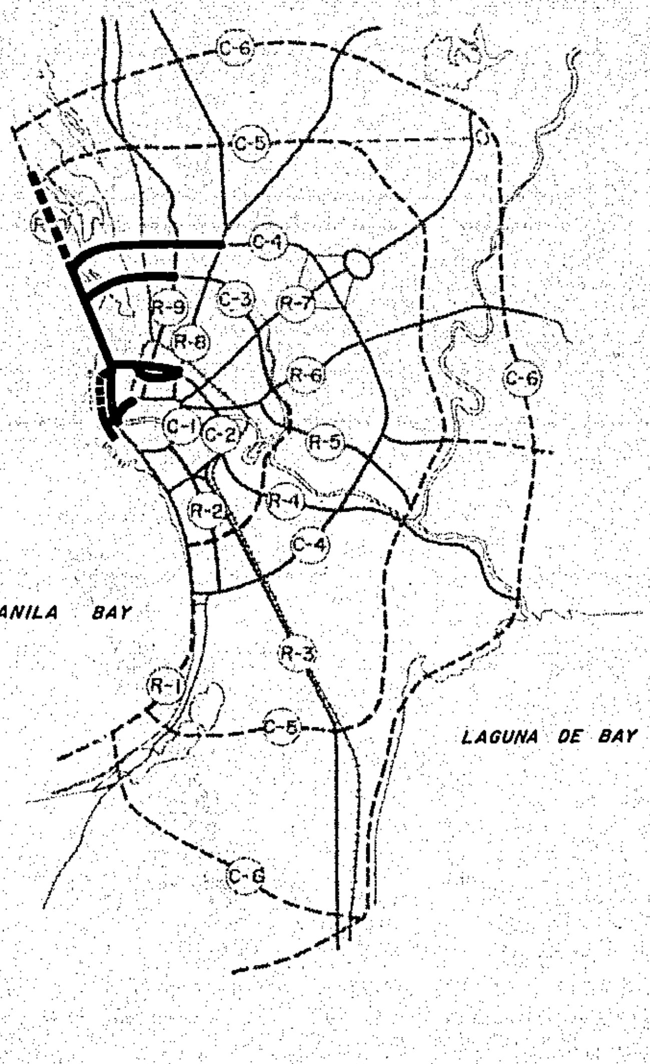
REPUBLIC OF THE PHILIPPINES

METROPOLITAN MANILA TRANSPORT

RADIAL ROAD R–10 FEASIBILITY STUDY



AUGUST, 1975

JAPAN INTERNATIONAL COOPERATION AGENCY

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PREFACE

In compliance with the request of the Government of the Republic of the Philippines, the Government of the Japan has decided to make a Radial Road R-10 Feasibility Study and the Japan International Cooperation Agency executed the study.

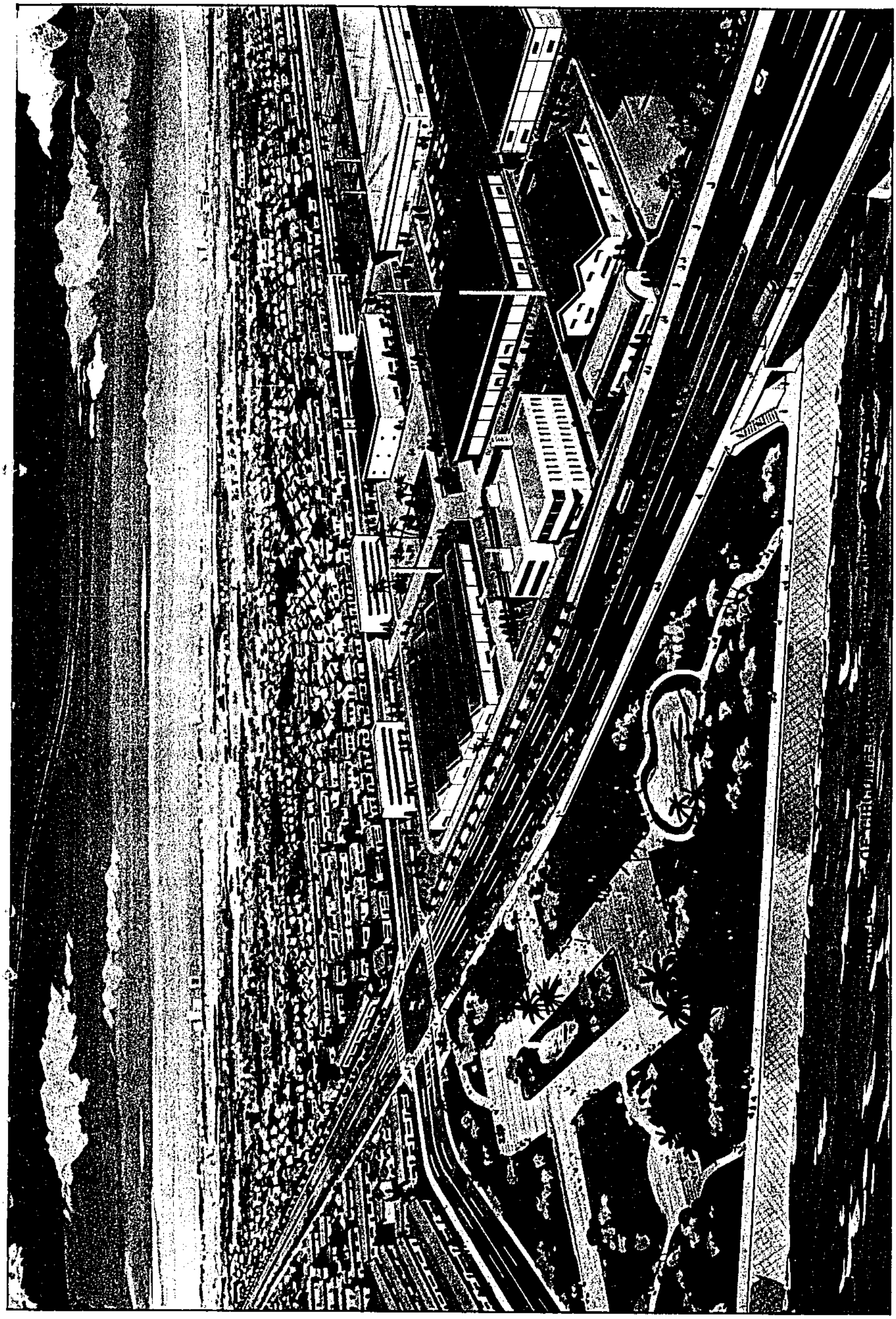
Noting that Radial Road R-10 Project has a vital bearing on the future Urban Transportation System in the Metropolitan Manila Area, the Agency dispatched a preliminary Survey Team to the Philippines in March, 1974 for planning and preparation of the feasibility study, and further sent, from July, 1974 to August, 1974, a 7-member supervisory team led by Prof. Takashi Inouye, Tokyo University and a 9-member survey team led by Dr. Toshiro Fukuyama. The R-10 Feasibility Study, undertaken by the said team, was carried out smoothly as scheduled for a period of about three months with the close and unlimited cooperation of the competent Philippine authorities. After its return to Japan, the team engaged in related studies and analyses, of which the results are compiled into this report.

I sincerely hope that this study would contribute to the socio-economic development in Metropolitan Manila Area and at the same time serve for 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 valuable assistance offered to the team throughout the survey period.

August, 1975

Shinsaku Hogen
President
Japan International
Cooperation Agency



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SUMMARY AND RECOMMENDATION

1. BASIS OF STUDY

1.1 Background

In the master plan proposed in the 1971 ~ 1973 Urban Transport Study of the Metropolitan Manila Area (UTSMMA), the completion of the major thoroughfare systems within the inner area was given high priority among the major transport projects proposed therein.

Of the major thoroughfares within the inner area, Radial Road R-10, also known as the Manila-Navotas Coastal Road, which is intended to serve the northwestern part of the Metropolitan Manila Area, has been selected for immediate implementation considering that five development projects, which are in various stages of execution, depend largely on R-10 and its related circumferential roads for access. These five important development projects are the:

(1) Tondo Urban Renewal Project,
(2) Dagat-Dagatan Resettlement Project,
(3) Navotas Fisheries Port Project,
(4) Vitas Industrial Complex Project, and
(5) Manila International Marine Port Project.

The purpose of this Study is to investigate the feasibility of Radial Road R-10 and the directly related sections of Circumferential Roads C-1, C-2, C-3 and C-4 which will link R-10 with existing major thoroughfares. The Study also includes the New Harbor Road which will provide a direct connection between the two marine ports north and south of the Pasig River, as well as to provide for future expansion of the ports by relocating the existing harbor road.

1.2 Population and Land Use Plans

The population plan for MMA adopted in the UTSMMA was modified by the Manila Bay Metropolitan Region Strategic Plan (MBMRSP) to effect the reordering of the population and economic activities of the Manila Bay Region by encouraging the growth of outer cities having strong developmental potentials.

On this basis, the planned night population within MMA was changed from 7,466,000 to 5,758,000 in 1987 and projected to 7,452,000 in the year 2000.

Based on the above population plan and the 1987 UTSMMA land use plan, a new land use plan for the year 2000 was prepared by the MBMRSP Team in close coordination with the

Japanese Study Team.

2. TRAFFIC ELEMENTS

2.1 Present Traffic

Results of traffic surveys conducted in 1974 by the Department of Public Highways (DPH) indicate that traffic volume on major thoroughfares ranges from 5,000 to 60,000 vehicles per day, most of which exceed the traffic congestion degree of 1.0. Hourly variations of traffic volume between 7:00 a.m. to 7:00 p.m. were also observed to have no significant changes compared with peak-hour volume in the mornings and afternoons. This traffic situation indicates that most major thoroughfares in the network are not functioning efficiently and urgently require improvement of their capacities.

In most major thoroughfares of the MMA, passenger cars, jeeps and jeepneys constitute about 80% of total traffic. In some sections, jeepney traffic is remarkably high, accounting for more than 70% of total traffic volume in many routes, and generally averaging from 40% to 50%. But traffic is about 10%, while cargo truck traffic is comparatively small.

Traffic survey results related to the Port of Manila, however, show that traffic volume on the major traffic corridors of the port area ranges from 6,000 to 23,000 vehicles per day, with truck traffic having the highest component ratio.

The results of origin-destination (O-D) surveys indicate that vehicular traffic at the Port of Manila primarily services the MMA. It has been observed that from 70% to 80% of total trips related to the north and south harbors have their origins and destinations from within the Central Business District (CBD).

However, O-D survey results for ferry (interisland vessel) passengers at the North Harbor indicate that these ferry facilities service not only the MMA but also areas beyond it. They likewise indicate that only about 20% of total ferry passengers have their origins and destinations from within the CBD.

About 50% of total cargo handled by trucks at the South Harbor are general merchandise, as compared to 42% at the North Harbor. The remaining cargo consist mainly of agricultural and marine products, chemical industry products, and miscellaneous light industry products.

2.2 Projection of Future Traffic Volume

The total transport demand in the entire MMA was projected to determine traffic volume on all R-10 project road sections, since traffic on the network of major thoroughfares in the

MMA and on the proposed urban rapid mass transit system will greatly influence traffic volume on the project roads. Projections were accordingly made for production, generation and attraction, and OD distribution of person trips, which were split among various modes of transport with the rate of travel time of two kinds of transport within the assumed transport networks considered.

The trip distribution of the traffic to and from the Manila Port were projected separately and assigned the total OD distribution of vehicle trips was determined by incorporating the OD distribution of trips related to ports to that of vehicle trips in the entire MMA. And vehicle OD tables assigned to an assumed thoroughfare network.

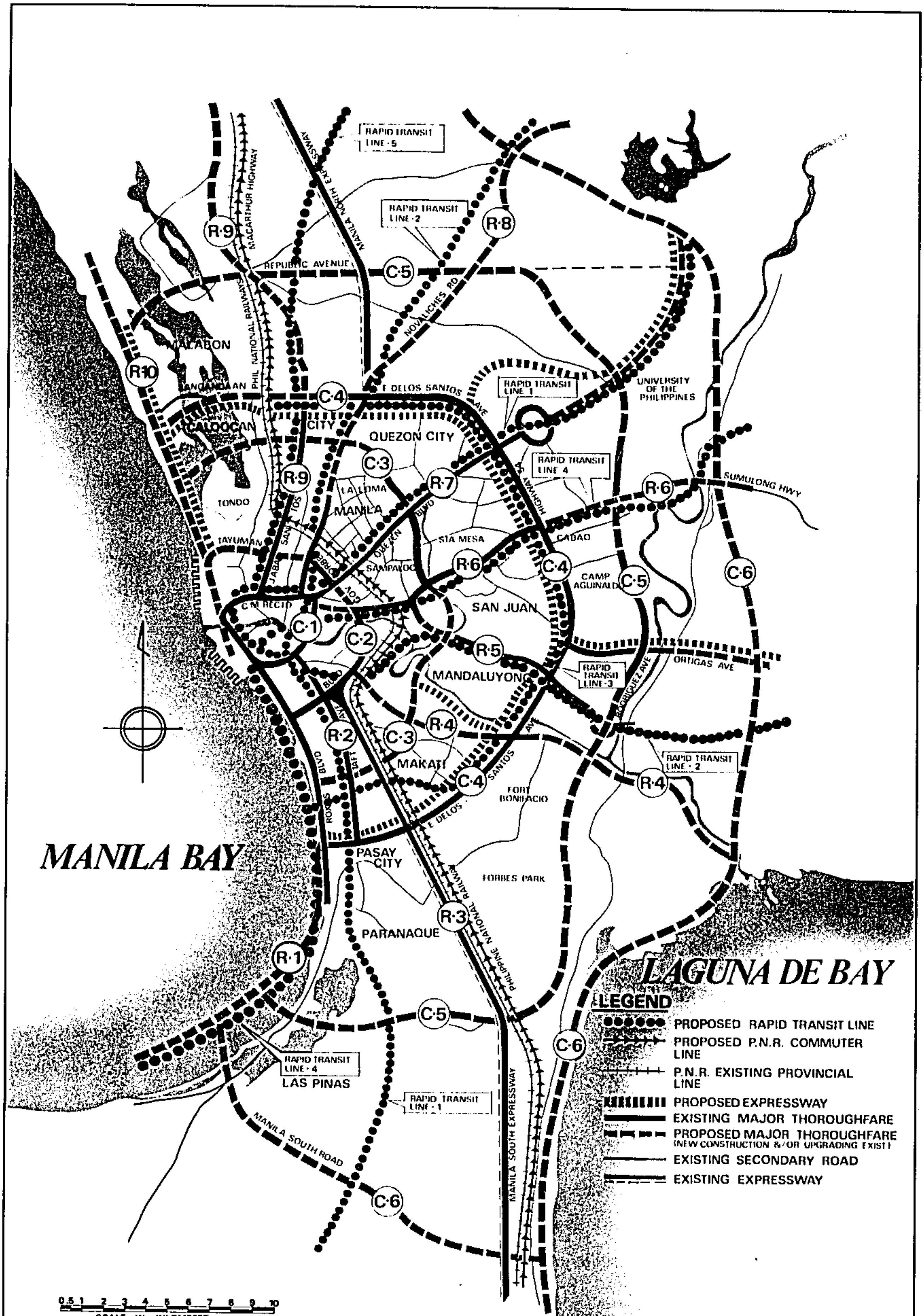
The main inputs used for the projections were the MBMRSP population and land use plans and the person trip information surveys of the UTSMMA. Results of passenger and commodity surveys were also used.

