridor.
7. The route should be planned in consideration of the curvature, gradient, and existing wayside structures and facilities.

2.3 CONNECTION OF RTR LINE NO. 1 WITH OTHER RTR LINES

The route of RTR Line No.1 has been so planned as to connected with other lines at the following stations:

1. Baclaran Station
   This is a connecting station from which Line No. 1 may be further extended in the south direction in the future.
2. Libertad Station
   This is a transfer station at which Line No.1 will be connected to the future Line No.3.
3. Rizal Park Station
   This is a transfer station at which Line No.1 will be connected to future Lines No.2 and No.4.
4. Tutuban Station
   This is a transfer station at which Line No.1 will be connected to the PNR and future Line No.5.
5. University of Santo Tomas Station
   This is a transfer station at which Line No.1 will be connected to future Line No.2.
6. Antipolo Station
   This is a transfer station at which Line No.1 will be connected to the PNR Line.
7. Quezon Station
   This is a transfer station at which Line No.1 will be connected to future Line No.3.

The distribution of the stations of Line No.1 is shown in Fig. 4.2.2, and the location and spacings of the stations, in Table 4.2.1.

Table 4.2.1 List of Stations For Line No. 1

No.		Location	Distance	Alternative Alt.1	Alternative Alt.2	Remarks
1.	Domestic Airport	0.100.00 (K M)		Under-ground	Under-ground	
			750.00			
2.	International Airport	0.850.00				
			3.210.00	Elevated	Elevated	
3.	Baclaran	4.060.00				
			840.00			
4.	North Baclaran	4.900.00				
			800.00			
5.	Libertad	5.700.00				Intersection with Line No.3
			930.00			
6.	Buendia	6.630.00				
			980.00			
7.	Vito Cruz	7.610.00				
			820.00			
8.	San Andres	8.430.00				
			1.000.00			
9.	General Hospital	9.430.00				
			810.00			
10.	Rizal Park	10.240.00				Connection with Line No.2 and No.4
			1.710.00			
11.	Aduana	11.950.00			Underground	
			1.750.00			
12.	Divisoria	13.700.00				
			900.00			
13.	Tutuban	14.600.00				Connection with PNR cenral station & Line No.5
			1.130.00			
14.	Far Eastern University	15.730.00				
			870.00			
15.	University of Santo Tomas	16.600.00		Underground		Connection with Line No.2
			850.00			
16.	Antipolo	17.450.00				Connection with PNR
			850.00			
17.	Welcome Rotonda	18.300.00				
			1.320.00			
18.	Santo Domingo	19.620.00				
			1.060.00			
19.	Roosevelt	20.670.00 (20.680.00)				
			1.080.00 (1.080.00)			
20.	Delta	21.750.00 (21.760.00)				
			1.150.00 (1.150.00)		Elevated	
21.	Quezon	22.900.00 (22.910.00)				Connection with Line No.3
			1.290.00 (1.150.00)			
22.	Capital Center	24.190.00 (24.060.00)				
			1.120.00 (1.110.00)			
23.	University of the Philippines	25.310.00 (25.170.00)				
	TOTAL:		25.220.00 (25.070.00)			
	Average distance between stations		1.096.00 (1.090.00)			

Note: Alternative 1 is partially elevated railway.
Alternative 2 is all underground railway. (figures shown in parentheses)

CHAPTER 3 SERVICE AND OPERATION PLANNING

3.1 SERVICE

3.1.1 Service Level

It should be taken into account in the planning of the service level of the RTR Line No.1 that it is convenient to passengers so that users of motor vehicles may be diverted to the railway.

3.1.2 Passenger Load Factor

The transport capacity of Line No.1 was so planned that standing passengers should not bodily come into contact with one another during peak period and that the cars would not be more crowded than normal passenger capacity during off-peak period.

Time Zone	Average Passenger Load Factor	Occupied Floor Area per Standing Passenger
One peak hour	190% or less of the normal passenger capacity	0.14 m^2
One hour before and after the peak period	130% or less of the normal passenger capacity	0.24 m^2
Off-peak period	100% or less of the normal passenger capacity	0.35 m^2

3.1.3 Operating Hours

The operating hours of Line No.1 was planned as follows in consideration of pattern of activities of the community people of Manila city and the time required for maintenance of ground facilities.

Starting time	5 o'clock a.m.
Terminating time	12 o'clock p.m.

3.1.4 Car Design

The compartment height (floor to ceiling) was planned to be 2,200 mm to provide sufficient riding comfort while reducing the cross-sectional area of the tunnel.

3.1.5 Air-conditioning of the Stations and Tunnel Ventilation

As the soil temperature is as high as 26°C, it cannot be expected that the heat generated by the running train will be totally absorbed by the tunnel walls. It was therefore planned that the concourses and platforms of all stations would be completely air-conditioned while the tunnel would be mechanically ventilated so as to maintain tolerable comfort.

3.1.6 Air-conditioning of Cars

The cars should be so designed that it may in future be converted to bear air-conditioning equipments on top of the roof.

3.2 OPERATION

3.2.1 Train Headway

Flexible train headways were planned in consideration of the passenger load factor discussed above so that the headway during peak hours is shortened but that during off peak period would be so maintained as to offer better service than other transports like buses and jeepneys.

3.2.2 Scheduled Travel Speed

The scheduled travel speed was so planned that Line No.1 would perform all functions required of a rapid transit railway line.

Operating kilometerage U.P. and Baclaran (between U.P. and Airport)	21.21 Km (25.21 Km)
Number of stations	21 (23)
Average distance between stations	1.061 Km (1.146 Km)
Scheduled speed	33 Km/h

3.2.3 Scheduled Travel Time

Alternative 1 (Recommended alternative)

Baclaran - Rizan Park (6.18 km)	11'20"
Baclaran - U.S.T. (12.54 km)	22'50"
Baclaran - U.P. (21.26 km)	38'30"
(M.D.A. - U.P.)(25.22 km)	(45'30")

Alternative 2 (Compared alternative)

U.P. - F.E.U. (9.59 km)	17'10"
U.P. - Rizal Park (15.08 km)	27'10"
U.P. - Baclaran (21.26 km)	38'30"
(U.P. - M.D.A.)(25.22 km)	(45'30")

3.2.4 Estimated Traffic Volume

The daily traffic volume and through-passenger volume between stations in one peak hour in the section which would be most crowded were estimated for various alternatives and by stages, as shown in Table 4.3.1.

3.3 TRANSPORT CAPACITY

3.3.1 Cars and Train Consist

Cars of 20 m in length were planned for operation in trains of 4 (Mc, M, M and Mc) to 6 (Mc, M, T, T, M and Mc) cars according to the passenger demand.

The normal passenger capacity is 132 persons for the head car and 144 persons for the intermediate car. The normal passenger capacity per train is therefore as follows:

4-car train	522 persons (including 216 seated persons)
5-car train	696 persons (including 274 seated persons)
6-car train	840 persons (including 332 seated persons)

Table 4.3.1 Daily Traffic Volume and through Passenger Volume between Stations during One Peak Hour in the Most Crowded Section

Alternatives		Year	Section in Operation	Daily Traffic Volume (Persons)	One Peak Hour Line Passenger Volume in the Most Crowded Section (One-way)
Recommended Alternative (PNR improved; Partially elevated)	Operation starting from U.P.	1983	U.P. - F.E.U.	363,525	15,318
		1986	U.P. - Rizal Park	554,926	21,310
		1987	U.P.- Baclaran	820,538	23,370
		2000	(U.P. - M.D.A.)	1,280,087	37,881
Compared Alternative 1 (PNR improved; Partially elevated)	Operation starting from Baclaran	1983	Baclaran - Rizal Park	133,670	7,065
		1986	Baclaran - U.S.T.	372,741	13,286
		1987	Baclaran - U.P.	820,538	23,370
		2000	(M.D.A. - U.P.)	1,280,087	27,881
Compared Alternative 2 (PNR not improved; All underground)	Operation starting from U.P.	1983	U.P. - F.E.U.	358,466	14,501
		1986	U.P. - Rizal Park	599,108	23,833
		1987	U.P. - Baclaran	902,840	22,707
		2000	(U.P. - M.D.A.)	1,368,989	42,353
Compared Alternative 3 (PNR not improved; All underground)	Operation starting from Baclaran	1983	Baclaran - Rizal Park	217,449	12,557
		1986	Baclaran - U.S.T.	496,087	19,825
		1987	Baclaran - U.P.	902,840	22,707
		2000	(M.D.A. - U.P.)	1,368,989	42,353

3.3.2 Train Headways and Transport Capacity

The one peak hour interstation through-passenger volume in the most crowded section (one-way) in Table 4.3.1 is plotted against the transport capacity at varying train headways with a passenger load factor of 190% as shown in Fig. 4.3.1 to Fig. 4.3.4. The forecast shown in these figures is based on the following assumptions:

(1) Interstation through-passenger volume after the opening of the entire line will grow as shown by the solid line from 1987 to 2000, and that for the years up to 1983 is shown by the broken line.

(2) In case of a stage construction and operation program as recommended being adopted, then in 1984 only part of the line will be operated. Therefore, the through-passenger volume in 1984 will be lower than the figure of 1983 mentioned above. Accordingly the through-passenger volume in 1983 was estimated on the basis of the estimate for 1987, assuming that the line would not have been extended beyond the first stage of construction by 1987. In 1983, however, people will take time to switch from the motor transport to the railway. Allowing for a time lag of 3 years during which period passenger demand

will build up from half the figure estimated through interpolation, the annual traffic volume for the initial years are obtained.

(3) The line will have been operated for 3 years by 1987 when the third stage of construction will be implemented. The estimate of through passenger volume for 1987 was therefore not changed.

(4) On the basis of the assumptions above, actual through passenger volume was thought to grow as shown by the bold line.

As is obvious from the graphs, the transport capacity (passenger load factor: 190%, transport capacity 20,960 persons) will exceed the through passenger volume in 1983, when the 4-car trains are operated at 3-minute headways, while the passenger load factor will be in excess of 190% in 1986 so that 5-car trains will have to be operated at 3-minute headways.

As through passenger volume grows, it will be necessary to operate 6-car trains at 3-minute headways in 1989 and 6-car trains at headways of 2 minutes and a half in 1994.

The yearly changes in train headways and number of trains are shown according to time zone in Table 4.3.2, and the transport capacity and passenger load factor in Table 4.3.3.

Table 4.3.2 Train Headway and Number of Trains

Time Zone \ Year	1983 1994		1994 2000		Remarks
	Headway	Number of Trains	Headway	Number of Trains	
5 - 6 o'clock	10'	6	7'30"	8	One way
6 - 7 "	4'	15	3'	20	
7 - 9 "	3'	40	2'30"	48	
9 - 10 "	4'	15	3'	20	
10 - 16 "	5'	72	3'	120	
16 - 17 "	4'	15	3'	20	
17 - 19 "	3'	40	2'30"	48	
19 - 20 "	4'	15	3'	20	
20 - 22 "	6'	20	6'	20	
22 - 23 "	10'	6	10'	6	
23 - 24 "	15'	3	15'	3	
Total		247		333	

Table 4.3.3 Transport Capacity and Passenger Load Factor

Year	Section	One Hour Peak in the Most Crowded Section			All-day in the Most Crowded Section		
		Through Passenger Volume (Persons)	Transport Capacity (Persons)	Passenger Load Factor(%)	Through Passenger Volume (Persons)	Transport Capacity (Persons)	Passenger Load Factor(%)
Alt. 1 :	From U.P. side						
1983	U.P. - F.E.U.	15,318	11,040	138	107,042	136,344	79
1986	U.P. - Rizal Park	21,310	13,920	153	143,039	171,912	83
1987	U.P. - Baclaran	23,370	13,920	168	163,102	171,912	95
2000	(U.P. - M.D.A.)	37,881	20,160	188	267,887	279,720	96
Alt. 2 :	From Baclaran side						
1983	Baclaran - Rizal Park	7,065	11,040	64	43,947	136,344	33
1986	Baclaran - U.S.T.	13,286	13,920	96	101,486	171,912	59
1987	Baclaran - U.P.	23,370	13,920	168	163,102	171,912	95
2000	(M.D.A. - U.P.)	37,881	20,160	188	267,887	279,720	96

Figure 4.3.1 One Peak Hour Through Passenger Volume in the Most Crowded Section and Transport Capacity

Case 1 - Alt. 1 : Operation from U.P. side

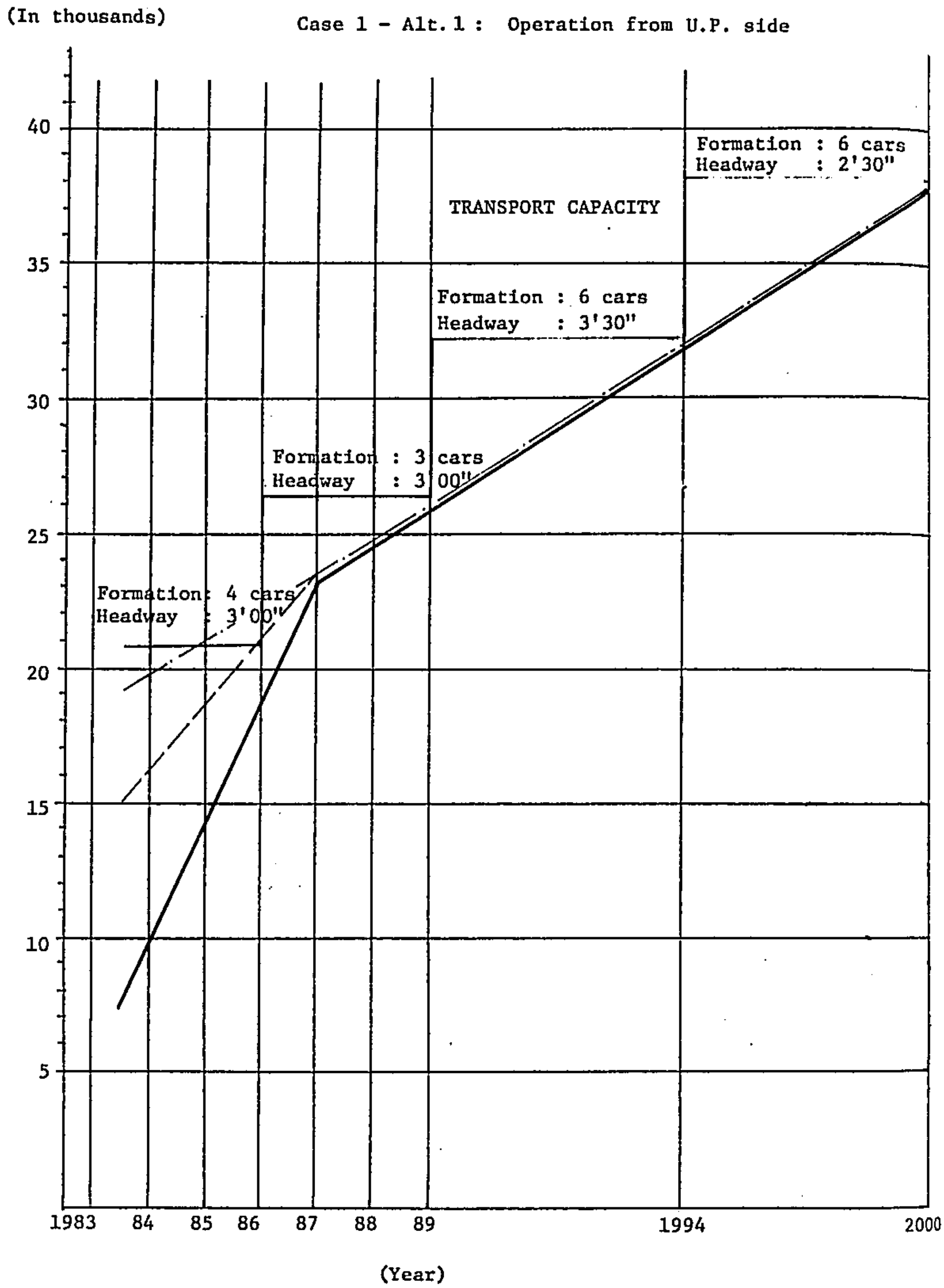


Figure 4.3.2 One Peak Hour Line Passenger Volume in the Most Crowded Section and Transport Capacity

Case 1 - Alt. 2: Operation from Baclaran side

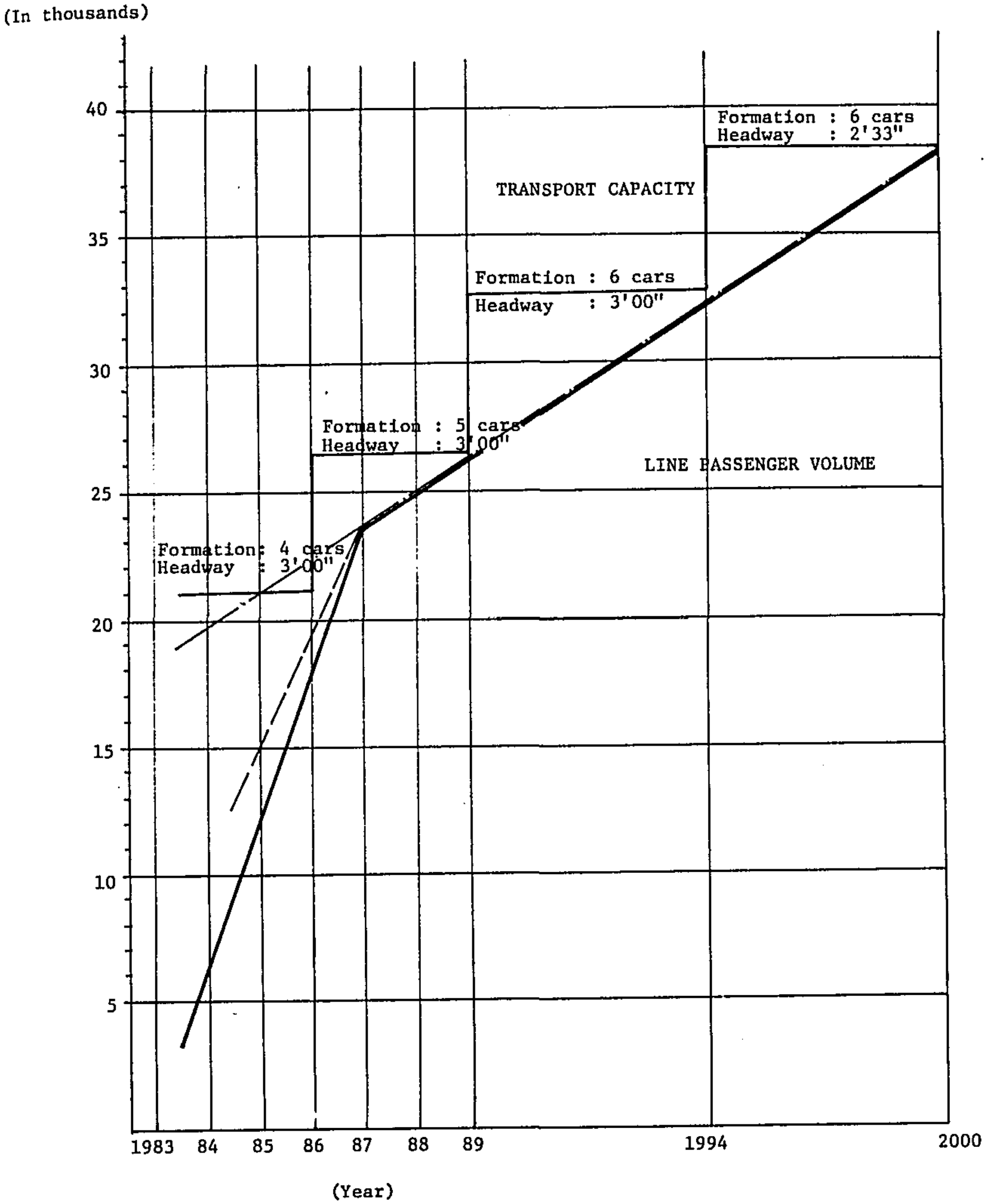


Figure 4.3.3 One Peak Hour Line Passenger Volume in the Most Crowded Section and Transport Capacity

Case 2 - Alt. 1: Operation from U.P. Side

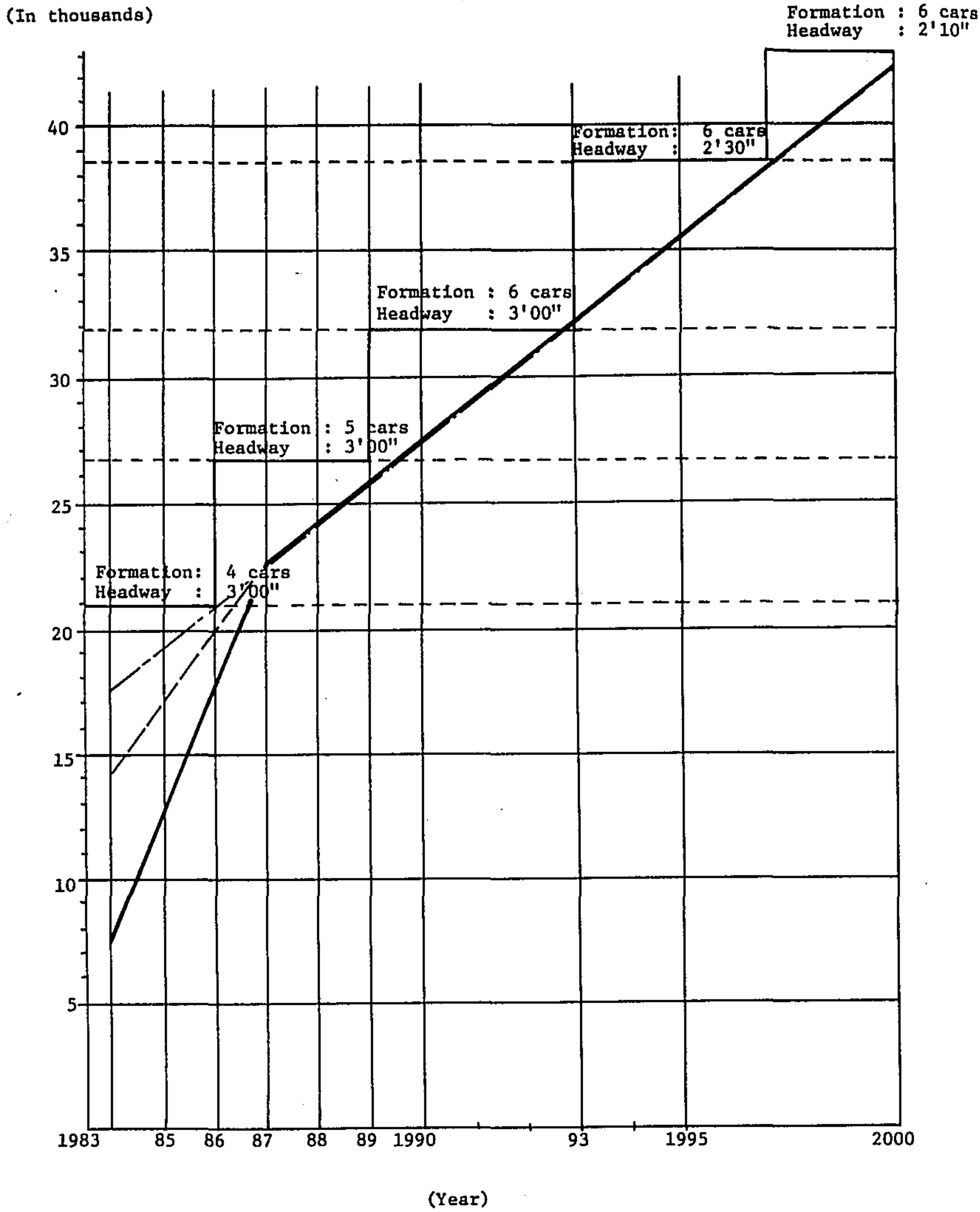


Figure 4.3.4 One Peak Hour Through Passenger Volume in the Most Crowded Section and Transport Capacity

Case 2 - Alt. 2: Operation from Baclaran side

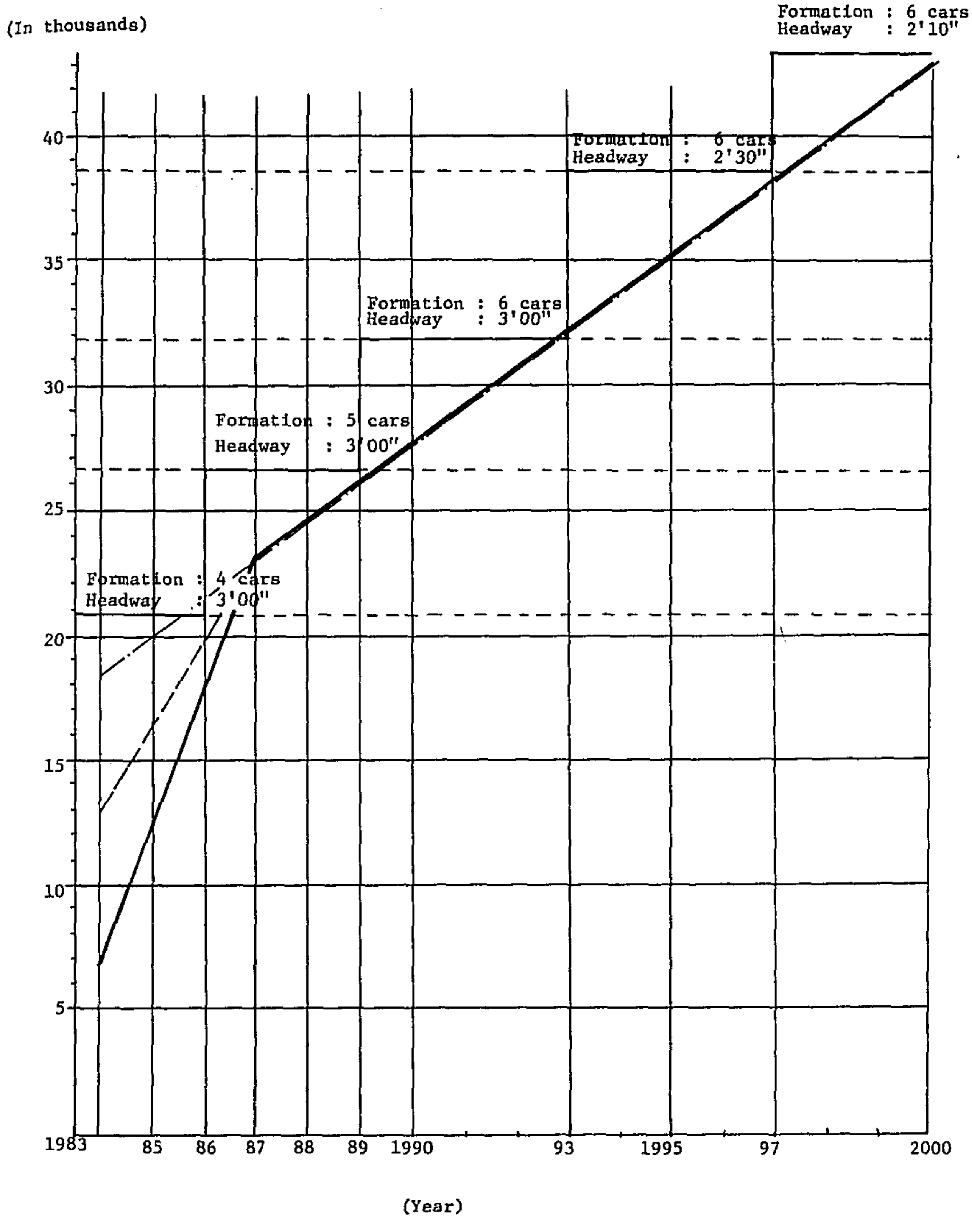


Table 4.3.4 Train Operating Time

Inter-station Distance (km)	Northbound Running Time	Northbound Station Dwell Time	Northbound Time Required	Name of Station	Southbound Running Time	Southbound Station Dwell Time	Southbound Time Required
			5'25"	(Domestic Airport)	5'25"		
0.750	1'15"						1'15"
		20"		(International Airport)		20"	
3.200	3'50"						3'50"
		30"	11'25"	Baclaran	11'40"	30"	
0.850	1'25"						1'25"
		20"		North Baclaran		20"	
0.800	1'10"						1'15"
		30"		Libertad		30"	
0.930	1'25"						1'25"
		20"		Buendia		20"	
0.380	1'25"						1'25"
		20"		Vito Uruz		20"	
0.820	1'15"						1'20"
		20"		Cruz		20"	
1.000	1'25"						1'25"
		20"		General Hospital		20"	
0.810	1'10"						1'15"
		30"	11'10"	Rizal Park	11'00"	30"	
1.710	2'25"						2'25"
		20"		Aduana		20"	
1.710	2'30"						2'25"
		20"		Divisoria		20"	
0.900	1'35"						1'30"
		30"		Tutuban		30"	
1.130	1'35"						1'35"
		20"		Far Eastern University		20"	
0.870	1'35"						1'35"
		30"	15'00"	University of Santo Tomas	14'50"	30"	
0.850	1'20"						1'15"
		30"		Antipolo		30"	
0.850	1'10"						1'15"
		30"		Welcome Rotonda		30"	
1.000	1'30"						1'55"
		20"		Santo Domingo		20"	
1.520	2'00"						1'20"
		20"		Roosevelt		20"	
0.930	1'25"						1'40"
		20"		Delta		20"	
1.150	1'40"						1'30"
		30"		Quezon		30"	
1.150	1'30"						1'35"
		20"		Capital Center		20"	
1.110	1'35"						1'30"
				U.P.			
21.260 (25.220)	31'05" (36'10")	7'30" (8'20")		Total		7'30" (8'20")	31'00" (36'05")
	38'35" (44'30")			Time required	38'30" (44'25")		
	33.12 (34.00)			Scheduled speed	33.13 (34.01)		

Note: Figures in ( ) indicate the case when the Baclaran-Airport branch is completed.

3.4 NUMBER OF CARS REQUIRED

3.4.1 Scheduled Travel Speed

The train operating time of the whole Line No.1 is computed basing on operating kilometerage, number of stations, car performance, and track conditions.

U.P. - Baclaran (Airport)	21.26 km	(25.22 km)
Number of stations	21	(23)
Average distance between stations	1.061 km	(1.146 km)

Station dwell time

30 seconds in Baclaran, Libertad, Rizal Park, Tutuban, F.E.U., Antipolo, Welcome Rotonda, and Quezon stations and 20 seconds in other stations.

Under the above condition, the scheduled travel speed of trains for the whole line is calculated to be 33 km/h.

The train operating time of the whole Line No.1 is shown in Table 4.3.4.

3.4.2 Number of Cars

The *number of cars is computed by the following equation.*

$$N = \frac{(L/V + to) \times 2}{t}$$

where,

N = number of trains operated during peak period

L = operating kilometerage (km)

V = scheduled travel speed (km/min)

t = train headway during peak period (min)

t_o = time of reversing at the terminal station (t + 1 min)

The number of spare cars is added to the value obtained by the equation above to determine the number of cars required for the operation of Line No.1. The spare cars account for 15-20% of the total number of cars. Table 4.3.5 shows the yearly numbers of cars and trains required, and Table 4.3.6 the train kilometerage, car kilometerage, and average daily operating kilometerage per car.

Table 4.3.5 Number of Cars by Required Years

	Year	Operating Section	Peak Period Headway	Number of Trains			Cars per Train	Total No. of Cars
				Operated	Standby	Total		
Case 1 (PNR improved)	Alt. 1 From U.P. Side							
	1983	U.P. - F.E.U.	3'	14	3	17	4	68
	1986	U.P. - Rizal Park	3'	21	5	26	5	130
	1987	U.P. - Rizal Park	3'	29	6	35	5	175
	1989	(U.P. - M.D.A.)	3'	33	8	41	6	246
	1994	(U.P. - M.D.A.)	2'30"	40	8	48	6	288
	Alt. 2 From Baclaran Side							
	1983	Baclaran - Rizal Park	3'	11	3	14	4	56
	1986	Baclaran - U.S.T.	3'	18	4	22	5	110
	1987	Baclaran - U.P.	3'	29	6	35	5	175
	1989	(M.D.A. - U.P.)	3'	33	8	41	6	246
	1994	(M.D.A. - U.P.)	2'30"	40	8	48	6	288
Case 2 (PNR not improved)	Alt. 1 From U.P. Side							
	1983	U.P. - F.E.U.	3'	14	3	17	4	68
	1986	U.P. - Rizal Park	3'	21	5	26	5	130
	1987	U.P. - Baclaran	3'	29	6	35	5	175
	1989	(U.P. - M.D.A.)	3'	33	8	41	6	246
	1993	(U.P. - M.D.A.)	2'30"	40	8	48	6	288
	1997	(U.P. - M.D.A.)	2'10"	44	9	53	6	318
	Alt. 2 From Baclaran Side							
	1983	Baclaran - Rizal Park	3'	11	3	14	4	56
	1986	Baclaran - U.S.T.	3'	18	4	22	5	110
	1987	Baclaran - U.P.	3'	29	6	35	5	175
	1989	(M.D.A. - U.P.)	3'	33	8	41	6	246
	1993	(M.D.A. - U.P.)	2'30"	40	8	48	6	288
	1997	(M.D.A. - U.P.)	2'10"	44	9	53	6	318

Table 4.3.6 Train- and Car-kilometerage and Average Daily Operating Kilometerage per Car

Year		1983	1986	1987	1989	1994	1997
Alt. 1 From U.P. Side							
Number of one-way trains per day		247	247	247	247	333	357
Train kilometerage (train km)	Daily	4,658.4	7,370.5	10,428.3	12,379.6	16,689.9	17,892.8
	Yearly	1,700,316	2,690,233	3,806,330	4,518,554	6,091,814	6,530,872
Car kilometerage (car km)	Daily	18,634	36,853	52,142	74,278	100,139	107,359
	Yearly	6,801,264	13,451,165	19,031,650	27,111,324	36,550,884	39,185,232
Average daily operating kilometerage per car (km)		274	283	298	302	348	338
Alt. 2 From Baclaran Side							
Number of one-way trains per day		247	247	247	247	333	357
Train kilometerage (train km)	Daily	3,057.9	6,199.7	10,428.3	12,379.6	16,689.9	17,892.8
	Yearly	1,116,134	2,262,891	3,805,330	4,518,554	6,091,814	6,530,872
Car kilometerage (car km)	Daily	12,232	30,999	52,142	74,278	100,139	107,357
	Yearly	4,464,536	11,314,455	19,031,065	27,111,324	36,550,884	39,185,232
Average daily operating kilometerage per car (km)		218	282	298	302	348	338

Note: The operating kilometerage does not include trips to and from the car depot.

Table 4.4.1 Construction Criteria Proposed for RTR Line No.1

Item		Standard	Remarks
Track gauge		1.435 m	
Power supply system		Third rail system	
Power supply		D.C. 750 V	
Car gauge		2.38 m x 4.00 m	
Construction gauge		3.28 m x 4.30 m	
Car length		20 m	
Minimum curve radius	Main line	200 m (160 m)	
	Siding	120 m	
	Turnout	150 m	
	Along the platform	500 m (300 m)	
Length of transition curve		$L \geq 3000$, where the curve radius is less than 800 m	
Distance between reversed transition curves		Not less then 15 m	
Cant		$C = 11.8\frac{V^2}{R} < 150$ mm	
Maximum gradient	Main line	35/1000	
	Siding	40/1000	
	Along the platform	10/1000	
Minimum gradient of the underground section		2/1000	
Minimum radius of vertical curve		Not less than 2000 m in a section where the variation in gradient exceeds 10/1000	
Expansion of construction gauge in the curved section		$W = \frac{24,000}{R}$, where the curve radius is less than 800 m	
Track gauge widening		$S = \frac{2,250}{R} \leq 25$ mm, where the curve radius is less than 600 m	
Height from rail level to formation level		Concrete bed : 500 mm Ballast bed : 700 mm	
Minimum track center distance		3.80 m	

CHAPTER 4 TECHNICAL STANDARDS

4.1 CONSTRUCTION CRITERIA

The construction criteria which form the basis for planning and design of the railway are shown in Table 4.4.1.

The construction criteria require a future detailed study at the implementation stage. At this stage the construction criteria have been established with reference to the construction standards currently in use in Japan.

(1) Power Collection System

DC 750 V, third rail

(2) Track Gauge

1,435 mm

(3) Car Gauge

The car gauge is decided, as shown in Fig. 4.4.1, through the transport capacity described in "Service and Operation Planning" of Chapter 3. The construction gauge was so planned that an allowance is provided on both sides of the car, and the tunnel was planned at the dimensions of 3,280 mm by 4,300 mm.

(4) Curvature

The scheduled speed adopted and consideration on avoiding properties were the main considerations in the planning of the route curvature. The minimum curve radius of this line was planned at 200 m but may be reduced to 160 m where absolutely necessary. The track along the platform was planned in a straight line as much as possible to ensure the safety of passengers and to save labor in station operation, but a curve of 500 m in radius may be used in case of absolute necessity.

(5) Gradient

The gradient of the proposed route is relatively gradual, since the tunnel was planned at a shallow depth to minimize construction cost. As a result, the maximum gradient of the main line was planned at 3.5%, and that of the sidings at 4%.

(6) Distance between Track Centers

The distance between track centers is decided from the car gauge to be 3,600 mm for the main line of the elevated section and 3,400 mm for the sidings.

(7) Track Structure

50-kg rail was proposed, and the track was planned to be ballasted for the elevated section and to be a direct fastened concrete one for the underground section so as to minimize the vibrations and noise from the train and to save labor in track maintenance.

4.2 ROUTE PLAN AND PROFILE

The plan and profile of recommended alternative the recommended alternative of Line No. 1 are shown in Fig. 4.4.2 to 4.4.10.

Description of Sections of Special Interest

1. Baclaran

The route is so planned that it passes through privately owned land, forming a curve 200 m in radius from point of about 4.1 km.

2. Section Near Rizal Park Station

Rizal Park Station was planned to be located as shown in Fig. 4.4.5 to provide connection with Line No.4 in future. The minimum curve radius of this section was 160 m in order to cross under the existing underpass and locate the station as near the north as possible.

3. Section Crossing the Pasig River

The section between 12.4 km and 13.2 km was planned to be a curve 400 m in radius to go around the Roxas Bridge. The route will descend and ascend a gradient of 3.5% to cross under the Pasig river. In this section will be built two single-track tunnels by the shield method.

4. Quezon Memorial

As the elevated structure is not permitted to cross the Quezon Memorial from the standpoint of the landscape, the route of the elevated structure is planned to form a curve 500 m in radius immediately after Quezon Station to go around the Quezon Memorial.

5. U.P. Terminal Section

As the car depot is planned to be built at the terminal station in the recommended alternative, the route will ascend at a gradient of 3.5% at 25.6 km to provide clearance for the extension of Quezon Boulevard and then lowered to ground level to enter the car depot.

6. International Airport Station - Baclaran Station

This is the section that may be extended in future when the traffic demand warrants. As the car depot will be located between these stations in the case that the line is implemented from the south this section was planned to be partially on the surface and partially elevated. The route will cross the Paranaque river about 1.3 km from International Airport Station and ascent at a gradient of 3.5%, to appear above the surface at 1.8 km from International Airport Station. To overpass the airport road, the section between 1.8 km and 2.3 km will be elevated. The section between 2.3 km and 3.2 km will be on the surface to have a connection with the car depot. At about 3.5 km the route will again go underground at a gradient of 3.5% to underpass a road before reaching Baclaran Station.