Projections were made for the years 1977, 1979, 1981, 1987 and 2000, considering the economic life of the project roads and the stage construction plan to be used. Traffic volumes on the project roads during intermediate years were estimated simply by interpolation.

In the estimate of modal splits and traffic assignments for the year 1987, several assumptions were made on some projects proposed in the UTSMMA, the implementation of which are not yet decided: (a) Improvement of the Philippine National Railways (PNR) facilities, (b) Construction of the expressways, and (c) Construction of Subway Lines No. 1 and No. 2.

TABLE 1 COMPARISON OF STREETS FACILITY AND TRAFFIC VOLUME IN MMA AND ON THE PROJECT ROADS

Areas	MMA			Project Roads		
Facility & Demand	Street Facility	Traffic Volume	Congestion Degree	Street Facility	Traffic Volume	Congestion Degree
Units	1000 Vehicle Km	1000 Vehicle Km	–	1000 Vehicle Km	1000 Vehicle Km	–
1977	19,559	21,755	1.11	1,040	956	0.92
1979	20,252	22,794	1.12	1,711	1,590	0.93
1981	21,062	23,892	1.13	1,978	1,755	0.89
1987	27,770	21,699	0.78	1,978	1,365	0.69
2000	46,083	24,795	0.54	1,978	950	0.48



PROPOSED TRANSPORTATION NETWORK FOR MANILA METROPOLITAN AREA UNDER UTSMMA.

According to the estimate, the proposed major thoroughfare system will not be able to meet total transport demand if the PNR facilities are not improved and Subway Lines No. 1 and No. 2 are not constructed by 1987.

For the year 2000, the total transportation system to be made up of streets, expressways, five urban rapid mass transit lines, and two PNR lines were all assumed to be operational as proposed in the UTSMMA.

The estimates indicate that the average traffic volume of the MMA will be heavier compared to that on the project roads as a whole, and the congestion degree of the project roads 0.92 in 1977, 0.93 in 1979, 0.89 in 1981, 0.69 in 1987, 0.48 in 2000.

3. PROPOSED ROAD PLAN

3.1 Road Characteristics

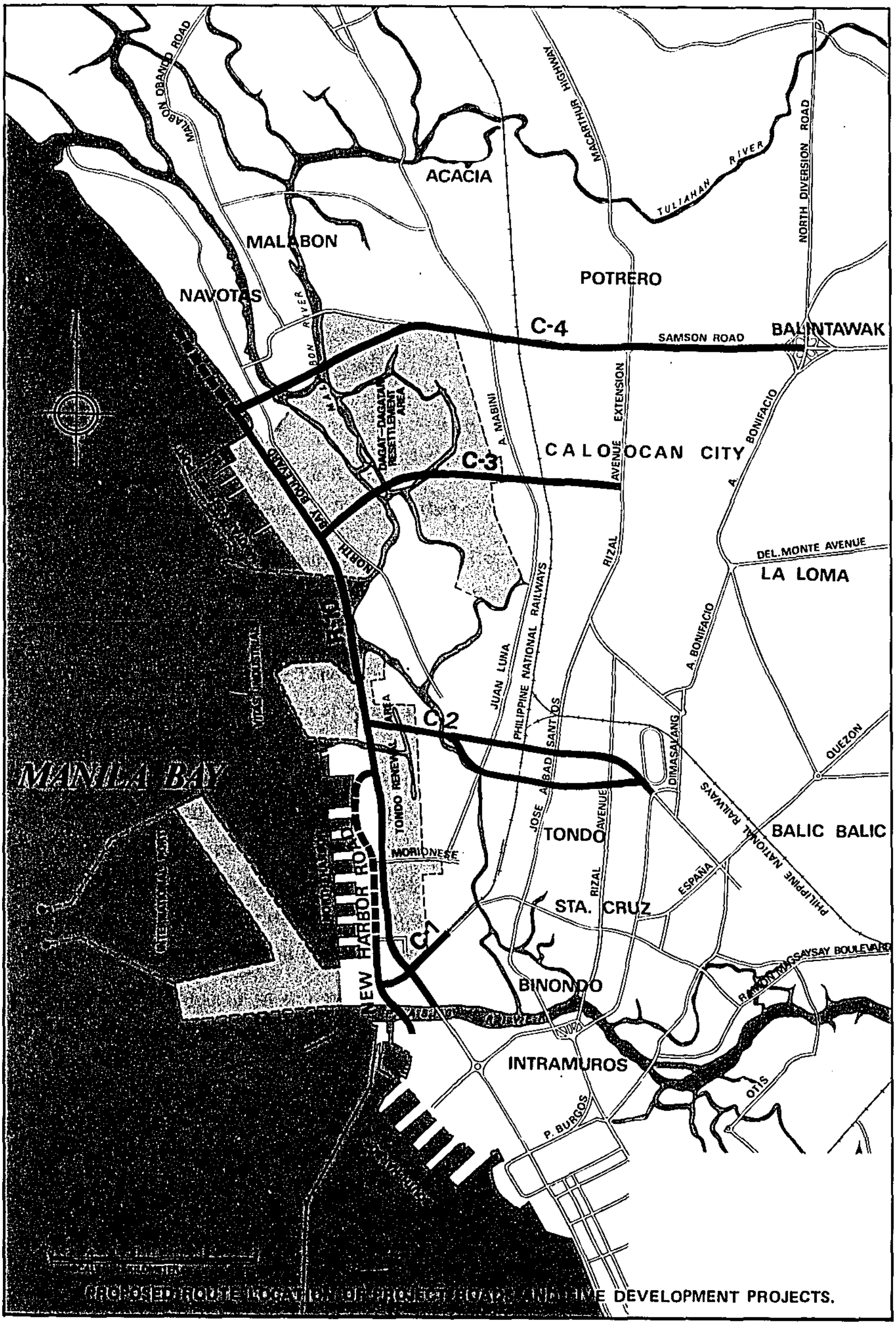
R-10 and its related circumferential road sections, C-1, C-2, C-3 and C-4, will assume the character of a major road with partial control of access. An expressway is proposed, however, within the right-of-way (R-O-W) of the northern section of R-10, from the New Harbor Road intersection up to C-4 and the entire length of C-4. Intersections of R-10 with the major circumferential roads C-1, C-2, C-3 and C-4 will be grade separated, while its intersections with secondary roads, like Moriones and Herbosa, will be at grade. All other roads will not be allowed to cross but may be provided with access.

While maintaining access to existing developed areas, a higher degree of control of access will be adopted within sections along newly planned areas, such as the Dagat-Dagatan Resettlement Project.

3.2 Design Features

Standards of the Association of American State Highway Officials (AASHO) were used for the geometric design of all roads and for the structural design of highway pavements and bridges. In cases not covered by AASHO standards, DPH and Japanese Ministry of Construction Standards were adopted. Vertical alignments were determined considering the planned elevations of related development projects, river improvement plans and required clearances.

A 2% normal cross slope of pavements was used considering heavy rainfall, and a maximum superelevation of 4% was adopted along curves. The side slopes of embankments were set at 1.5:1. In cases of high embankments, slope protection will be provided by concrete cribs.



PROPOSED ROUTE LOCATION OF PROJECT ROADS AND FIVE DEVELOPMENT PROJECTS.

3.2.1 Roads

The total length of the project road sections is 20.837 km broken down as follows:

Project Road	Length (km)
R-10	6.886
C-1	0.483
C-2	2.959
C-3	3.215
C-4	5.851
New Harbor Road	1.083
Total	20.837

Design speed was set at 60 kph for R-10, C-3 and C-4, and 50 kph for C-1 and C-2, considering existing roadside developments. The New Harbor Road was designed at 40 kph only.

The number of lanes was determined on the basis of estimated future traffic demand and R-O-W limitations. Service roads were provided along existing developed areas and auxiliary lanes on areas proposed for development.

Due to space limitations in the Tondo Foreshore area a limited R-O-W of 40 m was provided for R-10 from its point of origin at Roxas Bridge to the New Harbor Road intersection, while a 60 m R-O-W was proposed up to the interchange with C-4 to provide for the future expressway. A 40 m R-O-W was provided for C-1 to conform with the existing width of Claro M. Recto Avenue, while a 20 m R-O-W was generally adopted for C-2, along both Tayuman and Tayabas Streets (both proposed to be one-way roads) because of existing built-up areas. Beyond the converging point of the 2 one-way roads along C-2 in Tondo up to the intersection with R-10 and along the entire length of C-3, however, a 50 m R-O-W was adopted because of the relative ease of acquiring R-O-W and because of environmental considerations.

Variable R-O-W widths of 50 m, 65 m and 80 m were adopted along the section of C-4 between R-8 and R-10 because of one or the other or a combination of the following reasons:

(1) the proposed expressway,
(2) environmental considerations,
(3) the variable conditions of roadside development,
(4) total construction costs.

A 25 m R-O-W width was provided for the New Harbor Road to accommodate the traffic needs of the port area.

3.2.2 Interchanges

Diamond type interchanges were adopted for the R-10 intersections with C-1, C-2 and C-3, mainly because of the need to provide access to adjacent areas and for purposes of operational uniformity.

For the intersection of R-10 with C-4, a rotary type interchange was adopted considering the future extension of R-10 northward beyond C-4.

A grade separated rotary type interchange was adopted for the intersection of C-4 and R-9, with C-4 as the depressed roadway, to provide for the construction of the future elevated expressway and in order to preserve the existing historical Bonifacio Monument.

3.2.3 Major Structures

(1) Harbor Bridge

The proposed 200 m Harbor Bridge will cross the Pasig River, a very important navigable channel, and will require considerable vertical and horizontal clearances underneath the structure in order to maintain the present uses for navigation of that section of the channel.

Considering both the character of the bridge roadway and channel traffic and the acceptable approach grade among others, a 3-span continuous steel girder bridge was adopted, with prestressed concrete approaches provided for vertical clearance of 9.10 m above H.W.L. and with sufficient horizontal opening at the center.

(2) Other Bridges

All other bridge and overpass structures are proposed to be prestressed concrete superstructures supported by R.C. pile-bent type and R.C. columned type piers, which are preferred for the following reasons:

(a) local materials for concrete construction are abundant,
(b) practical and convenient construction methods can be adopted,
(c) maintenance costs are low,
(d) construction costs are comparatively low, and
(e) technical know-how for design and construction are locally available.

The bridge lengths in the Dagat-Dagatan Resettlement Area were established in accordance with the channel widths predetermined by the Flood Control and Drainage Division, Bureau of Public Works.

A 100 m length bridge at the mouth of Estero Marala is proposed with the embankments of its road approaches provided with riprap slope protection.

(3) Subsurface Conditions

The results of soil analysis at the proposed reclaimed areas and sea coast show that full consolidation of the underlying soil will take a considerable length of time. For bridge approach sections with embankments of 2 m or more, the employment of quick consolidation methods by means of over-burdening and the use of sand mats and sand piles is recommended.

For the protection of the new coastline, rock mounted seawalls with deflector or parapet walls will be employed since this will be more economical than driving sheet pile walls. The height of the deflector wall will be 3 m above H.W.L., assuming that wave height at the deep sea area is 1.5 m and average sea bottom gradient is 1/600.

4. STAGE CONSTRUCTION PLAN

A three-stage construction plan for implementing the Project Roads is proposed under this Study as shown in Fig. 1. The stage construction was arrived at considering the timing of the construction of related development projects, traffic demand, economic evaluation the limited resources and the need to alleviate traffic conditions with the end in view of maximizing the feasibility of the Project Roads.

The years indicated therein are expected completion dates. By 1977, vital sections of R-10 and all the related sections of C-1 and C-3 are scheduled to be completed to coincide with the expected completion of the related Dagat-Dagatan Resettlement Project and Navotas Fisheries Port Project. By 1979, most of the project roads are to be completed except for the New Harbor Road and that section of R-10 traversing the proposed Tando Urban Renewal Project Area, which are both scheduled to be completed by 1981.

5. ENVIRONMENTAL IMPACTS

While it is desirable to show that the impact of the R-10 Project on the environment has been considered and that adequate provisions for mitigation have been made, the R-10 Project is so closely interrelated to five other large development projects in the area that a truly comprehensive environmental impact analysis cannot be made separately but must be considered in relation to each of the other projects.

With the impacts and their corresponding mitigation measures as discussed as a basis, it can be concluded that the favorable impacts for outweigh the unfavorable impacts of the Project

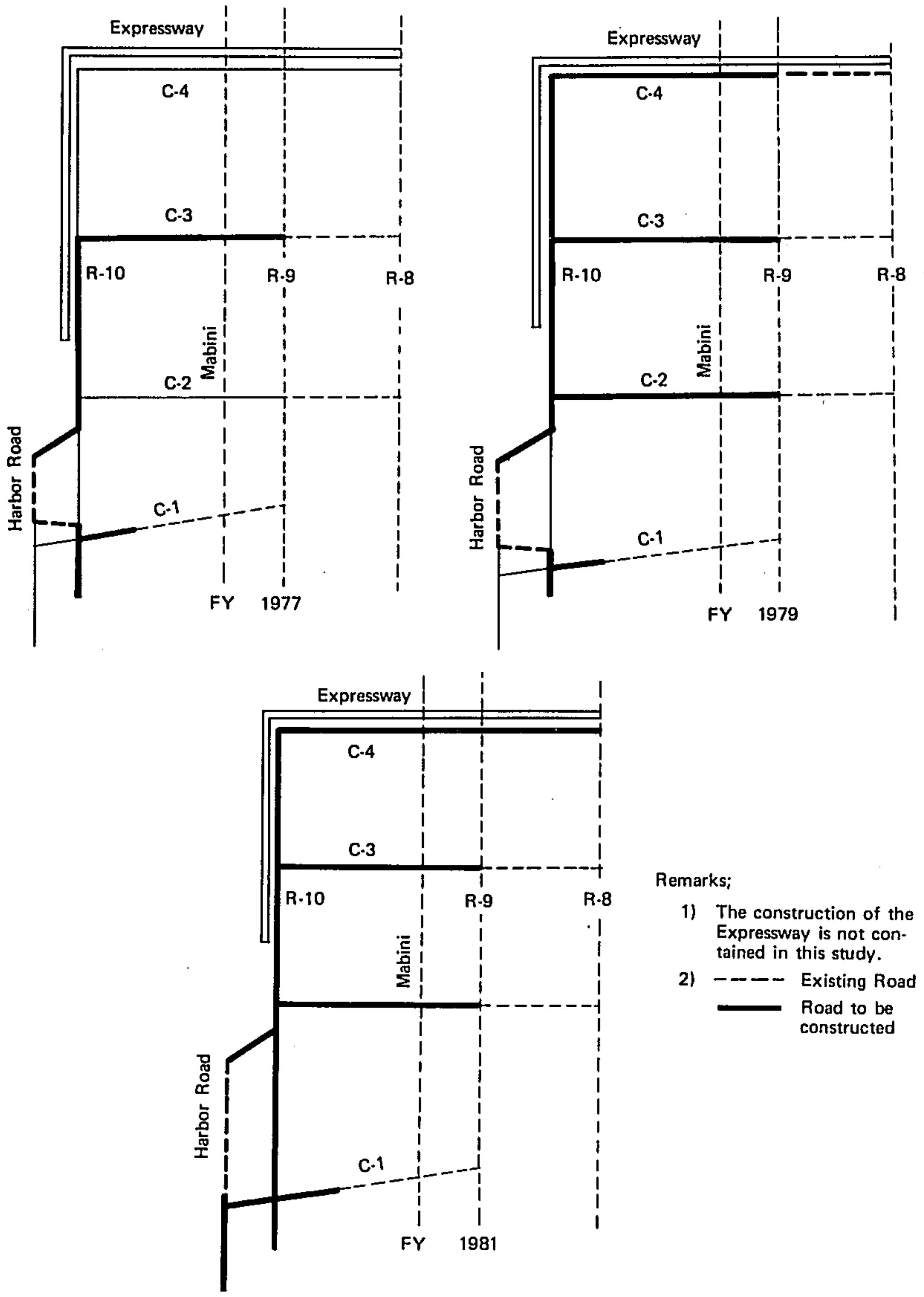


FIG. 1 STAGE CONSTRUCTION PLAN OF PROJECT ROADS

which are negligible, and that the R-10 Project meets the standards of environmental acceptability.

Certain steps should be taken by the GOP in the future however, to ensure that R-10 will be environmentally acceptable.

6. ECONOMIC EVALUATION

6.1 Project Cost

All costs in this Study were estimated based on June 1974 prices which were modified in certain necessary cases. The cost for R-O-W acquisition was estimated based on the results of a field survey of land and improvement costs carried out specifically for the Study in June 1974. Reclamation costs were also considered in determining project cost.

Total project cost based on 1974 prices was estimated at ₱631 million, including taxes. The actual construction cost of ₱1,030 million includes costs for mobilization, taxes, supervision, etc., with a 7.2% annual price increment increase applied. The total economic cost was estimated as of 1974 at ₱449 million, including maintenance costs for 20 years at a discount rate of 15% compounded annually. Details of cost estimates are shown in Tables 2 to 3.

6.2 Benefit

The reduction in vehicle operation costs and savings in travel time for both users and non-users of the project roads were included in the estimate of benefits. Other benefits, however, such as reduction of traffic accidents, opportunity costs for vehicles and drivers, and other indirect benefits, were not quantified.

Total benefits were estimated at ₱4,050 million for the period covering the years 1977 (when the first section will be opened to traffic) to 1996 (when the economic life of the project road will end).

6.3 Benefit and Cost Comparison

6.3.1 Analysis of the Project Roads

A Net Present Worth (NPW) of ₱3,601 million based on the assumed discount rate of 15%, a Benefit/Cost (B/C) ratio of 9.03 at the same 15% discount rate, and an Internal Rate of Return (IRR) of 83.5% over a 20-year life of the project roads were obtained from the estimates made.

TABLE 2 INVESTMENT REQUIREMENT

(Thousand pesos)

Year	Acquisition of Right of Way	Construction Cost			Total
		Bridge	Roadway	Sub Total	
1975	69,202				69,202
1976	91,934	45,526	37,131	82,657	174,591
1977	72,393	46,255	70,106	116,361	188,754
1978	63,328	25,590	65,994	91,584	154,912
1979	41,784	31,164	70,628	101,792	143,576
1980	–	75,021	60,737	135,758	135,758
1981	–	63,357	100,185	163,542	163,542
Total	338,641	286,913	404,781	691,694	1,030,335

Remarks: 1. Cost in 1974
2. Price increase 7.2% per year

TABLE 3 ECONOMIC COST

(Thousand pesos)

Year	Acquisition of Right of Way	Construction Cost			Total
		Bridge	Roadway	Sub Total	
1975	64,554	–	–	–	64,554
1976	80,000	28,971	23,120	52,091	132,091
1977	58,764	25,686	40,652	66,338	125,102
1978	47,953	14,177	35,709	49,886	97,839
1979	29,515	15,036	35,831	50,867	80,382
1980	–	22,647	44,564	67,211	67,211
1981	–	39,428	23,622	63,050	63,050
Total	280,786	145,945	203,498	349,443	630,229

6.3.2 Analysis by the Construction Stage of the Project Roads

A Net Present Worth (NPW) and a Benefit/Cost Ratio of 1st stage are ₱1,962 million and 11.95 based on the discount rate of 15% and the project life of 20-year, those of 2nd stage ₱1,485 million and 7.09, those of 3rd stage ₱926 million and 7.88.

6.4 Sensitivity Analysis

6.4.1 Traffic Volume

The minimum estimated traffic volume in 1987 on the project roads was adopted on the premise that the three urban rapid mass transit lines and an urban expressway, as proposed in the UTSMMA, would be operational. Should any of these projects not be implemented, traffic volume on R-10 would be correspondingly larger and would consequently make the project more feasible.

If only the improved PNR facilities are provided, NPW, B/C ratio and IRR would be ₱4,957 million, 12.06 and 85.0%, respectively, based on the estimated increased traffic volume.

6.4.2 Project Cost

If project cost increases by 50%, NPW, B/C ratio and IRR would be ₱3,377 million, 6.02 and 64%, respectively.

6.4.3 Discount Rate

If the discount rate is taken at 20% compounded annually instead of at 15%, NPW and B/C ratio become ₱2,380 million and 6.83, respectively.

6.4.4 Development Projects

If the Tando urban renewal project and the Dagat-Dagatan Resettlement project will not be completed as scheduled, NPW and B/C ratio would be ₱2,995 million and 8.56, respectively.

6.5 Conclusion

Based on the foregoing calculations, the R-10 Project is clearly shown to be highly feasible, confirming the extreme deficiencies of the existing road network in the MMA as a whole, particularly in the northwestern portion, and has sufficient and urgent justification to be implemented immediately within the probable range of variation of the factors affecting feasibility.

7. RECOMMENDATION

Considering that the project roads are highly feasible and are closely related to ongoing development projects, it is strongly recommended that the following steps be taken by the Philippine Government:

(1) Implementation of the project generally following the proposed construction staging plan of this Study;

(2) Close coordination among the agencies responsible for the implementation of the related development projects should be continued;

(3) The highest priority should be given to the R-10 Project on the national level.

It is further recommended that since traffic demands in the MMA increase at a rapidly accelerating rate and since the project roads are mere components of the total MMA Transport System, early obsolescence of these R-10 roads is foreseen unless the other major thoroughfares are upgraded and constructed and the other components of the System are implemented.

CHAPTER 1
INTRODUCTION

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Unless a rational road transport system is devised, the Metropolitan Manila Area (MMA) faces serious traffic problems which are characterized at present by daily traffic congestions that are expected to worsen further as the population and number of vehicles increase. The country's principal shipping center is also in the MMA and its present port facilities greatly contribute to the traffic congestion. To handle larger volumes of cargo in the future, the port of Manila has a development program which when completed is also expected to further aggravate traffic problems in the MMA.

In 1973, the Government of the Philippines (GOP) requested the Government of Japan (GOJ), thru its implementing agency, the Overseas Technical Cooperation Agency (OTCA), now known as Japan International Cooperation Agency (JICA), to conduct a transport survey of the MMA based on general urban development which would provide an effective solution to its present and future traffic problems.

This survey, which was made during the two-year period from 1971 ~ 73 and is known as the Urban Transport Study in Metropolitan Manila Area (UTSMMA), developed a Transport Master Plan which proposed the following:

(1) A Major Thoroughfare System consisting of ten radial and six circumferential lines;
(2) An Urban Mass Transport Transit System consisting of five rapid transit lines and complemented by several improved Philippine National Railways (PNR) lines;
(3) An Urban Expressway System consisting of a main line with three spur lines.

The UTSMMA emphasized the immediate need to determine the feasibility for completing and improving the major thoroughfares system inside Circumferential Road (C-4). During early 1973, therefore, the GOP formally requested the GOJ for technical assistance to conduct the Feasibility Study of the R-10 Project, consisting of Radial Road R-10 and its related Circumferential Roads C-1, C-2, C-3, and C-4.

High Priority was also given to the R-10 Project because its implementation would be more timely and responsive to the anticipated increase in traffic volume due to its linkage in the area with five other major development projects of high social and economic impact, namely:

(1) Tondo Foreshore Urban Renewal Project

(2) Dagat-Dagatan Resettlement Project

(3) Navotas Fisheries Port Project

(4) Vitas Industrial Complex Project

(5) Manila International Marine Port Project

In March 1974, a six-man survey Mission was dispatched to Manila by the GOJ through the JICA to discuss the Terms of Reference of the proposed R-10 Feasibility Study and establish its framework and general scope of work. The Study formally started on May 30th 1974 with the arrival of a five-man Supervisory Committee headed by Dr. Takashi Inouye and a seven-man Study Team headed by Dr. Toshiro Fukuyama. Different surveys as required were undertaken until the end of August 1974, under the supervision of the Study Team and with the full support of personnel from GOP counterpart agencies.

Traffic analysis, preliminary engineering and the economic analysis of the project roads were subsequently conducted in Japan. During this period, three key GOP staff members were able to discuss many salient features of the Project with the Japanese Study Team, resulting in the completion of the Draft Report which was submitted to the GOP in December 1974.

The Consultants wish to express their sincere appreciation for the kind cooperation extended by Secretary Baltazar Aquino and other officials of the Department of Public Highways and other agencies of the Government of the Philippines in the preparation of the Radial Road R-10 Feasibility Study, more particularly the following:

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	Kazuro Yanagida	(Tokyo Expressway Public Cooperations)
	Hiroshi Mori	(Japan Overseas Consultants)
	Toshiro Fukuyama	(Japan Overseas Consultants)
	Fumio Higai	(Japan International Cooperation Agency)

2. DETAILED SURVEY

2.1 Supervisory Team

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	Masamoto Fukami	(City Bureau, Ministry of Construction)
	Akira Shiina	(Secretary Office, Ministry of Constauction)
	Shinya Izumi	(Harbour Bureau, Ministry of Transportation)
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	Yoshihiro Daicho	(Japan Overseas Consultants)
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	Kazuo Inouye	(Japan Overseas Consultants)
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3. SUPERVISORY COMMITTEE

Chairman	Takashi Inouye	(Urban Engineering, University of Tokyo)
	Yukitaka Uemae	(Tokyo Expressway Public Cooperation)
	Yoshiro Watanabe	(City Bureau, Ministry of Construction)
	Shuji Watanabe	(Road Bureau, Ministry of Construction)
	Shunichi Onodera	(Harbour Bureau, Ministry of Transportation)
	Akio Namiki	(City Bureau, Ministry of Construction)
	Kazuo Yoda	(City Bureau, Ministry of Construction)
	Kazuro Yanagida	(Tokyo Expressway Public Cooperation)
	Shinichi Nomoto	(Road Bureau, Ministry of Construction)
	Masamoto Fukami	(City Bureau, Ministry of Construction)
	Akira Shiina	(Secretary Office, Ministry of Construction)
	Shinya Izumi	(Harbor Bureau, Ministry of Transportation)
	Fumio Higai	(Japan International Cooperation Agency)

CHAPTER 2
PHYSICAL BACKGROUND

CHAPTER 2
PHYSICAL BACKGROUND

2.1 Topography

Metropolitan Manila is located in the central western part of Luzon Island, bordered by the almost land-locked Manila Bay on the west, tidal flats heavily-developed into fishponds on the northwest, the Central Plain of Luzon to the north, the foothills of the Sierra Madre Mountain Range to the northeast and east, Laguna de Bay to the southeast, and by a narrow neck of flatlands on the south.