Fig. 4.4.1. Structure and Car Gauge

(a) Box Tunnel Section

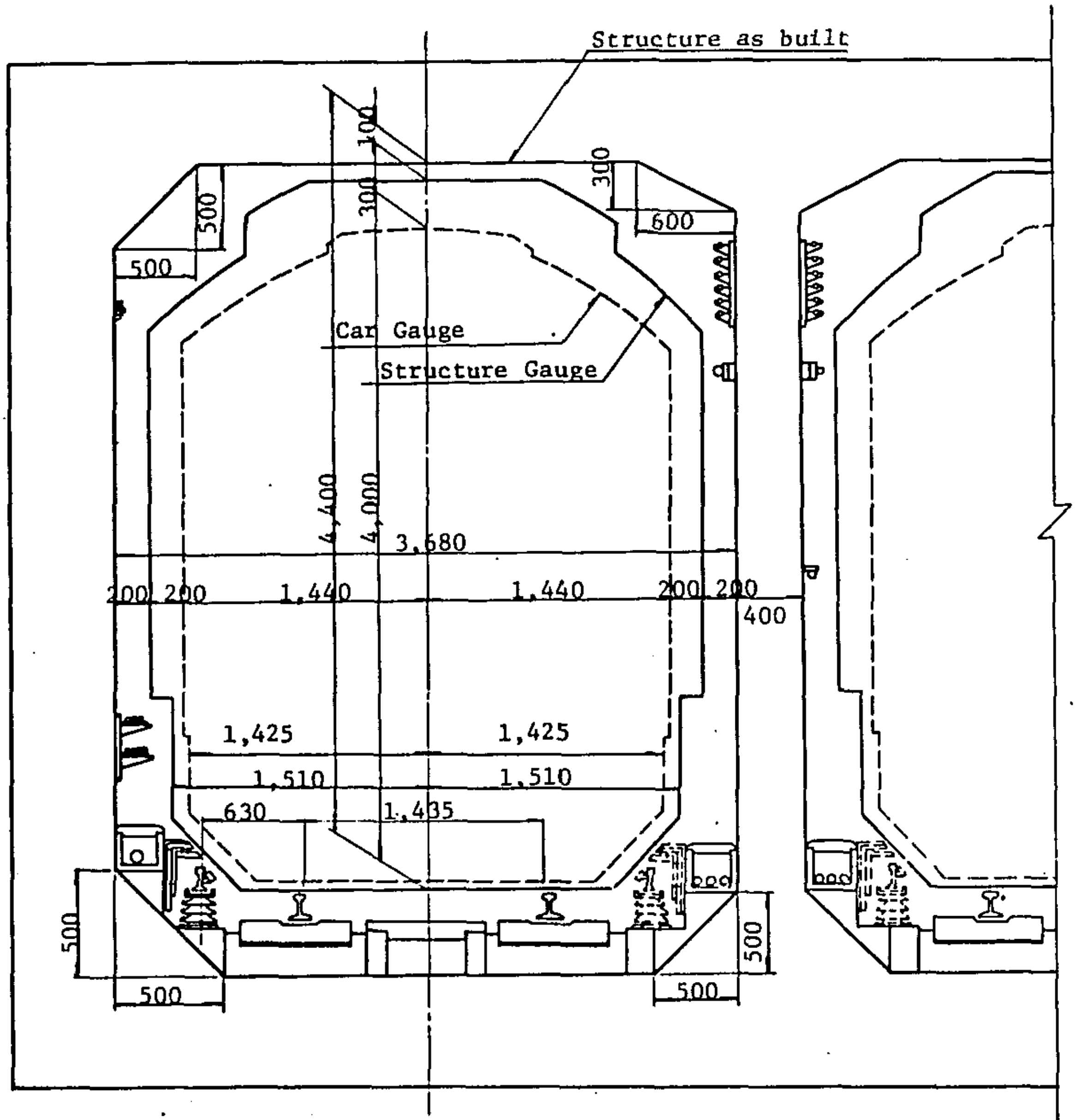
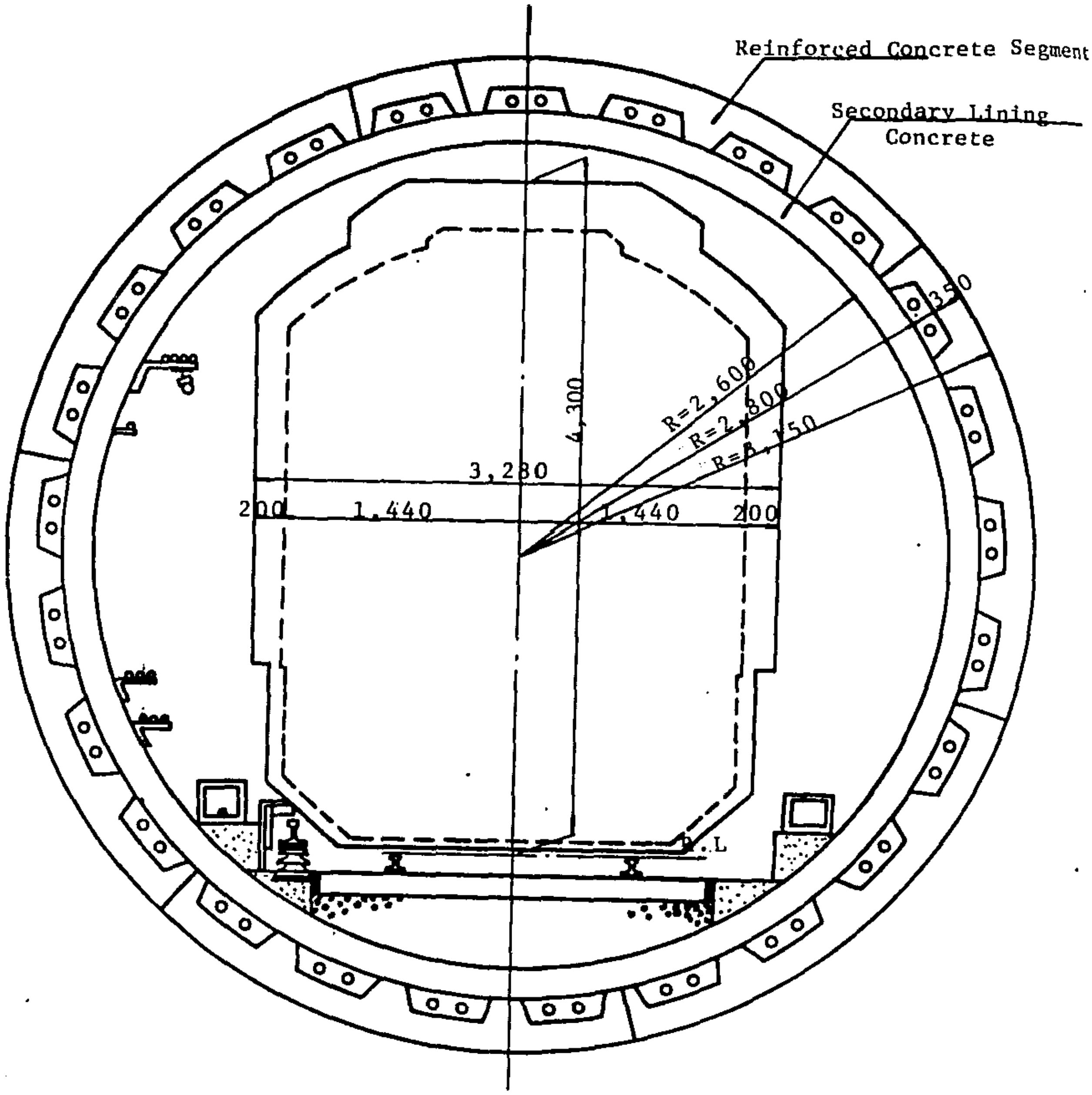
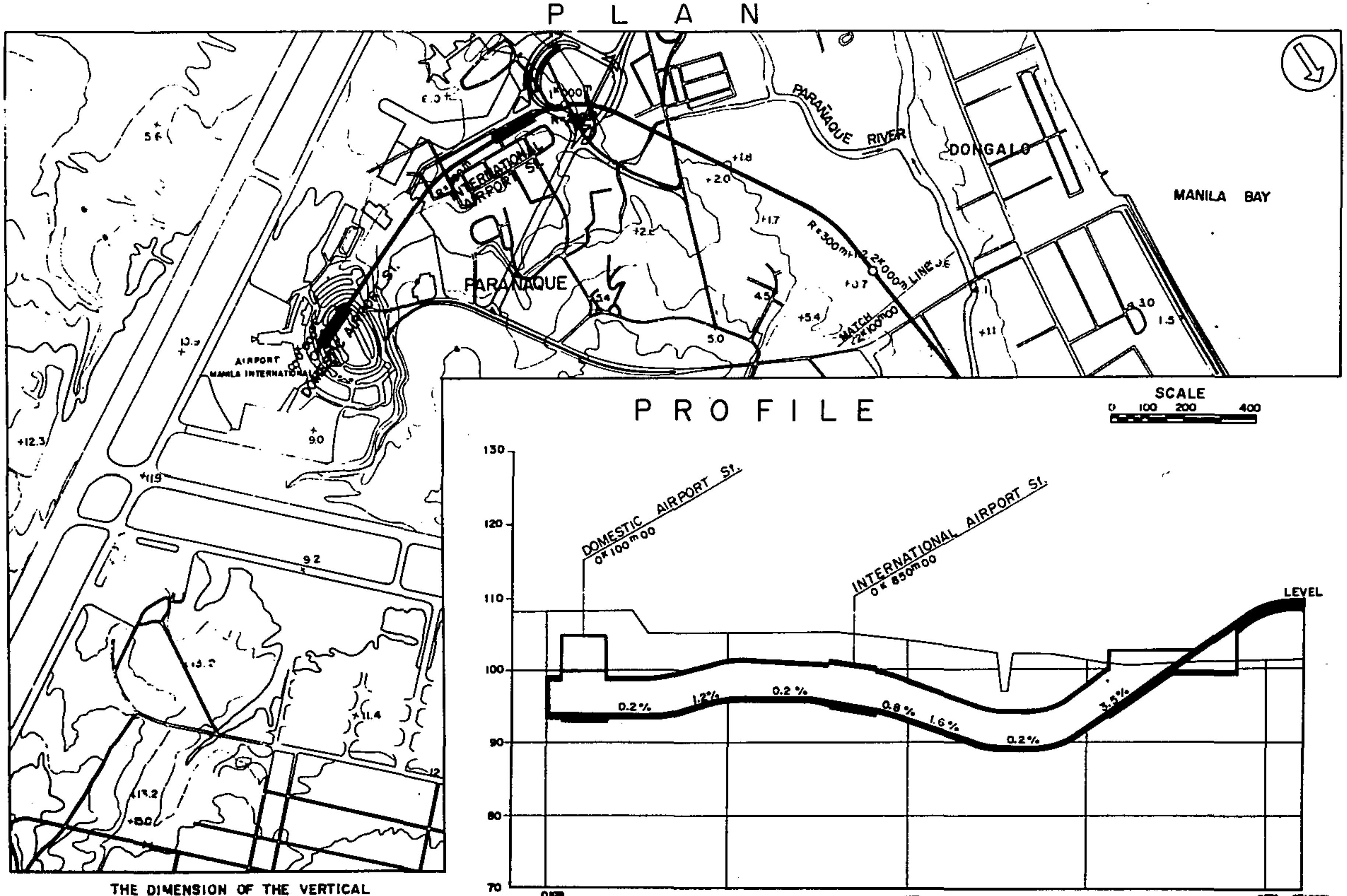


Fig. 4.4.1 Structure and Car Gauge

(b) Shield Tunnel Section

Shield tunnel section





THE DIMENSION OF THE VERTICAL SCALE IS OBTAINED BY ADDING 100M TO GROUND LEVEL.

Fig. 4.4.2 Plan and Profile of Recommended Alternative (1)

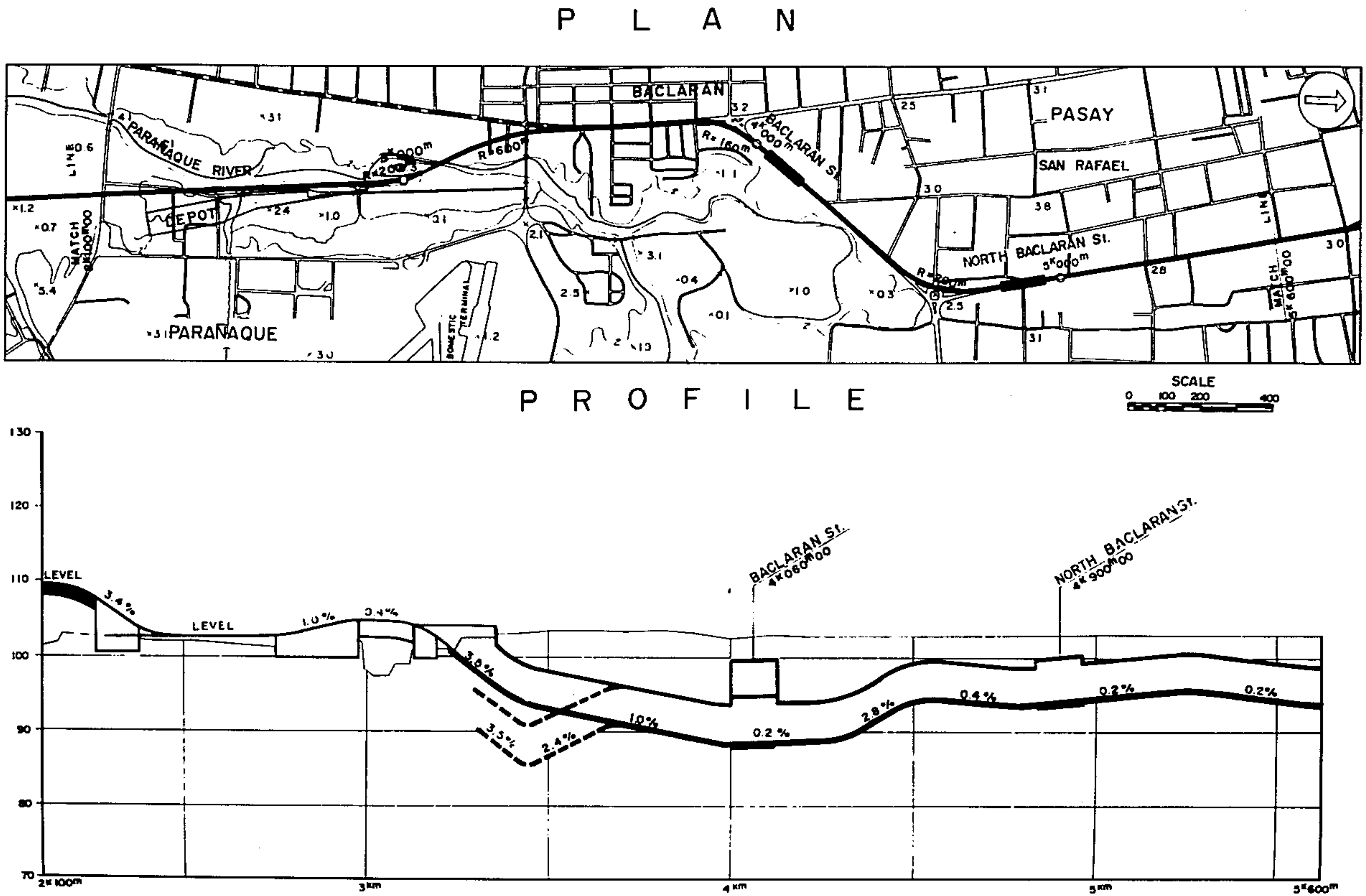


Fig. 4.4.3 Plan and Profile of Recommended Alternative (2)

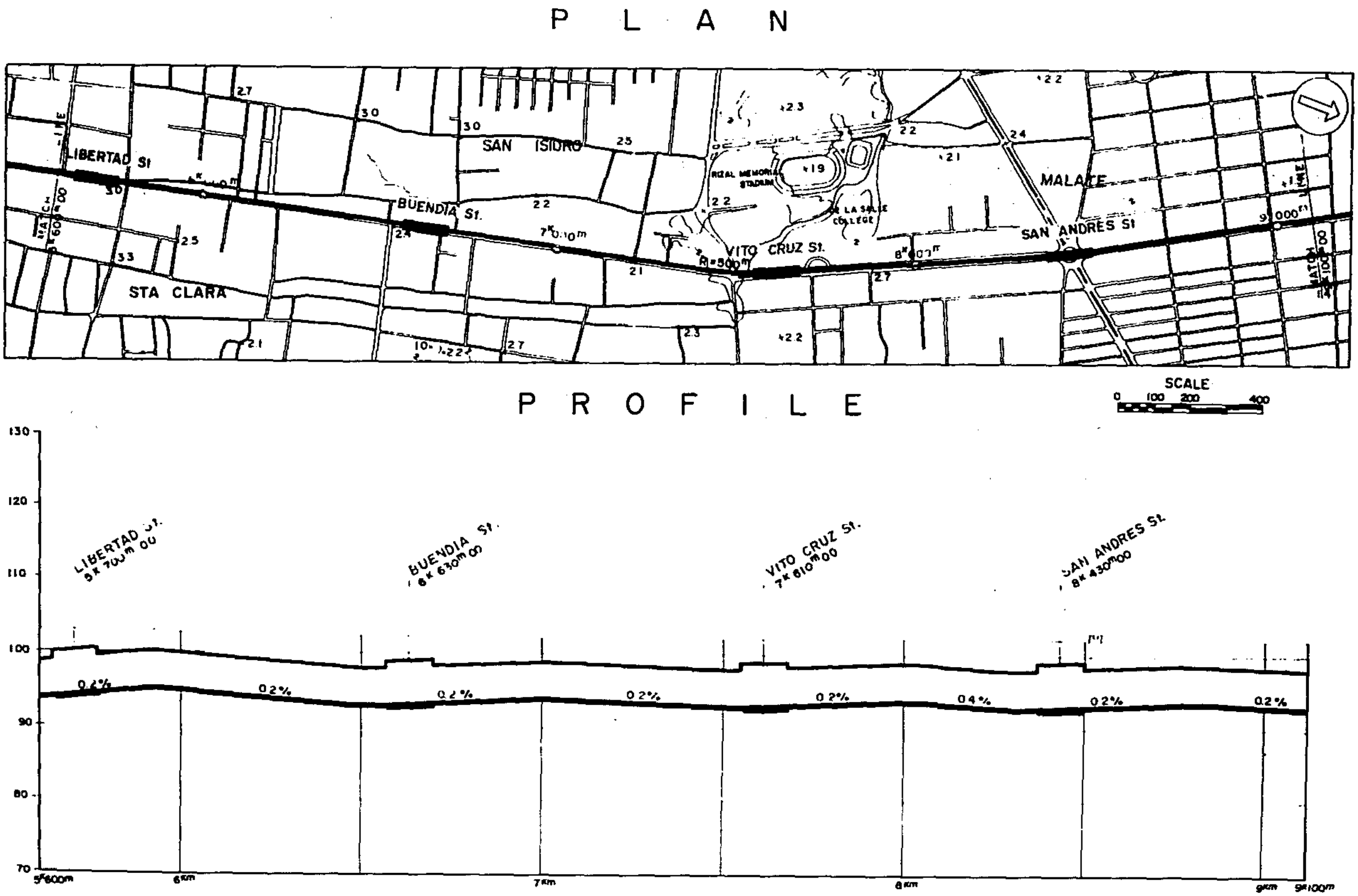


Fig. 4.4.4 Plan and Profile of Recommended Alternative (3)

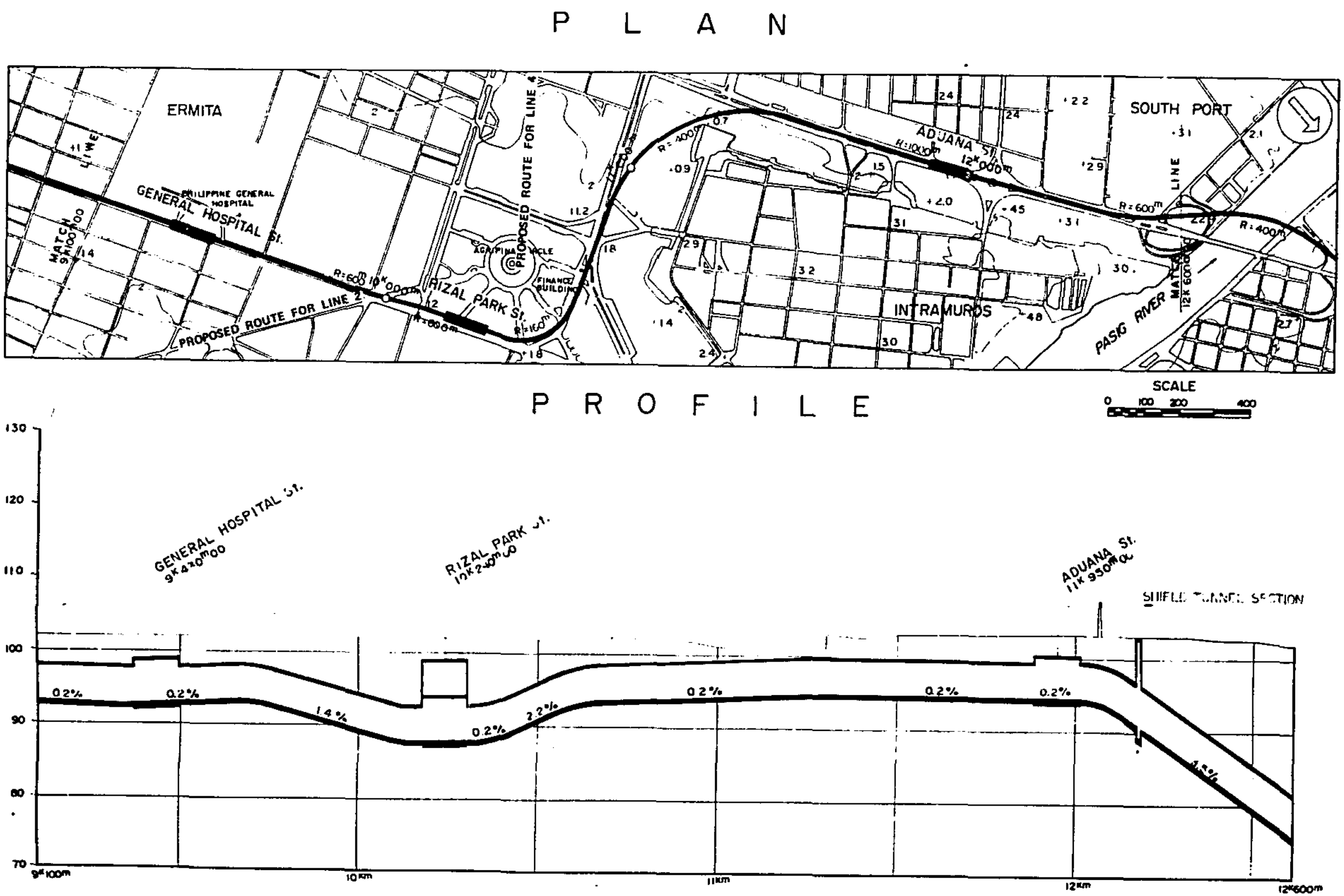


Fig. 4.4.5 Plan and Profile of Recommended Alternative (4)

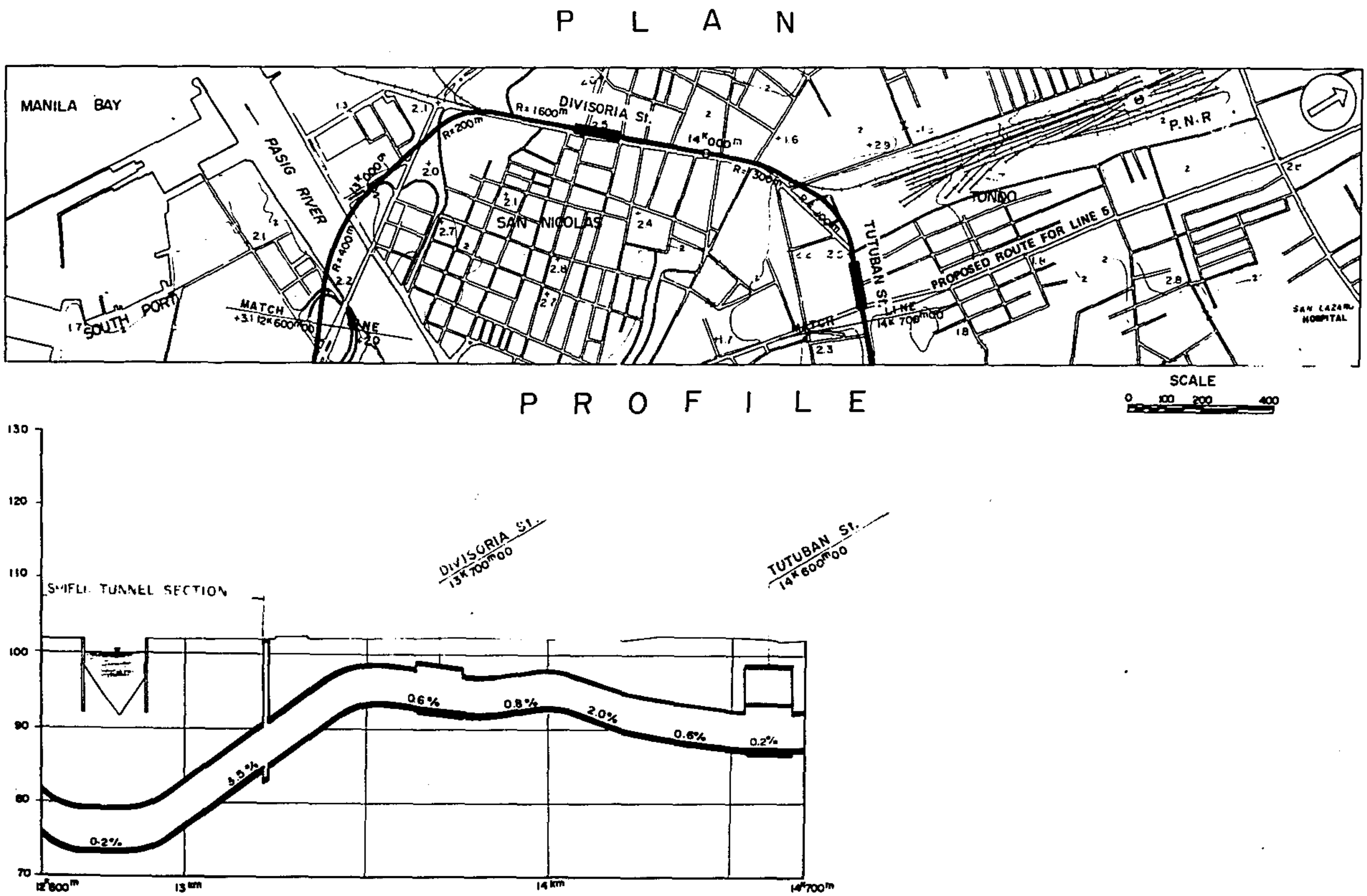


Fig. 4.4.6 Plan and Profile of Recommended Alternative (5)

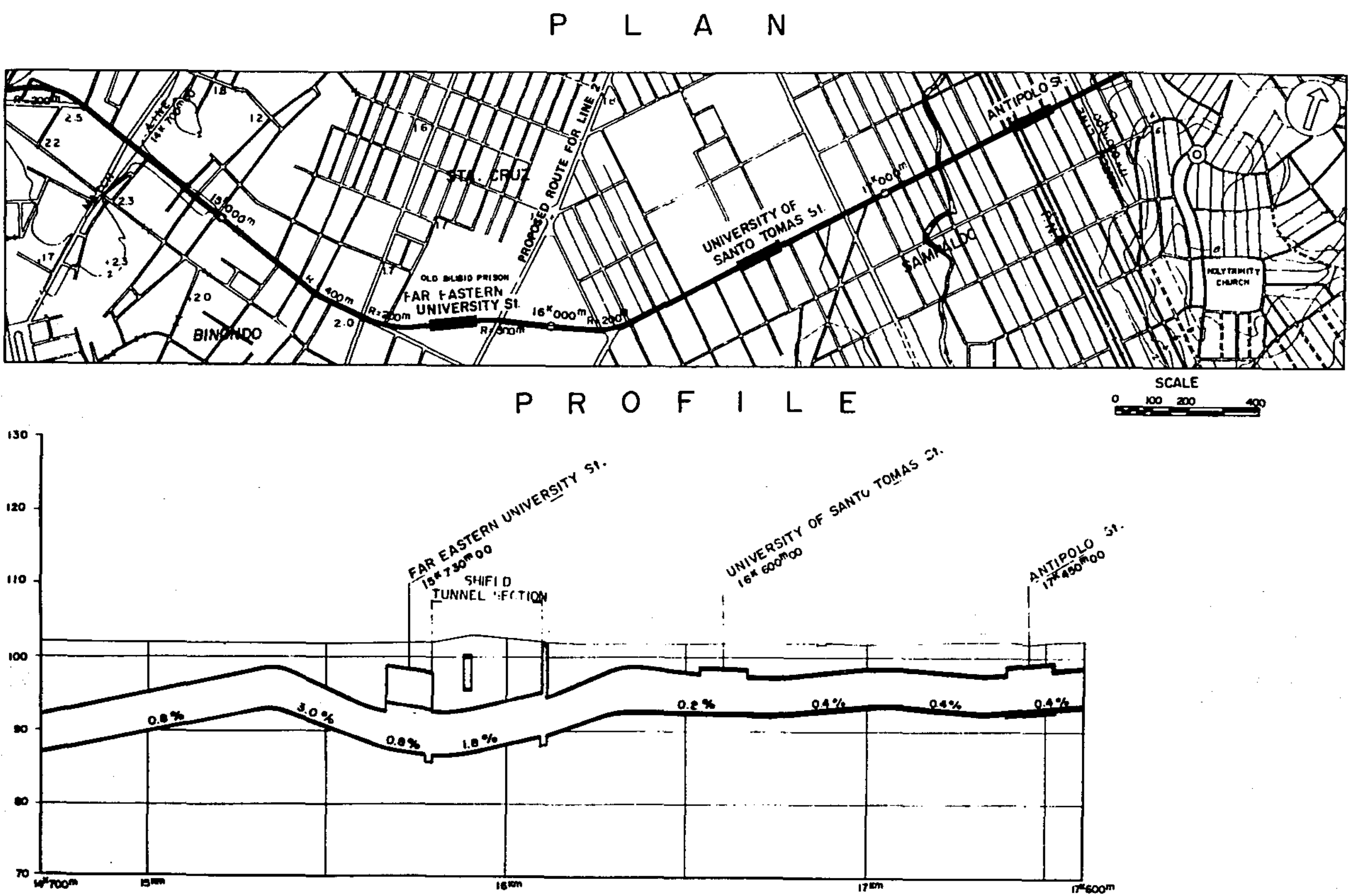


Fig. 4.4.7 Plan and Profile of Recommended Alternative (6)

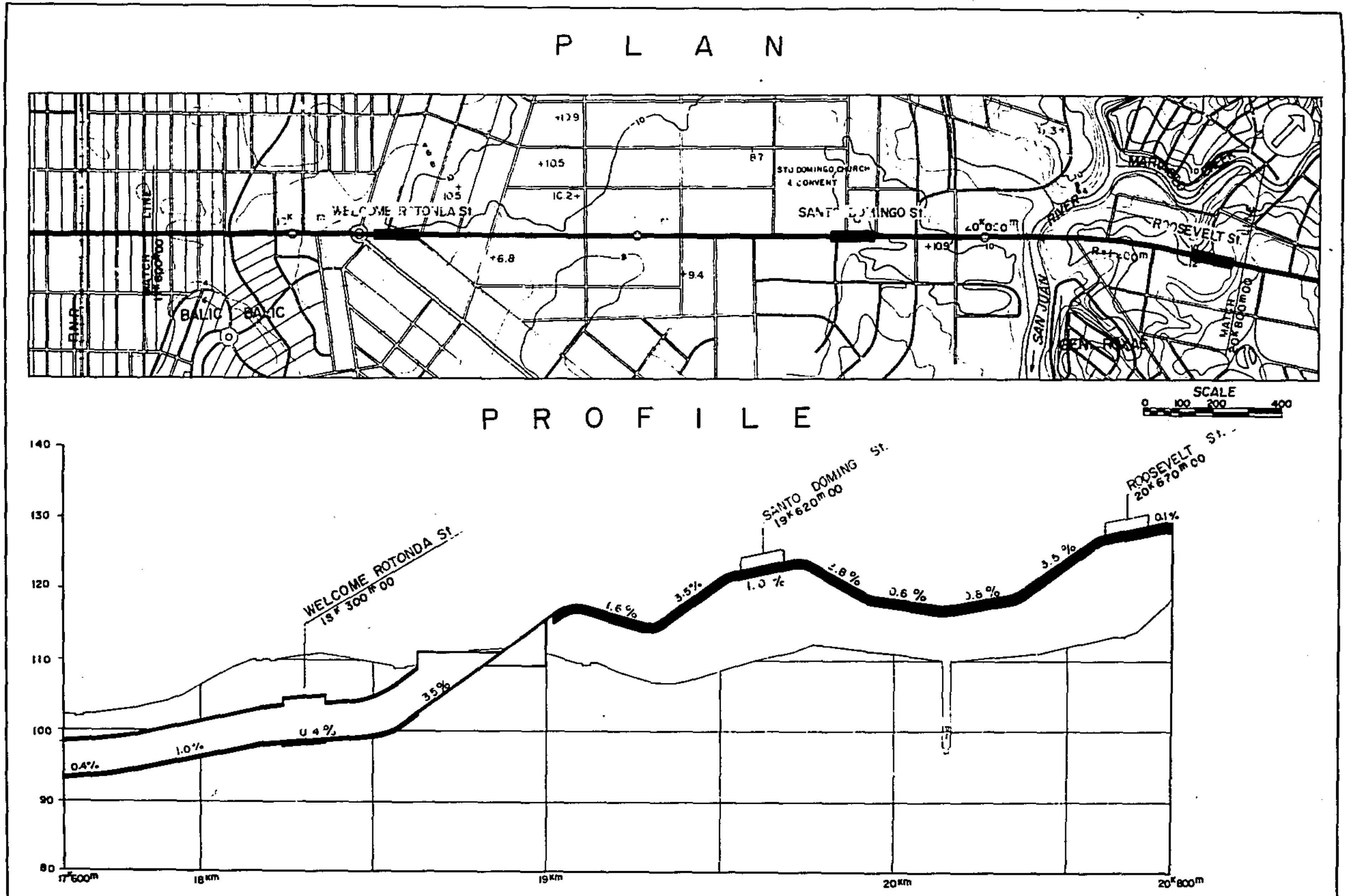


Fig. 4.4.8 Plan and Profile of Recommended Alternative (7)

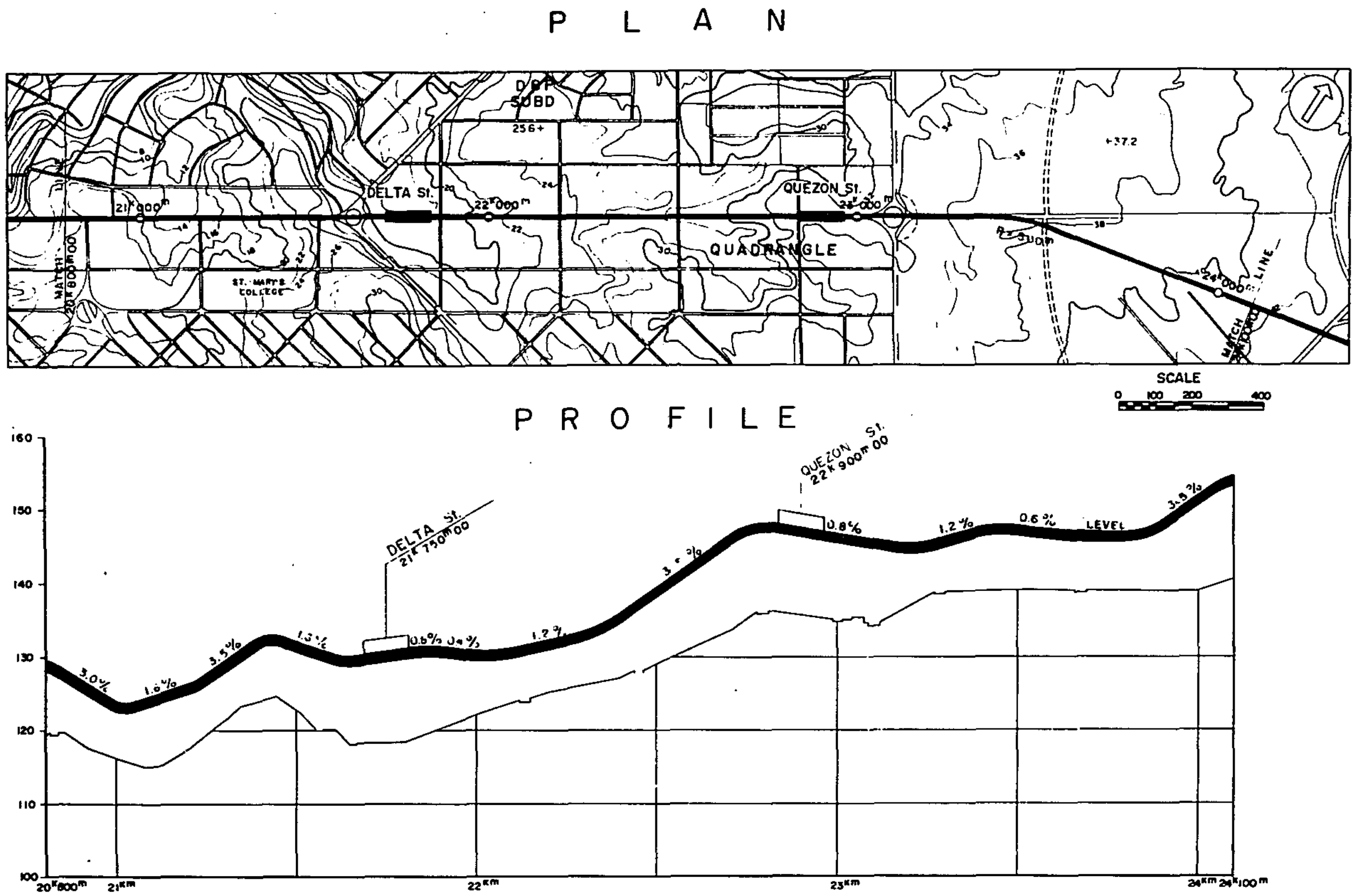


Fig. 4.4.9 Plan and Profile of Recommended Alternative (8)

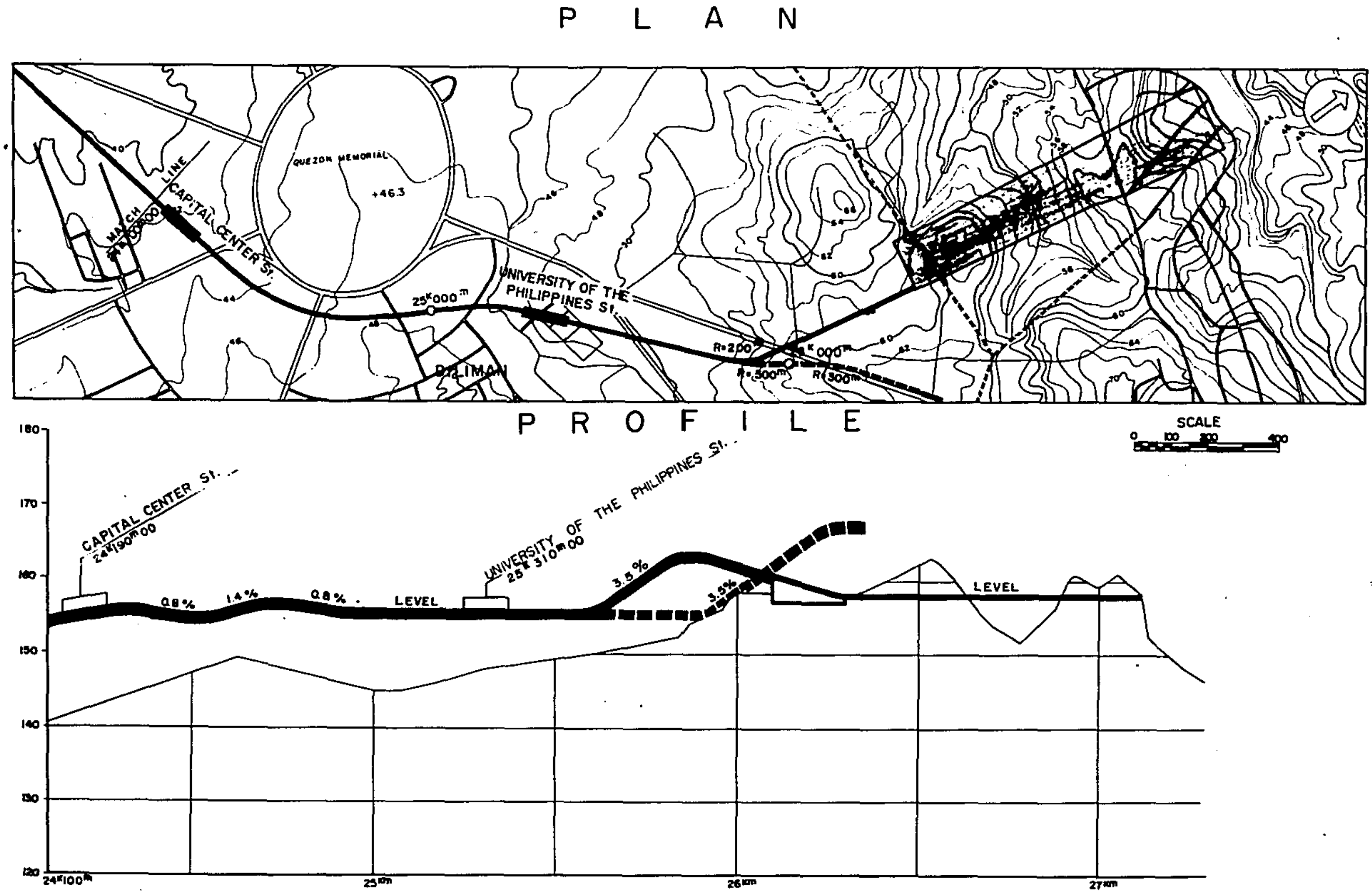


Fig. 4.4.10 Plan and Profile of Recommended Alternative (9)

4.3 SITING

4.3.1 Main Stations

The location of the stations is decided by such factors as relations with the neighboring area, passenger demand, connection with other railway lines, and conditions of train operation.

The passenger demand of each station of RTR Line No.1 was estimated in the previous Parts. The main stations of Line No.1 will now be briefly described.

1. Baclaran Station (The south terminal station)

   The south terminal station at the completion of RTR Line No.1 construction is planned to be located at Baclaran. In the future, however, it will serve as a junction station, should the line be further extended toward the south or the airport branch be built.

   The proposed site of Baclaran Station is a south entrance to the metropolitan Manila area, and almost all motor traffic from the south enters Manila city at this entrance. Judging by the congestion of street traffic in Manila city, the commuters who use motor transports such as buses and jeepneys to commute between home and business and school will change for the railway at Baclaran Station, when Line No.1 is built.

   Since Baclaran Station will serve as the south terminal station, it will need a car park which will enable commuters to complete the trip into town by transfering from road traffic to railway. Baclaran Station will be appreciated by not only the commuters but also the citizens who visit the neighboring public market and Redemptorist Church which attract a huge number of visitors at specific day of every week. The daily passenger volume of Baclaran Station is estimated to be 78,000 persons in 1987 and 199,000 persons in 2000.

2. Stations along Taft Avenue

   Six stations are planned along Taft Avenue: North Baclaran, Libertad, Buendia, Vito Cruz, San Andres, and General Hospital. The passenger volume of each station is estimated at between 30,000 and 90,000 persons per day, and the station spacings range from 850 to 1,000 m. Libertad Station will become a transfer station when Line No.3 is built.

3. Rizal Park Station

   Rizal Park Station which is planned to be located at about the middle of RTR Line No.1 will serve as a center of political, economic and cultural activities in the Manila Metropolis. The passenger volume of this station is estimated at 61,000 persons per day in 1987 and 83,000 persons per day in 2000, but a far greater number of persons will change trains at this station when Lines No.2 and No.4 are built, and this station will play an important role as a transfer station of the three lines of No.1, No.2 and No.4.

4. Aduana and Divisoria Stations

   The Pasig river will be sandwiched in between the two stations. Aduana Station will be appreciated by passengers from the South Port district. The passenger volume of this station is estimated at 59,000 persons per day in 1987 and 80,000 persons per day in 2000. The North Port district, neighboring Divisoria Station, does not provide an excellent environment for the community people at present, but will be improved after regional redevelopment. Divisoria Station will be appreciated by passengers from the

North Port and San Nicolas districts. The passenger volume of this station is estimated to be 67,000 persons per day in 1987 and 79,000 persons per day in 2000.

Aduana Station will be located 1,710 m away from Rizal Park Station and 1,750 m away from Divisoria Station. These stations have to be spaced wide apart because of Rizal Park located between Rizal Park Station and Aduana Station and the Pasig river separating Aduana Station from Divisoria Station.

5. Tutuban Station

Tutuban Station of Line No.1 is planned to be located in front of Tutuban Station of the P.N.R. and to serve as a transfer station between Line No.1, the P.N.R. and the future Line No.5. This station will therefore handle a rather heavy traffic by the P.N.R. from the Navotas and Malabon districts north of Manila city. The passenger volume of this station is estimated at 152,000 persons per day in 1987 and 192,000 persons per day in 2000.

6. Far Eastern University Station

Far Eastern University Station is planned to be located between the Santa Cruz and Quiapo districts, heart of the old Manila and of the business district. Other than the terminal stations, Far Eastern University Station will handle the heaviest traffic. The station is proposed at the site of the old Manila Prison. This station will become a transfer station, when Line No.2 is built. The passenger volume of this station is estimated to be 149,000 persons per day in 1987 and 276,000 persons per day in 2000.

7. Antipolo Station

Antipolo Station is planned to be located at a point where Line No.1 intersects the P.N.R. at Espana. When the P.N.R. is improved and a new station is built at this point, it will become possible for passengers change trains between Line No.1 and the P.N.R. at this station. The passenger volume of this station is estimated to be 156,000 persons per day in 1987 and 252,000 persons per day in 2000.