The topography of the city is largely divided into the hilly area and the lowland area. The hilly area, with altitudes ranging from 13 to 20 m above Mean Sea Level of Manila Bay, is indented by erosion valleys draining westward to the bay and eastward to the Marikina River. The lowland area, with altitudes of 1.5 to 2.5 m above Mean Sea Level, is the principal delta area of the Pasig River which drains Laguna de Bay, and meanders through the city in an east-west direction.

The R-10 Project area is located for the most part on the lowlands north of the mouth of the Pasig River, except for the eastern ends of the project roads, C-3 and C-4, which are on the higher central hilly portion of northern Manila. The Manila shorelines, both north and south of the Pasig River, are now under reclamation or scheduled for reclamation in the near future, which will result in the large-scale developmental transformation of this area.

2.2 Climate and Weather

The climate at the MMA is typically tropical, showing distinctive dry and rainy seasons, caused by prevailing monsoon winds during that particular time of the year.

(1) Wind

The northeast monsoon blows across Manila and the rest of the Philippines from November to February every year, brought about by the high atmospheric pressure developed over Siberia in the northeastern Asian continent. The northeast trade winds which follow from March to May causing a pronounced dry season, blow from a southeasterly direction across the city because the MMA is shielded from the eastern seaboard facing the Pacific Ocean by the high sierras. From June to October, the southwest monsoon blows across the Manila Bay region.

(2) Rain

It has been observed that more than 50% of the annual precipitation in the Philippines are brought by typhoons and tropical monsoon rains. Statistical data show that about 16% or 20 out of 123 typhoons that have entered Philippine territory during the past 32 years have passed within a radius of 120 km from Manila, with half of them occurring within the period from June to September. The months of June, July and August account with the heaviest rainfall in Manila due to the southwest monsoon. An annual average precipitation of 1600 mm has been recorded at Sangley Point southwest of Manila, and 2700 mm at Montalban east of Manila. Thunderstorms also occur during the months of May to October at an average of eight per month.

(3) Temperature

The highest recorded temperature was 38.6°C taken in April 1948 and the lowest was 14.5°C in January 1914. January has the lowest monthly average temperature, while April has the highest. The yearly average falls within the range of 25°C to 28°C.

(4) Humidity

The month of September has the highest humidity on record with an average of 84%, while April has the lowest average with 69%.

(5) Evaporation

The prevailing winds, temperature and humidity have influenced the evaporation rate in Manila and its environs. A typical monthly average precipitation of 1150 mm, which is approximately half the annual precipitation, has been recorded at Laguna de Bay, southeast of Manila.

(6) Flood

The concentration of about 50% of the annual heavy rainfall during the months from June to August causes the repeated floodings of the lowland areas of Metropolitan Manila. The areas along the Pasig River suffer most from inundations during the typhoon and southwest monsoon months. The flood record of the project area is shown in Fig. 22-1. High flood water levels may also be attributable to insufficient drainage in most cases. However, the OECF-assisted Manila & Suburbs Flood Control and Drainage Program is presently being implemented by the Bureau of Public Works and is targeted for completion by 1978.

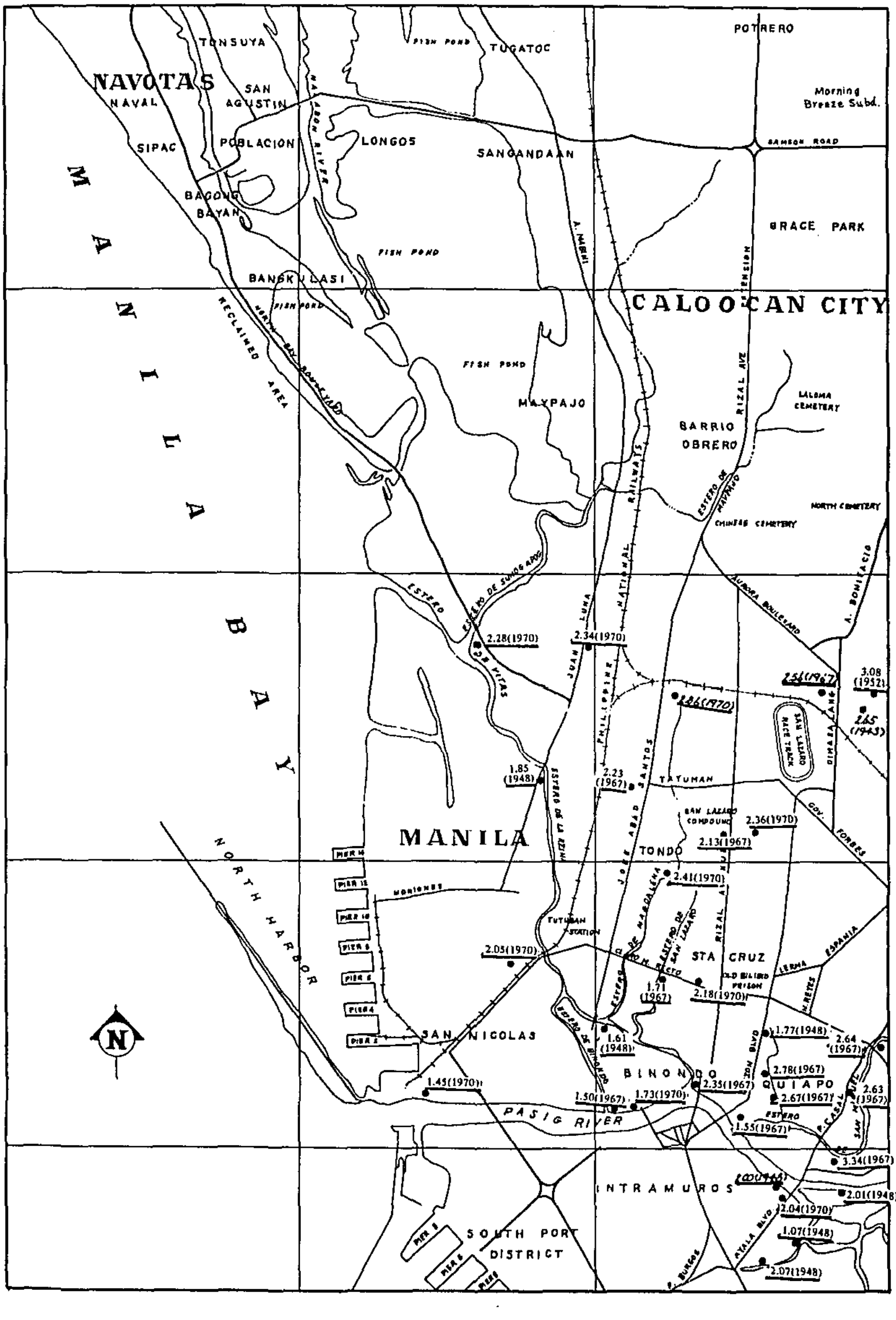


FIG. 2.2-1 MAXIMUM FLOOD ELEVATION FOR THE YEAR 1943, 1948, 1952, 1960, 1967, AND 1970

2.3 Geology and Soil Conditions

2.3.1 General Geological Description

The Sierra Madre Mountain Range running along the whole eastern breadth of Luzon east of Manila, and the western Zambales Mountain Range running from Lingayen Gulf downward to the Bataan peninsula on the west side of Manila Bay, are both composed of igneous rocks. The City of Manila and its adjoining northern hilly land are on a foundation of tuff belonging to the latter part of the Tertiary Period or the early part of Quarternary Period (Recent) of the Cenozoic Era. The surface of this tuff slopes down toward Manila Bay onto the delta of the Pasig River. The border line of hilly land and low land is shown in Fig. 2.3-1. The hilly land is an alluvial table between 13 to 20 m in altitude, which is covered with a 1 to 2-m depth of clayey volcanic ash and underlain by a deep adobe (tuff) stratum with a low density. The low alluvial land consisting of silty sand overlies the tuff strata. The thickness of the alluvial layer decreases as it approaches the hilly terrain and increases towards Manila Bay, although some variations have been observed on the site of the drowned valley.

2.3.2 Soils Investigation

Before the soil survey was conducted, all available soil data were compiled and found to be inadequate for purposes of the Study, hence requiring supplementary borings and soil tests which included standard penetration tests, sampling of undisturbed soil, collecting of bulk samples and meter pressure, triaxial compression and consolidation tests.

A total of 26 borings were conducted altogether at the proposed bridge sites and other places. Results of these tests could be used in the stabilization analysis of the materials for the embankment and sites of the two interchanges. The total drilling depth reached 550 m or an average depth of 21 m per hole. Standard penetration tests were conducted at depth intervals of one meter to confirm the consistency and relative density of each stratum. Samples taken were tested for gradation, water content, Atterberg limits, etc. Compaction and CBR tests of the earth materials were conducted for possible use in the design of the road. Undisturbed samples of clayey soil were collected with a stationary piston thin wall sampler and were tested for unconfined compression, consolidation and triaxial compression.

Locations of borings are shown in Fig. 2.3-2 while the soil profile, CBR and other test results are shown on Appendix Tables 2.3-1 ~ 2.3-6 and Appendix Fig. 2.3-1 ~ 2.3-4.

2.3.3 Ground Condition

In general, the ground can be classified into two kinds: the dense tuff (adobe) consisting