8. Quezon Station

Quezon Station is planned to be located at 23 km near the Quezon Memorial and serve as a junction station, when Line No.3 is built.

9. Capital Center Station

Since the elevated line will not be permitted to cross the center of the Quezon Memorial, it will have to take a long way around the green area of the Quezon Memorial and the station is located at 24 km near the circular road. The neighboring area of Capital Center Station will become the center of the administrative district of Quezon city after completion of the proposed regional development.

10. University of the Philippines Station (North terminal station)

This station is planned to be located in front of the University of the Philippines. As the neighboring district is sparsely populated, the station will be used mainly by the students commuting to the University of the Philippines. After regional development of the Quezon district, however, the station will become the center of administrative and business activities, handling a heavy passenger volume. The passenger volume of this station is estimated to be 188,000 persons per day in 1987 and 316,000 persons per day in 2000.

11. Manila Airport Station

This will be the terminal station of the branch line if Line No.1 should be extended to Manila Airport. As both the domestic and international air terminals of Manila Airport are planned to be moved to new locations, the line should have junction access to the new terminal buildings. The plan of airport construction shows that the two terminal buildings for domestic and international services will be built 700 m apart from each other. Accordingly it is considered necessary to build two stations to serve passengers demand of both air terminals.

The daily passenger traffic of the two air terminals in both directions is estimated as shown below.

Station	Daily Passenger Volume	
	1987	2000
Domestic Air Terminal	11,936	16,591
International Air Terminal	25,364	33,685

These railway stations may be built at the air terminals by the time the new air terminal buildings are built for Line No.1 to cater for the passenger traffic of the airlines.

4.3.2 Station Facilities

1. Station Facilities

The stations of RTR Line No.1 are planned to be provided with the following facilities:

1) Ticketing
Ticket office, ticket gates, fare adjustment office and public address system
2) Station operation
Station office, resting room and utilities
3) Power supply and lighting
Electric room, power distribution room and battery room
4) Airconditioning and ventilation
Mechanical equipment room
5) Sanitation
Cesspool, sewage pump and sewage treatment tank
6) Fire prevention
Hydrants and water tank
7) Drainage facilities

2. Platform

1) Type of platform

Station platforms are divided into separate and island platforms. The merits and demerits of these platforms are summarized in Table 4.4.2.

The following stations of Line No.1 are planned to have an island platform: Baclaran Station, Rizal Park Station, Tutuban Station, Far Eastern University Station, University of the Philippines Station, and the future Domestic Air Terminal Station. The rest will have separate paltforms.

Table 4.4.2 Comparison between Separate and Island Platform

	Separate Platform	Island Platform
1. Track	Straight	Two reverse curves are generally needed.
2. Concourse	Unnecessary	Necessary
3. Station depth	Station can be built at a shallow depth.	Not only station but also the tunnel must be built at a great depth.
4. Station space	Station space can be efficiently maintained with a small area.	Station space cannot be efficiently minimized because of extra space required for the wide section of platform.
5. Station width	Station must be wide to accommodate facilities on either side of track.	Station need not be very wide.
6. Construction	Cheap	Expensive
7. Platform expansion	Easy	Difficult
8. Connection between opposite platforms	Underpass is necessary.	Easy
9. Efficiency of platform utilization	Low	High
10. Platform congestion	There is no passenger concentration due to simultaneous arrival of up and down trains.	There may be passenger concentration due to simultaneous arrival of up and down trains.
11. Ticket office and gate	Ticket office and gate are needed at least at two locations.	Ticket office and gate can be concentrated at one location.

2) Platform Length

The length of the platform is decided by the car length and train formation. As it was planned to eventually operate 6-car trains in 2000, the platform should be 130 m long, allowing for some extra margin at both ends. The stations which will have an island platform should be so designed as to permit platform expansion when the operation of 8-car trains is required as a result of traffic growth in the long future.

3) Platform Width

The platform width is decided by the following three factors, if the assumption is made that the passengers are evenly distributed to all doors of the train. They are (a) width required for boarding, (b) width required for walking of the boarding passengers, and (c) width required for walking of unboarding passengers.

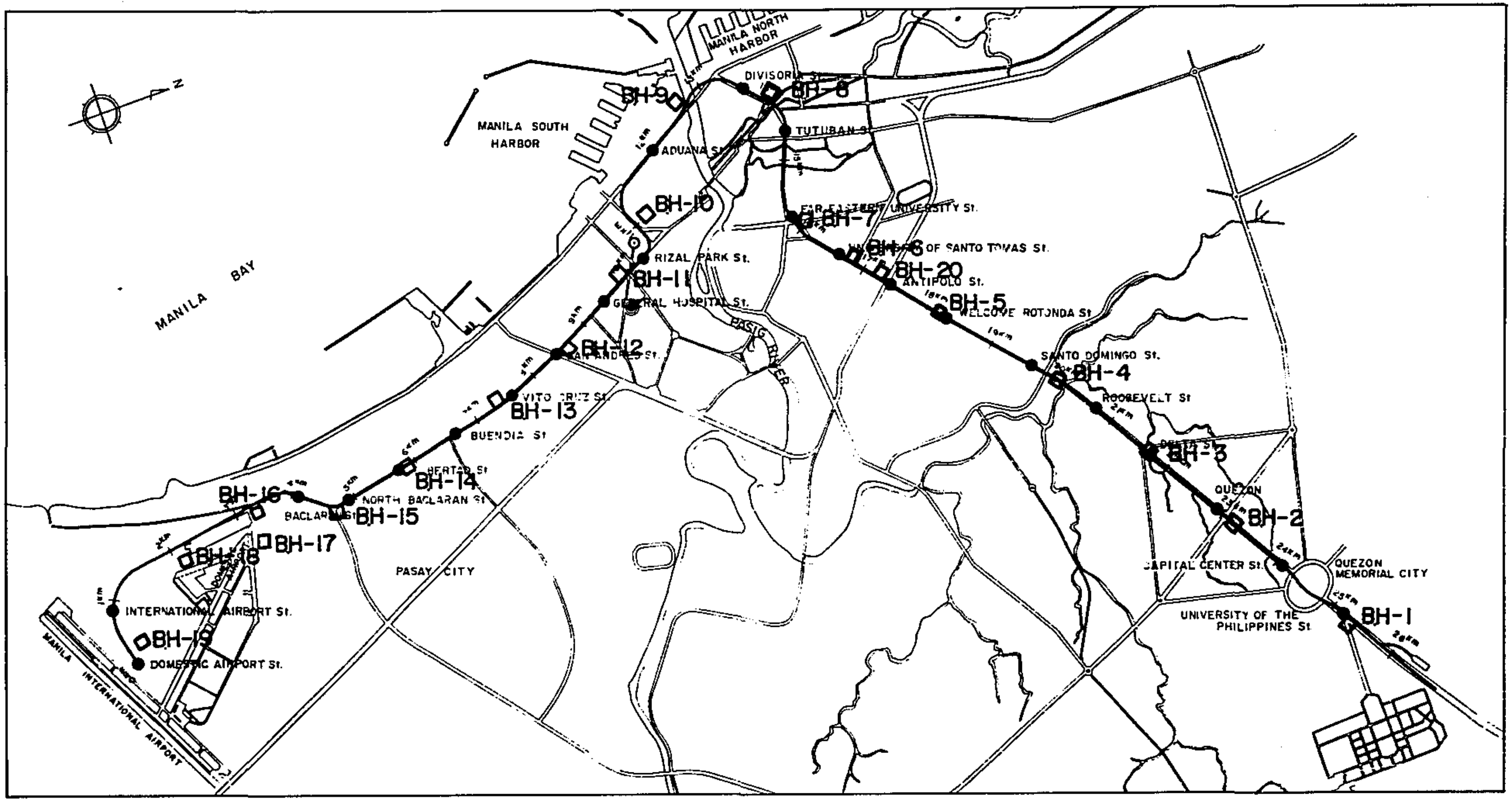


Fig. 4.4.11 Location of Bore Holes along RTR Line No. 1

With due considerations to these factors, the platform width is planned as follows:

Island Platform

12 m: Tutuban Station and University of the Philippines Station

10 m: Rizal Park Station and Far Eastern University Station

8 m: Baclaran Station (2 platforms in future), and the future Domestic Air Terminal Station

Separate Platform

7 m: University of Santo Tomas Station

6 m: Welcome Rotonda Station, Santo Domingo Station, and Delta Station

5 m: Other stations

4.4 STRUCTURE PLANNING

4.4.1 Soil Condition of the Proposed Route

In this study, soil exploration was carried out at 20 locations along the proposed route. However, since boring has been performed at wide spacings of about 1 km it is necessary to carry out a more detailed soil exploration including laboratory tests at the stage of detailed design.

Generally speaking, the vicinity of Quezon City and Pasay City in the neighborhood of Manila Airport is a tableland of diluvial soil composed of very hard silt with the value N reaching 50 or more. From the Pasig river to Rizal Park very soft alluvial soil composed of sand, clay and silt is deposited to a depth of about 20 m.

The soil data suggests that Manila city was at one time under the sea and that the creek surrounded by Quezon, Makati and Pasay cities was filled with silt and sand carried by water from the land, taking time to form the ground on which Manila city now lies.

The soil of the route of Line No.1 can therefore by roughly divided into diluvial deposits in the neighborhood of Quezon City and Pasay City and alluvial deposits in the neighborhood of Manila city.

The points of boring and the soil profile along the route are shown in Figs. 4.4.11 to 4.4.13, and the drilling log of No.9 boring hole near the Roxas Bridge of the Pasig river is shown in Fig. 4.4.14 as an example of alluvial deposits in Manila city.

The compact silt of diluvial deposits in Quezon City and Pasay City has a uni-axial shear strength of 80-95 kg/cm^2, and there seems little need to take into account ground water on Quezon city side.

From Espana through Rizal Park to Taft Avenue, however, the ground water level is as high as about 2 m below the surface. No pumping test was performed in this study, but there is no difficulty foreseen in removing water encountered during tunnel construction by pumping.

Fig. 4.4.12 BORE HOLE LOGS

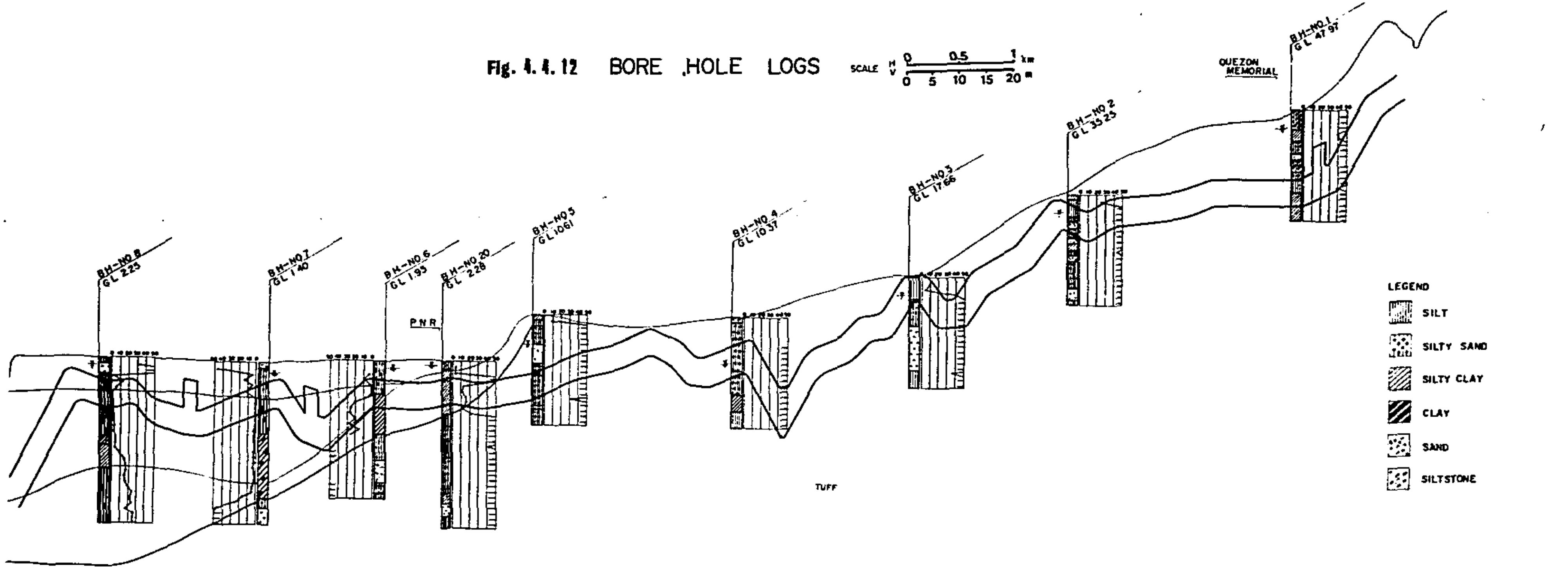


Fig. 4.4.13 BORE HOLE LOGS (CONT D)

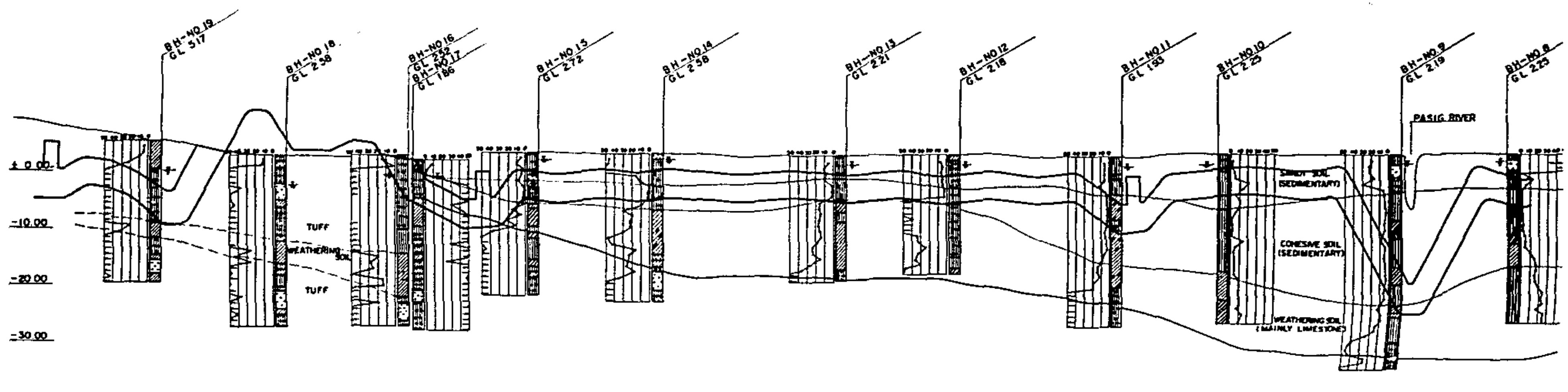
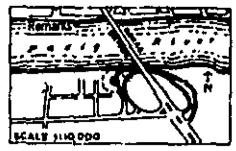


Fig. 4.4.14 Drilling Log



Name of Project MANILA RAPID TRANSIT LINE-1 | Type of Drilling PERGUSSION

Hole Number No. 9 | Elevation 2.19 m | Date MARCH 15-17, 1975

Location ROXAS BRIDGE | Water Table GL-1.50 m | Driller D T C I ( )

Elevation in m.	Depth in m.	Thickness	Type of Soil	Colour	Relative Density or Consistency	General Remarks
0.19	2.00	2.00	SILTY SAND	GRAY / BROWN	MEDIUM	FINE, WITH 2 CM MAX. SIGN OF GRAVEL; FINE TO COARSE, WITH 4 CM. MAX SIZE OF GRAVEL
-1.81	4.00	2.00	SAND	LIGHT GRAY	MEDIUM	FINE, WITH TRACES OF SEA SHELLS AND 5 CM MAX SIZE OF GRAVEL
-4.61	6.80	2.80	SILTY SAND		MEDIUM	FINE LOW TO NON-PLASTIC
-9.51	11.70	4.70	SILT	GRAY	SOFT / VERY SOFT	WITH TRACES OF SEA SHELLS
-11.71	13.90	2.20	CLAY		SOFT	WITH TRACES OF SEA SHELL HIGH PLASTICITY
-12.71	14.90	1.00	SILTY SAND			WITH TRACES OF HARDENED SILT AND SEA SHELL
-17.81	20.00	5.10	SILT	DARK GRAY	MEDIUM	HIGH PLASTIC WITH SILTSTONE & SHELL FRAGMENTS; WITH SHELL AND STONE FRAGMENTS HIGH PLASTICITY; W/ ORGANIC MATERIAL HIGH PLASTICITY
-20.81	23.00	3.00	CLAY		SOFT	WITH SEA SHELL AND ORGANIC MATERIAL HIGH PLASTICITY, WITH SAND
-24.41	26.60	3.60	SILT	DARK BROWN / LIGHT BROWN	MEDIUM / SOFT	WITH ORGANIC LAYER, HIGH PLASTICITY; WEATHERED LAYER HIGH PLASTICITY
-25.81	28.00	1.40	SILTY CLAY	ASH GRAY		ORGANIC LAYER HIGH PLASTICITY
-26.61	28.80	0.80	SILTY CLAY	Grayish BROWN		WEATHERED LAYER HIGH PLASTICITY
-31.61	33.80	5.00	SILT	DARK GRAY / Yellowish BROWN	STIFF	HIGH PLASTICITY; SANDY, WEATHERED LAYER MEDIUM TO LOW PLASTICITY
-34.61	36.80	3.00	SILTY SAND	LIGHT BROWN / DARK	DENSE	FINE, LOW TO NON-PLASTIC; W/TRACES OF SHELLS & SILSTONE
-35.81	38.00	1.20	SAND	GRAY	MEDIUM	FINE, NON-PLASTIC
-37.81	40.00	2.00	SILTY SAND	BROWN	DENSE	WITH 2CM. MAX SIZE OF GRAVEL, NON-PLASTIC
END OF BORING						

Standard Penetration Test or Core Recovery

Depth in m.	Sampling for Lab.	N-Value	Blows Per Each 10cm (1st)	(2nd)	(3rd)
0.70 / 1.00		19	3	4	12
1.70 / 2.00		22	9	7	6
2.70 / 3.00		21	12	5	9
3.70 / 4.00		17	7	5	5
4.70 / 5.00		30	16	9	5
5.70 / 6.00		7	3	2	2
6.70 / 7.00		5	1	2	2
7.50 / 8.00	UDS-1	SHELBY TUBE (PRESSED)			
8.70 / 9.00		3	1	1	1
9.70 / 10.00		2	1	0	1
10.50 / 11.00	UDS-2	SHELBY TUBE			
11.70 / 12.00		3	1	1	1
12.70 / 13.00		3	1	1	1
13.50 / 14.00	UDS-3	SHELBY TUBE			
14.70 / 15.00		9	1	1	7
15.70 / 16.00		4	2	1	1
16.50 / 17.00	UDS-4	SHELBY TUBE			
17.70 / 18.00		7	2	2	3
18.70 / 19.00		3	1	1	1
19.50 / 20.00	UDS-5	SHELBY TUBE			
20.70 / 21.00		3	1	1	1
21.70 / 22.00		3	1	1	1
22.50 / 23.00	UDS-6	SHELBY TUBE			
23.70 / 24.00		6	2	2	2
24.70 / 25.00		6	2	2	2
25.50 / 26.00	UDS-7	SHELBY TUBE			
26.70 / 27.00		12	3	4	5
27.70 / 28.00		9	3	3	3
28.70 / 29.00		9	3	2	4
29.70 / 30.00		13	4	4	5
30.70 / 31.00		14	3	5	6
31.70 / 32.00		25	7	8	10
32.70 / 33.00		40	9	20	11
33.70 / 34.00		43	12	15	16
34.70 / 35.00		45	14	15	16
35.70 / 36.00		43	12	13	18
36.70 / 37.00		26	7	9	10
37.70 / 38.00		27	7	9	11
38.70 / 39.00		50	15	30	5
39.70 / 39.80		50/10	50		

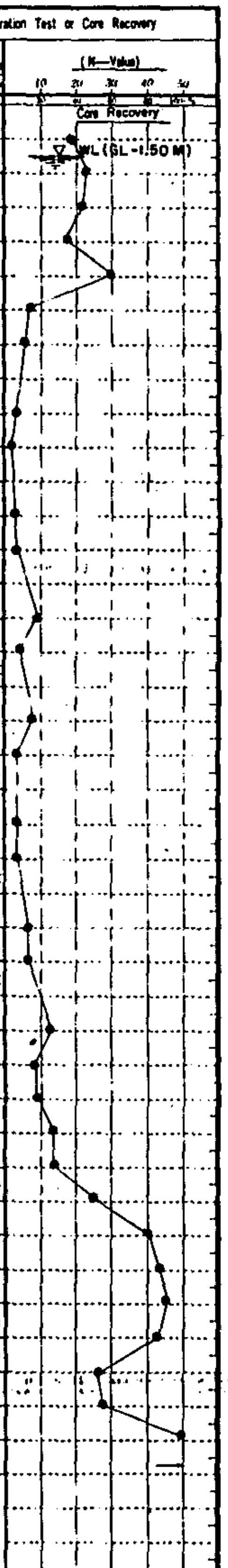


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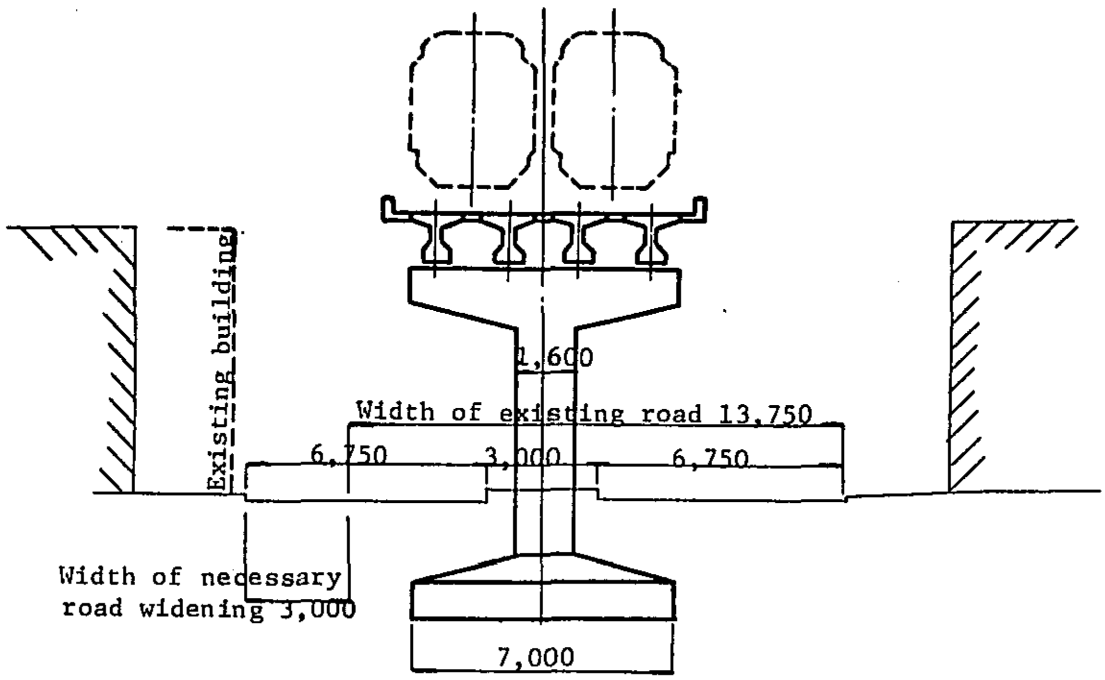
Fig. 4.4.15 Typical Cross Section of Elevated Section



4.4.2 Railway Structure

Studies had been made to determined whether RTR Line No.1 should be on the surface, underground or elevated as described below, from a technical point of view, with the considerations.

Surface Railway

The P.N.R. is built and operated at the ground level. However Line No.1 which is planned to carry 1.2 million persons per day and to be operated at train intervals of 2'30" during peak hours will completely interfere with road surface traffic at road crossings, if built on the surface. Thus it is easily seen that RTR Line No.1 on the ground level is entirely unpracticable. It may further be added that generally, a railway line may be built on the surface in the suburbs of a big city but is not practicable at all in the built-up urban area of heavy traffic and concentrated population.

Underground or Elevated Railway

For the reason mentioned above, underground and elevated railway structures were the two types for which detailed comparative studies were made for Line No.1 which is planned to be built in the metropolitan Manila area.

1. Underground Railway

    If the cost factor is not considered, then it is most desirable that Line No.1 should be built underground for the whole route. In point of fact, rapid transit railways have been built underground in the majority of world large cities. The subway does not interfere with road surface traffic or cause noise pollution. Unlike the elevated railway, there is little need to acquire land for road expansion. The biggest problem with the underground railway is that it is very expensive in construction cost.

2. Elevated Railway

    If the entire route of Line No.1 is elevated the construction cost will be largely minimized. It is obvious, however, that the elevated railway will cause various problems associated with the traffic and the environment of Manila city in the future, and this type of railway structure is not unconditionally recommendable.

    The compromise between the two types of railway structure is that Line No.1 should go underground in the built-up area of Manila city and be elevated above the surface in the suburban districts if possible. Specifically, the sections which are worth consideration for elevation are sections at Taft Avenue south of Vito Cruz and Quezon Boulevard north of Santo Domingo. The line, however should go underground within a radius of about 5 km from the center of Manila city.

    The merits and demerits of the elevated railway, as compared with the underground railway, are as follows:

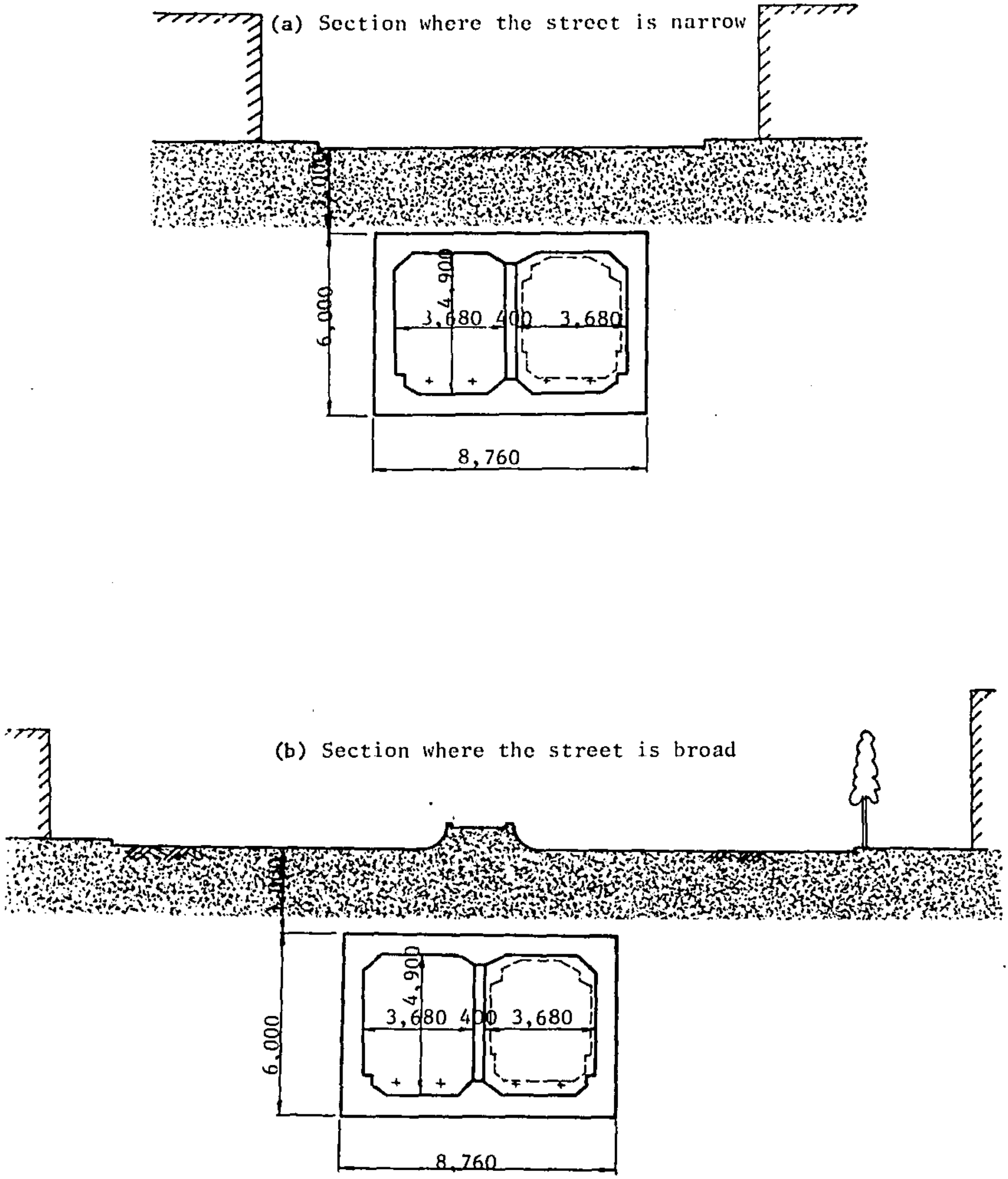
    (1) Construction cost

    The elevated railway is lower in construction cost.

    (2) Land

    Taft Avenue is only 13.5 m in width and has no median strip, thus affording no space for erection of the piers of the elevated structure. To erect the piers it is necessary to occupy a space of about 3 m wide at the middle of the road.

Fig. 4.4.16 Typical Cross Section of Interstation Section



Therefore, widening of the road is necessary and land must be acquired, resulting in an increase in construction cost.

(3) Operation

It may be necessary to suspend the operation of trains of the elevated railway during a typhoon.

(4) Environmental problems

The elevated railway is far more noisy than the subway, and the elevated structure over the entire length of the roads will be disagreeable to pedestrians, residents, neighborhood and road vehicle drivers. Especailly at the stations the whole width of the road will be shaded by the elevated structure.

The recommended alternative for RTR Line No.1 after detailed comparative studies is the partially elevated alternative whereby the section from Baclaran to Welcome Roponda is underground in structure while the remaining section up to U.P. is elevated. The structure are respectively described as follows:

a) Types of Elevated Structure

1. Standard Type Elevated Structure between Stations

As the greater part of the route of Line No.1 is above a street, the elevated structure is planned to be built with prestressed concrete piers to prevent street traffic disturbances. The standard span is planned at 20 m for an economic reason. The elevated structure of this type is supported on one row of piers erected in the median strip of the street. To support the elevated station, one pier is erected in the median strip, and two piers, in the sidewalks on both sides of the street. (See Fig. 4.4.15)

2. Special Type Elevated Structure between Stations

A special type elevated structure is required in the area where streets cross each other. In such an area the elevated structure is built with prestressed concrete girders to secure a span of 30 to 40 m. To cross the San Juan river, a steel bridge with a span is considered.

b) Tunnel Structure of Underground Section

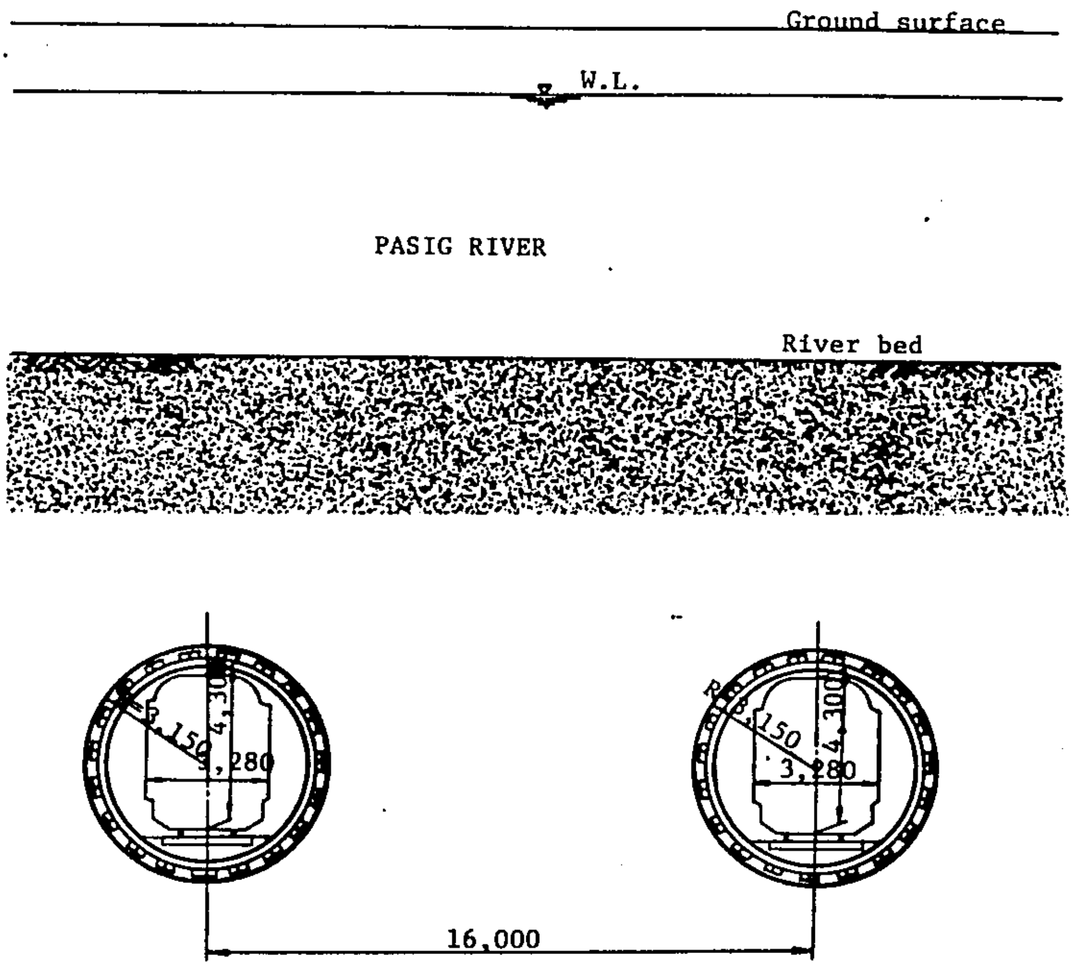
1. Standard Type Tunnel

The cross section of the standard type of tunnel structure is shown in Fig. 4.4.16.

2. Special Type Tunnel

A special type tunnel is planned to be respectively built across the Pasig river and the underpass in front of Far Eastern University. This is a circular tunnel to be driven by the shield method. Its cross section is shown in Fig. 4.4.17.

Fig. 4.4.17 Cross Section of Shield Tunnel Section



The detailed planning of the station structure requires to take into account whether the station is underground or elevated, the conditions of train operation, the crossing of other railways and roads, and the tunnel structure.

In this study the standard type of underground station structure has been planned to be a single-level structure with separate platforms, although two-level stations have also been considered for some of the stations.

Underground Two-Level Station

Baclaran Station	1 island platforms
	(May be increase to 2 in the future)
Rizal Park Station	1 island platform
	(May be increased to 2 in in the future)
Tutuban Station	1 island platform
Far Eastern Station	1 island platform
(Future Domestic Airport Platform)	1 island platform

Underground Single-Level Station

Stations other than mentioned above

Typical cross sections of the two-level and single-level underground stations are shown in Figs. 4.4.18 to 4.4.22.

Elevated Station

The elevated station is so planned that a concourse wide enough to permit station operation is built over the street and the track and platforms are built on the concourse. It is built with reinforced concrete piers and prestressed concrete girders, and the standard span will be 20 m. (Fig. 4.4.23)

Fig. 4.4.18 Typical Cross Section of Underground Two Level Station

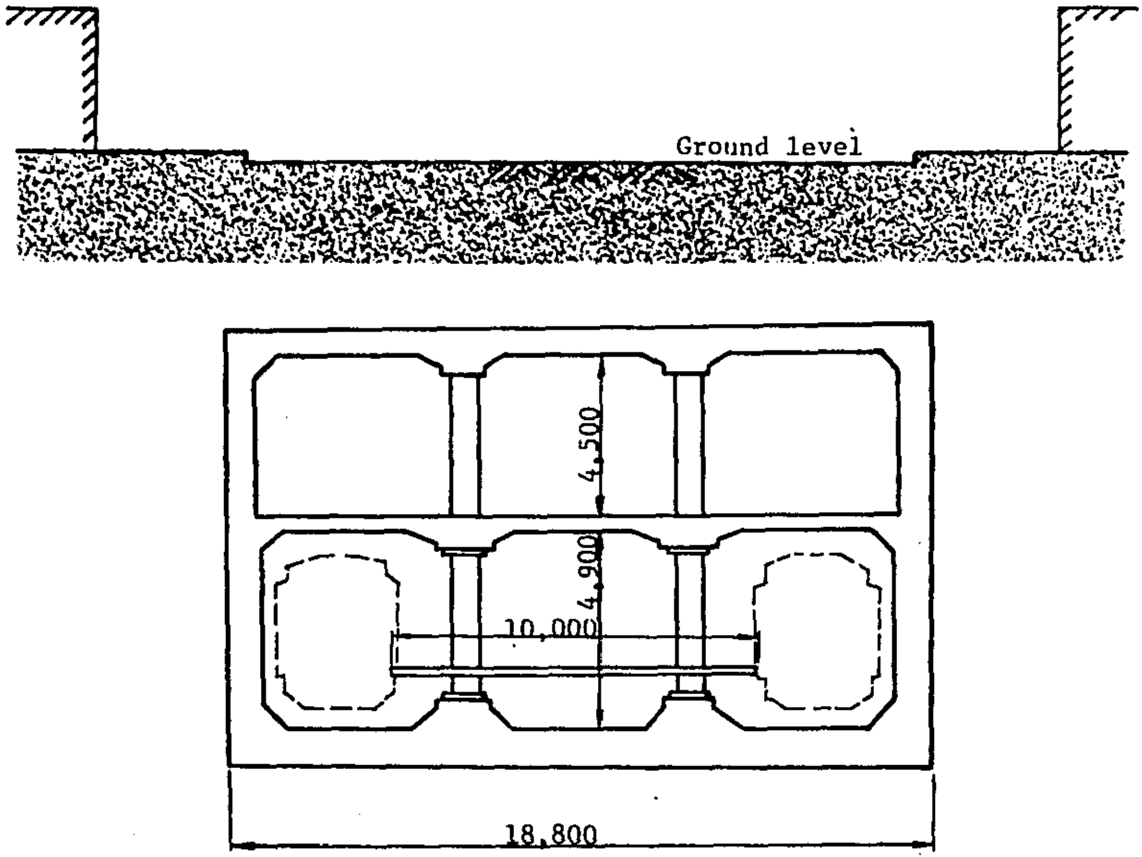
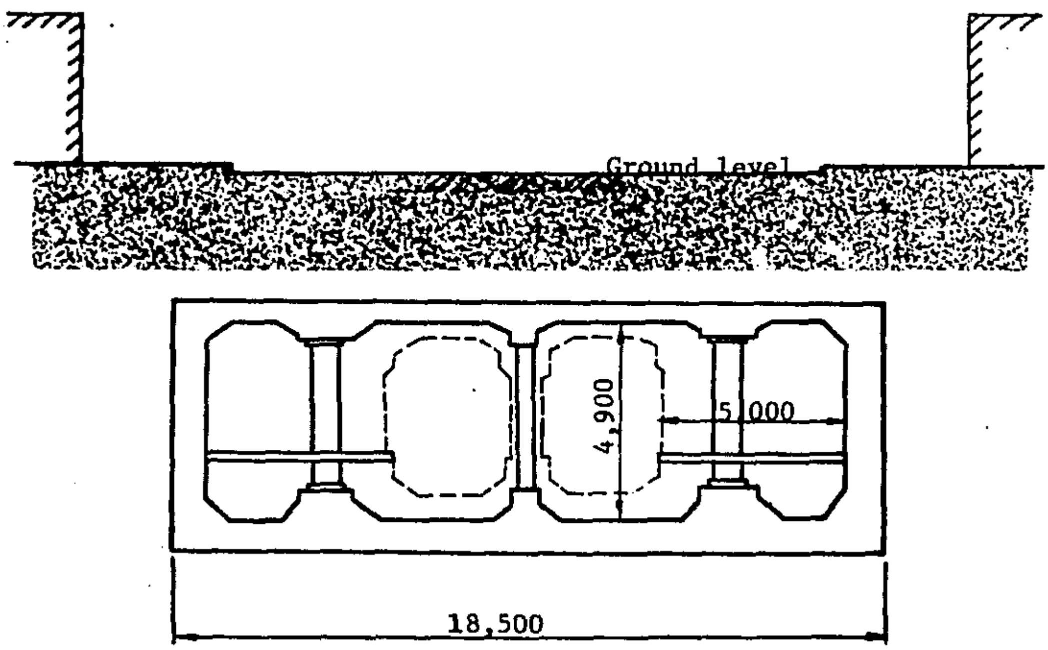