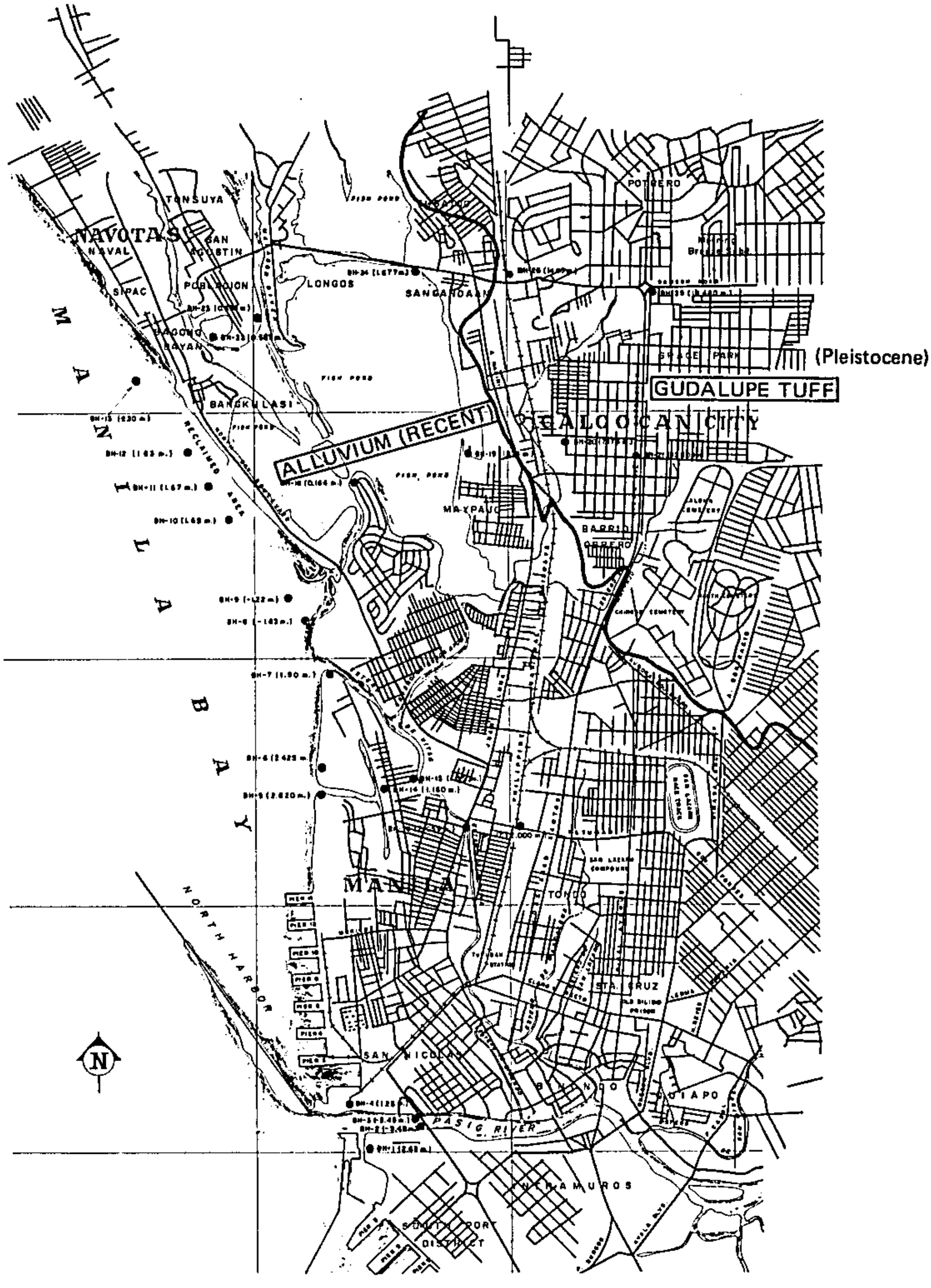
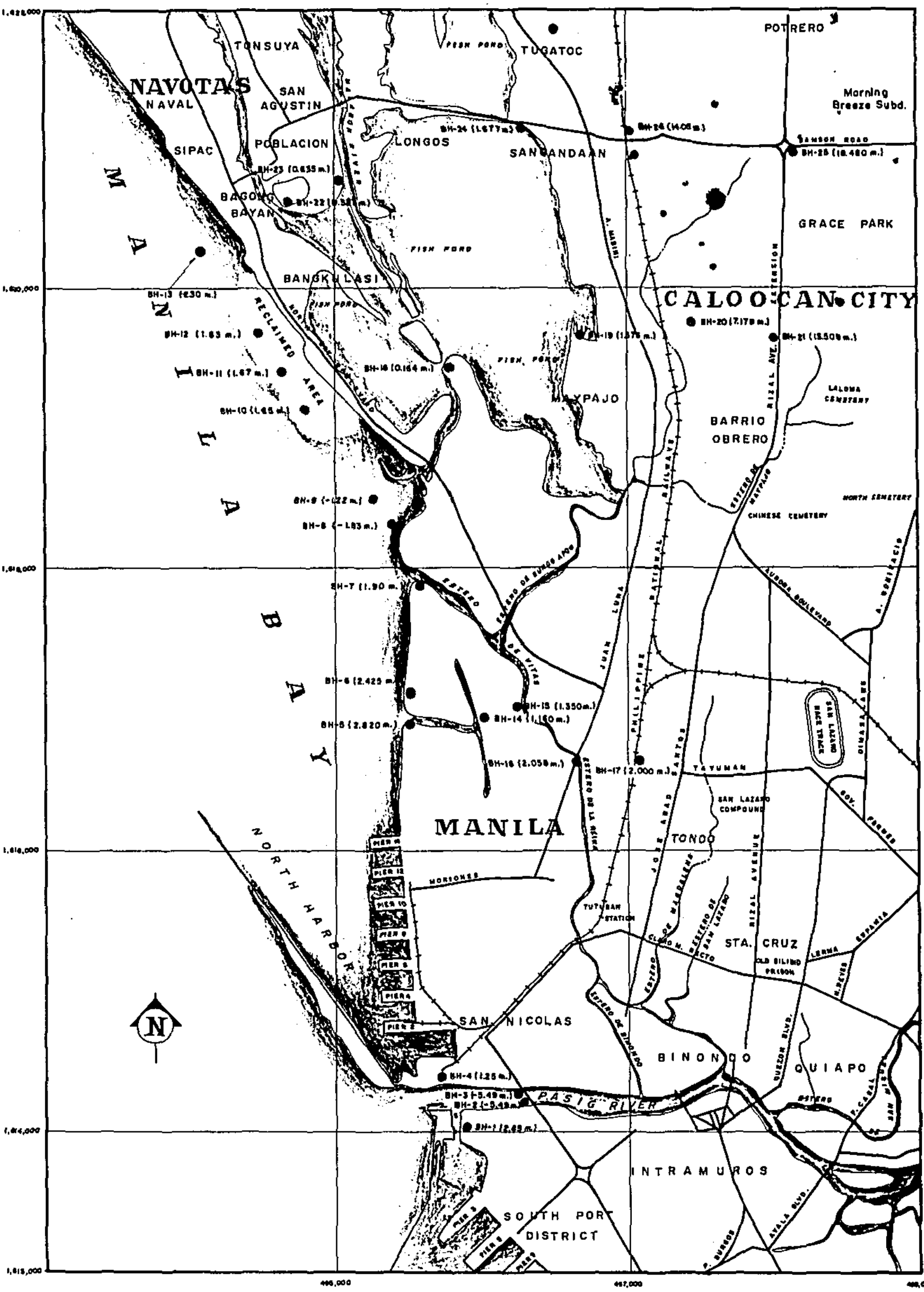


FIG. 2.3-1 BOUNDARY BETWEEN HILLY AND LOWLAND



LEGEND:

● = BOREHOLE LOCATION

(1.90m.) = GROUND ELEVATION MEAN SEA LEVEL DATUM

FIG. 2.3-2 BOREHOLE LOCATION PLAN

of the hilly land and the soft ground formed by the alluvial table. The alluvial sand is heterogeneous soil, which contains 20 to 30% fine sand and 70 to 80% clay. Since the soils mixtures are heterogeneous, proper identification of the soil strata is difficult. Fig. 2.3-3 shows the results of soil tests reflecting the strength properties of the different soil layers encountered.

(1) Sandy Clay Stratum

The surface of the reclamation area is almost covered with sand, but the upper stratum of low land is composed primarily of clayey soil several meters thick, which increases at the site of the drowned valley. Along the R-10 route it reaches to about 25 m near the Pasig River and 10 m near the Fisherman's Passage in Vitas and disappears completely at the boundary of the hilly land.

The results of soil tests are shown in Fig. 2.3-3. The bulk density increases with depth up to an average of 4.5 m and becomes constant beyond a depth of 4.5 m. Unconfined compression strength below a depth of 4.5 m is 0.05 to 0.2 kg/cm^2, and at the depth above it is 0.1 to 0.25 kg/cm^2.

(2) Silty Sand

The soil beneath the sandy clay is several meters thick. Its relative density is sufficient for supporting small structures only.

(3) Tuff

The base tuff is a highly weathered rock, which is soft at the boundary with the upper layer of silty sand as shown by standard penetration tests of 30 to 50 N-blows/ft. The unweathered portion showed about 10 cm penetration under 50 blows. Bearing capacity of this stratum is sufficient for supporting heavy structures.

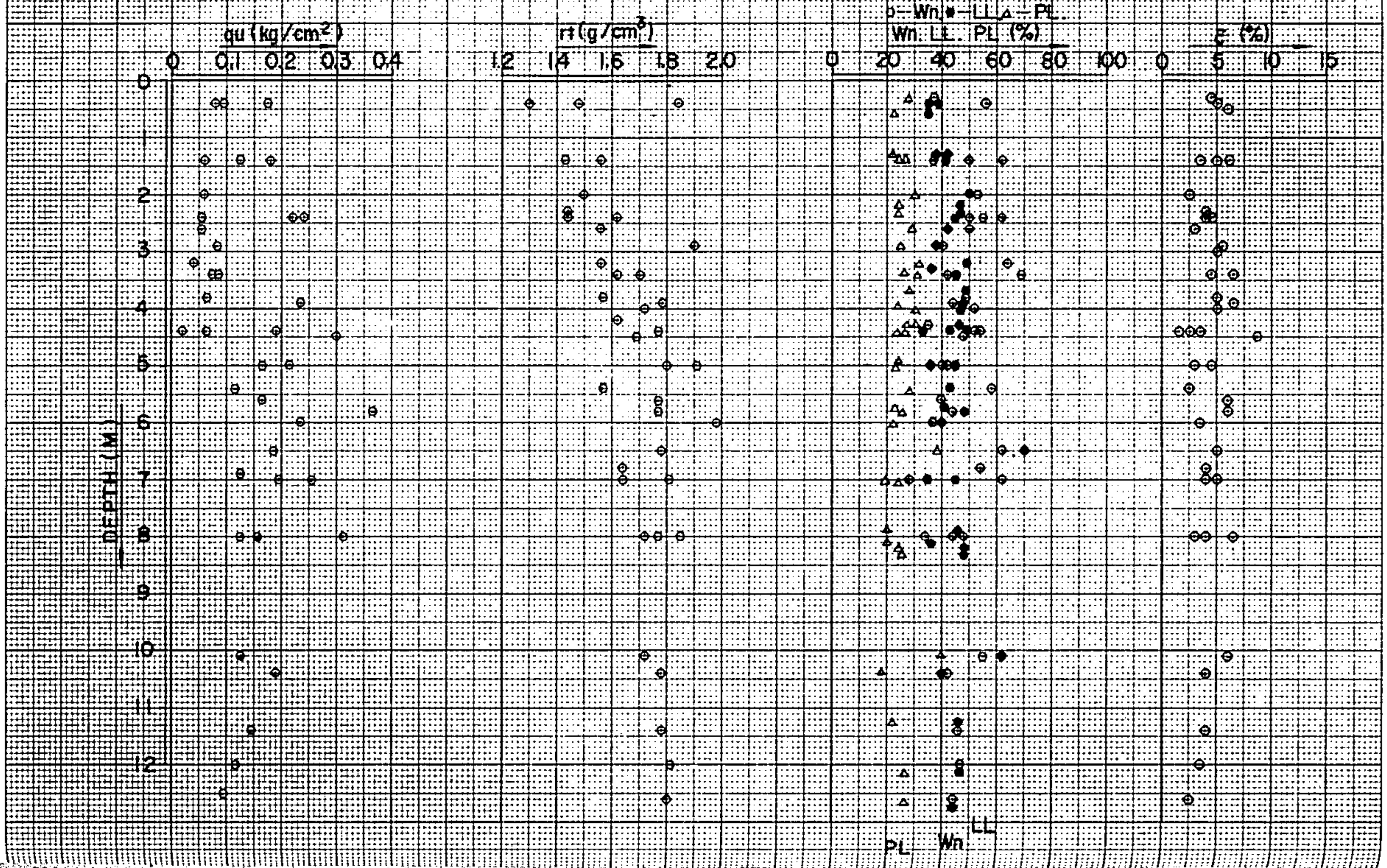
2.4 Materials

2.4.1 Embankment Materials

Good embankment materials are not available within the MMA. Suitable material can be obtained beyond a 35-km radius from the construction site. Since transporting materials over a long hauling distance is uneconomical, suitable materials located near the site, although insufficient in quantity, were analyzed for CBR and other tests.

Some potential borrow sites are located in Balara and Barrio Capre, Novaliches, Quezon City, within a radius of 8 to 12 km northeast of the construction site. The materials consist of volcanic clayey sand existing beneath decayed vegetation. Test samples were also taken from dredged materials at the Navotas Fisheries Port Project within the project area to ascertain their

FIG. 2.3-3 RESULT OF SOIL TEST



suitability for embankment. Further tests were conducted on materials taken from Cardona, Rizal, on the northern shore of Laguna de Bay.

Results of the tests are shown in Table 2.4-1. As indicated, the material from Navotas is relatively sandy, possibly because the clay may have been washed away during dredging, and showed a maximum dry density of 1.71 g/cm³, the highest in all the tests made, with corresponding CBR values of 4.7%. All materials tested showed CBR values of no more than around 3 to 4%, which indicates that they could be used for embankments. More thorough investigations are still required for the detailed design, since the materials contain large amounts of clay.

TABLE 2.4-1 RESULTS OF TESTS OF EMBANKMENT MATERIALS

Sample Location	Maximum Dry Density (g/cm³)	Optimum Water Content (%)	CBR (Soaked) (%)
Barrio Capre	1.59	15.6	3.8
Novaliches	1.64	15.0	4.2
Balara	1.59	14.6	3.6
Navotas	1.71	12.5	4.7
C-4 Route	1.56	14.9	3.3
C-3 Route	1.64	12.0	4.2
Cardona	1.56	14.4	3.1

The estimated quantities that can be taken from the investigated sites are as follows:

Barrio Capre	0.630 Million CM
Novaliches	0.780 Million CM
Balara	0.500 Million CM

2.4.2 Aggregates

(1) Boulders

Boulders for ripraping the revetment of the coastal portion of R-10 can be transported by barge from Bataan, where boulder stones can be procured from several quarry sites.

(2) Coarse & Fine Aggregates

Coarse and fine aggregates are available in sufficient quantity and quality in the MMA. The material sites are shown in Fig. 2.4-1.

2.4.3 Cement & Concrete Products

The procurement of cement will not be a problem during construction since there are six cement plants around the MMA, most of which can make bulk deliveries of cement. Transit mixed concrete can be delivered to the project site although there are only about 30 transit mixer units operating in the MMA.

2.4.4 Steel Materials

The Philippines domestically produces steel bars and small steel products from imported ingots. Prestressing steel and other large steel forms should, however, have to be imported.

2.5 Land and Housing

Except for the Dagat-Dagatan lagoon and the offshore sections, the project site is mostly located in developed residential areas, in Tondo, in Manila, Caloocan City, and Navotas and Malabon in Rizal.

Field investigations were conducted along the R-O-W of the project roads to determine land values and cost of structures in addition to other data required for estimating property acquisition costs. Unit costs were found to vary in different locations depending on the particular road or project route being assessed.

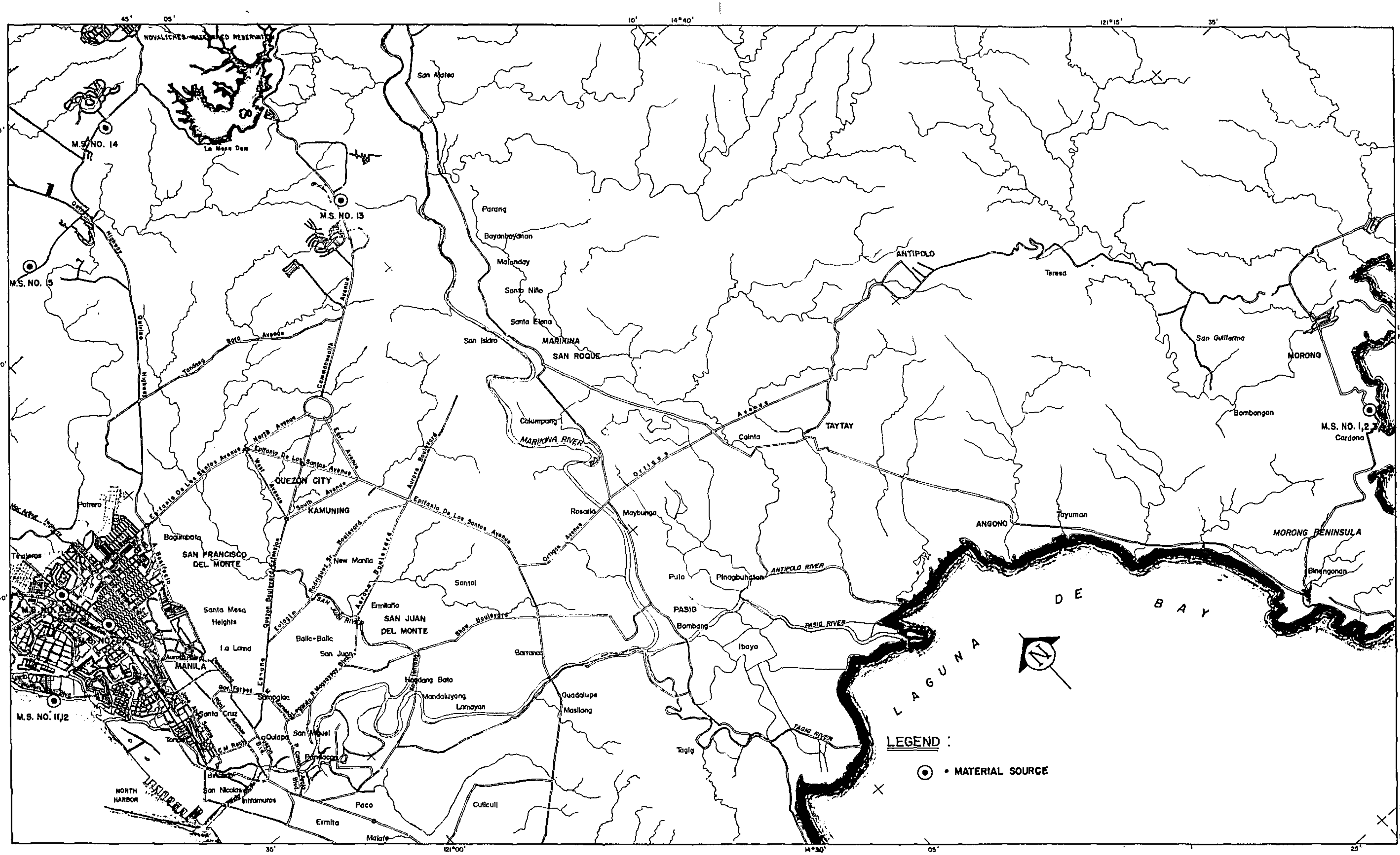


FIG. 2.4-1 MATERIAL SOURCE (Bulk Samples)
LOCATION PLAN

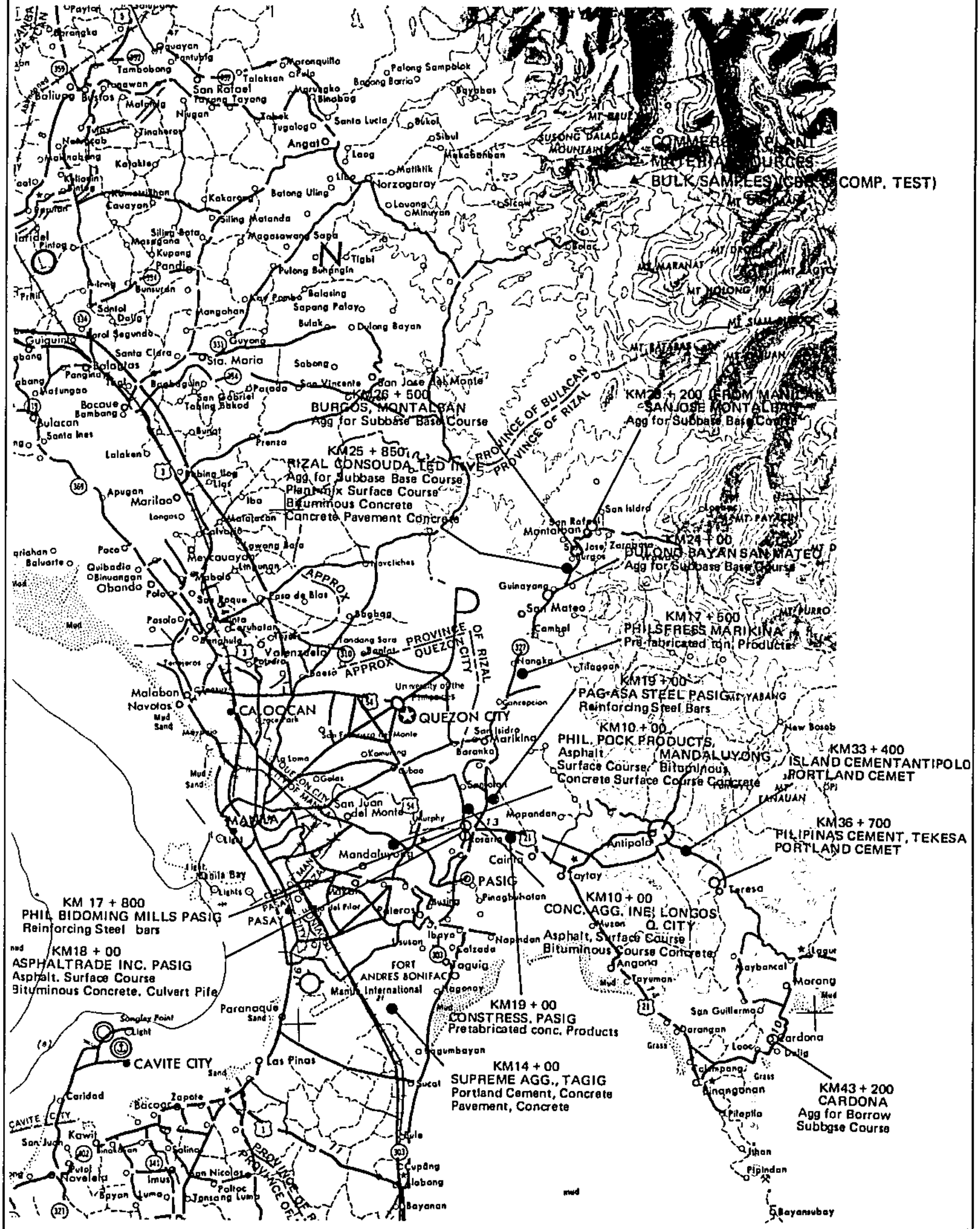


FIG. 2.4-2 · LOCATION MAP OF EXISTING COMMERCIAL PLANTS & MATERIAL SOURCES

CHAPTER 3
PRESENT TRAFFIC CONDITIONS

CHAPTER 3
PRESENT TRAFFIC CONDITIONS

3.1 Road Traffic Volumes

3.1.1 Existing Principal Roads Within the Influence Area of R-10

The major thoroughfares and auxiliary roads found in the influence area of R-10 are described as follows:

(1) A. Bonifacio Road-Quirino Highway (Novaliches Road)

This route has been recommended by the UTSMMA to become part of Radial Road R-8. A. Bonifacio Road starts from the Manila-Quezon City Boundary, where it extends from the CBD and runs 4 km northward to the Balintawak Cloverleaf Interchange on Epifanio de los Santos Avenue (C-4). It is a wide two-lane asphalt road, although some portions have recently been concreted. There are existing plans to widen this road.

Quirino Highway is the northern section of R-8 and is located outside C-4 and the inner area limits of the MMA. It extends from the Balintawak Interchange and runs 9 km northeastward to Novaliches. It is a two-lane concrete road with gravel shoulders. From Novaliches, a provincial road leads northward to San Jose del Monte and Norzagaray, Bulacan.

(2) Jose Abad Santos-Rizal Avenue Ex.-MacArthur Highway

Radial Road R-9 begins at Jose Abad Santos Ave. at its intersection with Claro M. Recto Avenue (C-1). From the CBD, it runs 3 km northward to Rizal Avenue Extension. It is a wide concrete paved 6-lane avenue. Its capacity has been increased with the recent removal of its wide median.

Rizal Avenue Extension extends R-9 from the inner area up to C-4, running 3 km northward to the Bonifacio Monument in Caloocan City. It is a narrow 6-lane divided concrete road.

MacArthur Highway (Manila North Road) leads to Central and Northern Luzon. It starts from the Bonifacio Monument and extends R-9 a distance of 7 km northward to Valenzuela, Bulacan. The outer section of the route is a four-lane paved highway.

(3) Juan Luna-A. Mabini-M. H. del Pilar

The UTSMMA recommended this route as a secondary radial route northward from the CBD. It is midway between R-9 and the proposed R-10. From the CBD, Juan Luna Street is a 10-m wide concrete roadway running 4 km northward to the Manila-Caloocan City

Boundary.

A. Mabini Street extends this route into Caloocan City and runs 3 km further northward to the Sangandaan intersection with C-4. It is also a 10-m wide concrete road.

M. H. del Pilar Street is the northern extension of this secondary radial route beyond C-4. It starts from the Sangandaan Junction and runs 6 km northwestward to Obando, Bulacan. It is a 10-m wide concrete road.

(4) Harbor Road

The existing Harbor Road is a wide 6-lane divided paved roadway adjoining the North Harbor, which starts from Pier 2 and runs 4 km northward to Vitas. It narrows to a two-lane undivided asphalt road in front of the Don Bosco Technical School.

(5) North Bay Boulevard

This route is the existing radial road leading from Tondo to Navotas, Rizal. It branches from Juan Luna Street west of Tayuman Street and runs 8 km northwestward to the Navotas River. It is a 12-m wide concrete road up to the Manila-Navotas Boundary. In Navotas, it becomes two-lane asphalt road running near the shoreline.

(6) Claro M. Recto Avenue

This avenue runs along the northern perimeter of the CBD and is a wide concreted avenue up to Asuncion St., where a 500-m long narrow unfinished section connects it with the North Extension of Roxas Boulevard (R-10).

(7) Tayuman Street

The existing street is a 12-m wide concrete road from Gov. Forbes Avenue that runs 2 km westward to Juan Luna Street. It is being utilized as a complementary route for C-2 together with another parallel road (Tayabas Street).

(8) 5th Avenue

The existing street is a narrow dead end road extending east-west from Rizal Avenue Extension (R-9). The western 500-m long section is asphalted. 5th Avenue is proposed to be utilized as part of C-3.

(9) Samson Road

Samson Road is the extension of E. de los Santos Avenue (C-4) west of the Bonifacio Monument. It is a one-km long 12-m wide concrete road up to the PNR crossing from where the 10-m wide Gen. San Miguel Street extends the route further westward to the Letre Road in the Dagat-Dagatan Area.

3.1.2 Traffic Volumes and Congestion

During a 40-day period in 1974 from April 22nd to May 31st, the Department of Public Highways (DPH) conducted a traffic survey in the MMA at 196 selected traffic stations consisting of control and coverage stations along the major and minor road systems within the influence area of the Project Roads. In the traffic analysis of this Study, however, only survey data gathered on the major road systems were used.

From the results of this survey, traffic volumes and degrees of congestion were estimated as shown in Fig. 3.1-1 & Table 3.1-1, from which the following observations can be made:

(1) The average daily traffic volume of North Bay Blvd. is approximately 10,000 vehicles with a high degree of congestion. This is primarily due to the low capacity of the road;

(2) The average daily traffic volume of A. Mabini St. is around 16,000 to 19,000 vehicles with a high degree of congestion;

(3) The average daily traffic volume of R-9 is about 60,000 vehicles with a very high degree of congestion;

(4) The traffic volumes along the existing sections of C-3 and C-4 within the influence area of R-10 are relatively low.

On the basis of the above observations, it may be concluded that the road network is not functioning efficiently and is not working as a system.

TABLE 3.1-1 AVERAGE DAILY TRAFFIC VOLUMES AND CONGESTION

April – May, 1974

Station No.	Road or Street	Traffic Volume	No. of Lanes	Capacity	Degree of Congestion
1	MORIONES STREET	36,100	4	40,000	0.90
2	REINA REGENTE STREET	37,000	4	40,000	0.93
3	RIZAL AVE. EXT.	30,200	4	40,000	0.76
4	NORTH BAY BLVD	10,200	2	10,000	1.02
5	NORTH BAY BLVD	11,200	2	10,000	1.12
6	ESTRELLA STREET	5,700	2	10,000	0.57
7	MARIANO NAVAL	11,700	2	10,000	1.17
8	GEN LUNA STREET	12,600	2	10,000	1.26
9	MARIANO NAVAL STREET	8,100	2	10,000	0.81
10	MARIANO NAVAL STREET	6,600	2	10,000	0.66
11	CONCE PCION STREET	5,500	2	10,000	0.55
12	GEN SAN MIGUEL	13,100	2	10,000	1.31
13	A. MABINI	17,800	3	20,000	0.89

Station No.	Road or Street	Traffic Volume	No. of Lanes	Capacity	Degree of Congestion
14	A. MABINI	15,300	3	20,000	0.77
15	SAMSON ROAD	19,100	4	40,000	0.48
16	SAMSON ROAD	41,000	6	60,000	1.03
17	CLARO M. RECTO AVE.	39,300	6	60,000	0.66
18	MORIONES	15,200	4	40,000	0.38
19	NORTH BAY BLVD	13,600	2	10,000	1.36
20	JUAN LUNA STREET	24,100	4	40,000	0.60
21	TAYUMAN STREET	17,900	3	20,000	0.90
22	JOSE ABAD SANTOS STREET	40,900	6	60,000	0.68
23	CLARO M. RECTO AVE.	44,700	6	60,000	0.75
24	BONIFACIO DRIVE STREET	36,800	4	40,000	0.92
25	JOSE ABAD SANTOS AVE.	60,100	4	40,000	1.50
26	TAYUMAN STREET	21,600	3	20,000	1.08
27	CAMARINES	5,600	2	10,000	0.56
28	TAYUMAN STREET	21,800	3	20,000	1.09
29	TAYUMAN STREET	19,700	4	40,000	0.49
30	JOSE ABAD SANTOS AVE.	38,100	4	40,000	0.95
31	JUAN LUNA STREET	19,200	3	20,000	0.96
32	JUAN LUNA STREET	13,400	3	20,000	0.67

3.1.3 Weekly and Hourly Variations of Traffic Volumes

The weekly variations of traffic volume on major thoroughfares are shown in Fig. 3.1-2. From these figures, it can be observed that there were no significant changes in daily traffic volumes for the whole week except on Sundays, where there was a decrease of traffic volume of about 20%.