Fig. 4.4.19 Typical Cross Section of Underground Single Level Station



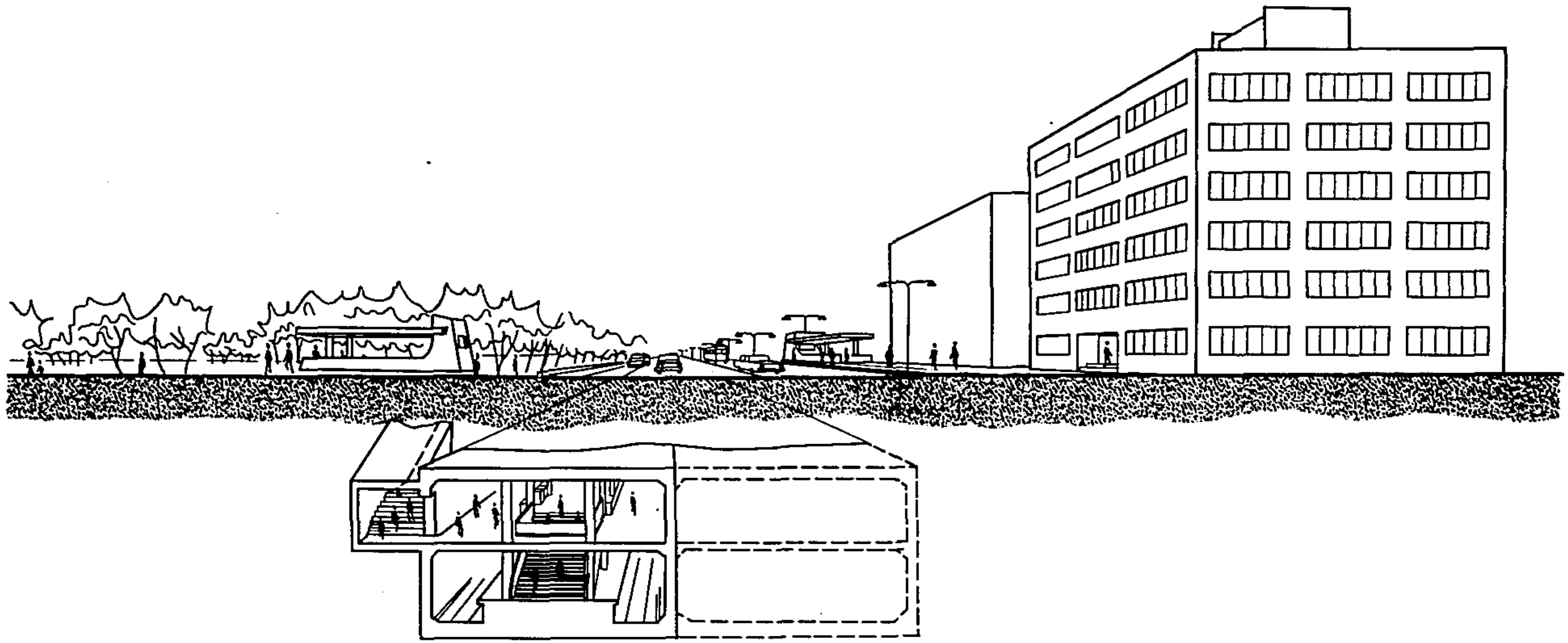


Fig. 4.4.20 Perspective of an Underground Railway

Fig. 4.4.21 Station Architecture Design Details: Underground Two Level Station

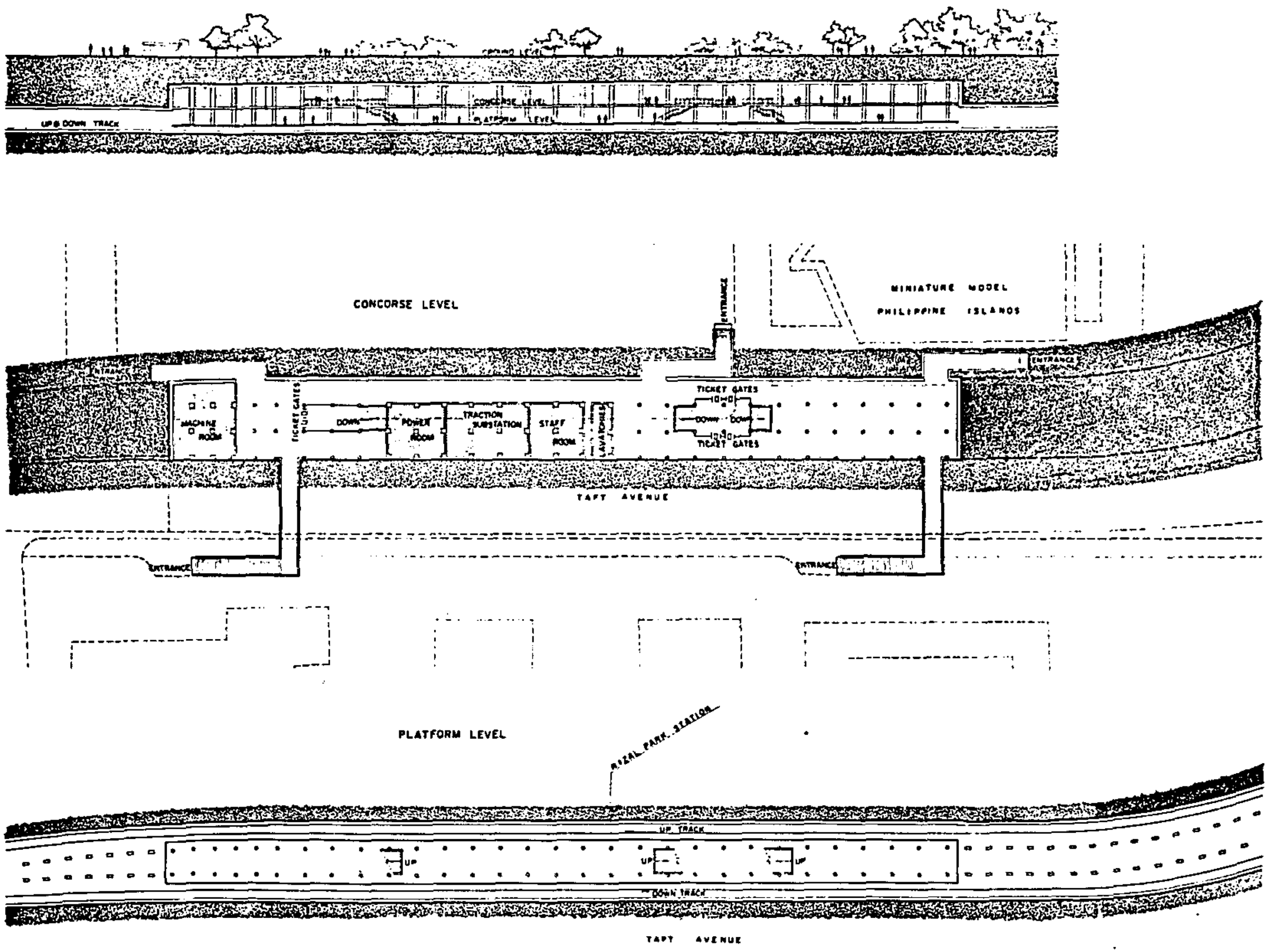
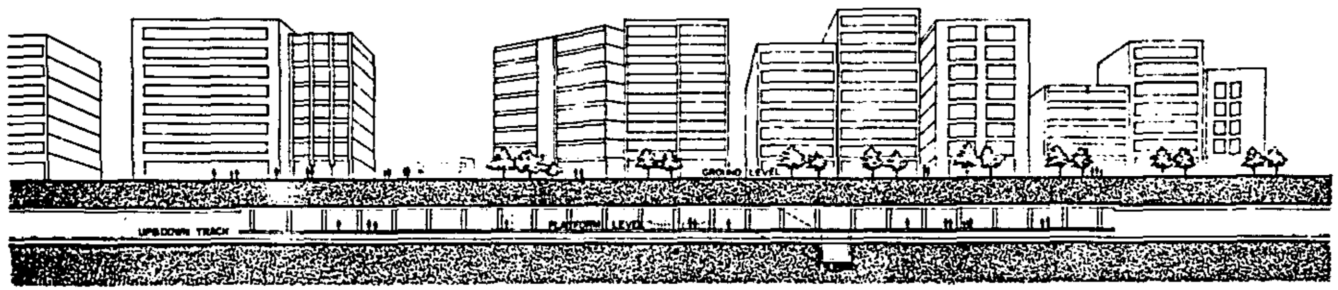


Fig. 4.4.22 Station Architecture
Design Details : Underground Single Level Station



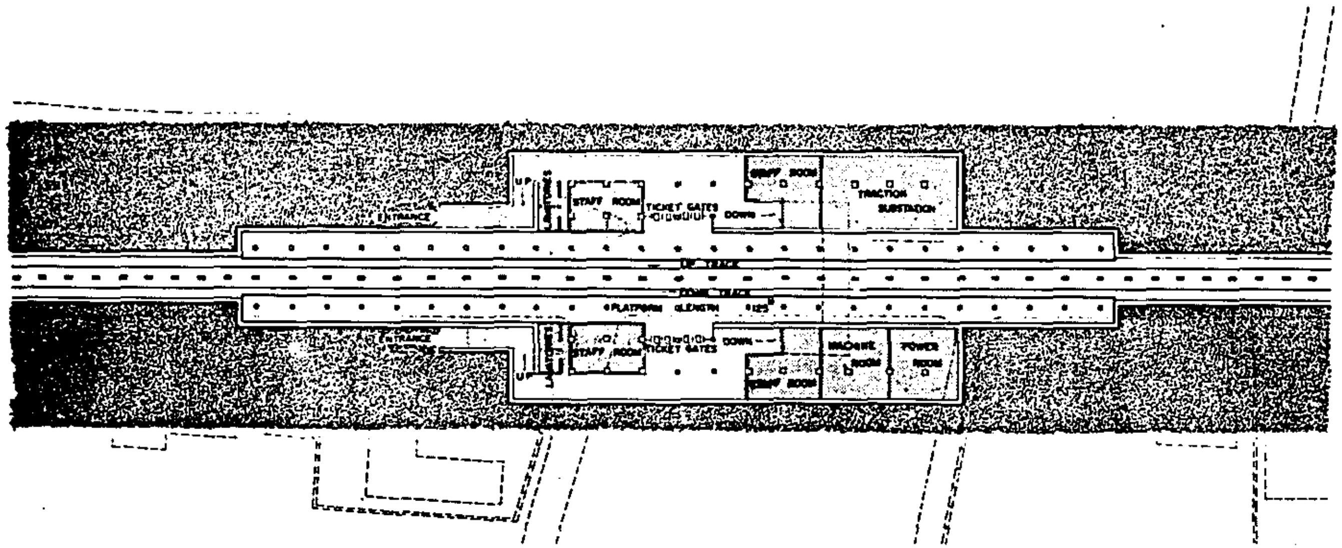
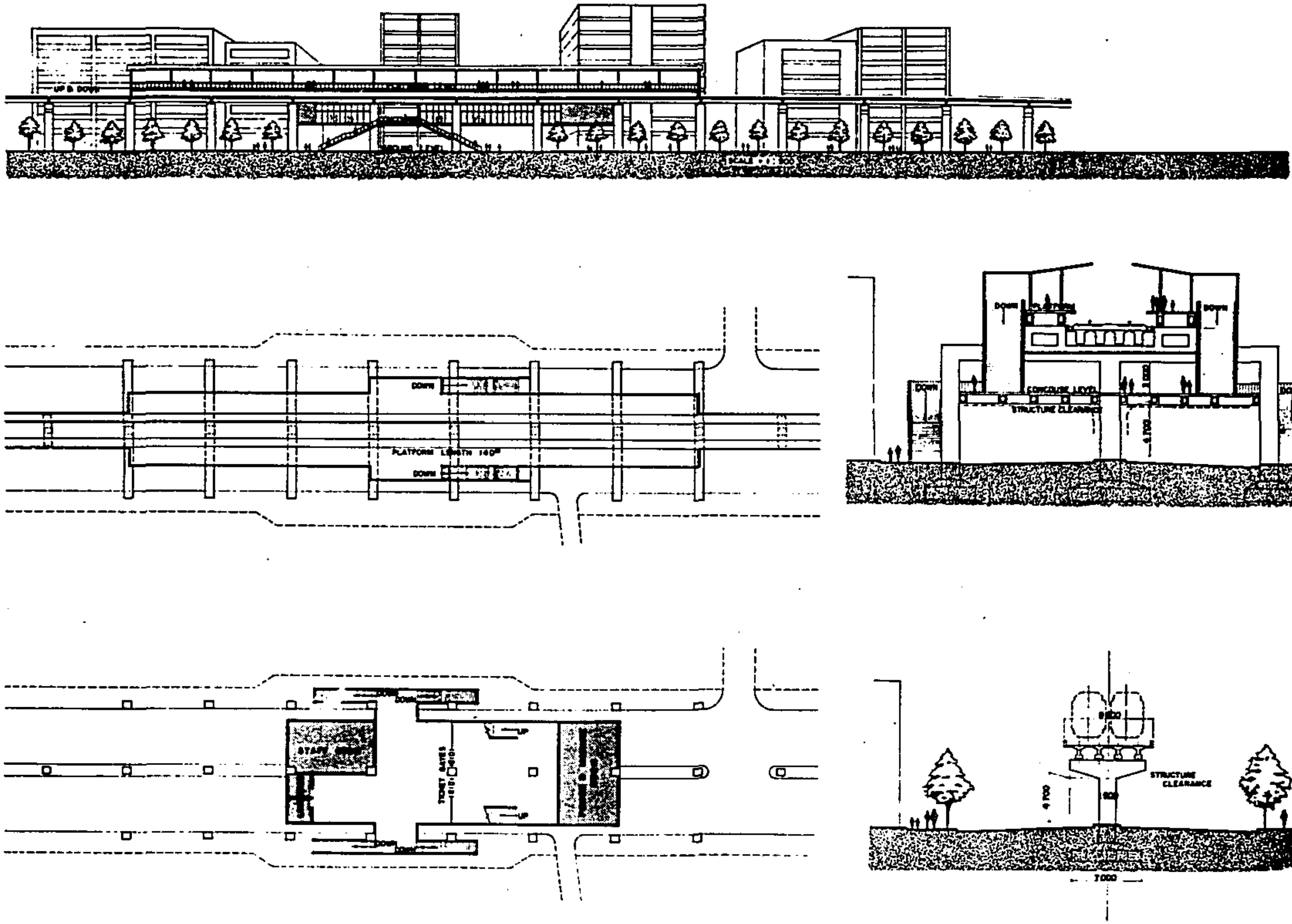


Fig. 4.4.23 Station Architecture
Design Details : Elevated Construction



4.5 VENTILATION AND AIR-CONDITIONING

4.5.1 Equipment

1. Ventilation Equipment

The structures of Line No.1 which need ventilation are the underground stations (including the platforms, concourses, station offices, machine rooms, and electric rooms), tunnels, and substations.

(1) Station

a) The platform is planned to be ventilated by a station air-conditioning system, introducing fresh air in a proportion of 30% for the separate platform and 30 m^3/h of fresh air per sq.m of floor area for the island platform.

b) The concourse is planned to be ventilated by introducing 10 m^3/h of fresh air per sq.m of floor area.

c) The station office will be ventilated by the station air-conditioning system, introducing 10 m^3/h of fresh air per sq.m of floor area.

d) The power and machine rooms are ventilated ten times per hour to maintain the room temperature within the permissible limits.

(2) Tunnel

a) Tunnel ventilation is effected by a longitudinal flow ventilation system and the air flow in the tunnel will be in the traffic direction.

b) The velocity of air in the tunnel is 2-3 m/sec.

(3) Substation

The substation is to be ventilated so that the room temperature does not exceed 40°C.

2. Air-conditioning Equipment

The structures which need air-conditioning are the platforms, concourses, station offices, administrative buildings, communication rooms, and power and machine room.

(1) Platform

a) The platform is so air-conditioned that the dry bulb temperature and relative humidity do not exceed 29°C and 70%, respectively, during the hottest days of the summer season.

b) The separate type platform is equally divided into two areas, and they are air-conditioned from two machine rooms built in the station concourse. Ducts are laid in the platform ceiling, sending fresh air downward. The island platform, however, is air-conditioned by a fan coil unit installed on the ceiling and a duct which introduces fresh air.

(2) Concourse

a) The concourse is so air-conditioned that the dry bulb temperature and relative humidity do not exceed 29°C and 60-65%, respectively, during the hottest days of the summer season.

b) The concourse is equally divided into two areas, and they are air-conditioned from two machine rooms. Ducts are laid in the ceiling of the concourse, sending fresh air downward.

(3) Station Office

a) The station office is so air-conditioned that the dry bulb temperature and relative humidity do not exceed 27°C and 60%, respectively, during the hottest days of the summer season.

b) An air-conditioning equipment is installed in the station office and fresh air is send downward from the duct laid in the ceiling.

(4) Water Cooling Tower

The cooling tower of water required for air-conditioning the platform concourse and station office is built on top of the building nearest the station.

3. Smoke Removal Equipment

Removal of smoke from the platform and concourse is effected by the ventilating equipment (exhaust fan), and that from the station office is by a special duct and exhaust fan.

(1) Platform

Removal of smoke from the platform is effected by the ventilating system, that is, return ducts and exhaust fans.

(2) Concourse

Removal of smoke from the concourse is effected by the ventilating system, that is, return ducts and exhaust fans.

(3) Station Office

Removal of smoke from the station office is effected by a special duct and exhaust fan.

(4) Tunnel

Removal of smoke from the tunnel is effected by the tunnel ventilating system, that is, fans and ventilation shafts.

4.5.2 Refrigerators

Refrigerators required may be broadly divided into the following two classes.

Final Load

Capacity	Quantity
300 tons of refrigeration	2
230 tons of refrigeration	2

Initial Load

Capacity	Quantity
360 tons of refrigeration	1
210 tons of refrigeration	1

4.6 ROLLING STOCK

The rolling stock which will serve Line No.1 must perform such functions as required of the commuter train and also meet specific conditions, because most of the line goes underground. The conditions which the cars must meet include the following:

(1) They should meet the traffic demand during the peak period and perform functions efficiently.

(2) They should afford tolerable riding comfort.
(3) They should be reliable and safe.
(4) They should be cheap to manufacture and should not require expensive ground facilities.
(5) They should be cheap to operate and maintain.
(6) They should be easy to operate and maintain.
(7) They should be non-combustible.
(8) They should not become obsolete in a short period of time.

Modern rolling stock which meets the requirements above have been studied on the basis of technical data taken from rich experience in rapid transit train operation in Japan.

4.6.1 Types of Cars and Train Formation

(1) The rolling stock of Line No.1 comprises motored cars (abbreviated as M) and trailers (T). Two motored cars constitute one powered unit one of which being a controlling car (abbreviated as Mc). The eight traction motors mounted on two motored cars are controlled as one group. The controlling equipment is mounted on one motored car, and the auxiliary power equipment on the other so as to minimize the car cost and make full use of the space under the car floor.
(2) In the initial stage of operation of RTR Line No.1, trains made up of 4-car formation, (Mc, M, M, Mc) will be operated, but trailers will be added with increasing traffic, so that in the later stage, trains of 6-car formation (Mc, M, T, T, M, Mc) will be operated.

4.6.2 Service Conditions

Table 4.4.3 Train Service Conditions

Item	Rating
Power supply	DC 750 V, third rail
Track gauge	1,435 mm
Maximum gradient	3.5% (main line)
Minimum curve radius	200 m (main line)

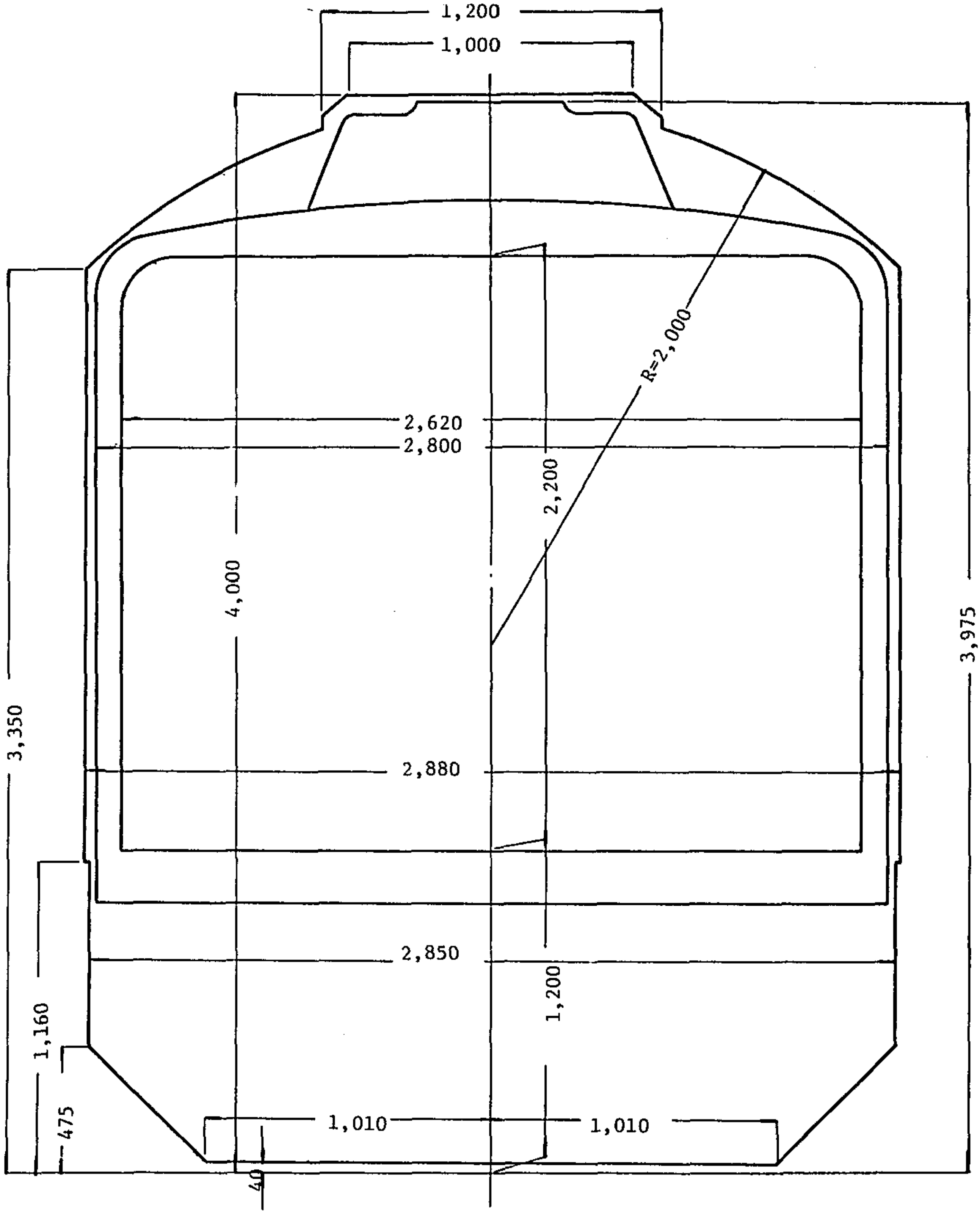
4.6.3 Car Gauge

It is desirable to minimize the car size in order to reduce the construction costs of the tunnel and stations. On the other hand, the cars must be large enough to meet the traffic demand with tolerable comfort. The car gauge is planned in consideration of these requirements, as shown in Figure 4.4.24.

4.6.4 Normal Passenger Capacity

The normal passenger capacity of a car can be defined as the total number of seated and standing passengers who are carried by one car, which is provided with suitable safety supports like straps and support bars for standing passengers. The normal passenger

Fig. 4.4.24 Cross Sectional Elevation of Car



capacity is planned, as shown in Table 4.4.4, so as to secure minimum floor space required by the standing passengers when the passenger load coefficient is 190%.

Table 4.4.4 Normal Passenger Capacity

(Persons)

Item		Head Car	Intermediate Car	Train Capacity (6 cars)
Normal Passenger Capacity	Seated	50/car	58/car	332
	Standing	82/car	86/car	508
	Total	132/car	144/car	840
Planned Maximum Passenger Capacity	Seated	50/car	58/car	332
	Standing	200/car	216/car	1,264
	Total	250/car	274/car	1,596

4.6.5 Appearance and Dimensions of the Car

(1) Dimensions and arrangement

The dimensions of the car and the arrangement of doors, windows, seats, driver's cab, and so forth are shown in Figs. 4.4.25 and 4.4.26.

The ceiling height of the compartment is great enough to afford good riding comfort. The distance from the top-of-rail level to the floor is great enough to provide sufficient space to accommodate the under floor equipments.

The car length and width are planned to be the same as those of the most widely used cars in order to reduce the car cost. Each car is provided with four doors on either side to accomplish quick loading and unloading at the station, thus minimizing the door open time.

(2) Distance between bogie centers

The distance between bogie centers is so decided that the excursion on a curved track does not differ from the car center to the car ends.

(3) Coupler

The two cars (Mc and M) of one powered unit are connected with a semi-permanent coupler. Other ends of the powered unit and trailer are connected with automatic tight lock couplers which can be easily connected and disconnected.

(4) Axle load

The car equipment are so arranged that the load is distributed on all wheels as uniformly as possible and the maximum axle load of a fully loaded car does not exceed 17 tons.

4.6.6 Specifications and Performance of the Rolling Stock

(1) Basic Performances

The performances of the rolling stock which have been determined in consideration of the conditions of the ground structures and facilities are shown in Table 4.4.5.

Fig. 4.4.25 Plan and Sectional Elevation of Head Car

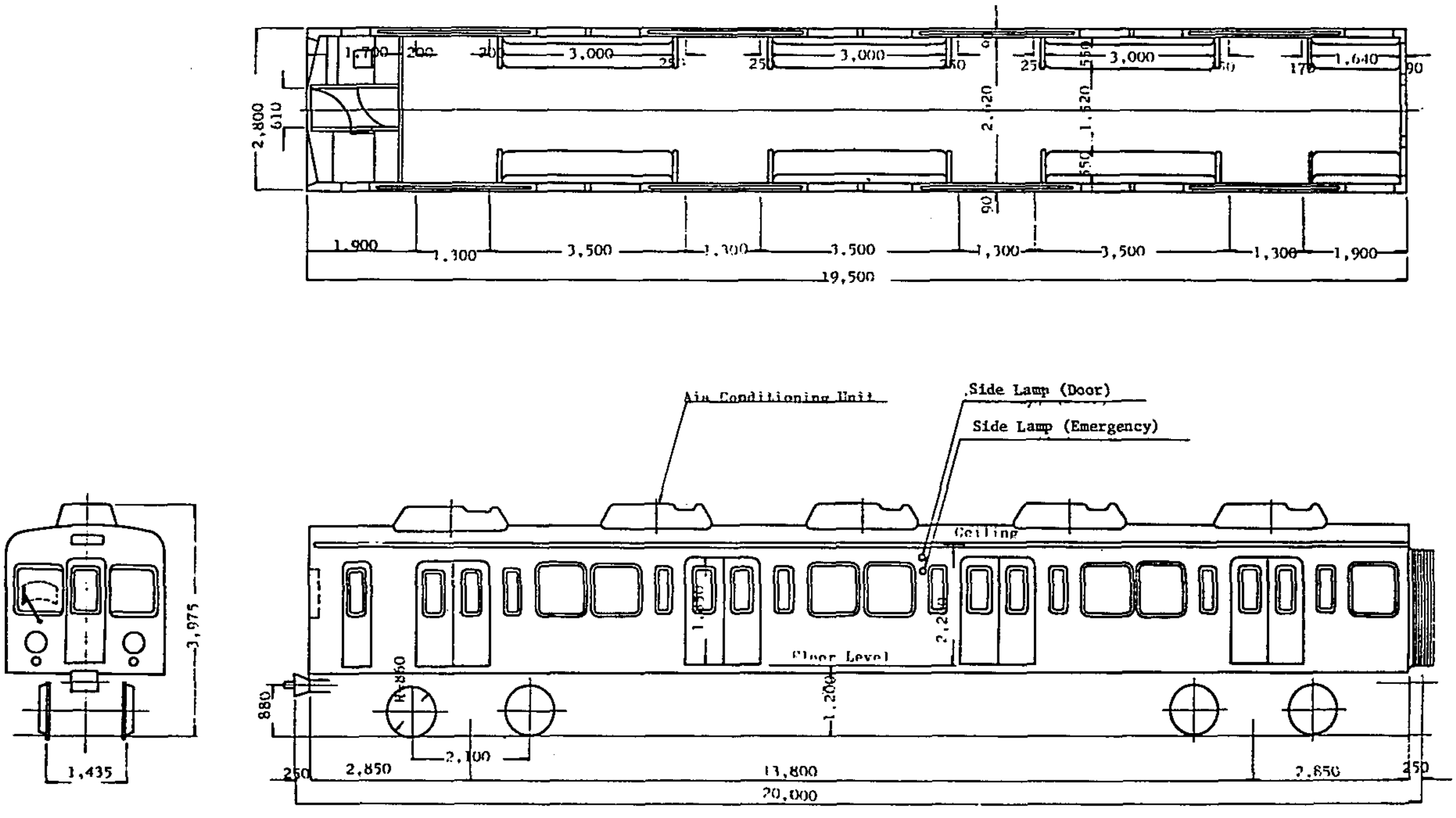


Table 4.4.5 Specifications of the Rolling Stock

Item	Rating	Remarks
Maximum speed	80 km/h	
Acceleration	3.2 km/h/s	Standard acceleration rate on flat, straight track
Deceleration	3.5 km/h/s	Standard deceleration rate on flat, straight track
Deceleration	4.0 km/h/s	Emergency stop
Scheduled speed	33 km/h	

(2) Interior Accommodations of Cars

The interior accommodations of cars are so arranged that the cars will carry passengers in a safe and comfortable manner.

a) The majority of car materials are fire-proof so as to prevent fire hazards inside the tunnel, and such materials as fabrics which cannot be made fire-proof are at least non-combustible.

b) The cars are provided with double leaf sliding doors which are operated electrically by commands from the driver's cab and have provisions for exit during emergencies.

c) The side windows are manually operable from inside the car.

d) Signaling and voice communication are provided between the driver and the conductor, and a compartment public address system is also provided. All these communication systems can be operated by a standby power source in the event of a main power failure.

e) A passageway is provided on each end of the car so that passengers can move from one car to the other safely.

f) A standby power source is provided in case of a main power failure to ensure that emergency devices and lights become operable.

g) Emergency pneumatic brakes which can be mainpulated by passengers are provided in case of an emergency, and an RF voice communication system is provided in the driver's cab to call the substation, central control room, and power control room.

h) A divan affording a space 400-430 mm wide for each passenger is provided on each side of the car, and straps are suspended from the ceiling for standing passengers.

(3) Bogie

The bogie carries the car body on the rails in a safe manner, and air springs and oil dampers are used in the swing bolster device to improve the riding quality. An axle box support is provided to prevent the uniaxle lateral movement of the car, and the traction motor is mounted on the bogie frame to minimize the unsprung load. All these provisions serve to minimize the vibrations and shock from the running car.

(4) Main Systems

The control and brake systems of cars are shown in Table 4.4.6.

Fig. 4.4.26 Plan and Sectional Elevation of Intermediate Car

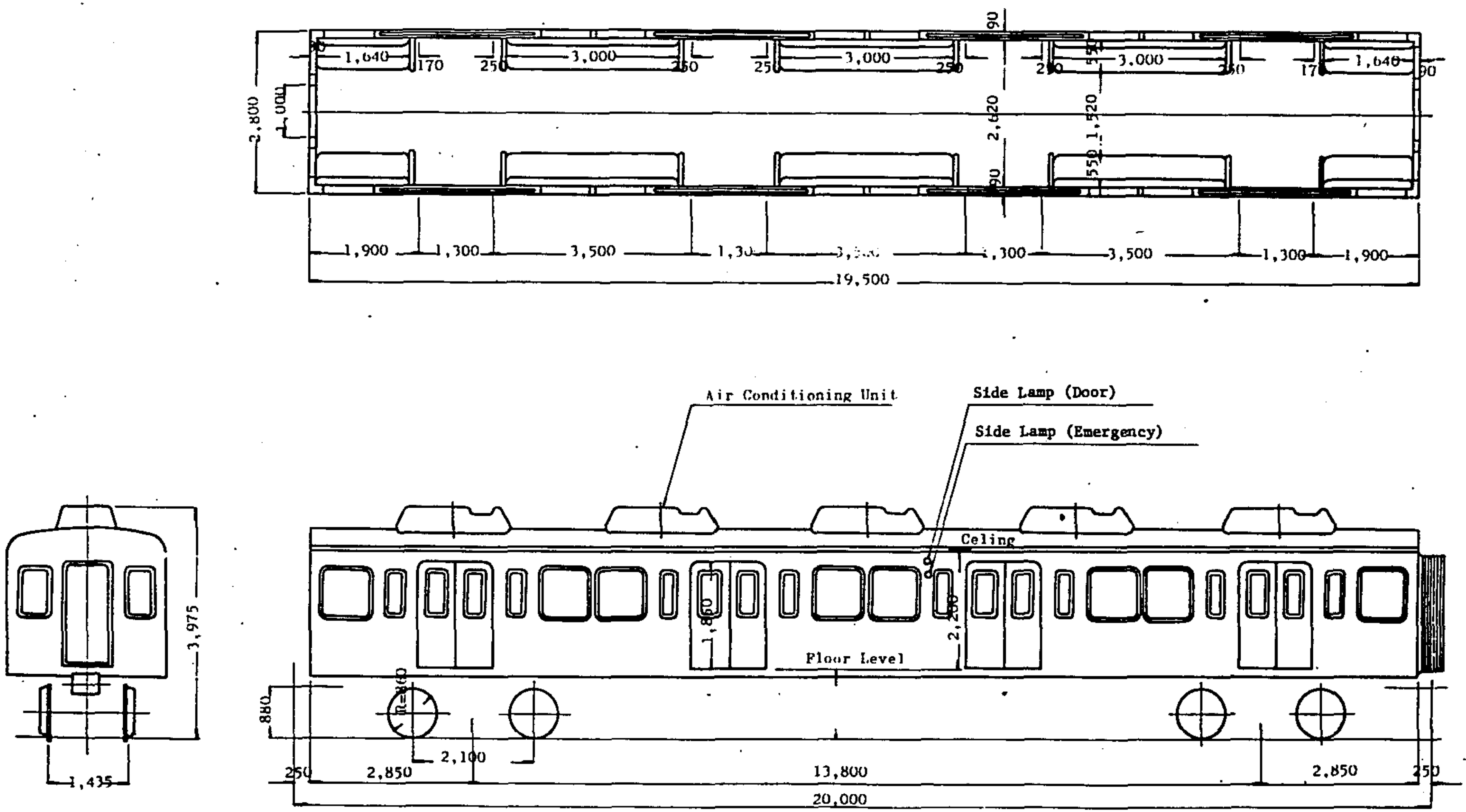


Table 4.4.6 Main Car Systems

Item	Description
Control System	Thyristor chopper control system with regeneration brakes
Brake System	Electro pneumatic chopper regeneration brakes
Safety System	Automatic train control system

a) Control system

The thyristor chopper control system which will be used in the cars is taking the place of the conventional rheostatic control system becuase of the following advantages.

(a) As the thyristor chopper control system is notchless, it does not give rise to a rapid change in current flow so that it improves the riding comfort.

(b) It improves the car adhesion.

(c) It permits the use of regeneration brakes.

(d) It saves a lot of power.

(e) It does not produce much heat in the tunnel so that the tunnel temperature can be held down.

(f) As the main circuit is contactless, the system is cheap to maintain.

The car of this control system is more expensive to manufacture than the car of the conventional rheostatic control system, but it pays for itself in operating savings.

b) Brake system

As the thyristor chopper control system makes it possible to use regeneration brakes, the electro pneumatic brakes with regeneration brakes will be used in the cars. The brake system is so designed that automatic pneumatic brakes are applied in an emergency.

c) Safety system

Should train speed exceed the planned running speed in a section, the brakes are automatically applied through remote control of the switches and signals from a central point to reduce the speed below the permissible level, thus avoiding accidents. This system is called "Automatic Train Control" (ATC).

(5) Train Operation

The trains are usually operated at the scheduled speed of 33 km/h (station dwell time: 30 sec in the main stations and 20 sec in other stations) with a 10% margin of recovery. The car drive is so designed that even if the circuits of 50% of the traction motors are opened on an ascending curve of 200 m in radius having a gradient of 3.5%, the motors are started again to complete the rest of the journey to the next station.

(6) Air-conditioning

The cars will not be air-conditioned at the initial stage of train operation, but will be so designed that they can bear air-conditioning equipments on top of their roofs to improve the passenger service in the future.

(7) Specification of the Rolling Stock

The specification of the rolling stock is shown in Table 4.4.7.

Table 4.4.7 Specification of the Rolling Stock

Item	Specification
1. Type and weight (empty)	
T	Approx. 35 tons (air-conditioned)
M	Approx. 40 tons (air-conditioned)
Mc	Approx. 40 tons (air-conditioned)
2. Passenger load	Mc / M / T
	Seats: 50 / 58 / 58 (persons)
	Normal passenger capacity: 132 / 144 / 144 (persons)
	Crush capacity: 360 / 387 / 387 (persons)
	(Weight): (20.5) / (22) / (22) (tons)
	Average passenger weight: 57 kg (including baggage)
3. Car body	Paint-finished, light-weight steel construction
(1) Distance between coupling faces	20,000 mm
(2) Car body length	19,500 mm
(3) Car body width	2,800 mm
(4) Car height (top-of-rail level to top of air-conditioning equipment)	3,975 mm
(5) Car floor height (top-of-rail level to floor)	1,200 mm
(6) Compartment height (floor to ceiling)	2,200 mm
(7) Distance between bogie centers	13,800 mm
(8) Doors	4 double leaf sliding doors on each side
4. Bogie and transmission	
Bogie	Air spring bogie built with welded steel construction
Transmission	Cardan Type driving device
Fixed wheel base	2,100 mm
Wheel diameter	860 mm
5. Power collection system	Third rail (top contact type)
6. Traction motor	
Type	Bogie-mounted, self-ventilated DC series motor with interpoles

Table 4.4.7 (cont'd)

Item		Specification
1-hour ratings	Output	Approx. 150 KW
	Voltage	375 V
	Current	Approx. 440 A
7. Traction control system		Thyristor chopper control and regeneration brake
8. Motor generator		Output: Approx. 20 KVA
9. Motor-driven air compressor		12 KW (30-minute rating)
10. Signaling system		ATC
11. Brake system		
Service brake		Electric and pneumatic chopper regeneration brakes
Emergency brake		Pneumatic brake
12. Coupler		Tight lock couplers and semi-permanent bar couplers
13. Lighting		Average compartment light intensity: 300 luxes (at a height of 750 mm from floor)
14. Air-conditioning (to be provided in the future)		Roof-mounted unit coolers

4.7 POWER SUPPLY

4.7.1 Power Supply Condition

In the Philippines, National Power Corporation (HPC) is the main organ which not only plans and builds the major power stations, transmission lines and substations but supplies power to various islands including Luzon, Mindanao, and Visayas islands. However, Manila Electric Company (MERALCO) which has a total installed capacity of 1,517 MW (15 MW hydraulic, 1,502 MW thermal) as shown in Table 4.4.8, supplies power to such big load centers as Greater Manila area (Manila city, Quezon city, Pasay city, Paranaque, Taguig, Makati, Mandaluyong, San Juan, Pasig, Caloocan, Malabon and Navotas) and part of Rizal, Bulacan, Cavite, Laguna, and Quezon. NPC has an installed capacity of 644 MW (419 MW hydraulic, 225 MW thermal) in Luzon island as shown in Table 4.4.9. Both companies reciprocate power supply to cover their service areas.

On the other hand, power demand in 1974 was 1,033 MW in the service area of MERALCO and 388 MW in the service area of NPC. At present, therefore, both NPC and MERALCO have a surplus in the power supply.

Table 4.4.8 Installed Capacity of the Power Stations of MERALCO

(1974)

Power Station	Type of Power Generation	Installed Capacity (MW)
Botocan	Hydraulic	15
Blaisdell	Thermal	32
Tegen	Thermal	220
Rockwell	Thermal	315
Gardner	Thermal	385
Snyder	Thermal	550
Total		1,517

Table 4.4.9 Installed Capacity of the Power Stations of NPC in Luzon Island

(1974)

Power Station	Type of Power Generation	Installed Capacity (MW)
Ambuklao	Hydraulic	75
Binga	Hydraulic	100
Angat	Hydraulic	212
Bataan	Thermal	225
Caliraya	Hydraulic	32
Total		644

The future power demand and expansion plans of MERALCO are shown in Table 4.4.10. The company has a plan to build thermal power stations of a combined capacity of 720 MW by 1978 but has no expansion plan thereafter. NPC, on the other hand, plans to build hydraulic, pumping-up, geothermal, thermal and nuclear power stations as shown in Table 4.4.11. Of these power stations, pumping-up power stations are planned to utilize excess power of other power stations during low demand hours. With that excess power, water is pumped up and stored in upper dam and utilized for peak demand hours. With this integrated power supply system, NPC intends to meet all power demand of Luzon Island. The power demand in Luzon island in 1985 is estimated at about 3,000 MW, whereas the total installed capacity of NPC is expected to increase to about 5,000 MW by that year. Accordingly, the power supply to the existing substations and transmission lines which is too small for the heavy load of the subway will have to be increased on a large scale.

Table 4.4.10 Estimated Power Demand and Plans of Expansion of MERALCO

Fiscal Year	Estimated Power Demand (MW)	Station or Unit Planned	Type of Power Generation	Installed Capacity (MW)	Total Capacity (MW)
1974	1,033	Existing stations	Thermal Hydraulic		1,502 15 1,517
1975	1,057	Malaya No.1	Thermal	330	1,847
1976	1,143.1				1,847
1977	1,233.9				1,847
1978	1,327.9	Malaya No.2	Thermal	390	2,237
1979	1,426.5				2,237
1980	1,529.5				2,237
1981	1,637.5				2,237
1982	1,749.5				2,237
1983	1,868.1				2,237

Note: MERALCO has no plan of capacity expansion after 1978.