The hourly variations of traffic volumes are shown in Fig. 3.1-3. It has been observed that during the 12-hour period from 7:00 a.m. to 7:00 p.m. when the full capacities of the roads are reached, the hourly traffic volume decreases only at noon without any significant changes as compared with the peak-hour volumes in the morning and in the afternoon.

3.1.4 Traffic Composition by Vehicle Types

The composition of traffic by vehicle type in the MMA are as follows:

(1) 80% of total traffic volume consist of cars, jeeps and jeepneys;

(2) The composition of jeepneys in some sections are remarkably high, accounting for more than 70% of the total traffic volume, as compared to the general average of 40 to 50%;

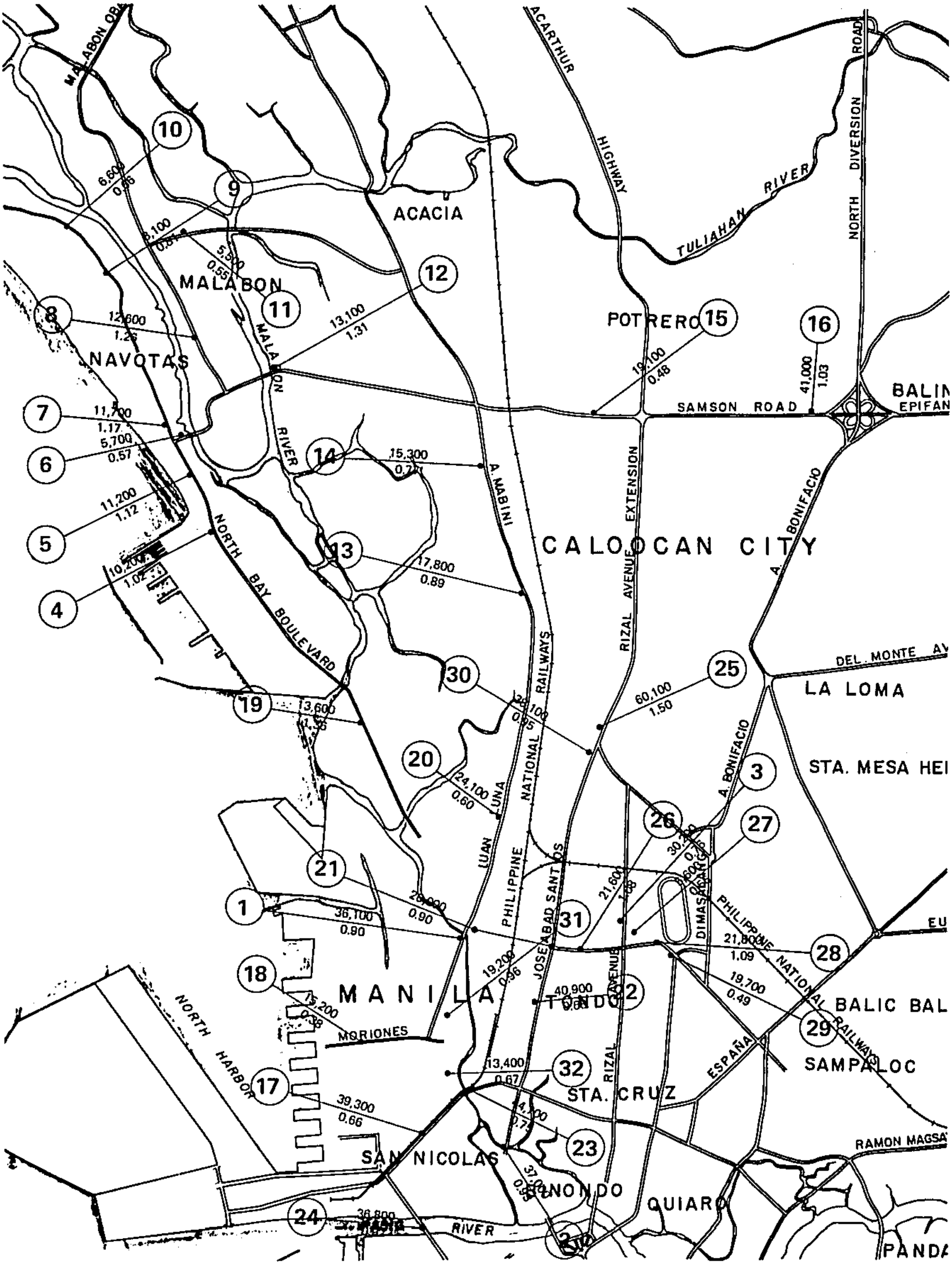


FIG. 3-1-1 TRAFFIC VOLUMES AND CONGESTION IN 1974

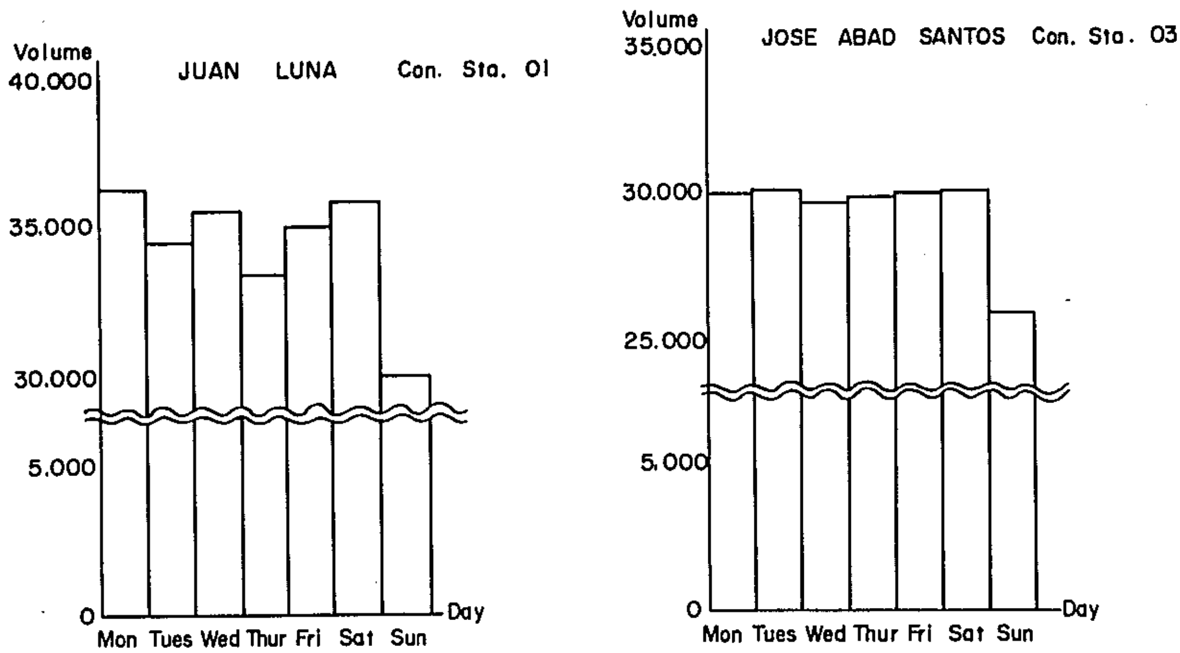


FIG. 3.1-2 WEEKLY VARIATIONS OF TRAFFIC VOLUME

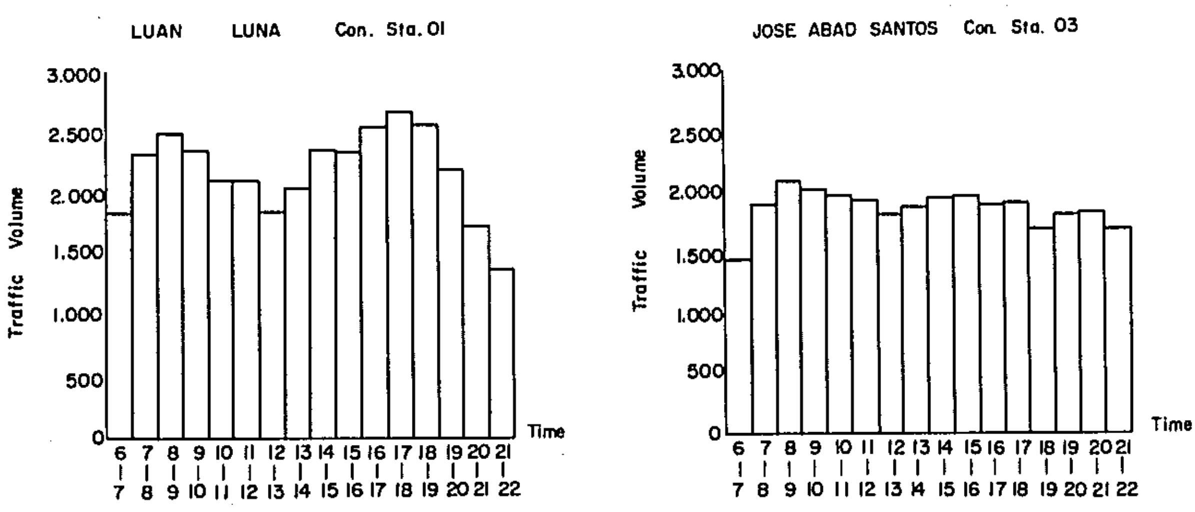


FIG. 3.1-3 HOURLY VARIATIONS OF TRAFFIC VOLUME

(3) The share of bus traffic to the total volume is very much less than that of jeepney traffic with the highest share recorded at 16%;

(4) Truck traffic is comparatively small except in the vicinity of Port Area.

3.2 Traffic Volume Related to Port of Manila

3.2.1 Traffic Field Surveys Related to Port of Manila

The survey of traffic volume related to the Port of Manila was conducted by the GOP during the 7-day period from July 8th to the 14th in 1974. The following were the types of surveys undertaken:

(1) Manual Vehicular Traffic Volume Count Survey,

(2) Automatic Vehicular Traffic Volume Count Survey,

(3) Roadside Interview Survey,

(4) Loadmeter Survey,

(5) Ferry (Interisland Vessels) Passenger Survey.

The questionnaire used in these surveys are contained in the Appendix Fig. 3.2-1 ~ 3.2-4.

3.2.2 Results of Traffic Surveys

(1) Traffic Volumes at Survey Points

Fig. 3.2-1 shows the traffic volumes observed at the traffic survey stations at the North and South Ports of Manila. The traffic volume at Survey Station No. NH-01, North Port of Manila, is very high with 23,000 vehicles, while that at NH-02 is 14,000. In other stations, traffic volumes do not exceed 10,000 vehicles, which means that the degree of traffic congestion at present around these stations is not high.

(2) Traffic Composition by Vehicle Types

As shown in Fig. 3.2-1, the component ratio of truck traffic including heavy trucks ranked first in the overall traffic entering and leaving the Port Area.

As pointed out in Subsection 3.1-4, the share of jeepneys is especially high in the North Harbor since this is the location of a major jeepney line terminal station.

(3) Vehicular Traffic Composition by Trip Purpose

The composition of vehicular traffic by trip purpose is shown in Table 3.2-1.