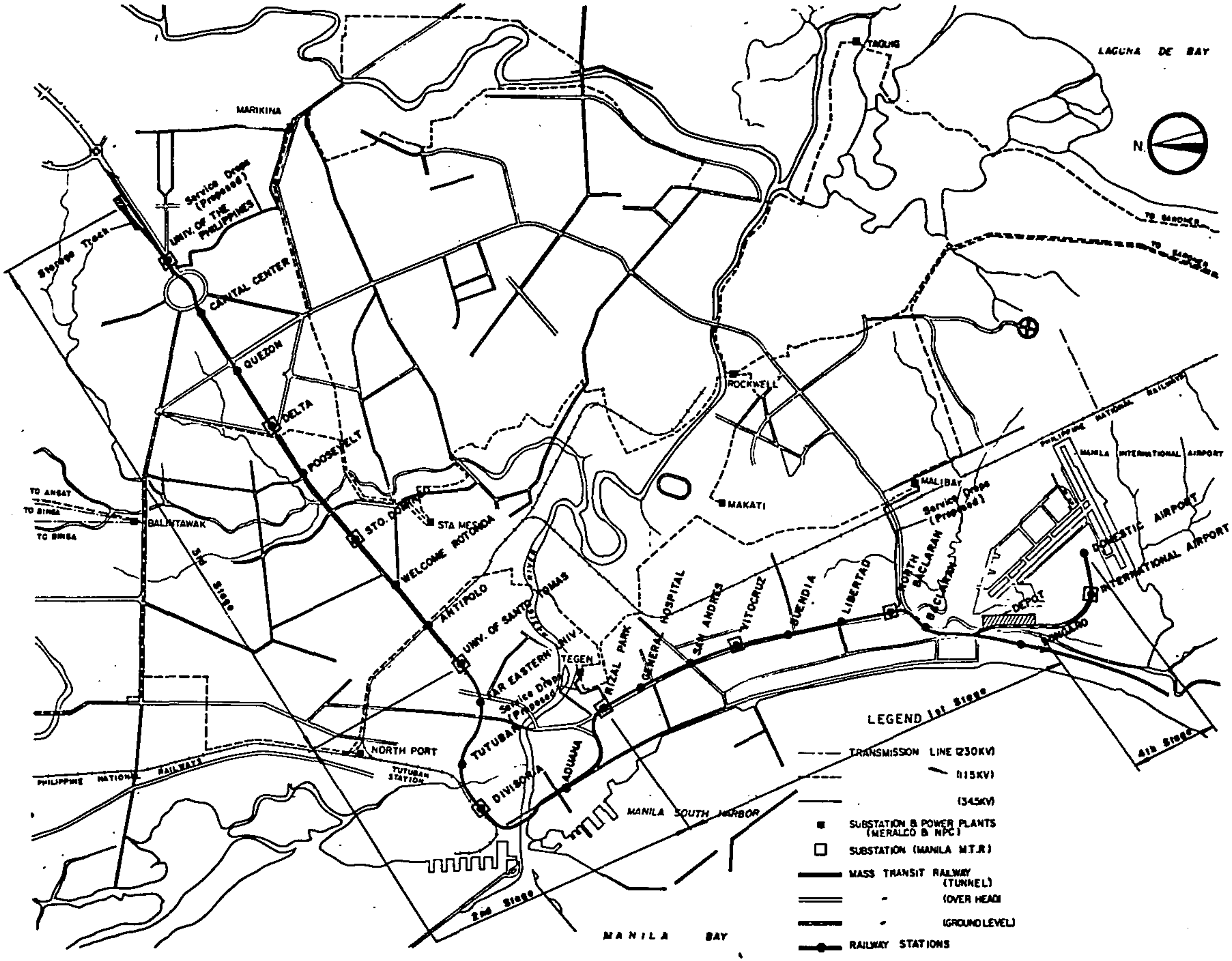


Fig. 4.4.27 Outline Diagram of Power Supply System for Recommended Alternative

Table 4.4.11 Estimated Power Demand and Plans of Expansion of NPC

(Luzon Island only)

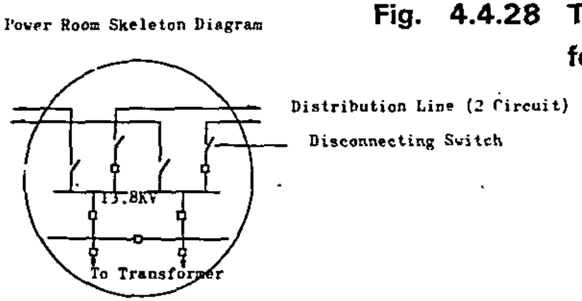
Fiscal Year	Estimated Power Demand(MW)	Station or Unit Planned	Type of Power Generation	Installed Capacity (MW)	Total Capacity (MW)
1974	388	Existing stations	Hydraulic Thermal		419 225) 644
1975	452				644
1976	512				644
1977	612	Bataan No. 2	Thermal	150	794
1978	675	Pantabangan No. 1 2	Hydraulic	100	894
1979	731	Kalayaan No. 1 Tiwi No. 1	Pumping-up Geothermal	150 50	1,044 1,094
1980	801	Kalayaan No. 2 Tiwi No. 2	Pumping-up Geothermal	150 50	1,244 1,294
1981	868	Magat No. 1 4 Tiwi No. 3 4 Blaisdell (retired)	Hydarulic Geothermal Thermal	200 100 -50	1,494 1,594 1,544
1982	1,003	Magat No. 5 6 Tiwi No. 5 6	Hydraulic Geothermal	100 100	1,644 1,744
1983	1,058	Sadanga No.1 4 Tiwi No.7 8	Hydraulic Geothermal	240 200	1,984 2,184
1984	1,139	Bagac No. 1 Sadanga No.5 6	Nuclear Hydraulic	600 120	2,784 2,904
1985	1,224	Tiwi No. 9	Geothermal	100	3,004
1986		Bagac No. 2	Nuclear	600	3,604
1987		Kalayaan No. 3	Pumping-up	150	3,754
1988		Ternate No. 1	Nuclear	600	4,354
1989		Kalayaan No. 4	Pumping-up	150	4,504
1990		Ternate No. 2	Nuclear	600	5,104

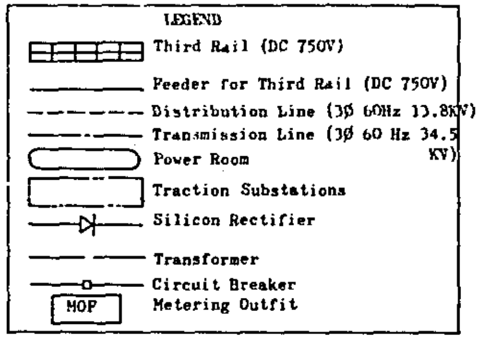
Note: Power demand is not estimated for the years after 1985.

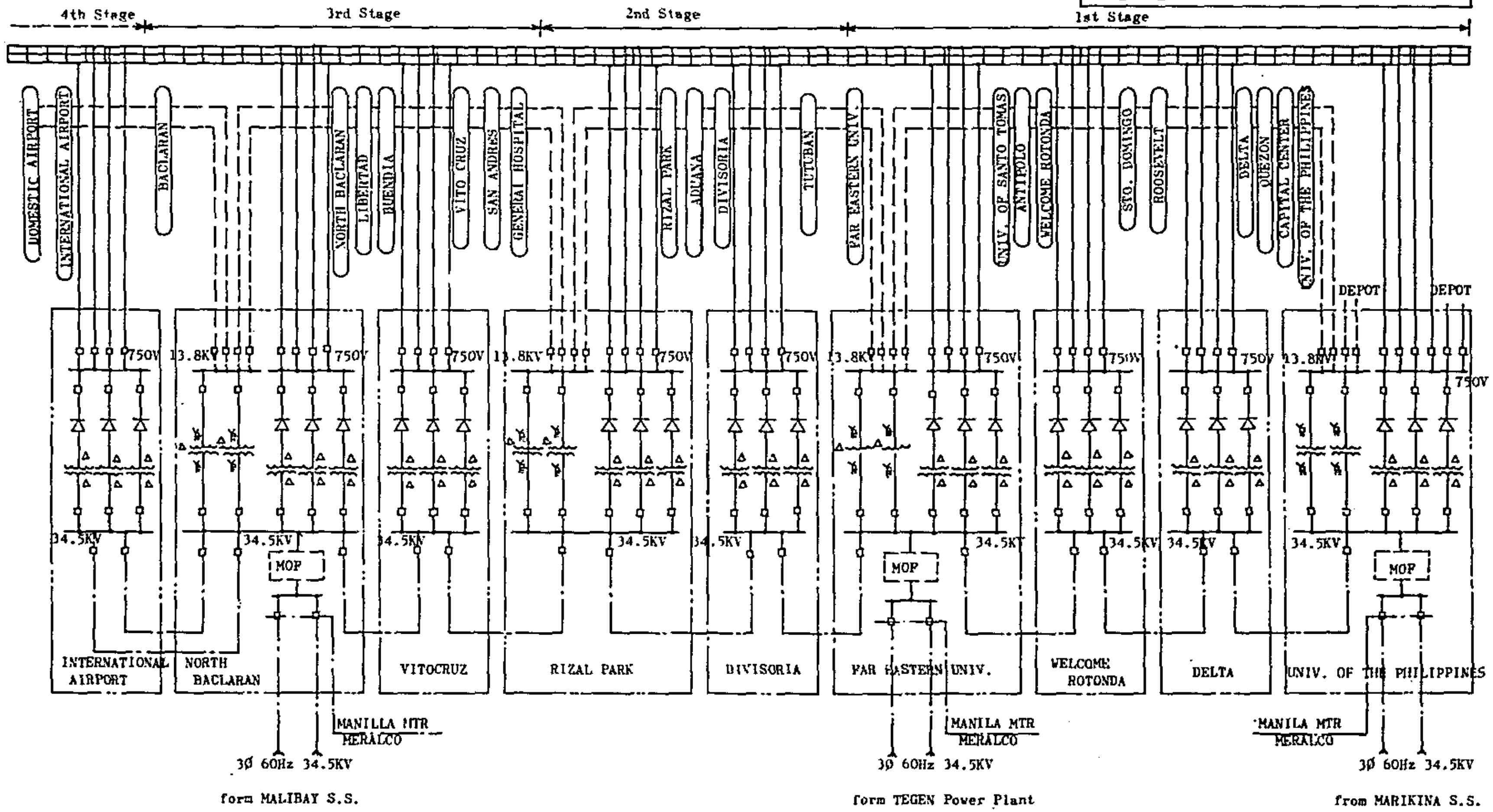
4.7.2 Power Supply to Line No. 1

The network of power transmission lines near Line No.1 is shown in Fig. 4.4.27. Of them, the 34.5-KV lines are too small for a rapid transit railway system. If these lines are used to supply both the railway and the residential area, the power supply in the residential area will be undesirably affected by large voltage fluctuation resulting from the railway operation. On the other hand neither is it desirable that the power supply for the railway should be

Fig. 4.4.28 Transmission & Distribution Line System Diagram for Recommended Alternative







affected by a power failure in the residential area. It is therefore recommended that the RTR line should be supplied by the three big substation, Malibay, Tegen and Marikina, situated along Line No.1 and connected with 115-KV transmission lines. For this purpose, overhead transmission lines for exclusive use of the RTR should be built from the 34.5-KV bus of these three substations.

The arrangement of main power stations, substations, and traction substations of Line No.1 is shown in Fig. 4.4.27. To minimize the tunnel construction cost, it is necessary to reduce the cross-sectional area of the tunnel. This dictates the adoption of a 750-volt third rail system. Necessarily, the traction substations will be constructed at about 2.5-km spacings. As it seems difficult to secure the land for the traction substations in the underground section of Line No.1, the substations should be built underground contiguously to the underground stations. The arrangement of underground substations which has been planned with these considerations in mind is shown in Fig. 4.4.28.

The traction substatoins are connected with one another by one circuit 34.5-KV transmission line and receive power from the three main substations of MERALCO. (See Fig. 4.4.28). In the event of a failure of one of the three main substations, power is supplied from the other receiving substations to ensure the continuity of power supply. The network of transmission lines for Malibay, Tengen and Marikina substations is shown with the capacity of each substation and power plant in Fig. 4.4.29.

4.7.3 Substations

The proposed location of the substations is shown in Fig.4.4.27 and 4.4.30. It is seem from the figures that it is necessary to change the location of some substations, depending on whether the RTR line is to be built from the south or the north side, becuase it is desirable that a power source be provided in the neighborhood of the terminal of the section opened to traffic. In the recommended alternative whereby the RTR is to be built from U.P. side, the three main traction substations to receive power from MERALCO should be North Baclaran, F.E.U. and University of the Philippines substations. However if the RTR is to be built from the Baclaran side, it is necessary to substitute Rizal Park substation for F.E.U. substation.

The capacity of rectifiers required for train operation has been determined in consideration of the train schedule during peak period at each stage of line construction as shown in Table 4.4.12

The capacity and number of transformers required for auxiliary equipment at each stage of line construction have been determined for both alternatives of starting from the south and north sides as shown in Table 4.4.13.

The breaking capacity of circuit breakers to be installed in the three main traction substations of Manila RTR has been determined in consideration of the short-circuit current of the transmission system and the power expansion program of MERALCO and NPC.

A remote control system will be provided at the power control center to control and monitor the operation of the equipment of all substations from the control center, and control subsystems will be provided in the substations, connecting them by a small number of communication lines.

Table 4.4.12 Capacity of Rectifiers

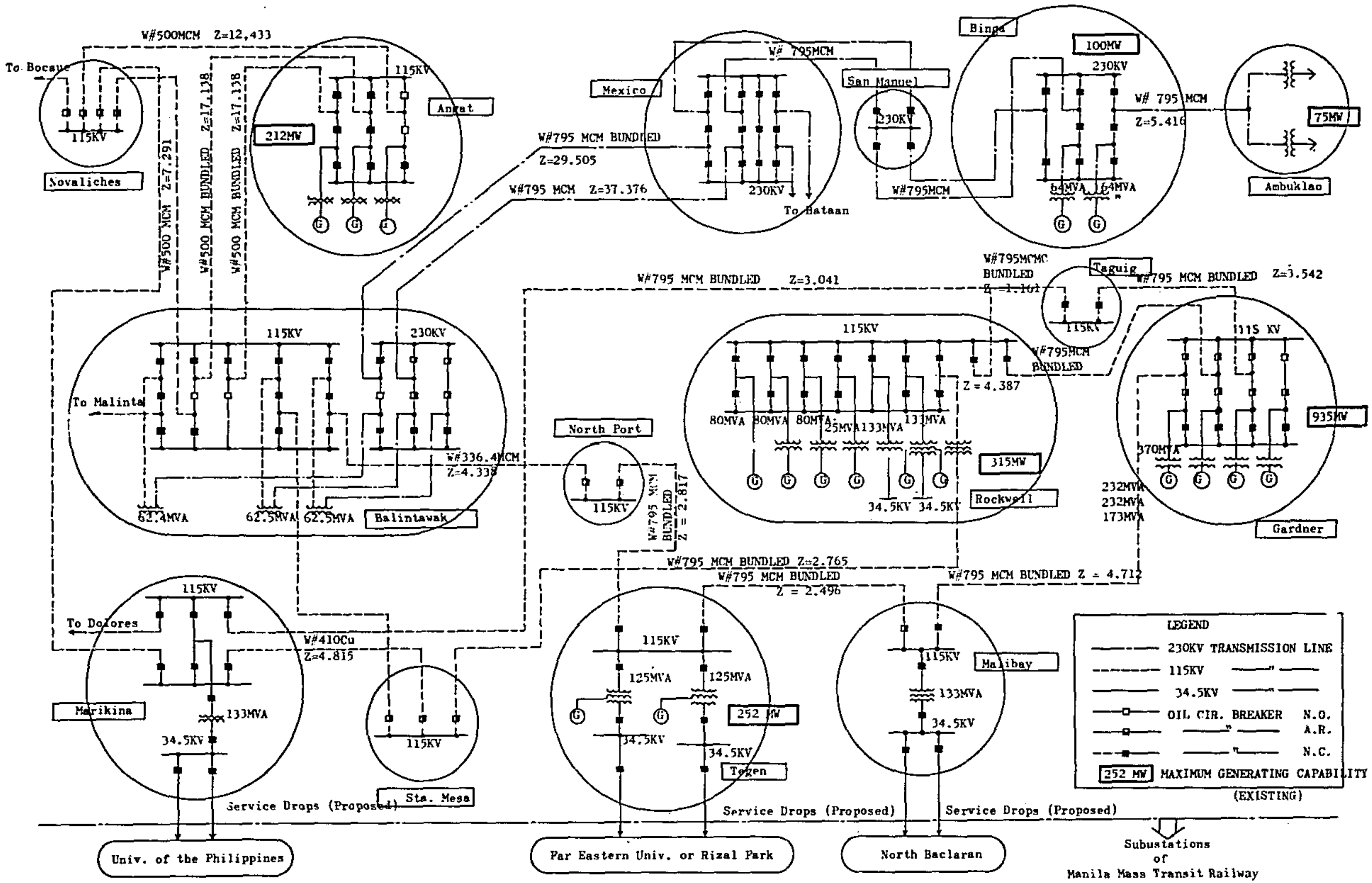
	Number of 2000-KW Rectifiers								
	Recommended Alternative				Compared Alternative				
	Stage 1	2	3	4	Stage 1	2	3	4
International Airport				3				3
North Baclaran			3	3	3	3	3	3
Vito Cruz		2	3	3	3	3	3	3
Rizal Park		2	3	3	2	3	3	3
Divisoria		3	3	3		3	3	3
Far Eastern Univ.	2	3	3	3				
Univ. of Santo Tomas						2	3	3
Welcome Rotonda	3	3	3	3				
Santo Domingo							3	3
Delta	3	3	3	3			3	3
U.P.	2	2	2	3			2	3

NoteS: 1) Recommended Alternative: construction from U.P. side

2) Compared Alternative: construction from Baclaran side

3) The number of rectifiers of each substation includes one rectifier which will be held in reserve.

Fig. 4.4.29 Outline System Diagram of Transmission Line



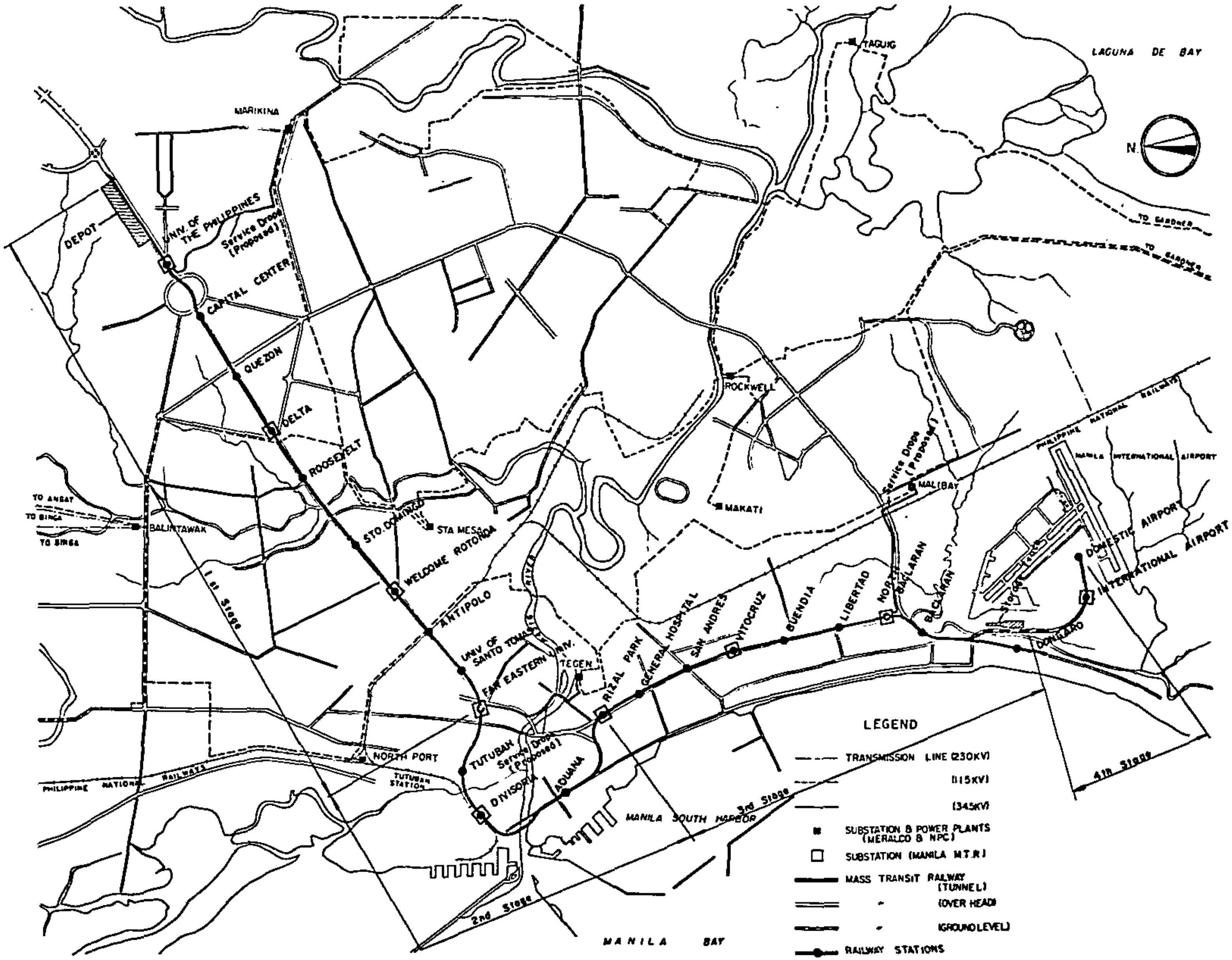


Fig. 4.4.30 Outline Diagram of Power Supply System (Part) for Recommended Alternative

Table 4.4.13 *Capacity of Transformers for Auxiliary Equipment*

Substation Name	Capacity (KVA) x Number							
	Recommended Alternative				Compared Alternative			
	Stage 1	Stage 2	Stage 3	Stage 4	Stage 1	Stage 2	Stage 3	Stage 4
North Baclaran			4,500 x 1	4,500 x 2	4,500 x 2	4,500 x 2	4,500 x 2	4,500 x 2
Rizal Park					4,500 x 1	4,500 x 2	4,500 x 2	4,500 x 2
Far Eastern Univ.	4,500 x 2	4,500 x 2	4,500 x 2	4,500 x 2				
Univ. of Santo Tomas								
U.P.	3,000 x 2	3,000 x 2	3,000 x 2	3,000 x 2			3,000 x 2	3,000 x 2

Note: Recommended Alternative: Construction from U.P. side.
Compared Alternative : Construction from Baclaran side.

4.7.4 Contact System

(1) Adoption of Thrid-Rail System

As tunnel construction is very expensive, it is desirable that the cross-sectional area (especially the height) of the tunnel be minimized. The third-rail can be laid along the track if the track is for exclusive use as in the railway. If overhead contact system is adopted, the tunnel will be about 0.6 m higher than in the case of third-rail system because of the current collector and the overhead contact line. Therefore, third-rail system is more desirable.

(2) Type of Third-Rail System

The third-rail system can be classified into the top-, bottom- and side-contact types according to the position of the collector shoes against the rail. As it is difficult to maintain the supports and protections in the bottom- and side-contact types, it is advisable to use the top-contact type in the DC 750-volt system. (See Fig. 4.4.31 and Fig. 4.4.32)

(3) Board Protection

Board protections are provided for the third rails in the sections between stations and in the depot as well as in the station sections lest persons should touch the third rails by mistake and the conductive tools should contact easily the third rails.

Fig. 4.4.31 Wayside Cable Layout of Line No. 1 (Tunnel Section)

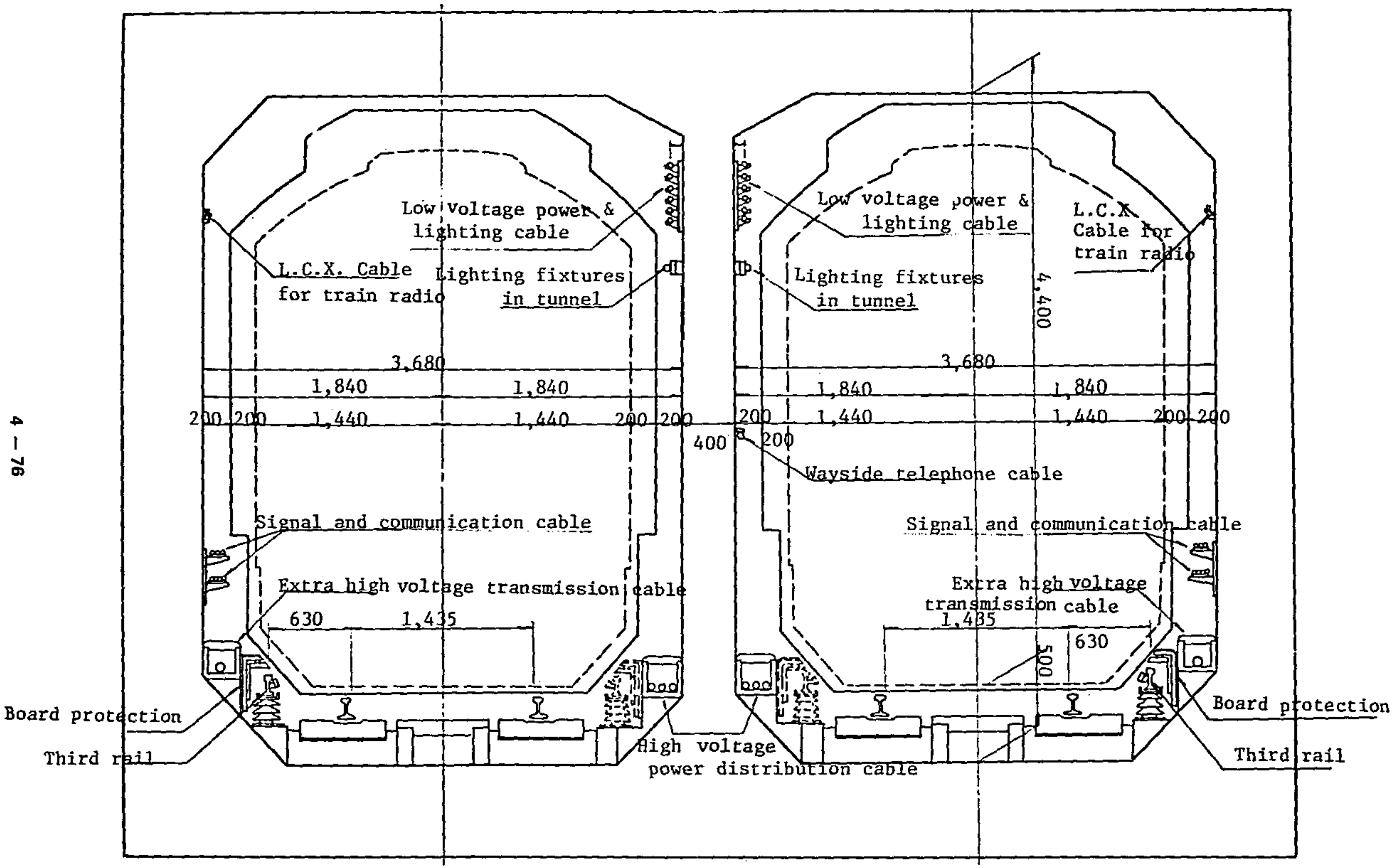
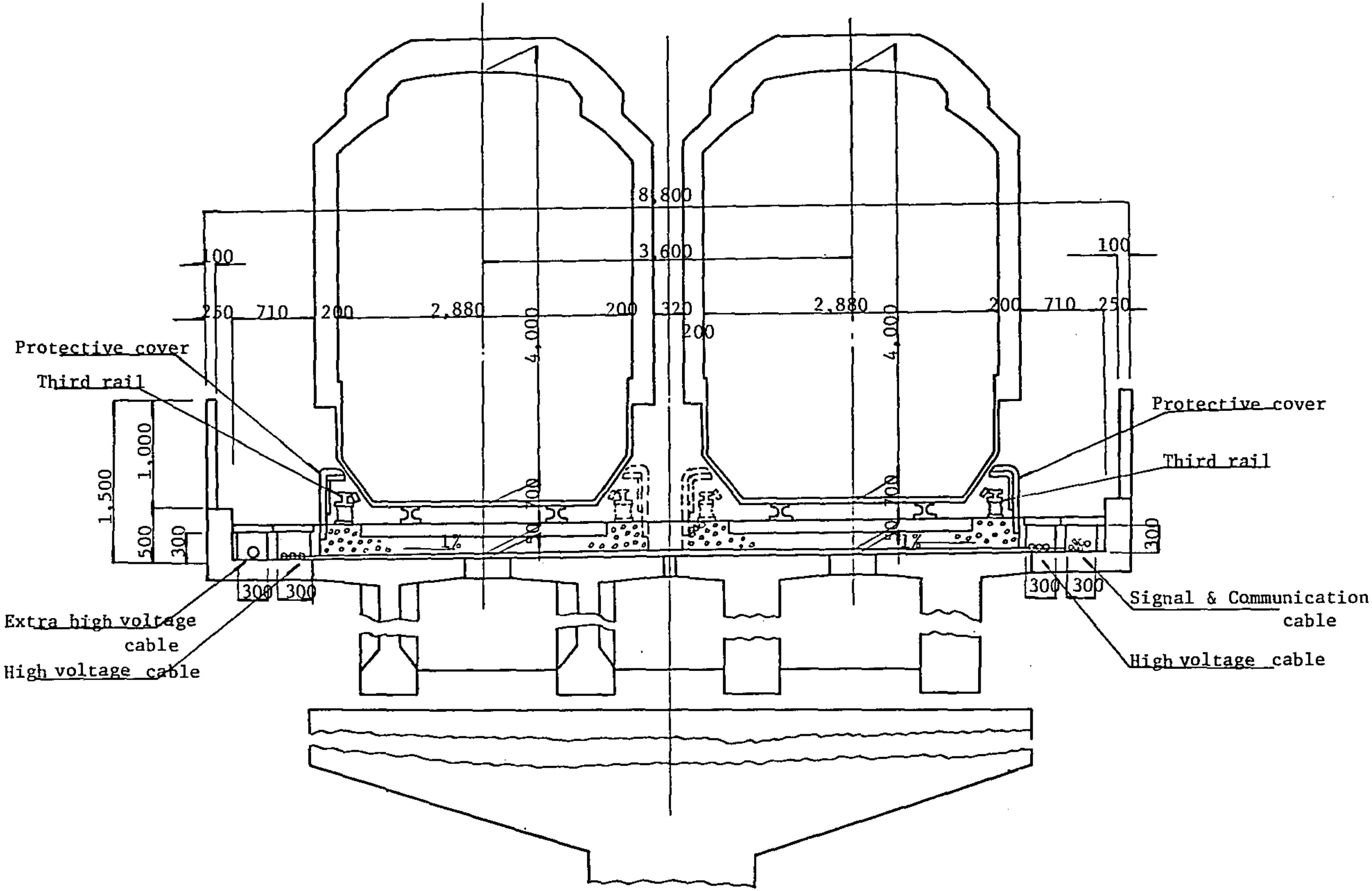


Fig. 4.4.32 Wayside Cable Layout of Line No. 1 (Elevated Section)



4.7.5 Power Distribution System for Station and Tunnel Auxiliary Eqaipment

The power distribution system for station and tunnel auxiliary equipment is so planned as to prevent the passengers from feeling uneasy in the event of a power failure. The loads are divided into essential and general loads, and extended power supply is provided for the essential loads. Two circuit distribtuion calbes are installed as shown in Fig. 4.4.28. 13.8-KV, 3-phase between traction substations equipped with transformers for auxiliary equipment listed in Table 4.4.13. Usually one circuit supplies power to the essential loads, and the other, the general loads, and if one circuit faults the other circuit supplies to all the loads. Besides, extended power supply from the adjacent substation is provided for the essential loads in the event of a power failure in one traction substation. Each power cable is laid in an independent through and protected against damage by rodent and ants.

Two distribution calbes are run to the power room of each station and from there power is distributed to the terminal loads through circuit breakers, transformers (which reduce the voltage from 13.8 KV to 460/230 V) and power distribution boards. The circuit breakers are tripped in the case of load faults, and emergency lighting facilities must be considered for a power failure.

The loads include signals, telecommunication facilities, lighting fixtures, tunnel lighting fixtures, smoke-removal equipment, pumping euqipment, ventilators, air-conditioners, and other power loads.

4.8 SIGNALING AND SAFETY FACILITIES

The signaling and safety facilities are an integral part of the mass transit railway which is required to carry a large number of passengers with safety.

Line No.1 which is planned to operate at high speed and short headway needs such signaling and safety facilities as mentioned below.

(1) Blcok system

(2) Signaling system

(3) Automatic train control system (ATC)

(4) Centralized traffic control system (CTC)

(5) Interlocking system

1. Block System

If many trains are operated at random between two stations to carry as many passengers as possible, there will be danger that one train may collide with another from behind (on the double track, following each other in the same direction) or head-on (on the single track, running in opposite directions). To prevent train collisions, a control system called "block system" is employed. This system consists in dividing the track into several sections. A train is not permitted to enter a section until the train ahead has left it. This divided section is called "block section" and the device for this system, a block device. A system detecting automatically the presence of a train in the block section and protecting the train behind against a collision is called an "automatic block system". An automatic double-track block system is provided for Line No.1, and its concept is illustrated in Fig. 4.4.33.

To detect the presence of a train in the block section the track is generally used as electric circuits. The principle of detection is illustrated in Fig. 4.4.34.

The train detection current (often used in common with the signal current) shown by the broken line is short-circuited by the train when it enters the block section, de-energizing the track relay which in turn detects the presence of the train in the block section. This electric circuit is called a track circuit. The traction current superposed with the signal current can flow undisturbed and does not adversely affect the signal current by the use of an impedance bond.

Fig. 4.4.33 Automatic Double-track Block System

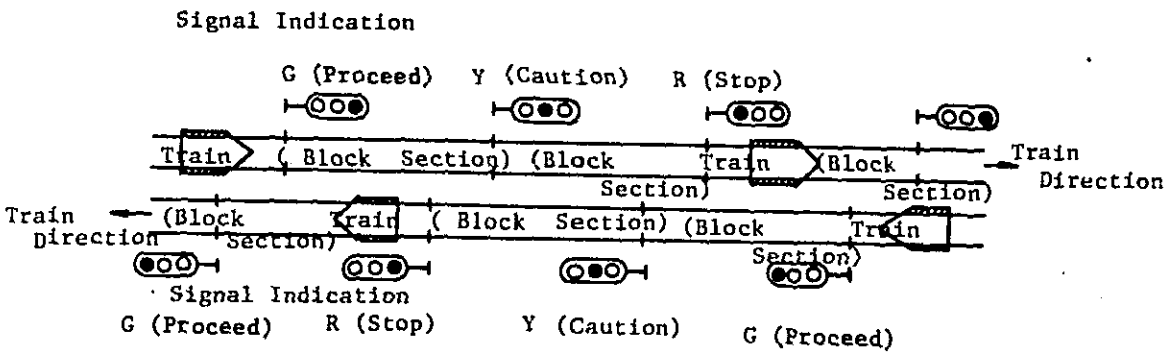
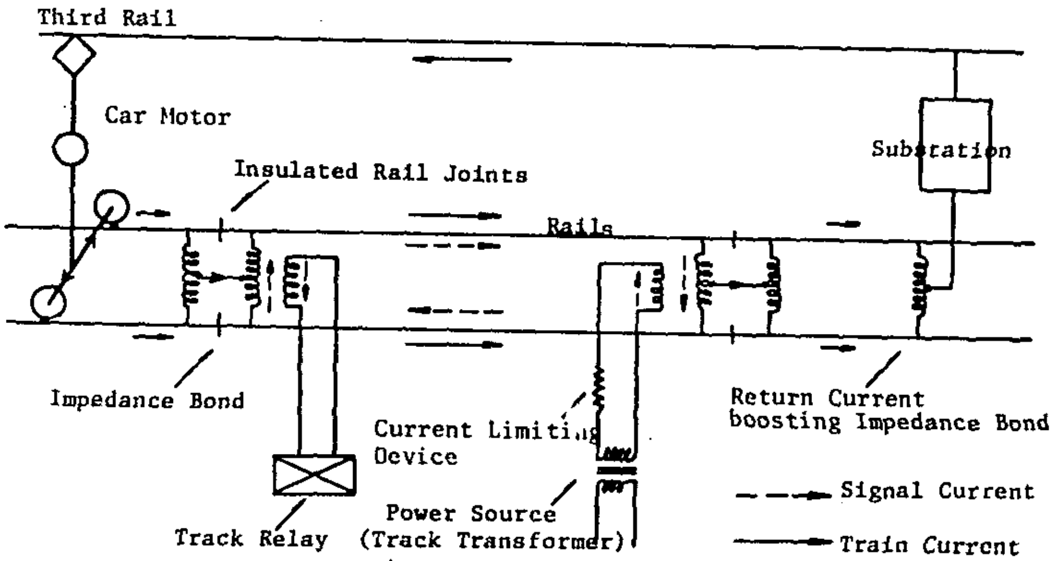


Fig. 4.4.34 Principle of the Double-rail Track Circuit to be Provided for Line No. 1



2. Signaling System

Railway signaling is a system to indicate the operating condition in a certain area or section (block section, etc.) to the train or car by means of shapes, colors or sounds.

Trains run towards the destination on the track which differs in station layouts, curvature and gradient. To ensure the safety of train operation under varying tack conditions, it is necessary to keep each train informed of the track conditions in the block section ahead. Signals are built at the entrance of the block section to inform the the train crew whether the block section has been cleared. The signals which are used in the automatic block system are so designed as to inform the train crew of not only the absence of a train in the block section ahead but also give the train crew other information, e.g. whether the train can proceed at the same speed or must reduce its speed. So long as the train crew operates the train according to the information given by the block system, the trains can be safely operated at optimum speed.

The signal indications must be simple and distinct night and day, must not be confusing, and must not convey more than one meaning.

Railway signals are usually installed on the wayside adjacent to the tracks, but in recent years cab signals have come into use. In Line No.1 it is advisable to use the signals of the latter type in view of special conditions peculiar to the underground railway (e.g. restricted visibility by curves and grades, and limited clearance in the tunnel).

3. Automatic Train Control System (ATC)

Automatic train control functions in such a way that the brakes are automatically applied to reduce the train speed below the permissible level, should it exceed the speed indicated by the signal. In train operation the rear-end collisions and derailments due to signal violation must be avoided by all means. Trains are generally operated by the driver confirming and following the signal indications. However, possibility of misunderstandings and inadvertent operations on the part of train operator cannot be totally eliminated. To prevent accidents in such cases it is necessary to provide ATC for the underground and highly congested railways.

(1) Functions of ATC

Train operation is not restricted by ATC so long as the train is operated at a lower speed than indicated by the cab signal.

The train speed is reduced by automatic operation only when it is over the indicated speed by the speed signal.

The type of ATC for Line No.1 will be a high-frequency continuous inductive type in which modulated high-frequency current according to the signal indication will be transmitted through the track circuit or loop wire (laid along the track at turnouts), wherefrom the train will pick up inductively the high-frequency current as information for continuous train control. The track circuits are not insulated except at the stations where turnouts are installed.

Control informations will consist of seven speed signals, namely 70, 60, 40, 25, 15, 0, and 00, and will be transmitted by the carrier current (of 10 kHz or more) which is modulated by frequencies corresponding to these signals.

The high-frequency current transmitters and receivers for control information will be concentratively installed in the relay rooms located along the line at suitable intervals within 10 km (5 km on either side of each relay room).

In the cab, the high frequency current transmitted to the track circuit or the track loop is picked up inductively by the receiver, and the signal indications are displayed in the cab signal by the signal output of the receiving unit after selecting the class of control information, while the information is compared with the tacho-generator output at the speed detecting unit and if the train speed exceeds the speed limit, the train is automatically slowed down or stopped.

As mentioned above, ATC automatically reduces train speed according to the speed signal indications and controls train speed according to the gradient, curvature, and situation (e.g. turnouts).

(2) Cab Signal ATC

a) Comparison with the Trackside Signals

Since in the case of cab signal ATC system, the signal aspect of the block section is displayed in the cab only after the train has entered into the section, the train cannot be stopped before the signal indicating "stop" as can be done in the case of the wayside signal system. Accordingly, it is necessary to provide another "stop" section doubly in front of the one which must not be entered by the train.

b) Cab Signals and ATC and Brake Application

The ATC speed limits corresponding to the cab signals and the brake applications are shown in Table 4.4.14.

Table 4.4.14 Cab Signals, ATC Speed Limits, and Brake Application

Cab Signal	ATC Speed Limit	Brake	Note
"00"	Stop in all circumstances	Emergency brakes	Emergency brakes will be applied to the train entering the section even upon the acknowledging operation. After stopping, brakes are released only by the operation of a restoring button. After the restoring operation, the train is able to run only at 15 km/h or less.
"0"	Stop	Service brakes	The train will be stopped according to a fixed deceleration stop pattern within the "0" signal section. Acknowledging operation is possible only within the "0" signal section. After that operation the train can run at 15 km/h or less.
"15"	Reduce speed to 15 km/h	Service brakes	"15" signal indication is given as necessary to stop train at stations.
"25"	Reduce speed to 25 km/h	Service brakes	These signal indications are given according to train interval, curvature, and gradient.
"40"	Reduce speed to 50 km/h	Service brakes	
"60"	Reduce speed to 60 km/h	Service brakes	
"70"	Reduce speed to 70 km/h	Service brakes	

In the above table, "acknowledging operation" denotes train operation performed by driver after confirming safety ahead, putting on the acknowledging switch installed in the driver's cab of the train and stopping the train once even in the case of stop signal. "Restoring oepration" denotes the said acknowledging operation after the train is stopped compulsively by the "00" signal and the "00" signal changes to the "0" signal.

The train speed limits set by wayside color-light signals and cab signals in ATC are graphically presented in Figs. 4.4.35 and 4.4.36, and the train route control and block diagram of CTC System are shown in Figs. 4.4.37 and 4.4.38.

Fig. 4.4.35 Train Run Curve in ATC by Wayside Colour-light Signal

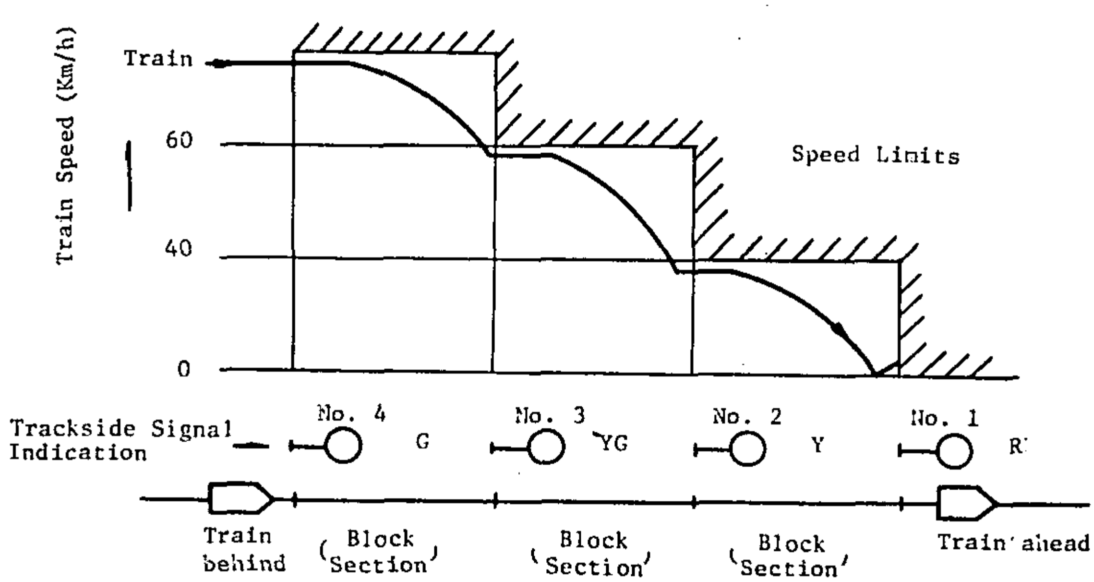


Fig. 4.4.36 Train Run Curve in ATC by Cab Signal

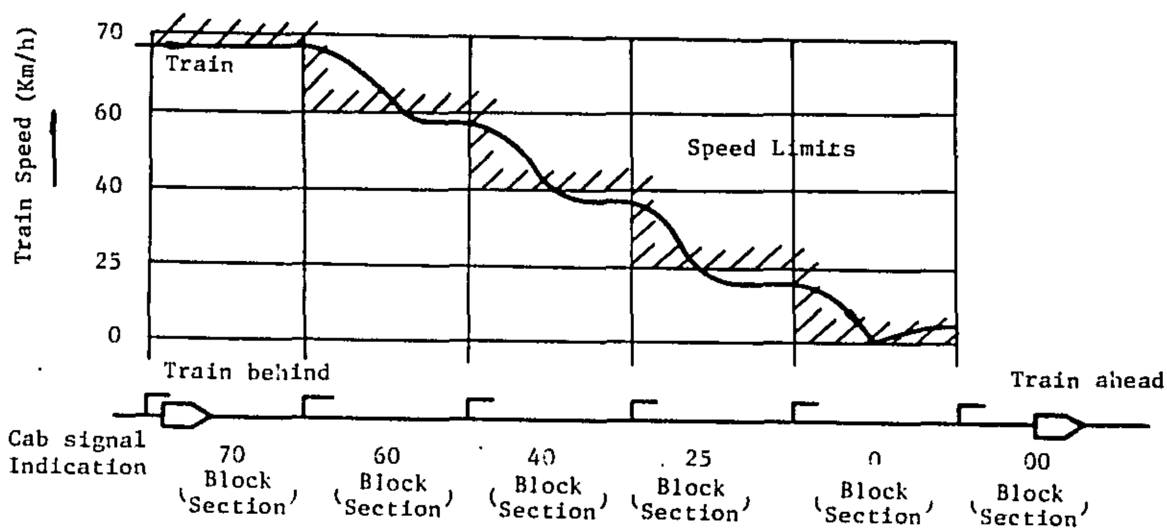


Fig. 4.4.37 Train Route Control by CTC

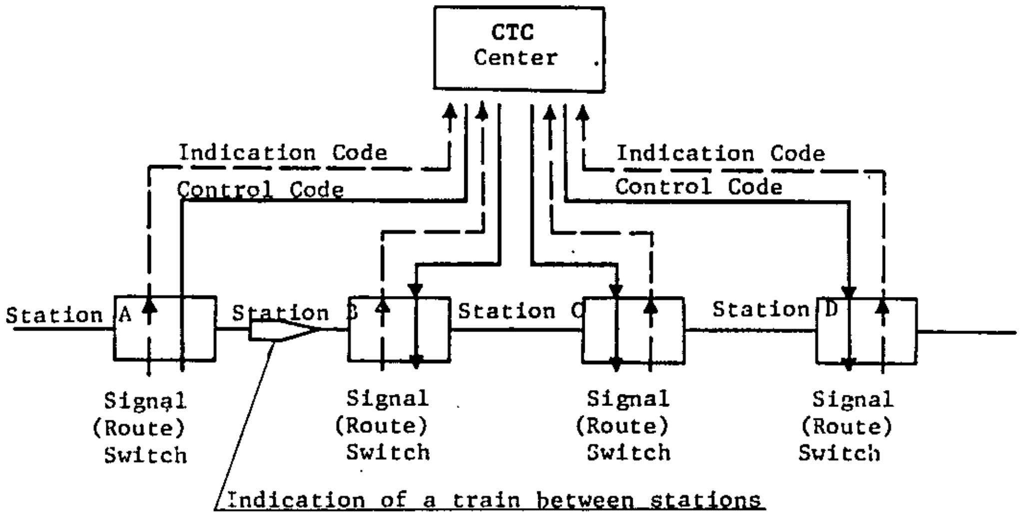


Fig. 4.4.38 Block Diagram of the CTC System

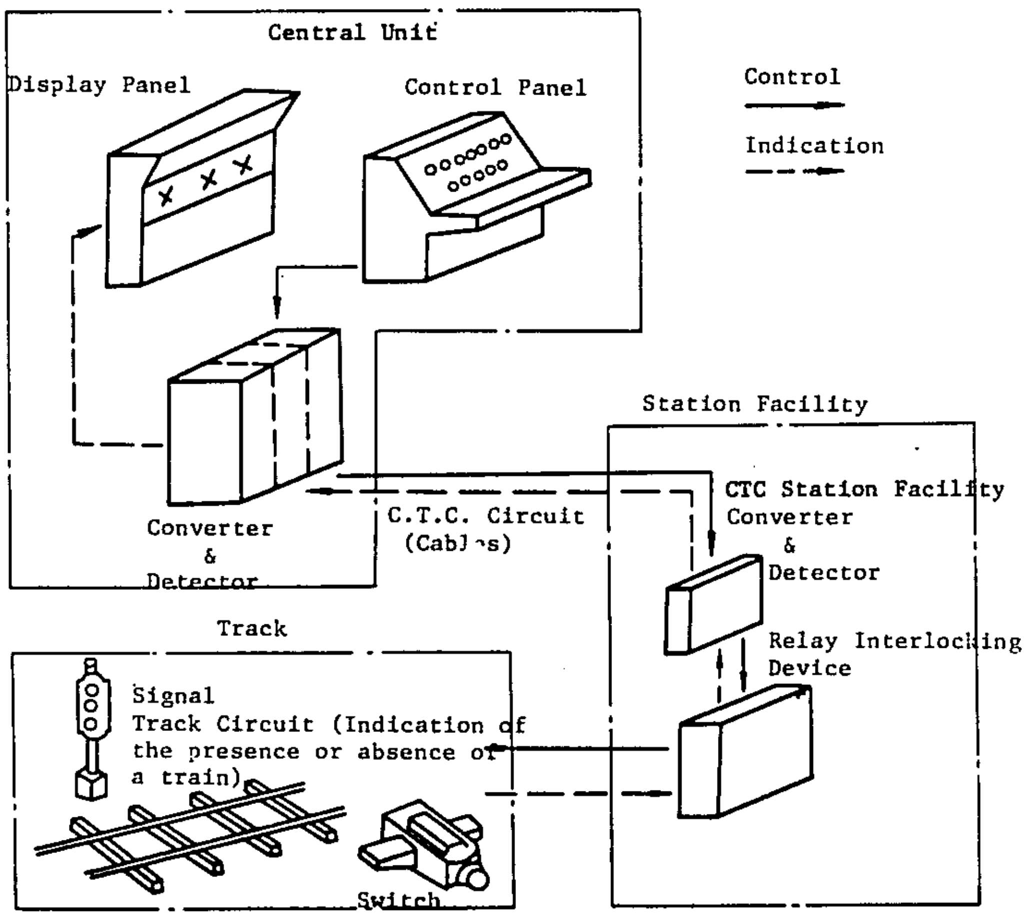
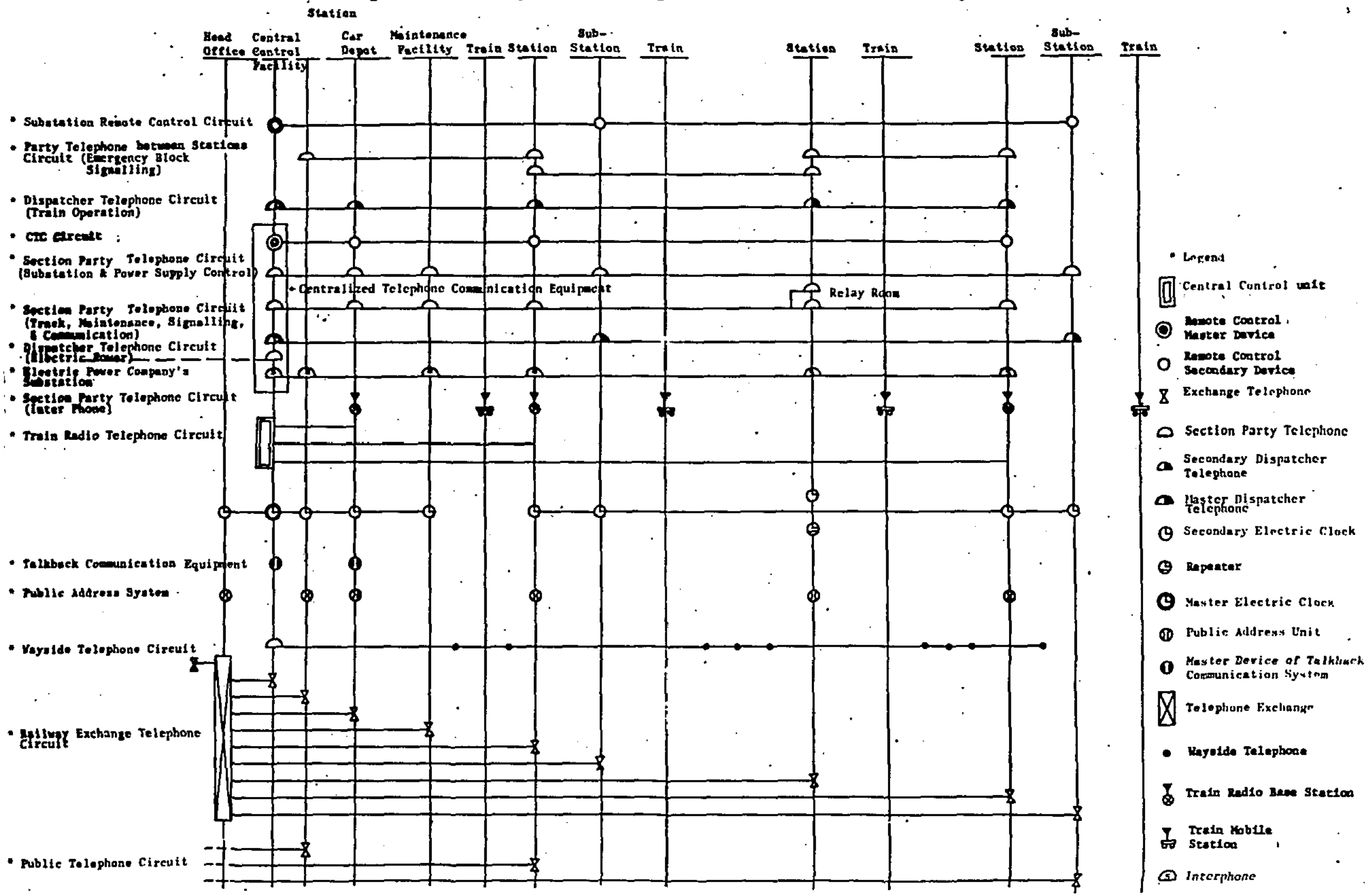


Fig. 4.4.39 Organization Diagram of the Communication System



4. Centralized Traffic Control System (CTC)

To run trains according to train diagram and in compliance with the order of train dispatcher, turnouts at stations are operated and signals are displayed for safety. By establishing control center to visually grasp and control train condition, the center train dispatcher can not only remotely control the signals and turnouts of each station but operate train at high efficiency and safety as well as promptly control and restore train traffic at times of train disruption. The controlling system including the facilities thereof for the above mentioned purpose is called CTC.

As can be known from Fig. 4.4.38 a central unit is installed in the control center wherefrom the signals and switches of all the stations of the route are controlled. Moreover, a dispaly panel is provided on which the conditions of the signals and switches and the location of all trains are indicated.

5. Interlocking System

It would be extremely dangerous if the switch of the section for which a "proceed" indication has been given is reversed or if a "proceed" indication is given to another signal obstructing the said section. To prevent such conditions even if the signals and switches are mishandled, a safety mechanism is provided between the signals and switches. This is the so-called interlocking device which may be structurally electrical or mechanical. For Line No.1 the most up-to-date and reliable "class A" electric relay interlocking device will be introduced.

4.9 COMMUNICATION SYSTEM

Line No.1 which is planned to be operated at high speed and at short train intervals requires provisions ensuring high safety, high accuracy, and high efficiency of operation. Furthermore, provisions must also be made to take quick and proper actions in case of emergencies. To meet the requirements, it is necessary to provide a special, dedicated communication system which will maintain rapid and accurate communication longitudinally between the control center and relevant field organs and laterally among relevant organs.

The functional configuration of the communication system is illustrated in Fig. 4.4.39. The communication system will be briefly discussed in the following.

1. Exchange Telephone

The railway which is to be operated on such a large scale as Line No.1 needs for itself a telephone system similar to the public telephone system. To establish communication among the head-office, stations, maintenance facilities, and car depot, 100 circuits will be necessary at the initial stage of operation, and at the final stage 200 circuits will be needed. The capacity of telephone exchanges should be decided in consideration of other RTR lines which will be construction after Line No.1.

2. Direct Telephone

The railway exchange telephone system may not serve the purpose when lines are busy in an emergency. To keep up communication at all times, it is necessary to provide special direct communication systems which will establish communications between two or more specific locations in case of need. Line No.1 will require the following direct communication systems:

(1) Dispatcher Telephone

Dispatcher telephone communication will be provided between the control center on one hand and the stations and other organs on the other on a selective or general call basis. Two dispatcher telephone systems will be provided, one for train dispatching and the other for power dispatching.

(2) Section Party Telephone

For routine or emergency (e.g. restoration after accidents) telephone communication, point-to-point telephones will be provided between the control center, the stations and field organs.

(3) Party Telephone between Stations

Station-to-station telephone communication will be provided between stations mainly to block the section in case of signal failure.

3. Work Telephone Communications

(1) Wayside Telephone

Telephones will be provided along the line to enable maintenance men to communicate with the control center.

(2) Talkback Telephone

Talkback telephone communication will be provided in the car depot between the signal cabin and the site of signals or switches. The master device will be installed at the signal cabin in the car depot, and loud speakers are installed near the shunting signals or switches as secondary devices. When a key or a push-to-talk switch is depressed, communication circuit will be formed on a mutual call basis.

4. Train Radio

As it is necessary for the crew of the moving train to communicate with the control center for train dispatch and emergency calls in an accident, train radio will be provided between the control center and trains. In consideration of the purposes, performance characteristics, reliability, and economy, VHF wave type will be introduced, and a leaky coaxial cable will be used as transmission medium in the tunnel. The train radio organization is outlined in Fig. 4.4.40 and comprises the following.

(1) Control Center Equipment

In the control center, the central control unit operation panel will be provided, wherefrom the dispatcher not only speaks with the train crew but receives and transmits emergency signals in accidents through the base stations distributed along the entire line.

(2) Base Stations

Base stations will be built along the line at 5-6 km intervals.

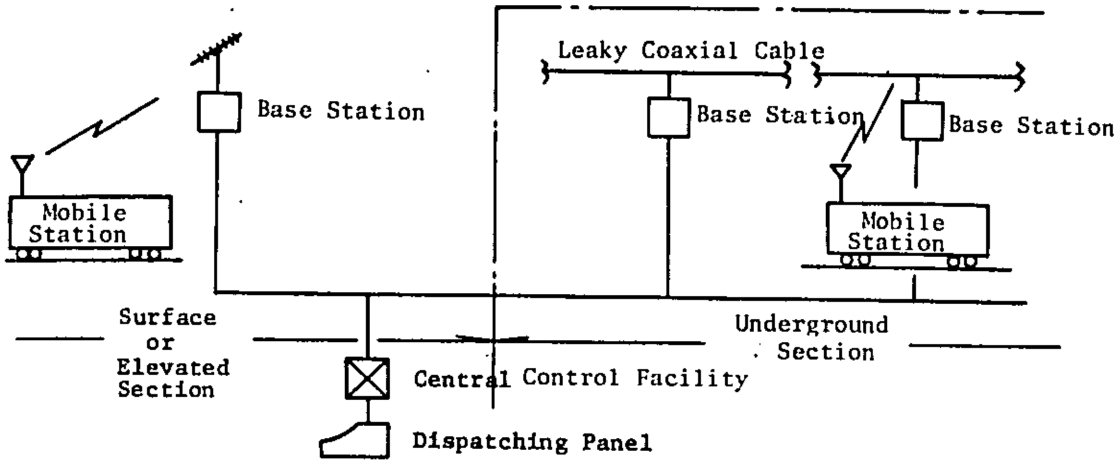
(3) Mobile Stations

A mobile station comprising a transmitter, a receiver, an antenna, and a loud speaker, will be carried on each train.

(4) Leaky Coaxial Cable

Leaky coaxial cable will be strung on the wall of the tunnel to disperse the radio wave in the tunnel.

Fig. 4.4.40 Train Radio Organization Diagram



5. Other Facilities

Other necessary facilities include the following:

(1) Electric Clocks

A quartz crystal controlled master clock will be installed at the control center to control all the secondary clocks in each station.

(2) Public Address Systems

Public address unit will be provided in each station to guide passengers.

6. Communication Lines

The cable lines of the above mentioned communication circuits will be mainly accommodated in polyethylene-insulated, corrugated sheath carrier composite cables laid on the cable rack on the wall of the tunnel or in a trough common with signal cable on both sides of the double-track. The remote control circuits of CTC and traction substation will also share these cables.

4.10 CAR DEPOT

4.10.1 General

The car depot is planned to be a railway complex where various facilities including the car storage, car and ground facilities, maintenance facilities, and the administrative building of Line No.1 are all accommodated. The facilities which will be accommodated in the car depot include the following:

(1) Car storage

(2) The following maintenance and inspection facilities

a. Daily and monthly inspection facilities

b. Car washing and cleaning facilities

c. Wheel profile milling equipment

(3) Repair shop for general inspection and intermediate inspection

(4) Track maintenance facility

(5) Maintenance facility of electrical equipment such as signals and telephone

(6) Maintenance facility of mechanical equipment

(7) Material warehouses

(8) Train operation and power supply control facilities and administrative building

(9) Other facilities

All these facilities other than the repair shop are so planned as to serve the purposes of Line No.1. The repair shop is planned to be located in an area which is wide enough to permit its expansion so that general inspection and intermediate inspection of the cars of Line No.2 can also be performed there in the future.

The number of trains and cars of the recommended alternatives, used in the planning of the car depot are as follows:

Year	1983	1986	1987 ·	1989	1994	Reference
A) Recommended Alternative						
Number of trains	17	26	35	41	48	(38)
Number of cars	68	130	175	246	288	(228)
Cars/train	4	5	5	6	6	(6)
B) Compared Alternative						
Number of trains	14	22	35	41	48	(38)
Number of cars	56	110	175	246	288	(228)
Cars/train	4	5	5	6	6	(6)

Note: Figures in parentheses indicate the numbers of trains and cars of Line No.2 which are assumed at 80% of the final capacity of Line No.1.

4.10.2 Car Storage Facilities

All trains except the trains which are held overnight in the starting stations will be held in the car depot. These trains are held in storage and inspection track. The car storage capacities of car depot are shown in Table 4.4.15.

The car storage track consists of 16 tracks each of which can hold two trains, for a total of 32 trains in all. At the initial stage the car storage track is planned to have 11 tracks, each of which can hold a 4-car train. The capacity of the car storage will be gradually increased to meet increasing passenger traffic demand.

Table 4.4.15 Car Storage Capacities

(Unit: train)

Year	1983	1986	1987	1989	1994
Recommended Alternative (Construction from U.P. side)					
a. All trains	17	26	36	41	48
b. Trains held in the starting stations	2	2	8	8	10
c. Trains held in the car depot	15	24	27	33	38
Storage track	11	16	18	21	25
Inspection track	3	5	5	7	7
Washing and cleaning track	1	2	2	3	3
Repair shop	-	1	2	2	3
Compared Alternative (Construcion from Baclaran side)					
a. All trains	14	22	35	41	48
b. Trains held in the starting stations	2	2	8	8	10
c. Trains held in the car depot	12	20	27	33	38
Storage track	8	12	18	21	25
Inspection track	3	5	5	7	7
Washing and cleaning track	1	2	2	3	3
Repair shop	-	1	2	2	3

4.10.3 Car Inspection Facilities

(1) Kinds, Periods and Locations of Inspection

The kinds and periods of inspection have been so determined as shown in Table 4.4.16 in consideration of the performance characteristics and functions of car equipment that optimum car performance between intervals of inspection will be ensured and superfluity of servicing will be avoided.

The locations of inspection, on the other hand, have been determined in consideration of required inspection time, train operation and degree of car dismantling for inspection.

Table 4.4.16 Kinds, Periods and Locations of Inspection

spection Classification			Inspection Period		Location
Type of Inspection		Procedure	Period	Running Mileage	
	General inspection	Cars are completely dismantled and all parts are completely inspected and repaired.	3 years or less	500,000 km or less	Repair shop
	Intermediate inspection	Major car parts are dismantled, disassembled, inspected and repaired.	1.5 years or less	250,000 km or less	Repair shop
	Monthly inspection	Car parts are inspected as mounted, on its functions.	30 days or less		Inspect-tion shed
Daily inspection		Cars are inspected routinely between operations.	48 hours or less		Inspect-tion shed
Special inspection		Overall or partial inspections are made on newly purchased cars, reconstructed or heavily reparied cars, or cars which have been laid up for a long time.	As re-quired		Repair shop

Note: Intermediate and monthly inspection periods are extended for one interval after general inspection or intermediate inspection.

(2) Car Cleaning

Cars will be cleaned according to the schedule shown in Table 4.4.17.

Table 4.4.17 Schedule of Car Cleaning

Type of Cleaning	Period	Procedure		Location
Major cleaning	30 days	Compartment	Floor, windows, doors, panel boards and other compartment areas are cleaned and dis-infected.	Cleaning track
		Body	Car ends are cleaned.	"
			Car sides are cleaned.	Car washing machine track
Inter-mediate cleaning	6 days	Compartment	Windows, floor and seats are cleaned.	Cleaning track
		Body	Car ends are cleaned.	"
			Car sides are cleaned.	Car washing machine track
Minor cleaning	Everyday	Compartment	Windows and floor of driver's cab are cleaned.	Storage track
Car washing	2 days	Body	Car sides are washed.	Car washing machine track

(3) Methods of Car Inspection and Repair

A. Repair Shop

a) Trains are entered into the repair shop in formation for general inspection and intermediate inspection, and they also leave the repair shop in formation.

b) To standardize the working procedure, half the train is given general inspection and the other half is given intermediate inspection.

c) Car repair is accomplished in three stages, as shown in Table 4.4.18, and the repair work at each stage is independently controlled. The inter-relation of the three stages of car repair are illustrated in Fig.4.4.41.

d) The flow chart of car repair is shown in Fig. 4.4.42.

1) The body and bogie of each car are separated and put together by crane.

2) The car is dismantled of its equipment on a fixed rest, using mechanical power to remove heavy parts.

3) Car bodies are painted in an isolated workshop.

4) Car equipment are given inspection and repairs in special workshops.

e) Two kinds of trial runs are made: one on the yard trial run track; and the other on the main line. The trial runs on the main line are made on timetable.

Table 4.4.18 Classification of Car Repair Processes

Stage	W o r k
1st stage	Car bodies and equipment and parts are given inspection and repairs without dismantling the cars.
2nd stage	Cars are dismantled, and major equipment and other parts are given inspection and repairs.
3rd stage	Parts and materials needed for the repairs in the two stages above are fabricated.

B. Car Inspection Shed

a) Cars are given monthly inspection during the daytime without breaking up the train formation.

b) Cars are given daily inspection between train operations night and day without breaking up the train formation.

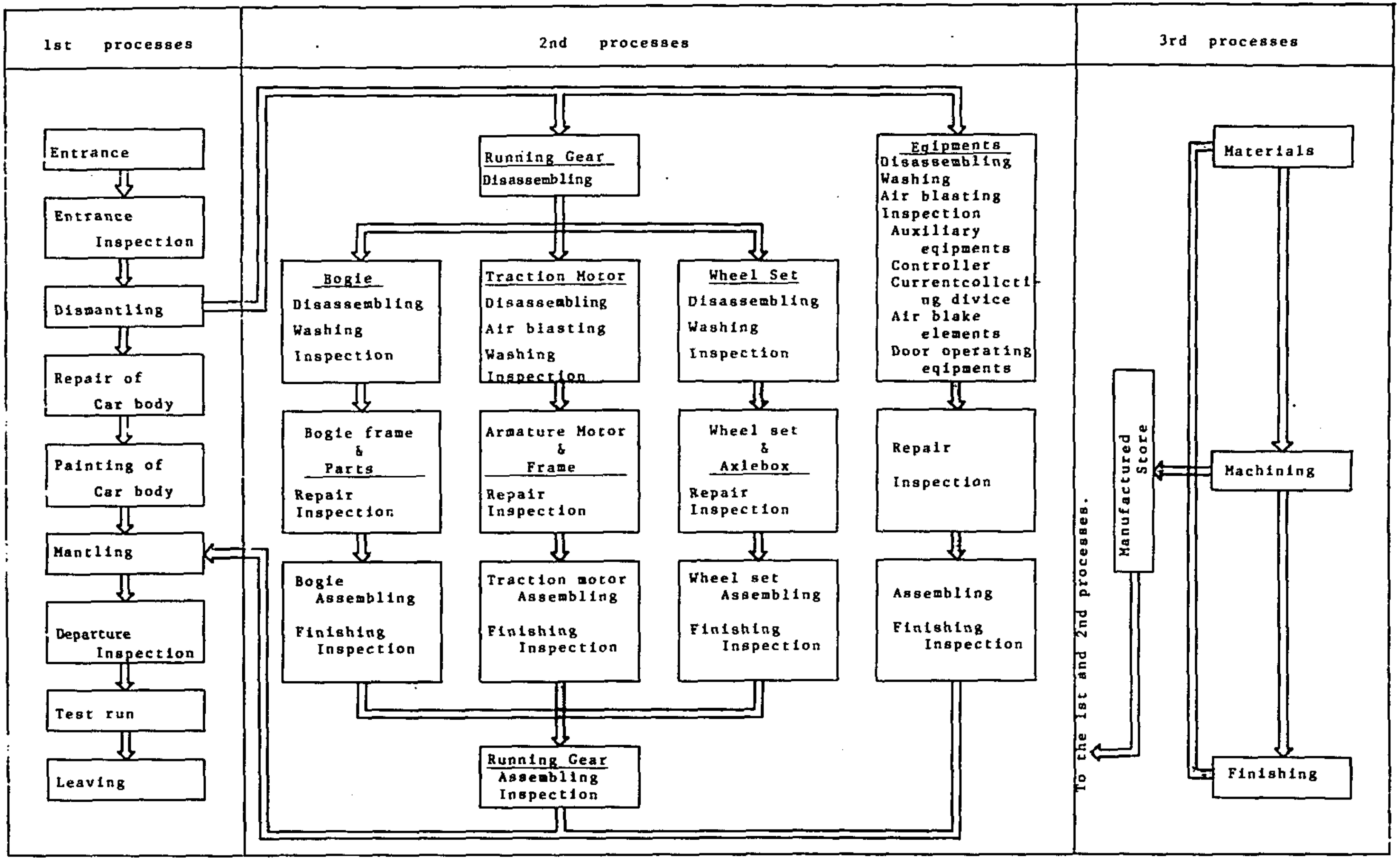
c) Wheels are profile-milled between train operations during the daytime without breaking up the train formation

d) Parts and consumables needing replacement are replaced with new ones during inspection.

e) Parts which are replaced are given repairs in the repair shop.

f) Cars are cleaned between train operations during the daytime without breaking up the train formation. Car bodies are washed by a car washing machine while the train moves on the track.

Fig. 4.4.41 Electric Car Repairing Processes



[NOTE] The shaded arrow indicates the flow of repair work which is carried out independently of the first processes of car repair and circulating spare parts are used in the second processes of car repair.

C. Yearly Working Days of the Repair Shop and Inspection Shed

The yearly working days of the repair shop and inspection shed are as follows:

Repair shop	250 days
Inspection shed	
Monthly inspection	250 days
Daily inspection	365 days
Major cleaning	365 days
Intermediate cleaning	365 days

(4) Volume and Standard Required Days (hours) of Car Inspection

The yearly volume of car inspection is given by the following formula:

$$Im = N \cdot a$$

where,

Im = Volume of car inspection (trains/year)

N = total number of trains

a = cycle of inspection (times/year)

The cycle of inspection is determined from the inspection periods established according to type of work.

A. Volume of Car Inspection

The yearly volume of inspection work in the repair shop and inspection shed are shown in Tables 4.4.19 and 4.4.20.

Table 4.4.19 Yearly Volume of Inspection in the Repair Shop

(Unit: trains/year)

	1983	1986	1987	1989	1994
Recommended Alternative (Construction from U.P. side)					
Total of general inspection and intermediate inspections	12	18	23	27	32
Compared Alternative (Construction from Baclaran side)					
Total of general inspection and intermediate inspections	10	15	23	27	32

Fig. 4.4.42 Work Flow of Repair Shop

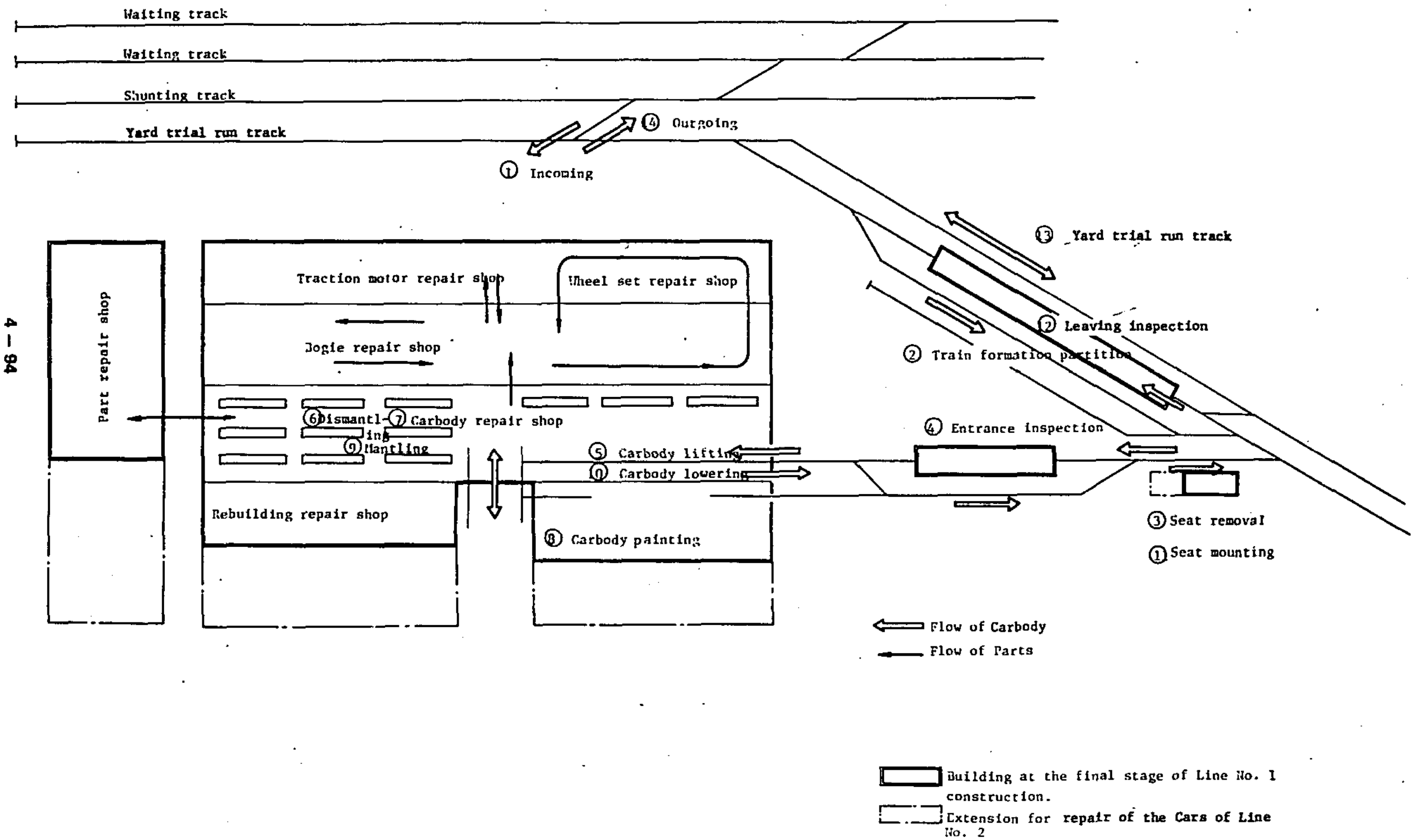


Table 4.4.20 Volume of Inspection in the Inspection Shed

(Unit: trains)

	Annual					Daily Average				
	1983	1986	1987	1989	1994	1983	1986	1987	1989	1994
Recommended Alternative (Construction from U.P. side)										
Monthly inspection	196	299	403	472	552	0.8	1.2	1.6	1.9	2.2
Daily inspection	2,805	4,290	5,775	6,765	7,920	7.7	11.8	15.8	18.5	21.7
Total	3,001	4,589	6,178	7,237	8,472	8.5	13.0	17.4	20.4	23.9
Compared Alternative (Construction from Baclaran side)										
Monthiy insepction	161	253	403	472	552	0.7	1.0	1.6	1.9	2.2
Daily inspection	2,310	3,630	5,775	6,765	7,920	6.3	9.9	15.8	18.5	21.7
Total	2,471	3,883	6,178	7,237	8,472	7.0	10.9	17.4	20.4	23.9

(Reference)

Volume of Cleaning Work

Recommended Alternative (Construction from U.P. side)

Major cleaning	208	318	427	501	586	0.6	0.9	1.2	1.4	1.6
Intermediate cleaning	827	1,264	1,701	1,993	2,333	2.3	3.5	4.7	5.5	6.4
Total	1,035	1,582	2,128	2,494	2,919	2.9	4.4	5.9	6.9	8.0
Compared Alternative (Construction from Baclaran side)										
Major cleaning	171	269	427	501	586	0.5	0.7	1.2	1.4	1.6
Intermediate cleaning	681	1,070	1,701	1,993	2,333	1.9	3.0	4.7	5.5	6.4
Total	852	1,339	2,128	2,494	2,919	2.4	3.7	5.9	6.9	8.0

B. Standard Required Days (Hours) of Car Inspection

a) Standard required days of car inspection in the repair shop

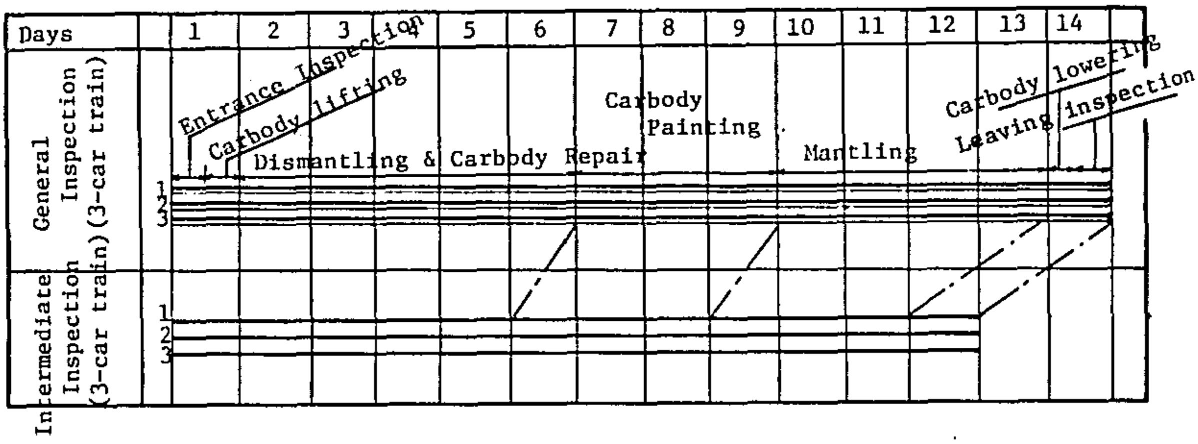
The standard required days of car inspection in the repair shop is 20 days per train. The time period required for the inspections will be 14 days for general inspection and 12 days for intermediate inspection. After completion of the inspection, 1 day for formation test and yard trial runs and 1 day for main line trial run will be required. The time schedule of car inspection is shown in Fig. 4.4.43.

b) Standard required hours of car inspection in the inspection shed

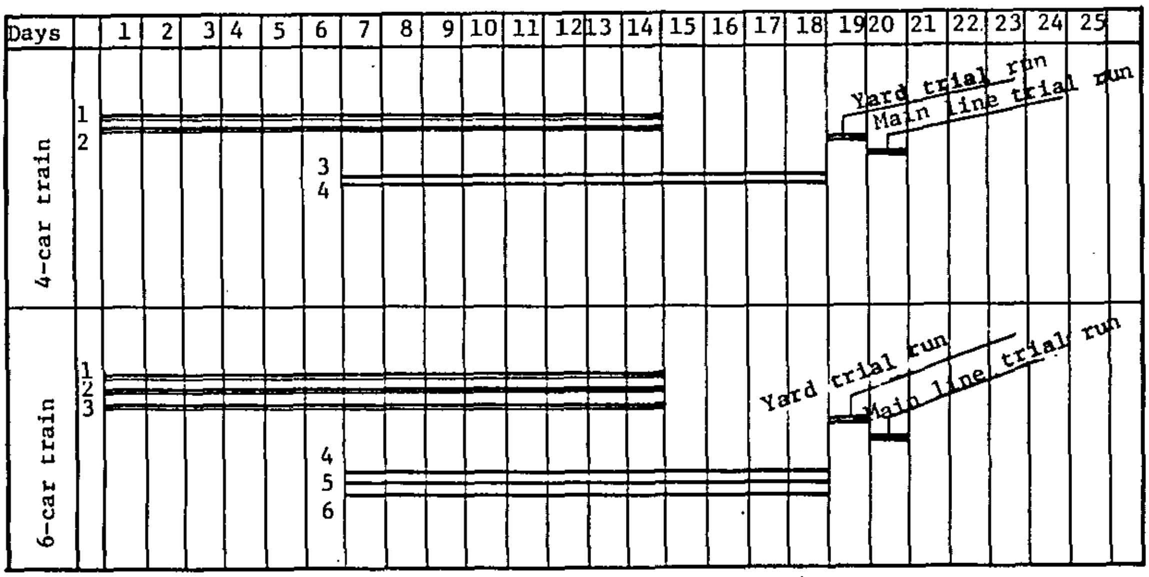
The following hours are allocated for car inspection and cleaning in the inspection shed in consideration of the time available between train operations.

Monthly inspection	7 hours/train
Daily insepction	1 hour/train
Major cleaning	3 hours/train
Intermediate cleaning	1 hour/train

Fig. 4.4.43 Standard Schedule of Car Inspection by Kinds of Inspection



Standard Schedule of Inspection by Train Formation
(6 car train)



4.10.4 Repair Shop

(1) General

a) The repair shop is of such a scale that car dismantling, part disassembly, repairs, tests, part assembly, and fitting-out required to give cars a general inspection and intermediate inspection can be all accomplished within the prescribed period.

b) The repair shop is equipped according to the method of car inspection and repair and the equipment layout is rational so that it suits the flow of inspection and repair work.

c) The repair shop is so planned that special car inspection, repairs, and renewal can also be performed.

(2) Scale of the Repair Shop

The scale of the repair shop is determined as shown in Table 4.4.21 from the volume of inspection shown in Table 4.4.19, the standard required days of car inspection shown in Fig. 4.4.43 and the standard required days of car inspection described in the previous section. The planning of the repair shop takes into account the oepration of 6-car trains at the later stage of Line No.1 operation.

Table 4.4.21 Scale of the Repair Shop

	1984	1987
Maximum number of trains simultaneous in shop	1 train	2 to 3 trains
Car body repair shop	6 cars	12 cars
Car body painting shop	3 cars	3 cars
Entrance inspection shed	3 cars, one track	3 cars, one track
Leaving inspection shed	6 cars, one track	6 cars, one track
Special repair shop	3 cars, one track	3 cars, one track
Rebuilding or renewal shop	6 cars	6 cars

(3) Planning of Shops and its Layout

A. A siding to divide the train into two parts for general inspection and intermediate inspection and a leaving inspection track are arranged in parallel with the repair shop trial run track.

a) Leaving inspection track

The leaving inspection track holds a 6-car train, and an open pit is dug from one end to the other of the track.

B. The layout of the repair shop is so planned that entrance inspection, car body lifting (from the bogie), car body dismantling, car body repairs, bogie repairs, and part repairs can be performed in a systematic manner.

a) Entrance inspection track

The entrance inspection track holds one half (3 cars) of the train divided for general inspection and intermediate inspection, and an open pit is dug from one end to the other of the track.

b) Car body repair shop

Car body lifting, dismantling, car body repairs, fitting-out, and car body mounting are performed in the same car body-repair shop. The car holding capacity is so planned that it holds 6 cars in the initial stage of Line No.1 operation but can be extended to holds 12 cars in the late stage of its operation. Cars are moved from place to place by two overhead cranes in this shop, but a traverser is used to carry cars to the car body painting shop.

c) Car body painting shop

A car body painting shop which can hold 3 cars is arranged in parallel with the car body repair shop. In consideration of air pollution by painting, the painting shop is isolated from other shops.

d) Repair shops of bogies, wheel sets and electric rotating machine

A shop for bogie disassembly and reassembly is located adjacent to the car body repair shop, and repair shops of bogies, wheel sets and electrical rotating machine are arranged around the shop for bogie disassembly and reassembly to perform the repair work in a systematic manner and save time in transportation. The planning of the wheel sets shop takes into account the whole line operation, as dictated by the relationship between the rolling property of wheel sets and the equipment layout, but the shops of bogies and electric rotating machines are planned to meet the requirements at the stage of partial operation of Line No.1, although they can be easily expanded with increasing rate of railway operation.

e) Part repair shop

The repair shop of electric parts and brake equipment are concentrated according to type of repair work apart from the shops for car repair, painting and bogie, wheel sets and electric rotating machine repairs.

f) Cushion repair shop

As cushion repair can be performed independently of other repair works, the cushion repair shop is located between the entrance inspection shed and the leaving inspection shed in consideration of the flow of car repair work.

g) Yard trial run track

A track for testing repaired and inspected cars is located at the boundary of the repair shop and inspection shed so that the yard trial runs may not be restricted by any repair work and the terminal of the yard trial run track may be used as a connecting track of the repair shop and inspection shed.

h) Special repair track and rebuilding repair shop

A special repair track which can hold 3 cars is laid adjacent to the car body repair shop, and a rebuilding repair ship which can holds 6 cars is also laid adjacent to the car body repair shop.

(4) Mechanical Equipment

The following were the main considerations in planning the mechanical equipment.

(a) Assurance of Required Car Performance and Function

Electrical and mechanical testing machines and machine tools which are required to ensure optimum performance of car equipment are planned.

(b) Safety and Avoidance of Manpower in Heavy Part Transportation

Car bodies are lifted and lowered by overhead traveling cranes. Necessary transports are also provided to ensure the safety of workers and to avoid the use of manpower in the transportation of heavy parts.

(c) Hygiene Maintenance

Proper mechanical equipment for air blasting, cleaning, and painting is provided to maintain a sanitary condition in the shops.

(5) Repair Shop of Future Line No.2

In planning the repair shop, comparative studies were made on whether not only the cars of Line No.1 but also those of Line No.2 could be given general inspection and intermediate inspection in the same car depot.

As a result, it has been made clear that the maintenance of the cars of the two lines in the same repair shop is possible by making only small-scale expansion of the buildings. The required expansion of the building includes the following:

a) Expansion of the car body repair shop, car body painting shop, and part repair shops.

b) It is not necessary to increase expensive mechanical equipment.

c) It is not necessary to change the flow of car repair work.

The buildings which need expansion are shown by an interrupted line (——..——..——) in the drawing of the car depot layout.

The basic conditions for the expansion of the repair shop of Line No.1 are as follows:

Number of cars in service	6 cars/train x 86 trains = 516 cars
Yearly amount of inspection work	58 trains : total of general and intermediate inspections
Standard required days of inspection	17 days per train

To meet these conditions, the repair shop must have the capacity shown below.

	Ultimate Capacity of Line No. 1	Combined Capacity of Lines No.1 and No. 2	Remarks
Maximum number of trains simultaneous in shop	3 trains	5 trains	
Car body repair shop	12 cars	18 cars	Increase of 6 cars
Car body painting sop	3 cars	6 cars, one track	Increase of 3 cars
Entrance inspection shop	3 cars, one track	3 cars, one track	
Leaving inspection shop	6 cars, one track	6 cars	
Special inspection shop	3 cars	3 cars	
Rebuilding or renewal shop	6 cars	6 cars	

4.10.5 Inspection Shed

(1) General

a) The facilities for monthly and daily inspections and auxiliary shops are concentrated in one building. Car cleaning and wheel profile milling are performed on one and the same track group to facilitate the facility control.

b) A shunting track is provided, because one reversing of the train is required to move it from the inspection facility to the storage track on account of land restraints.

(2) Scale of the Inspection Shed

The scale of the inpsection shed is determined, as shown in Table 4.4.22, from the daily volume of inspection (Table 4.4.20) and the standard required days of car insepction (Paragraph (5) b), Section 4.10.3).

Table 4.4.22 Scale of the Inspection Shed

(Unit: track)

	1983	1986	1987	1989
Inspection track				
Monthly inspection track	1	2	2	3
Daily inspection track	2	3	3	4
Total	3	5	5	7
Reference				
Washing and cleaning track	1	2	2	3

Note: A track is assumed to hold one train.

(3) Layout of Inspection Facilities

a) Monthly and Daily Inspection Sheds

Inspection tracks are laid in the same building, and they are arranged in parallel with the car storage tracks. This building has 3 tracks which can hold a 6-car train each and another 2 tracks each of which can hold 2 6-car trains each. All told, 7 trains can be held in this building. At the initial stage of operation 3 tracks which can hold 1 train each are built, and the auxiliary shops are built behind the inspection tracks. An open pit is dug from one end to the other for all the inspection tracks.

b) Washing, Cleaning and Wheel Profile Milling Tracks

The car washing machine track is arranged at the converging point of the five inspection tracks. Three car washing and cleaning tracks each of which can hold 3 6-car trains are arranged between the car washing machine track and the group of car storage tracks. At the initial stage of operation, however, only one car washing and cleaning track is built. A wheel profile milling track is built between the car washing and cleaning track and the car washing machine track. This track can hold one 6-car train each before and behind the wheel profile milling equipment installed at the middle of the track which can be used without disturbing the use of other tracks.

c) Shunting Track

A shunting track is laid at the converging point of the inspection tracks, car washing and cleaning track, and wheel profile milling track. The shunting track can hold a 6-car train and is arranged in parallel with the waiting tracks ahead of the car storage tracks.

(4) Mechanical Equipment

The work which is done in the car inspection shed includes the following:

a) Checking the operation condition of car equipment from the outside without breaking up the train formation

b) Replacement of consumables

c) Maintenance of normal wheel tread profile for car safety and service.

d) Car cleaning

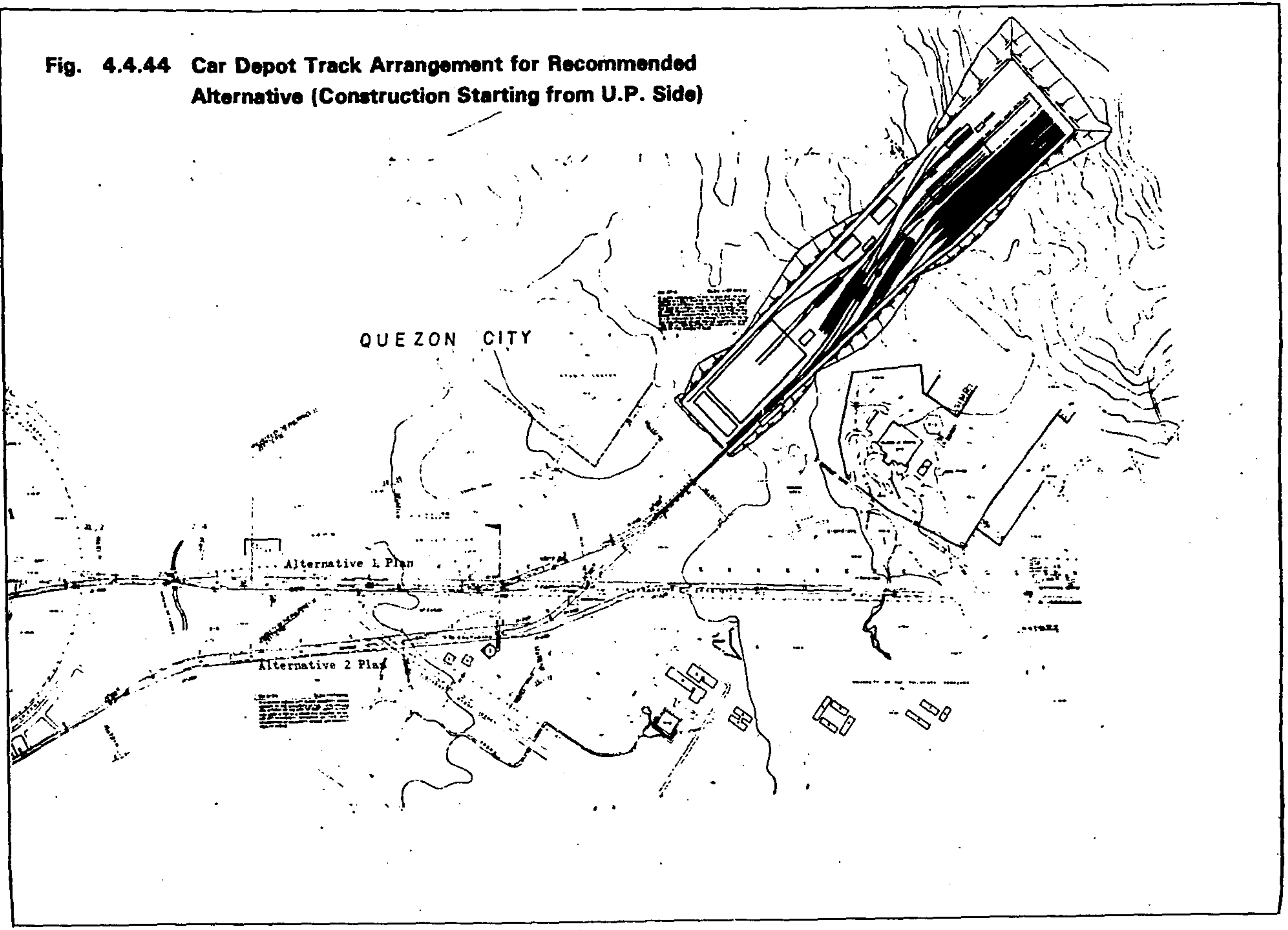
The car inspection shed is therefore provided with simple testing equipment and wheel profile milling equipment.

4.10.6 Track Maintenance Facilities

The track maintenance facilities comprises a long-rail welding shop and a turnout repair shop. The rail welding equipment are so arranged as to facilitate the easy delivery of rails from the road and the easy transportation of welded long-rails by exclusive wagons to the main line.

Rail is welded by the low-temperature gas heating butt welding method into lengths of 100 m. The turnout shop is so equipped that turnouts needing repair can be disassembled, repaired, and reassembled. The transportation of turnouts to and from the shop is by conveying truck.

Fig. 4.4.44 Car Depot Track Arrangement for Recommended Alternative (Construction Starting from U.P. Side)



4.10.7 Car Depot

The car depot is a base where cars are inspected, repaired and stored. The administrative head office of Line No.1 is also located in the car depot so that centralized control can be maintained of train operation, maintenance and personnel management.

The site of the car depot has been selected with emphasis on the following considerations:

1. The loss of time in forwarding should be minimized.
2. The car depot should permit further expansion in the future.
3. The car depot should not conflict with the plans of future land development and road construction.
4. The site is wide enough to hold the cars and facilities required.

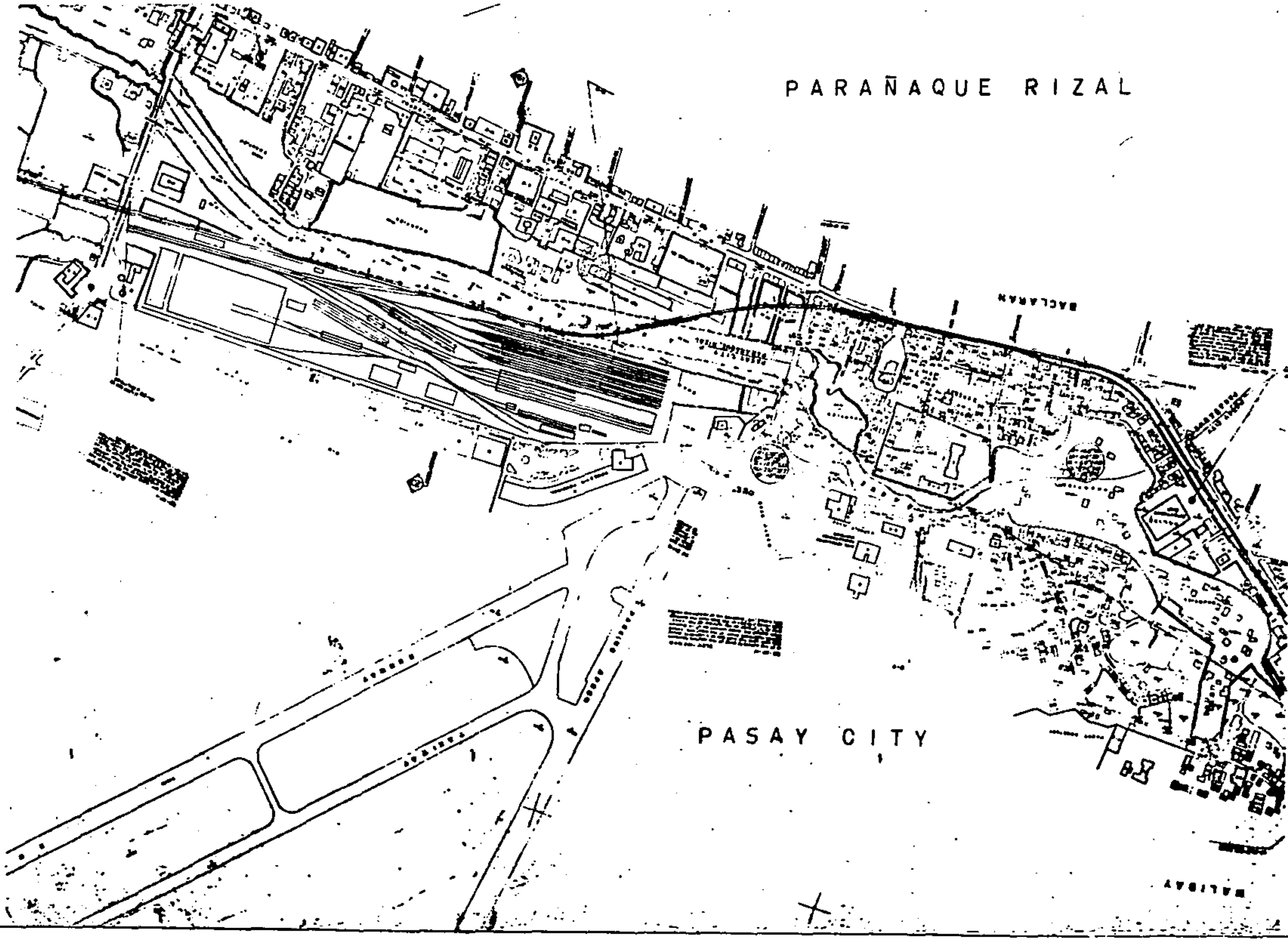
The planning of the location of the car depot requires to take into account various factors such as the modes of future transportation, topography and availability of land. The car depot of Line No.1 has such a close relation with the method of stage construction of the railway that its siting cannot be planned regardless of which side of the route will be first opened to traffic, Baclaran or U.P.

As a result, two alternative plans have been considered:

1. Line No.1 is built from the side of U.P.
   In this case the car depot should be located on the Quezon side.
2. Line No.1 is built from the side of Baclaran.
   In this case the car depot should be located on the Baclaran side.

The location and layout of the car depot for the two cases of railway construction are shown in Figs. 4.4.44 and 4.4.45, respectively.

Fig. 4.4.45 Car Depot Track Arrangement for Compared Alternative (Construction Starting form Baclaran Side)



CHAPTER 5. COMPARATIVE STUDIES ON ALTERNATIVE PLANS

As mentioned previously, the recommended route was selected after comprehensive comparative studies on several alternative plans, from the points of traffic, engineering, economic and financial considerations. In this chapter, a brief description shall be made of the main engineering features of the compared alternatives.

5.1 ELEVATION OF VITO CRUZ – BACLARAN SECTION

The recommended route proposes the elevation of the U.P. - Sto. Domingo section. However, in the course of the study, studies as to the viability of elevating a section of the line on the Taft Avenue, namely the section between Vito Cruz and Baclaran, was also made.

Results of analysis show that although the elevation of this section is not technically impossible, this alternative cannot be easily recommended due to the narrowness of the Taft Avenue along this section. The width of Taft Avenue is about 13 m to 16 m, and the road traverses very densely built up area, with extremely heavy traffic. The elevation of the railway line necessitates construction of piers in the middle of the road. As a result, the remaining width of the road will be too narrow to cope with the road traffic demand. Thus, on the elevation of the railway, it is necessary to widen the road. Land acquisition and demolition of the buildings along the affected section will be required. The extent of land acquisition is estimated at about 3 m in width.

The general alignment of the elevated section will be about the same as the recommended underground alternative except that the terminal Baclaran Station will be shifted to about 200 m east of the Quirino Avenue, passing through a tract of private land.

Should the line be extended to the Airport in future, the airport branch will have to go underground again at a point some 2 km south of the Baclaran station in order to comply with aviation requirements.

Figs. 4.5.1 to 4.5.3 show the plan and profile of the elevated alternative of the Vito Cruz - Baclaran section.

5.2 UNDERGROUND STRUCTURE FOR U.P. – STO. DOMINGO SECTION

Particular care was given to the comparative study of the structure to be adopted for this section. The elevation of this section will greatly reduce the construction cost. On the other hand, the possible detrimental environmental effect on this area of high environmental quality has to be investigated and possible counter-measures have to be considered before the elevation of this section can be recommended.

The road on this section is wide, and the building up along the road is at present not heavy. Thus such environmental pollution as noise, vibration or reprieval of sunshine are of minor problems. As for aesthetical effects, it is not difficult to blend the elevated structure into the surrounding scenery through proper landscape planning. These and other considerations led to the recommendation on elevation of this section.

The alignment of the all underground alternative will be basically the same as that for the recommended partially elevated alternative. However, at the Quezon Memorial, the route will not make a big detour around the monument but will pass under the memorial, thus shortening the route somewhat. The terminal U.P. station in this case will be situated directly under the Commonwealth Avenue. Also, at the San Juan River, the route will be detour around the existing arch bridge instead of passing directly under the bridge.

Figs. 4.5.4 to 4.5.6 show the plan and profile of the all underground alternative for the U.P. - Sto. Domingo section.

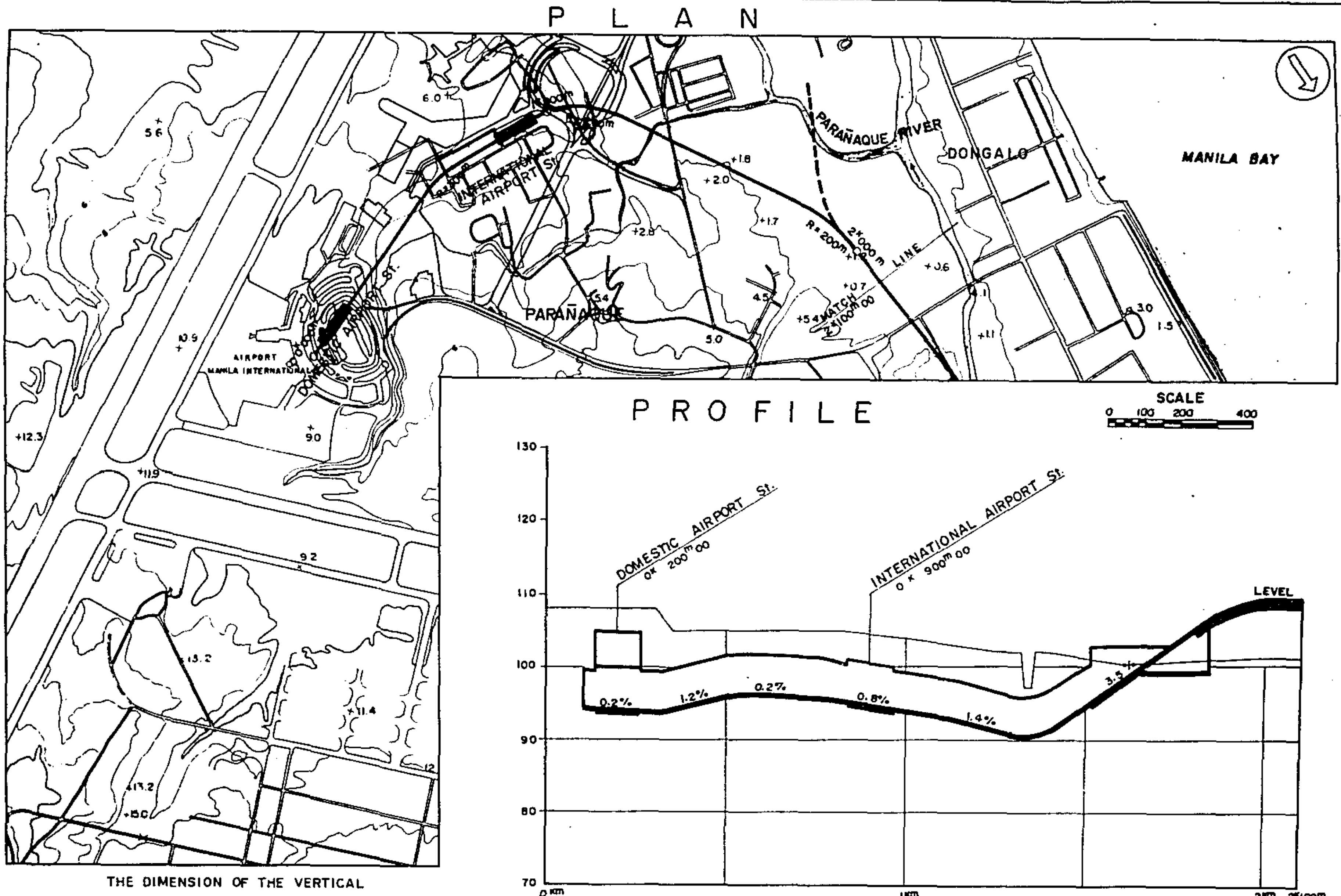
5.3 ELECTRICAL INSTALLATIONS OF THE ALL UNDERGROUND RAILWAY

The electrical installations of the all underground section do not differ in substance from those of the recommended partially elevative section. The undergrounding of the railway, however, increase the necessity of the power supply system for tunnel ventilation, air-conditioning and lighting and the auxiliary installations of RF communications like leak coaxial cables which are necessary instead of the antennas. Furthermore, the track structure is, as a matter of course, different from partially elevated structure. The underground facilities like substations do not differ from the elevated railway to the underground one.

As the all underground railway has more wayside electrical installations than the elevated one, the capacity of substation transformers differ accordingly, as shown in Table 4.5.1.

Table 4.5.1 Capacity of Substation Transformers of the Partially Elevated Railway System

Substation Name	Capacity (KVA) x Number of Transformers			
	Partially Elevated Structure		All Underground Structure	
	Recommended Alternative	Compared alternative (from Baclaran Side)	from Baclaran	from U.P.
North Baclaran	4,500 x 2	4,500 x 2	4,500 x 2	3,000 x 2
Rizal Park		4,500 x 2	4,500 x 2	4,500 x 2
Far Eastern University	4,500 x 2			4,500 x 2
Univ. of Santo Tomas			4,500 x 2	
Univ. of the Philippines	3,000 x 2	3,000 x 2	3,000 x 2	4,500 x 2



THE DIMENSION OF THE VERTICAL SCALE IS OBTAINED BY ADDING 100M TO GROUND LEVEL.

Fig. 4.5.1 Plan and Profile for Elevation of Taft Avenue (1)

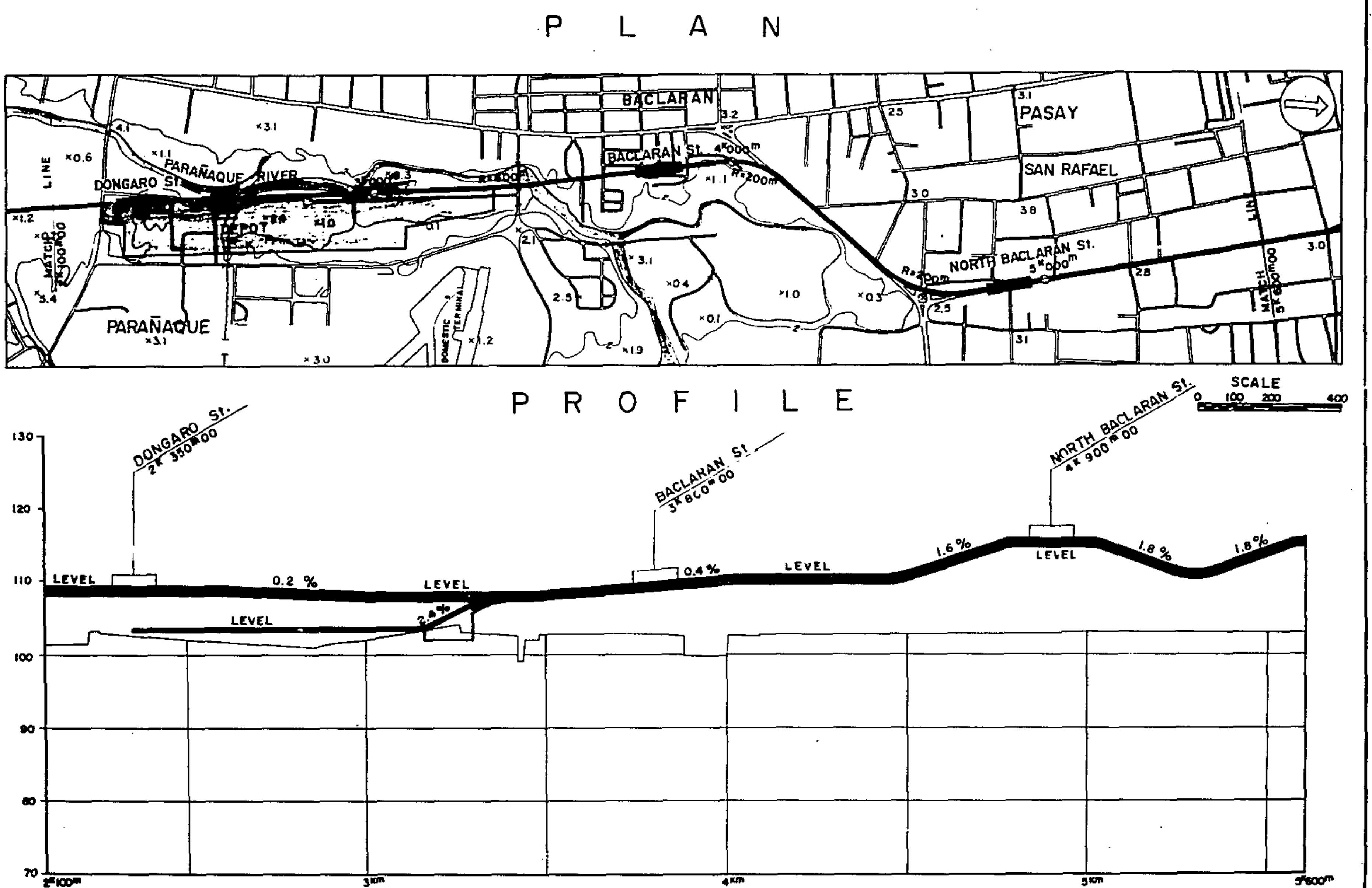


Fig. 4.5.2 Plan and Profile for Elevation of Taft Avenue (2)

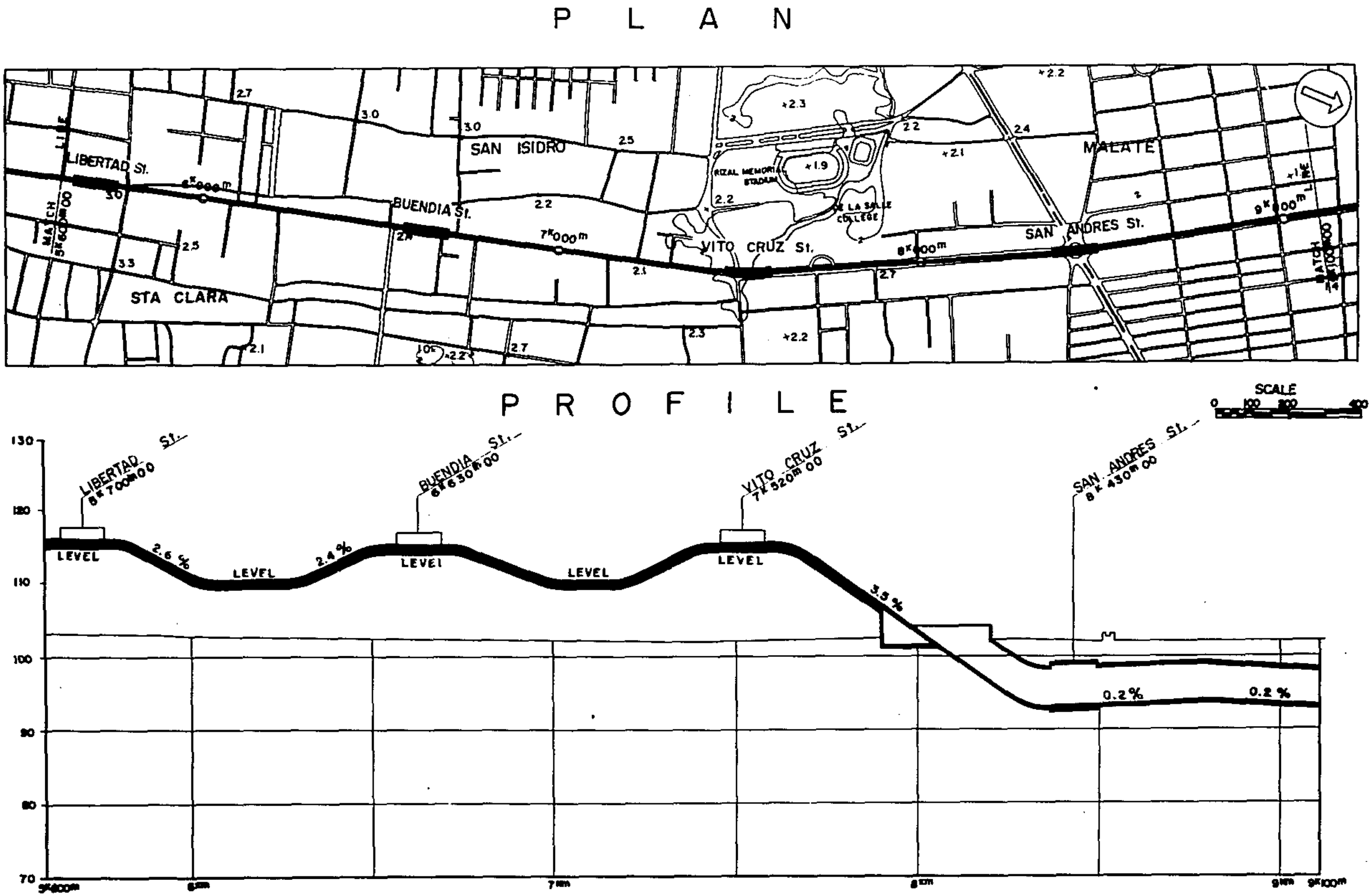
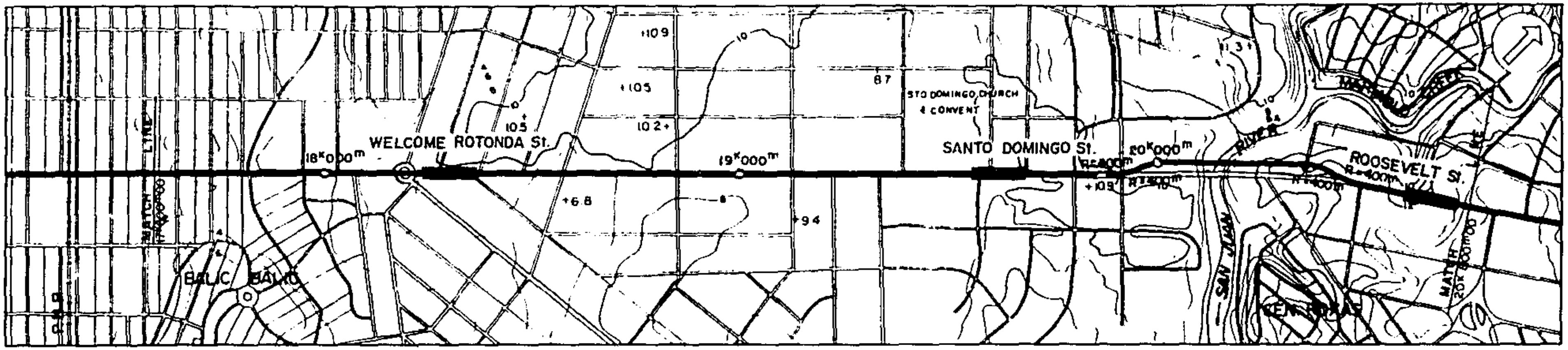


Fig. 4.5.3 Plan and Profile for Elevation of Taft Avenue (3)

PLAN



PROFILE

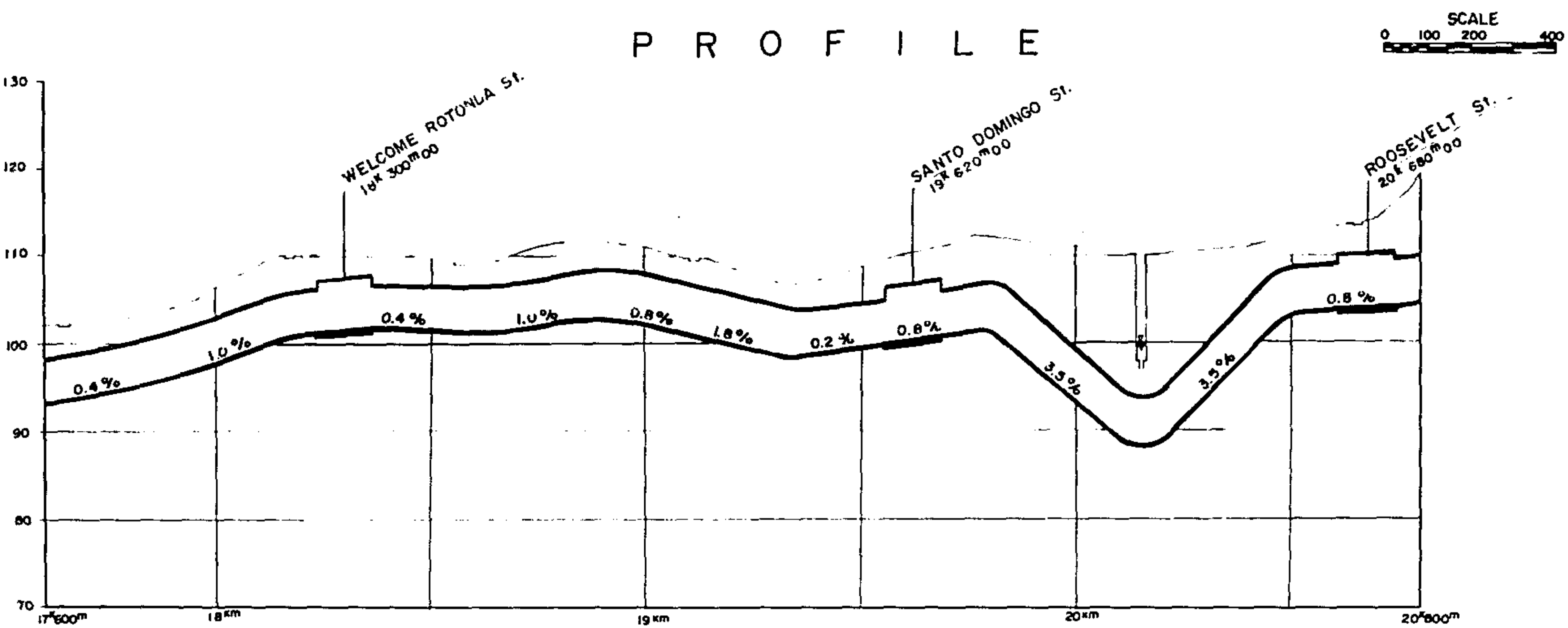


Fig. 4.5.4 Plan and Profile for All Underground Alternative (1)

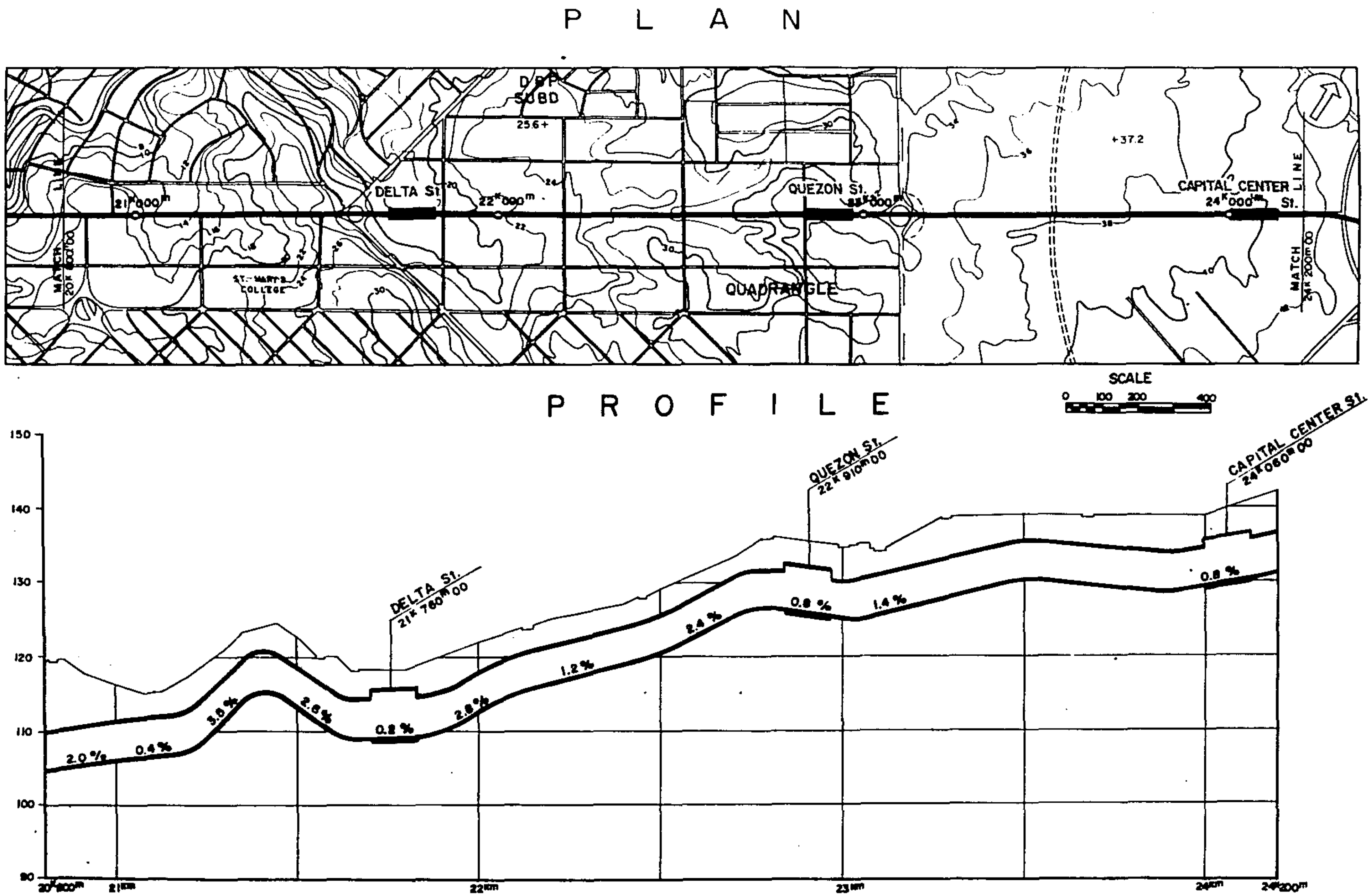


Fig. 4.5.5 Plan and Profile for All Underground Alternative (2)

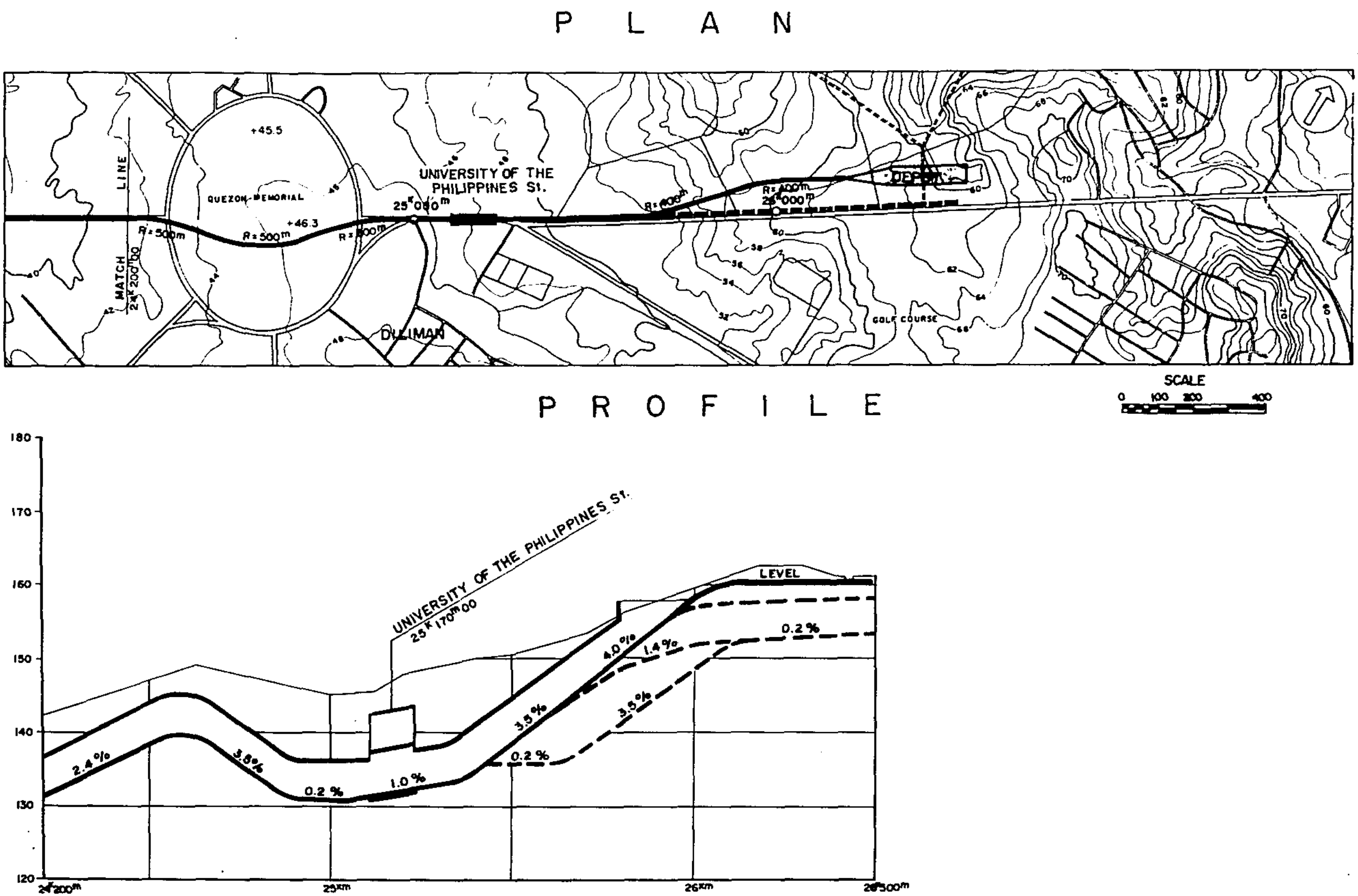


Fig. 4.5.6 Plan and Profile for All Underground Alternative (3)

CHAPTER 6 CONSTRUCTION PLANNING

6.1 METHODS OF CONSTRUCTION

6.1.1 Cut-and-cover Method

The underground stations and box-type tunnels of the underground sections of RTR Line No.1 are planned to be built by the cut-and-cover method. To support the sides of the cut, horizontal wood planks are placed between vertical H-shaped steel beams.

In the wide streets like Quezon Boulevard, no decking is used over the cut, because two lanes or more can be secured to maintain vehicle traffic on either side of the cut except for the stations and crossings. The s tandard cut-and-cover method is illustrated in Fig.4.6.1.

Taft Avenue and Espana towards the urban centre and Buendia Station are proned to be flooded after a heavy rain, partly because the road surface is lower than the level of the surrounding ground and partly due to inadequate drainage. This problem can be nearly solved if drainage is provided. To cope with the flooding during tunnel construction, the construction cost and period will be increased to a considerable extent.

6.1.2 Special Construction Methods

1. Tunnel Crossing the Pasig River

The tunnel crossing the Pasig river is the most difficult of all the sections of Line No.1. The soil of the site is composed of soft alluvial deposits reaching a depth of 40 m, and the soil 30 m below the surface is so soft that its value N is about 5. Up to this depth very soft silty sand, silt and clay alternate, and there is a layer of slightly hard silty sand (value N = about 30) between 30 and 40 m below the surface. Below the depth of 40 m there is a layer of diluvial deposits composed of compact silt similar to the soil seen in the Quezon area.

The deepest bottom of the Pasig river is about 15 m below the ground surface. This means that the tunnel of Line No.1 must be constructed between 20 and 27 m below the ground surface, passing through the layer of clay and silt with a value N of about 5.

Several construction methods can be considered for the tunnel crossing the Pasig river. They are the compressed air caisson method, compressed air shield method, and submerged tube method. These methods have been compared from various angles to select a suitable one for the tunnel to be built across the Pasig river.

<u>Submerged Tube Method</u>

If a tunnel is to be built across the Pasig river by this method, it is necessary to dredge a trench in the river to sink a prefabricated tube into it. This method, however, is not recommendable from the standpoint of safety, because the proposed route of the tunnel runs in close proximity to the Quezon bridge. Furthermore, it is also necessary to cut away the embankment on either side of the river to dredge a wide area of the ground. This necessitates the movement of existing ground facilities and buildings. On top of that, navigation must be suspended while dredging a trench and building a tube tunnel. The construction period by this method is placed at about 3 years, and the construction cost, about $30,000 per meter.

Caisson Method

The caisson method is a general practice to build a tunnel across a river. By this method it is necessary to dam up part of the river to build an artificial island from which caissons are sunk one after another. This makes it necessary to suspend navigation during construction. As the cross section of water flow in the river is reduced by the artificial island, the operation of tunnel construction is restricted during the rainy season. The construction period is placed at about three and a half years, and the construction cost is estimated at about $35,000 per meter.

Shield Method

The shield method will be the most suited to the proposed site of tunnel construction. The tunnel which extends for about 980 m is built by driving a shaft on each bank of the river. As the shafts provide a passageway to move the excavated earth to the surface and bring in the building materials from the surface, the operation of tunnel construction will neither cause damage to the existing ground structures nor disturb the traffic of the vicinity. This method which is cheaper than the other two costs about $24,600 per meter. The shield section of this tunnel is about 1 km, and its construction period is placed at about two and a half years.

As a result of a comparative study of the three methods of tunnel construction, a conclusion has been reached that the shield-driven tunnel is most desirable for the proposed site.

2. Tunnel in Front of the Far Eastern University

In front of the Far Eastern University Line No.1 is planned to be built right under the underpass near the university. The soil of the site is of much the same nature as the soil under the Pasig river. As it is neither possible nor practical to destory the existing underpass, the tunnel should be built by the shield method.

6.2 STAGE CONSTRUCTION

As the route of Line No.1 extends for over 20 km, its construction involves huge amounts of investment, labor, and mechanical power.

When building a railway of such length, the general practice is to employ stage construction to open the line to traffic from section to section instead of waiting for the entire line to be completed.

Two alternatives of stage construction can be considered for Line No.1.

(1) Construction of the line from Baclaran side

(2) Construction of the line from the University of the Philippines side

If construction of the line is to be started from Baclaran side, it is most desirable that the construction of Line No.1 should be started at the earliest possible date, because it is not before long that the motor traffic capacity of Taft Avenue is expected to be exceeded by traffic demand.

On the side of the University of the Philippines, on the other hand, Quezon Boulevard still has excess capacity. It is shown, however, by the analysis of future traffic demand that the potential railway passenger demand is greater on the side of the University of the Philippines than on the side of Baclaran.

Fig. 4.6.1 Standard Cut-and-Cover Method

(a) Station Section

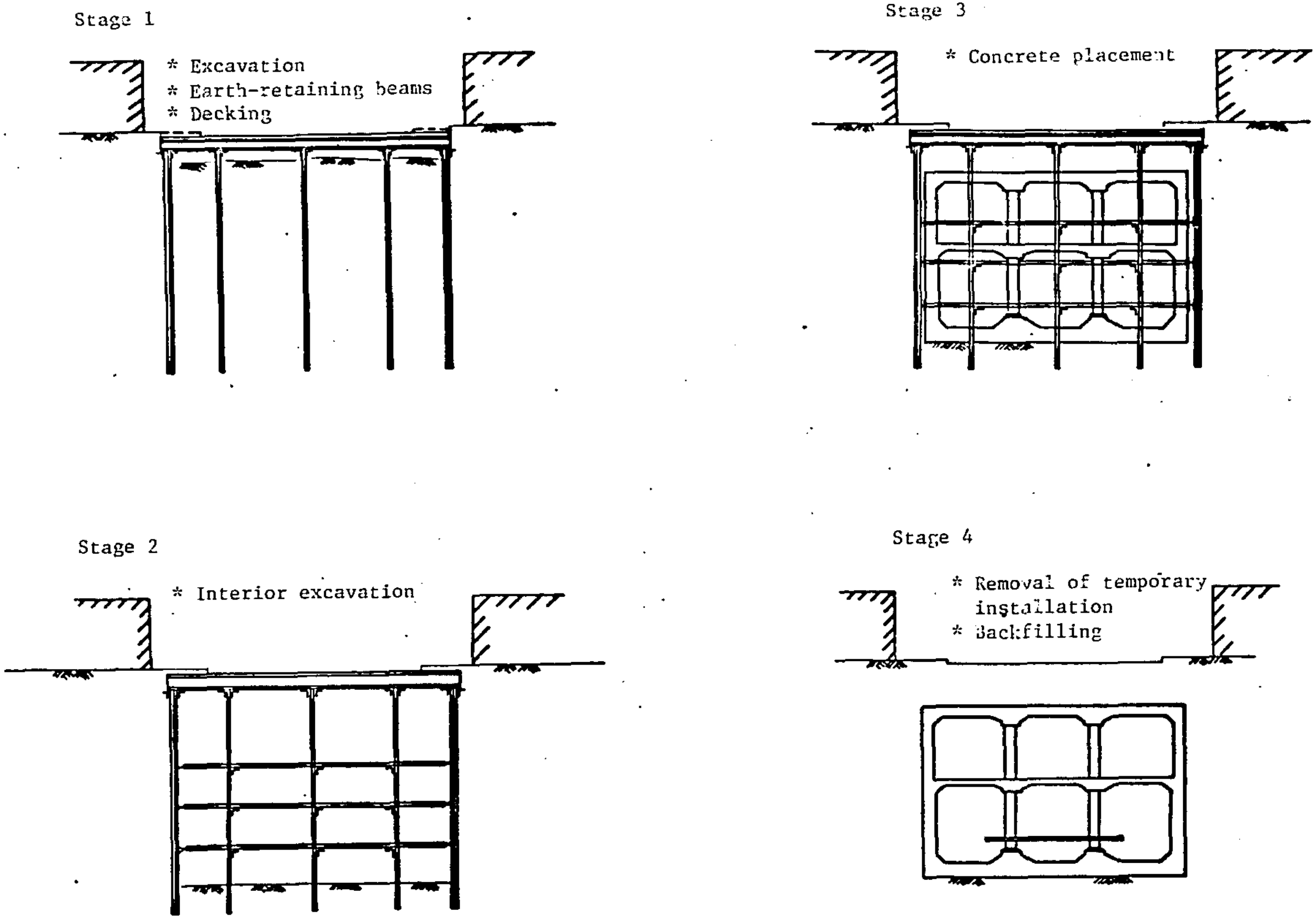
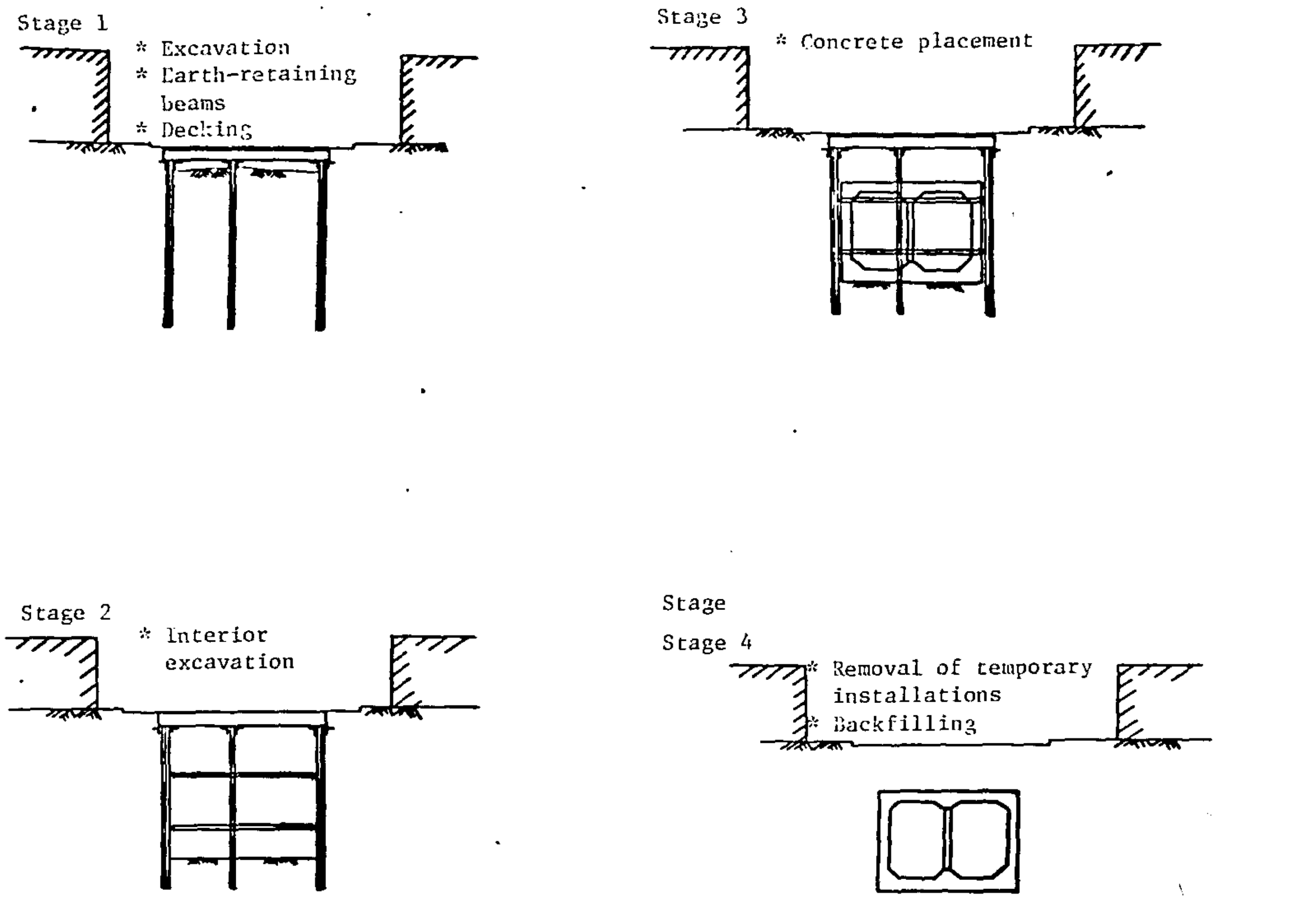


Fig. 4.6.1 Standard Cut–and–Cover Method

(b) General Section



From the standpoint of passenger usage, therefore, the construction from U.P. side is more advantageous. From an engineering point of view construction from U.P. side is also more desirable because the wide Quezon Boulevard makes the operation of railway construction easy. In this case the operation gradually becomes difficult as the work progresses.

The kilometerage at each stage of construction has been planned as shown in Table 4.6.1 in consideration of the facilities required to reverse the trains. (See also Figs. 4.6.2 & 4.6.3)

Table 4.6.1 Kilometerage at Each Stage of Line No.1 Construction

	Stations	Starting Point	Terminating Point	Remarks
Recommended Alternative	1st stage U.P. - F.E.U.	$25^K\ 700^M$	$15^K\ 650^M$	
	2nd stage F.E.U. - Rizal Park	15 650	10 150	
	3rd stage Rizal Park - Baclaran	10 150	2 600	
	4th stage (Baclaran - M.D.A.)	2 600	0 000	Future extension
Compared Alternative	1st stage Baclaran - Rizal Park	2 600	10 320	
	2nd stage Rizal Park - U.S.T.	10 320	16 700	
	3rd stage U.S.T. - U.P.	16 700	25 700	
	4th stage (M.D.A. - Baclaran)	0 000	2 600	Future extension

6.3 CONSTRUCTION SCHEDULE

The construction schedule of Line No.1 has been planned on the basis of the concept of stage construction discussed in the previous section.

The planning of the construction schedule requires taking into account the period of time which is needed to prepare for the operation of railway construction.

The preparations for railway construction include the following:

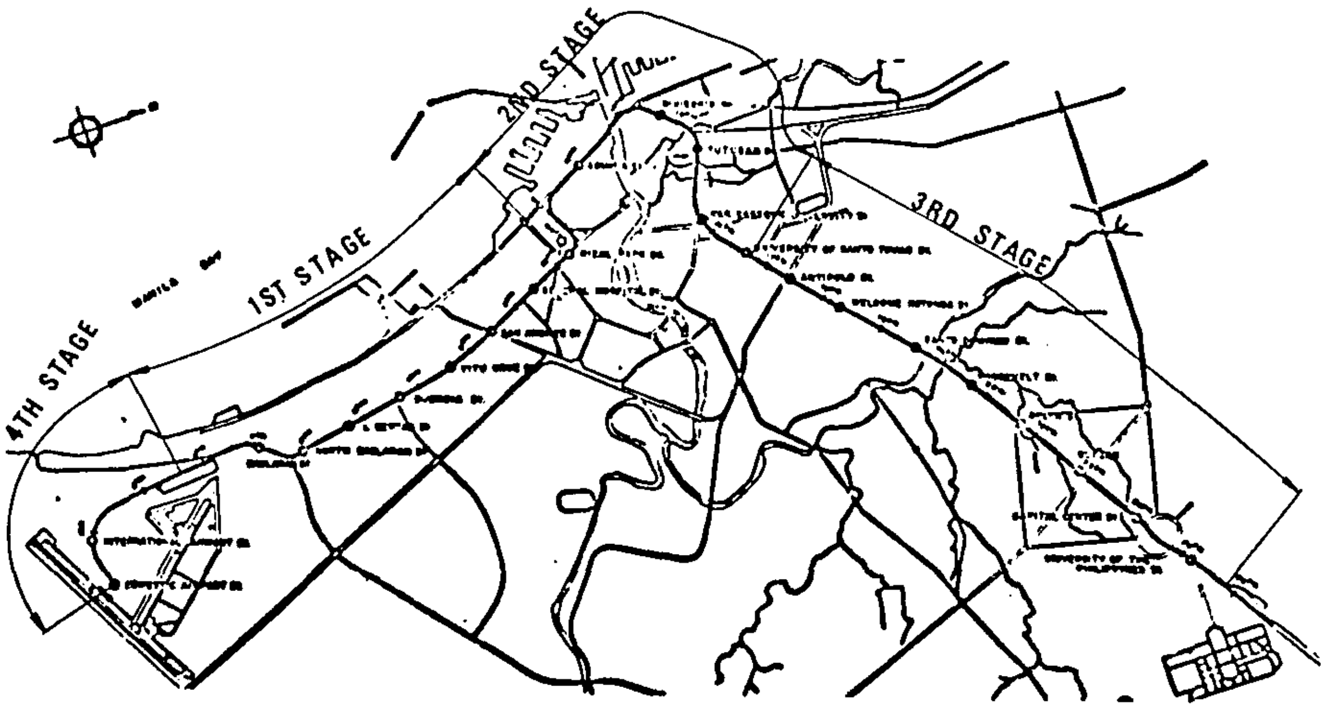
1. Establishment of an organization for coordination, supervision and programing of the construction and equipment procurement of Line No.1
2. Revision of the relevant laws for the construction of Line No.1
3. Land acquisition
4. Engineering works
5. Establishment of financial source
6. Calling of tender, assessment, negotiation, and selection of contractor

Usually, it takes four years or more to complete the preparation works for a construction of such a large scale, even if no obstacles are encountered in the course of the preparation. This may be summarized as shown in Table 4.6.2.

On completion of the preparation works, the construction works for each section will take about 3 to 3 1/2 years. In Figs. 4.6.4 and 4.6.5, construction schedule is proposed for the implementation of the whole recommended section, taking into consideration the effective and efficient use of materials, equipment and manpower.

Fig. 4.6.2 Stage Construction

(1) Construction of Line No.1 from the side of Baclaran



(2) Construction of Line No.1 from the side of the University of the Philippines

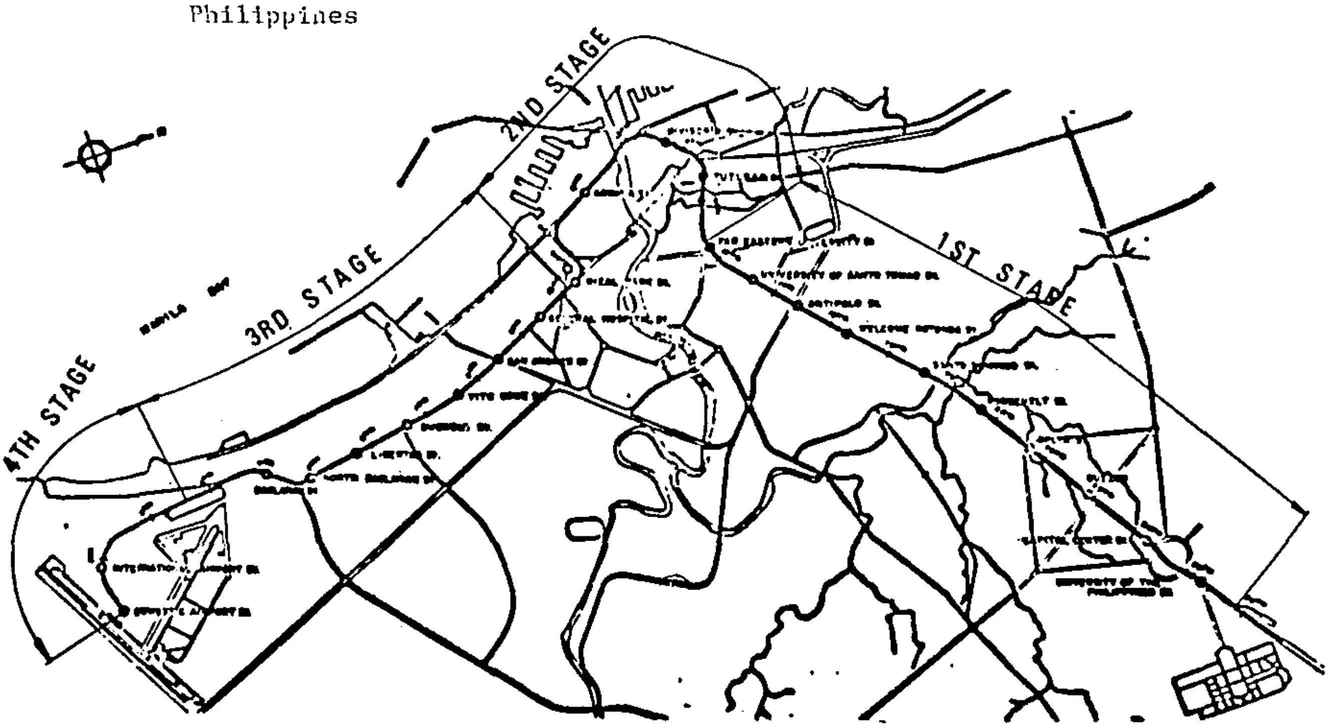


Table 4.6.2 (a) Construction Work Time Schedule (Construction from U.P. side)

Item	1976	77	78	79	80	81	82	83	84	85	86	87	88	89	90	Remarks
Financing																
Survey and Design																
1st stage (civil engineering, structure and track)																Including the car depot.
U.P.-F.E.U. (9k430m) (power supply, signals and communications)																
(Mechanical installations)																
(Rolling stock)																
Personnel training																
Test runs and inauguration of service								Inauguration of service								
2nd stage (civil engineering, structure and track)																
F.E.U.-Rizal Park (5k490m) (power supply, signals and communications)																
(Mechanical installations)																
(Rolling stock)																
Test runs inaugmation of service										Inauguration of service						
3rd stage (civil engineering, structure and																Including the car storage.
Rizal Park-Baclaran (6k190m) (power supply, signals and communications)																
(Mechanical installations)																
(Rolling stock)																
Test runs inauguration of service												Inauguration of service				

Table 4.6.2 (b) Construction Work Time Schedule (Construction from Baclaran side)

Item	1976	77	78	79	80	81	82	83	84	85	86	87	88	89	90	Remarks
Financing																
Survey and design																
1st stage (civil engineering, structure and track)																
Baclaran- Rizal Park (power supply, signals (6k190m) and communications)																
(Mechanical installations)																Including the car depot.
(Rolling stock)																
Personnel training																
Test runs and inauguration of service								Inauguration of service								
2nd stage (civil engineering, structures and track)																
Rizal Park-U.S.T. (power supply, signals (6k360m) & communications)																
(Mechanical installations)																
(Rolling stock)																
Test runs and inauguration of service										Inauguration of service						
3rd stage (civil engineering, structures and track)																
U.S.T.-U.P. (power supply, signals and (8k560m) communications)																
(Mechanical installations)																Including the car storage.
(Rolling stock)																
Test runs and inauguration of service												Inauguration of service				

CHAPTER 7 PROJECT COST

7.1 UNIT CONSTRUCTION COST

The oil crisis sent prices soaring after 1973, but in 1975 the price index showed that the pace of increase has considerably showed down. However, it is still difficult to estimate the prices of building materials because of the precarious situation.

In this study, therefore, the construction cost has been estimated on the basis of the market prices of building materials as of July 1975. In the presentation of various cost estimates of the basic materials, the assumption was made that the rolling stock, signals, communication equipment, electrical equipment, air-conditioning and ventilating equipment, and other support systems which form an integral part of the railway would be all imported from abroad. Tables 4.7.1 to 4.7.3 summarize the unit cost of major construction elements at July 1975 price.

7.2 PROJECT COST

The total construction cost was estimated based on the above unit cost. The total project cost is then estimated by including also the cost for equipment and rolling stock procurement, engineering services and land acquisition.

Table 4.7.4 summarizes the project cost for the recommended alternative implemented at recommended schedule, broken down into cost items and stages. The total project cost is seen to come to 547 million US$ of which the cost on civil engineering construction works makes up the largest share of 273 million US$ or about 50% of the total project cost.

Comparative studies of project cost various other alternatives both in the type of structure and in the method of staging of construction schedule had been made, and the results are also listed for reference. Thus, Table 4.7.5 shows the project cost for the recommended partial elevated structure if the implementation is started from Baclaran side, while Tables 4.7.6 and 4.7.7 show the project cost if the all-underground structure were adopted.

Although the alternative on elevation of the southern portion of Taft Avenue has been rejected from technical points, the project cost has also been analysis and is listed in Table 4.7.8 for reference purpose.

In all alternatives, the project cost for the future extension of the section from Baclaran to the airport has been shown for reference and is expressed as 'stage 4' in the respective tables.

Table 4.7.1 Unit Construction Cost as of July 1975

Item	Unit	Unit Price (pesos)
Portland cement	Ton	330
Gravel	m^3	35
Sand	m^3	35
Reinforcing steel	Ton	3,500
Shaped steel	Ton	3,000
Steel pile	Ton	6,500
Sheet pile	Ton	3,100
Cover	m^2	735
Form (steel)	m^2	27
Concrete pile, 400 mm	m	100
Ready-mix concrete, 210 kg/cm^2	m^3	200
Ready-mix concrete, 280 kg/cm^2	m^3	230
Ready-mix concrete, 350 kg/cm^2	m^3	265

Table 4.7.2 Rental Fees of Construction Machinery as of July 1975

Item	Unit (day)	Rental Fee (pesos)
Bulldozer, 10 tons	1	820
Bulldozer, 20 tons	1	1,580
Dump truck, 6-8 tons	1	430
Truck, 2 tons	1	290
Truck, 5 tons	1	420
Pile driver, D12	1	870
Pile driver, D22	1	1,290
Crawler crane, 6-10 tons	1	430
Crawler crane, 10-15 tons	1	590

Table 4.7.3 Labor Cost as of July 1975

Item	Unit(day)	Unit Cost (pesos)
Common labor	1	18
Skilled labor	1	20

Table 4.7.4 Project Cost for the Recommended Alternative

($000)

Item	Stage 1	Stage 2	Stage 3	Stage Total	(Reference) Stage 4
Land acquisition and demolition	2,220	1,230	2,570	6,020	2,210
Civil engineering works	87,750	90,020	95,120	272,890	22,880
Track	5,620	2,410	3,220	11,250	1,630
Architectural works	21,230	2,400	3,390	27,020	1,220
Power transmission facilities	17,190	7,210	10,460	34,860	5,130
Signal facilities	7,810	1,640	4,030	13,480	890
Communication facilities	1,570	900	680	3,150	480
Substations	7,930	3,960	4,830	16,720	2,100
Rolling stock	34,170	26,650	21,120	81,940	27,490
Mechanical equipment	12,960		1,190	14,150	
Air-conditioning equipment	4,620	4,650	10,810	20,080	2,820
Subtotal	203,070	141,070	157,420	501,560	66,850
Survey, design and supervision	18,590	12,770	14,680	46,040	5,310
Total Project Cost	221,660	153,840	172,100	547,600	72,160

Note: 1) The project cost is estimated in July 1975 price and excludes interest or adjustment for inflation during construction.

2) The recommended alternative indicates the implementation only of the section from U.P. to Baclaran, with partially elevated structure (elevated section: U.P. - Sto. Domingo) and with construction starting from U.P. side.

Table 4.7.5 Project Cost of Compared Alternative (1)

a) Partially elevated structure (elevated section: U.P. - Sto. Domingo)

b) Construction starting from Baclaran side

($000)

Item	Stage				(Reference)
	1	2	3	Total	Stage 4
Land acquisition and demolition	2,570	1,230	2,220	6,020	2,210
Civil engineering works	100,320	107,850	64,730	272,900	22,880
Track	5,100	2,720	3,910	11,730	1,140
Architectural works	17,650	2,780	6,590	27,020	1,220
Power transmission facilities	14,540	8,520	11,650	34,710	5,120
Signal facilities	7,770	1,660	4,040	13,470	890
Communication facilities	1,380	1,010	810	3,200	530
Substations	6,970	3,960	5,780	16,710	2,100
Rolling stock	28,180	23,350	30,410	81,940	27,490
Mechanical equipment	12,960		1,190	14,150	
Air-conditioning equipment	8,680	5,630	5,770	20,080	2,820
Subtotal	206,120	158,710	137,100	501,930	66,400
Survey, design and supervision	19,200	14,700	12,190	46,090	5,260
Total Project Cost	225,320	173,410	149,290	548,020	71,660

Table 4.7.6 Project Cost for Compared Alternative (2)

(a) All underground structure

(b) Construction starting from U.P side

($000)

Item	Stage				(Reference)
	1	2	3	Total	Stage 4
Land acquisition and demolition	580	1,230	2,570	4,380	2,210
Civil engineering works	143,250	90,020	95,080	328,350	22,880
Track	5,850	2,410	3,220	11,480	1,630
Architectural works	18,730	2,400	3,390	24,520	1,220
Power transmission facilities	17,900	7,370	10,780	36,050	5,370
Signal facilities	7,810	1,640	4,030	13,480	890
Communication facilities	1,900	870	990	3,760	500
Substations	8,330	4,130	4,640	17,100	1,940
Rolling stock	34,170	26,650	21,120	81,940	27,490
Mechanical equipment	12,960		1,190	14,150	
Air-conditioning equipment	10,810	4,650	12,090	27,550	2,820
Subtotal	262,290	141,370	159,100	562,760	66,950
Survey, design and supervision	24,520	12,800	14,850	52,170	5,320
Total Project Cost	286,810	154,170	173,950	614,930	72,270

Table 4.7.7 Project Cost of Compared Alternative (3)

(a) All underground structure

(b) Construction starting from Baclaran side

($000)

Item	Stage 1	Stage 2	Stage 3	Stage Total	(Reference) Stage 4
Land acquisition and demolition	2,570	1,230	580	4,380	2,210
Civil engineering works	100,320	107,820	120,220	328,760	22,880
Track	5,100	2,720	4,140	11,960	1,140
Architectural works	17,650	2,780	4,090	24,520	1,220
Power transmission facilities	15,070	8,710	12,290	36,070	5,150
Signal facilities	7,770	1,660	4,040	13,470	890
Communication facilities	1,720	960	1,230	3,910	310
Substations	6,970	4,320	5,970	17,260	2,100
Rolling stock	28,180	23,350	30,410	81,940	27,490
Mechanical equipment	12,960		1,190	14,150	
Air-conditioning equipment	8,680	5,630	13,240	27,550	2,820
Subtotal	206,990	159,180	197,400	563,570	66,210
Survey, design and supervision	19,290	14,750	18,220	52,260	5,240
Total Project Cost	226,280	173,930	215,620	615,830	71,450

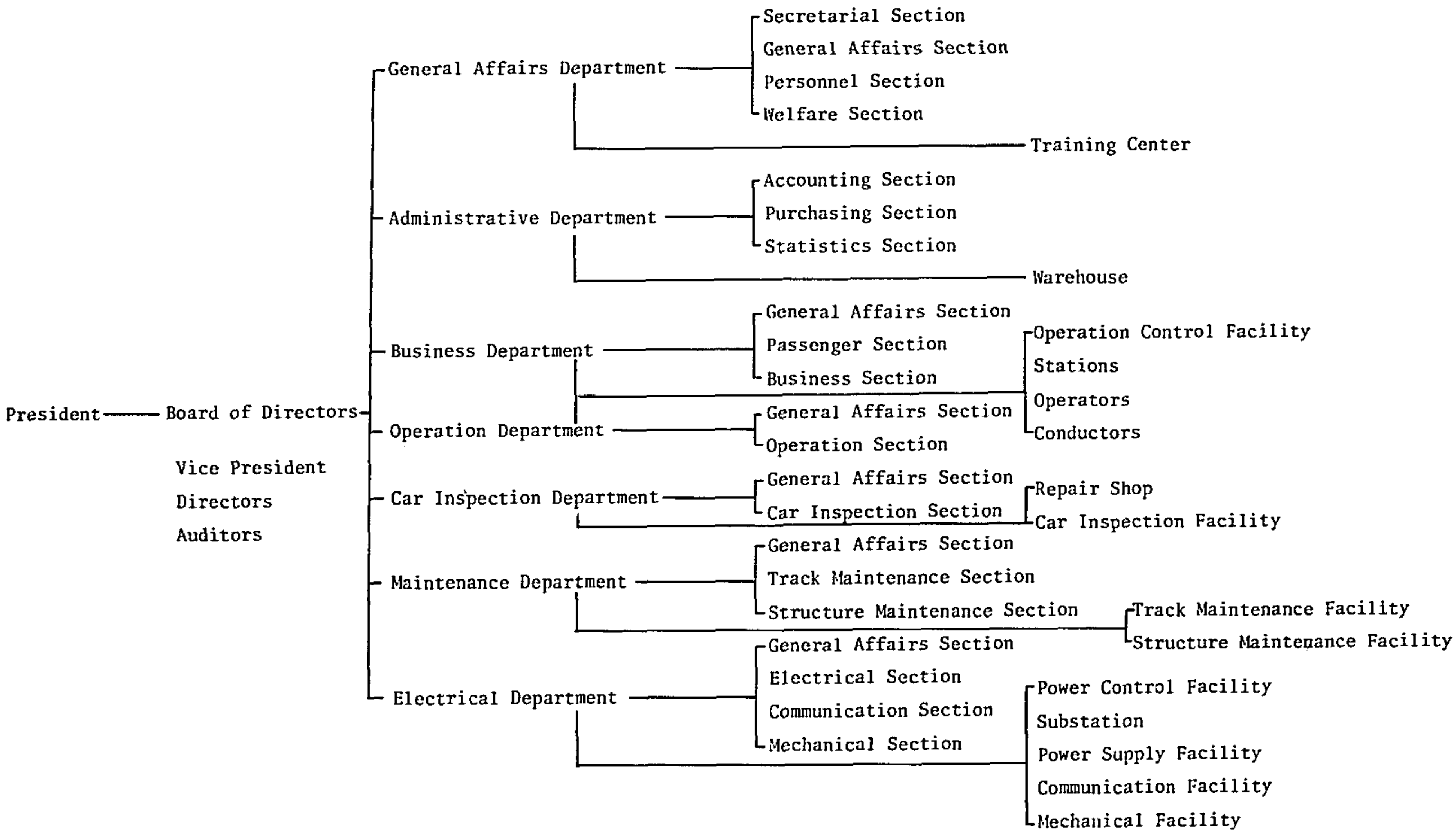
Table 4.7.8 Project Cost for Compared Alternative (4)

(a) Elevation of both (i) U.P. - Sto. Domingo section and
(ii) Baclaran - Vito Cruz section

Item	Cost (Stage 1 - Stage 3)
Land acquisition and demolition	13,680
Civil engineering works	226,250
Track	11,730
Architectural works	27,010
Power transmission facilities	33,290
Signal facilities	13,460
Communication facilities	2,920
Substations	16,710
Rolling stock	81,940
Mechanical equipment	14,150
Air-conditioning equipment	12,610
Subtotal	453,750
Survey, design and supervision	499,860
(reference) Total Cost for Stage 4	71,440

Note: This alternative was rejected from technical considerations and the above project cost is listed only for reference purpose.

Table 4.8.1 Organization chart



CHAPTER 8 OPERATION AND ADMINISTRATION PLANNING

8.1 BASIC CONCEPT OF ORGANIZATION AND PERSONNEL PLANNING

The basic concept for planning the system operation and administration is described below.

For the time being labor-saving in the operation and administration of Line No.1 will not be an all-important consideration because of the present abundance in supply of labor in the Philippines, but in the future the labor cost may be a heavy drain on the revenue of the railway. Accordingly, Line No.1 should be so planned that labor-saving can be effected as labor cost increases in the future.

8.2 OPERATION AND ADMINISTRATION PLANNING

1. Administrative Organization

   In Fig. 4.8.1 is shown for reference purpose an example of an administrative organization necessary for the operation of a rapid transit railway system. The final organization to be adopted, however, cannot be decided without due consideration on the relation with other government bodies, the local customs and tradition and other relevant local factors.

8.3 PERSONNEL PLANNING

Personnel requirements for system operation and maintenance have been projected on the following basis:

1. Functional Classification

   The type and function of personnel for the operation of RTR Line No.1 have been classified as follows:

   - Track maintenance
   - Electric circuit maintenance
   - Rolling stock maintenance
   - Train operation personnel
     - Operating personnel
       - Train crew
       - Switchmen
     - Administrative personnel
   - Station personnel
     - Station staff
       - Station attendants
       - Instructors
     - Administrative personnel
   - Operation control
     - Superintendents
     - Control personnel
   - Supervisors
   - Training personnel & administrative personnel

2. The reserve personnel of the station attendants, instructors, train crew, switchmen, operation control personnel, and power supply control personnel are placed at 55% of the regular personnel requirements.

3. The station attendants, instructors, operation control personnel and power supply control personnel work in shifts day and night, and other personnel work by day.

4. Personnel Requirements

The personnel requirements of Line No.1 have been roughly estimated on the basis of the data of rapid transit railways operated in various parts of the world including Japan as show below:

Administration		200 persons
Operation		2,100 persons
	Total:	2,300 persons

5. Personnel Requirements by Stages

The personnel requirements at the three stages of Line No.1 operation have been projected as shown in Tables 4.8.1 and 4.8.2 for two cases of service inauguration in 1987 and 2000.

Table 4.8.1 Personnel Requirements by Stages for Recommended Alternative

	Section Operated	Personnel Required	Remarks
Stage 1	U.P. - F.E.U.	900	
Stage 2	U.P. - Rizal Park	1,400	
Stage 3	U.P. - Baclaran	1,900	
	U.P. - Baclaran (year 2000)	2,300	

Table 4.8.2 Personnel Requirements by Stages for Compared Alternative (Operation Starting from Baclaran side)

	Section Operated	Personnel Required	Remarks
Stage 1	Baclaran - Rizal Park	800	
Stage 2	Baclaran - U.S.T.	1,300	
Stage 3	Baclaran - U.P.	1,900	
	Baclaran - U.P. (Year 2000)	2,300	

8.4 TRAINING OF PERSONNEL

Since the operation of the rapid transit railway line under study will involve expertise of various disciplines which are new and not experienced in the Philippines, to ensure safe and reliable oepration, it is of utmost importance to provide training programs for the personnel who are to take part in the technical departments, in order for them to obtain the necessary new technics, when the Line No.1 is put into operation.

The training should be provided by an organization which is now operating an urban rapid transit railway system. However, it will be difficult as well as costly to train the whole necessary staff in such an organization, and it is also doubtful whether the receiving organization will have the capacity to receive all the technical staff. The training may therefore be limited to only the key personnel.

The key personnel who receive the training, will on completion of the training course, have actual practice on the trial running section of the Line No.1 which should have been completed and ready for trial operation by then, and will also be responsible for the training of those who have not received training.

As for the training period, it is estimated that for the operation department, the train operating engineer (driver) will require 600 hours of indoor study and 300 hours of field practice for a total training period of 7 months, whereas the conductor will require a 3-month training period. A summary of the estimated number of key personnel in the various fields required for training and the respective training period is given as follows.

Item	Number of trainees (persons)	Training period (months)
Operating Department		
Train operating engineers	15	7
Conductors	5	3
Electrical Department		
Power supply lines personnel	5	3
Substation personnel	5	6
Signalling Personnel	6	6
Communication Personnel	5	6
Rolling Stock Personnel	10	9
Track Maintenance Personnel	4	3
Supervising Personnel	5	3
Total:	60	

The above estimates are made, based on the assumption that the trainees have some basic experience in their respective fields of specialty.

In the operation of Line No.1, besides the above key personnels for training, it will also be necessary to request the organization which is actually operating a rapid transit railway system to despect experts in the various fields to provide guidance and assistance during the initial years.

8.5 OPERATING COSTS

The operating costs of Line No.1 by stages are estimated from the operational activities of each stage. The operating cost includes labor cost, power cost, rolling stock maintenance cost, track maintenance cost, electric circuit maintenance cost, transportation expense and administrative expense. The annual operating cost however does not include the interest on capital cost, taxes, or depreciation of the property.

The expenses on the consumption of electric power calculated at MERALCO unit cost make up the largest portion of the total expenses. In this respect, it is noted that if the NPC unit cost of electricity were make applicable, the total expenses will be substantially reduced. Thus, while the expenses basing on the MERALCO unit cost is adopted for subsequent calculations, the figures based on NPC unit costs are also shown in parentheses for reference purpose.

The annual operating cost of the various alternatives for the key years are summarized in Tables 4.8.3 to 4.8.6.

Table 4.8.3 Annual Operating Cost for Recommended Alternative

(a) Partially elevated structure (U.P. - Sto. Domingo Section)

(b) Operation starting from U.P. side

	Stage	1	2	3		4 (Reference)
	Section in Operation	U.P. - F.E.U.	U.P. - Rizal Park	U.P. - Baclaran		U.P. - Airport
	Year	1983	1985	1987	2000	2000
	Operating kilometerage (km)	9.4	14.9	21.1	21.1	25.1
	Number of stations	10	14	21	21	23
	Rolling stock (No. of cars)	68	130	175	288	288
Annual Operating Expenses (Thousand US$)	Track maintenance	513	813	1,160	1,160	1,383
	Electric circuit maintenance	600	953	1,360	1,360	1,620
	Rolling stock maintenance	607	1,180	1,593	2,610	2,610
	Operating expense	330	647	873	1,308	1,433
	Power	2,077 (727)	3,803 (1,337)	6,197 (2,177)	8,070 (2,833)	9,277 (3,727)
	Transportation	1,923	2,687	4,010	4,010	4,410
	Maintenance administration	103	163	230	230	277
	Transportation administration	67	87	130	130	143
	Employees' welfare	163	263	377	377	450
	Administrative	280	447	633	637	753
	Total	6,663 (5,313)	11,043 (8,577)	16,563 (12,543)	19,892 14,655)	22,356 (16,806)

Note: Figures in parentheses indicate cost of power at NPC unit price.

Table 4.8.4 Annual Operating Cost for Compared Alternative (1)

(a) Partially elevated structure

(b) Operation starting from Baclaran side

	Stage	1	2	3		4 (Reference)
	Section in Operation	U.P. - F.E.U.	U.P. - Rizal Park	U.P. - Baclaran		U.P. - Airport
	Year	1983	1985	1987	2000	2000
	Operating kilometerage (km)	6.2	12.6	21.1	21.1	25.1
	Number of stations	8	13	21	21	23
	Rolling stock (No. of cars)	56	110	175	288	288
Annual Operating Expenses (Thousand US$)	Track maintenance	347	690	1,160	1,160	1,383
	Electric circuit maintenance	407	810	1,360	1,360	1,620
	Rolling stock maintenance	493	990	1,593	2,610	2,610
	Operating expense	273	543	873	1,308	1,433
	Power	2,644 (927)	4,606 (1,617)	6,197 (2,173)	8,070 (3,242)	9,277 (3,727)
	Transportation	1,523	2,487	4,010	4,010	4,410
	Maintenance administration	70	137	230	230	277
	Transportation administration	50	80	130	130	143
	Employees' welfare	113	223	377	377	450
	Administrative	190	377	637	637	753
	Total	6,110 (4,393)	10,943 (7,954)	16,567 (12,543)	19,892 (15,064)	22,356 (16,806)

Table 4.8.5 Annual Operating Cost for Compared Alternative (2)

(a) All underground structure

(b) Operation starting from U.P. side

	Stage	1	2	3		4 (Reference)
	Section in Operation	U.P. - F.E.U.	U.P. - Rizal Park	U.P. - Baclaran		U.P. - Airport
	Year	1983	1985	1987	2000	2000
	Operating kilometerage (km)	9.4	14.9	21.1	21.1	25.1
	Number of stations	10	14	21	21	23
	Rolling stock (No. of cars)	68	130	175	288	288
Annual Operating Expenses (Thousand US$)	Track maintenance	513	813	1,160	1,160	1,383
	Electric circuit maintenance	600	953	1,360	1,360	1,620
	Rolling stock maintenance	607	1,180	1,593	2,610	2,610
	Operating expense	330	647	873	1,308	1,433
	Power	3,277 (1,147)	5,007 (1,757)	7,451 (2,617)	8,070 (2,833)	10,478 (3,678)
	Transportation	1,923	2,687	4,010	4,010	4,410
	Maintenance administration	103	163	230	230	277
	Transportation administration	67	87	130	130	143
	Employees' welfare	163	263	377	377	450
	Administrative	280	447	633	637	753
	Total	7,863 (5,733)	12,247 (8,997)	17,817 (12,983)	19,892 (14,655)	23,557 (16,757)

Table 4.8.6 Annual Operating Cost for Compared Alternative (3)

(a) All underground structure

(b) Operation starting from Baclaran side

	Stage	1	2	3		4 (Reference)
	Section in Operation	U.P. - F.E.U.	U.P. - Rizal Park	U.P. - Baclaran		U.P. - Airport
	Year	1983	1985	1987	2000	2000
	Operating kilometerage (km)	6.2	12.6	21.5	21.5	25.1
	Number of stations	8	13	21	21	23
	Rolling stock (No. of cars)	56	110	175	288	288
Annual Operating Expenses (Thousand US$)	Track maintenance	347	690	1,160	1,160	1,383
	Electric circuit maintenance	407	810	1,360	1,360	1,620
	Rolling stock maintenance	493	990	1,593	2,610	2,610
	Operating expense	273	543	873	1,308	1,433
	Power	2,644 (927)	4,606 (1,617)	7,393 (2,597)	8,070 (2,833)	10,478 (3,678)
	Transportation	1,523	2,487	4,010	4,010	4,410
	Maintenance administration	70	137	230	230	277
	Transportation administration	50	80	130	130	143
	Employees' welfare	113	223	377	377	450
	Administrative	190	377	637	637	753
	Total	6,110 (4,393)	10,943 (7,954)	16,567 (12,547)	19,892 (14,655)	23,557 (16,757)

Note: The figures in parentheses indicate costs of power at Meralco price.