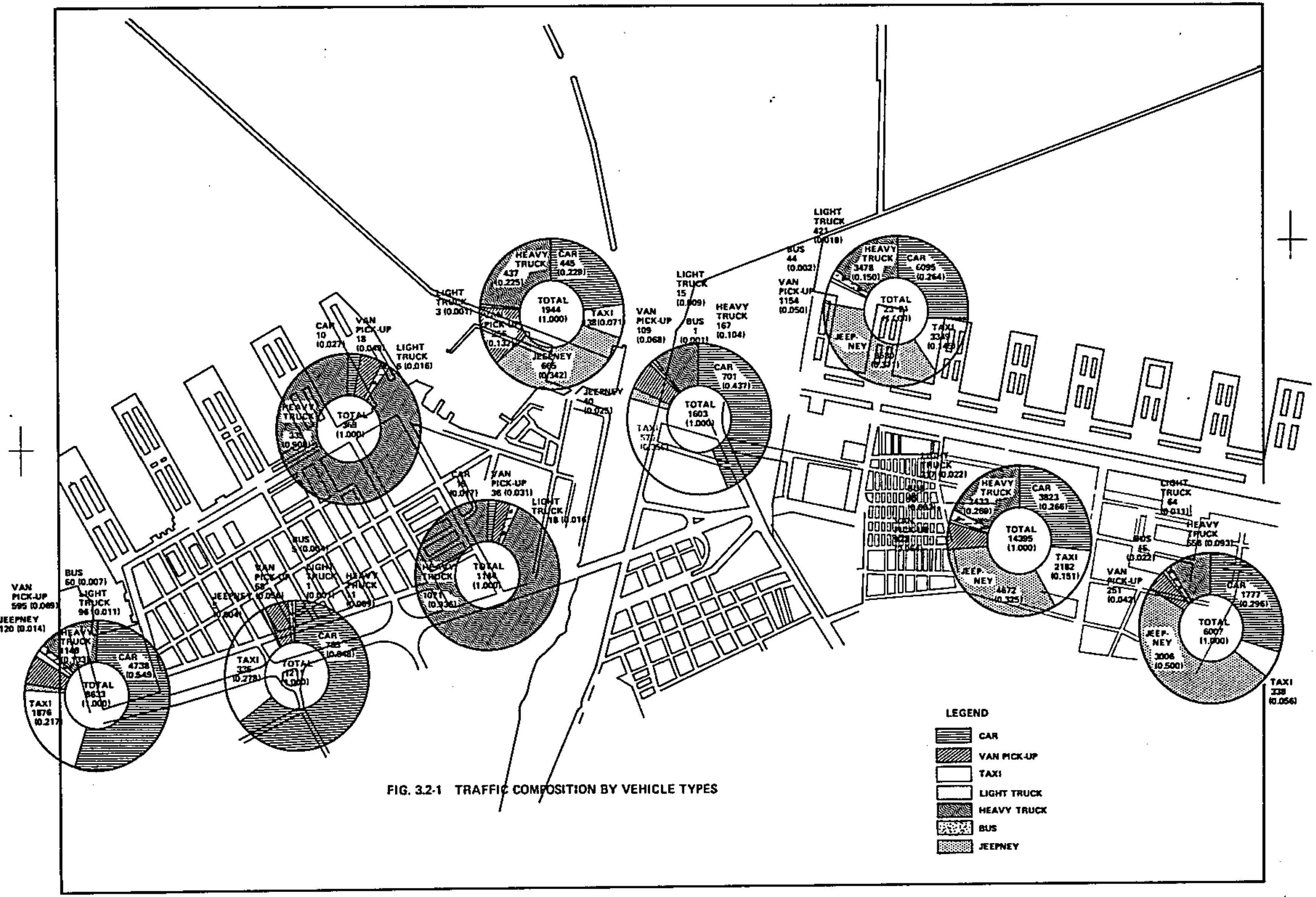


FIG. 3.2-1 TRAFFIC COMPOSITION BY VEHICLE TYPES

It can be noted that the composition in South Harbor is different from the North Harbor primarily because of the larger share of ferry passengers at the North Harbor.

Of the total trips at the North Harbor, the composition of passengers commuting to work and for work purposes are relatively smaller than that of passengers returning home. On the other hand, the composition of vehicular trips at the South Harbor has a higher composition of passengers commuting to work and for work purposes than those returning home.

TABLE 3.2-1 THE COMPOSITION OF CAR TRAFFIC BY TRIP PURPOSE (IN VEHICLES)

Trip Purpose	North Harbor	South Harbor
Commuting to Work	779 0.08	1512 0.23
To School	118 0.01	59 0.01
Private	2210 0.23	2311 0.35
Work	884 0.09	1230 0.19
Ferry Passenger	3054 0.31	152 0.02
To Home	2726 0.28	1375 0.21
Unknown	1007 –	411 –
Total	9711 1.00	7050 1.00

(4) Traffic Composition of Cargo Items

The composition of cargo traffic items is shown in Table 3.2-2.

As can be seen from Table 3.2-2, about 50% of the total cargo handled by trucks in the South Harbor are general goods, compared to the 42% of the total cargo handled in the North Harbor. The rest consists mainly of agricultural and marine products, chemical industry products and light miscellaneous industry products.

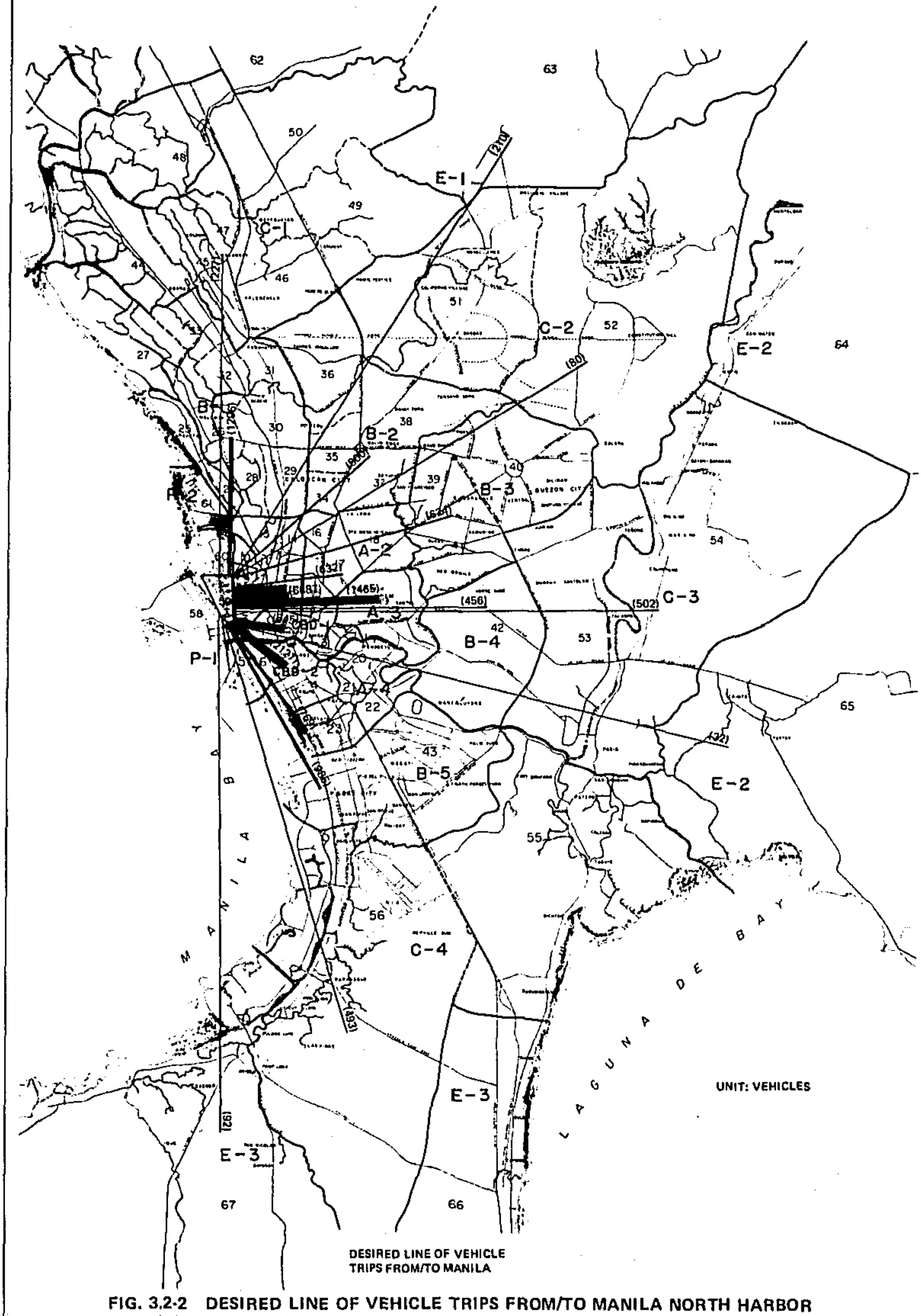


FIG. 3.2-2 DESIRED LINE OF VEHICLE TRIPS FROM/TO MANILA NORTH HARBOR

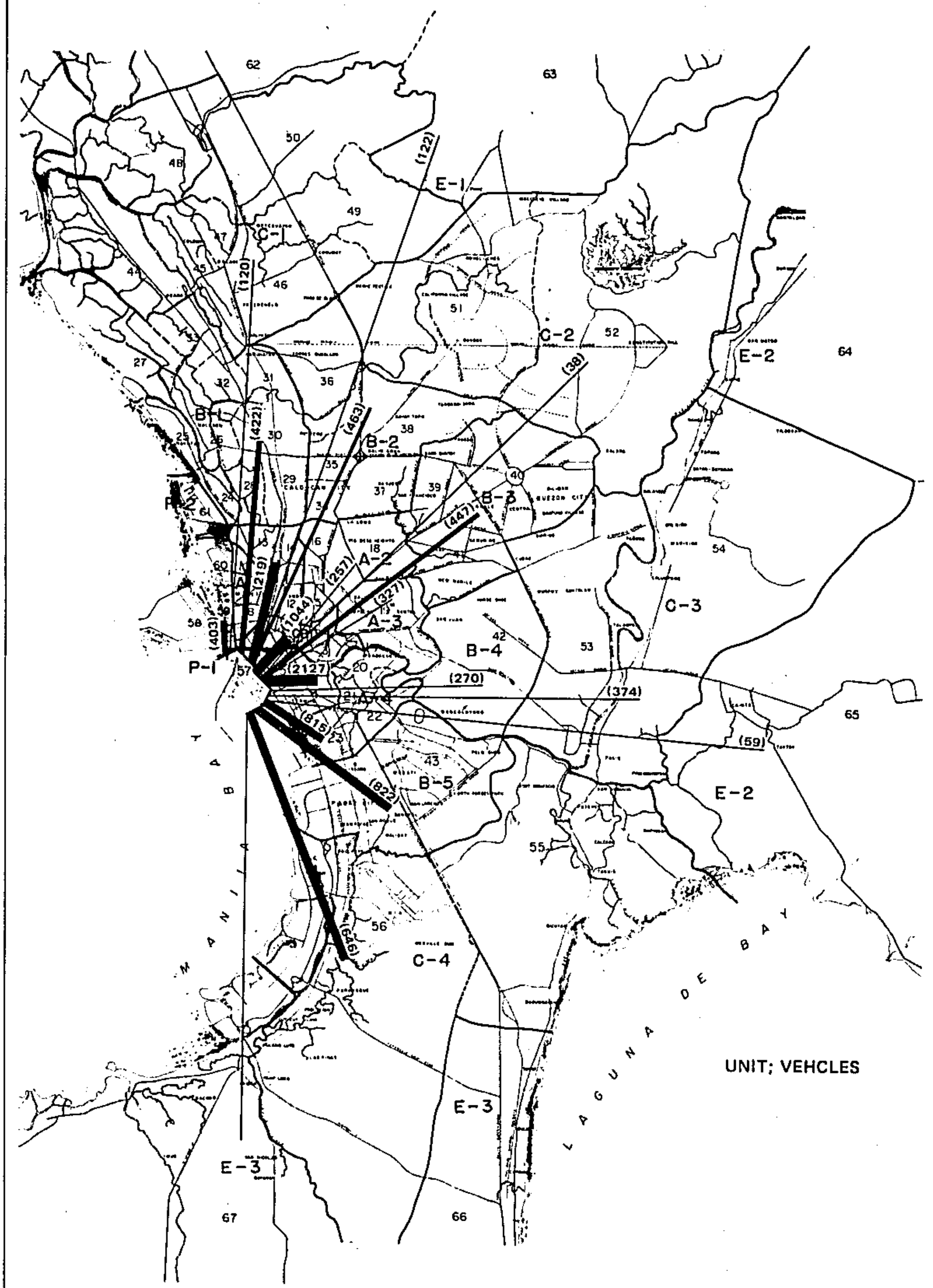


FIG. 3.2-3 DESIRED LINES OF VEHICLE TRIPS FROM/TO MANILA SOUTH HARBOR

TABLE 3.2-2 TRUCK VOLUMES BY CARGO ITEM (IN VEHICLES)

Cargo Item	North Harbor	South Harbor
Agricultural & Marine Products	867 0.13	748 0.17
Forest & Mineral Products	768 0.11	54 0.01
Metal & Machines	478 0.07	294 0.07
Chemical Industry Products	513 0.08	795 0.18
Light Miscellaneous Industry Products	1242 0.18	309 0.07
General Goods	2804 0.42	2230 0.50
Unknown	70 0.01	33 0.01
Total	6741 1.00	4463 1.00

3.2.3 O-D Distribution Related to Port of Manila

From Fig. 3.2-2 and 3.2-3, which shows the O-D distribution of vehicular traffic related to the Port of Manila, the following observations can be made:

(1) The trips related to the North Harbor and South Harbor of Manila have their origins and destinations mostly within the MMA, and the trips outside the MMA are very small in number.

(2) Of the total trips related to North and South Harbor, 70 to 80% have their origin and destination within the CBD Ring 1.

(3) The distance of trips related to the South Harbor is a little longer than those related to the North Harbor.

Based on the above analysis, it can be stated that the Port of Manila Primarily services the MMA.

3.2.4 Ferry Passenger Traffic

(1) Travel Characteristics of Ferry Passengers

The ferry (interisland vessel) passenger traffic survey results show that about 60% of the total ferry passengers travel with their relatives, 12% with their friends, while the remaining passengers travel alone.

From Table 3.2-3, which shows the composition of ferry passengers by trip purposes, it can be noted that the trip purposes of 31% of total ferry passengers is to visit friends and relatives, 39% to return home, 11% for recreation and sightseeing, 15% to work, and 5% for resettlement.

TABLE 3.2-3 FERRY PASSENGERS BY TRIP PURPOSE

Trip Purpose	Number of Passenger	Component Ratio
Visit	407	0.31
Recreation, sightseeing	147	0.11
Work	193	0.15
Resettlement	44	0.03
To Home	509	0.39
Total	1300	1.00

(2) O-D Distribution of Ferry Passengers

According to Fig. 3.2-4, which shows the O-D distribution of the ferry passengers, the O-D distribution pattern of ferry passengers is different from that of vehicular passenger traffic at the North and South Harbors of Manila. These noted differences in travel pattern are as follows:

(a) The length of trips of ferry passengers are longer compared with those of car passengers.

(b) 20% of total ferry passengers have origins and destinations in the CBD. This differs greatly from the results of the origin and destination survey of vehicular traffic related to the Port of Manila.

It can be concluded from the above observations that the ferry facilities of the North Harbor serve the people both inside and outside the MMA.

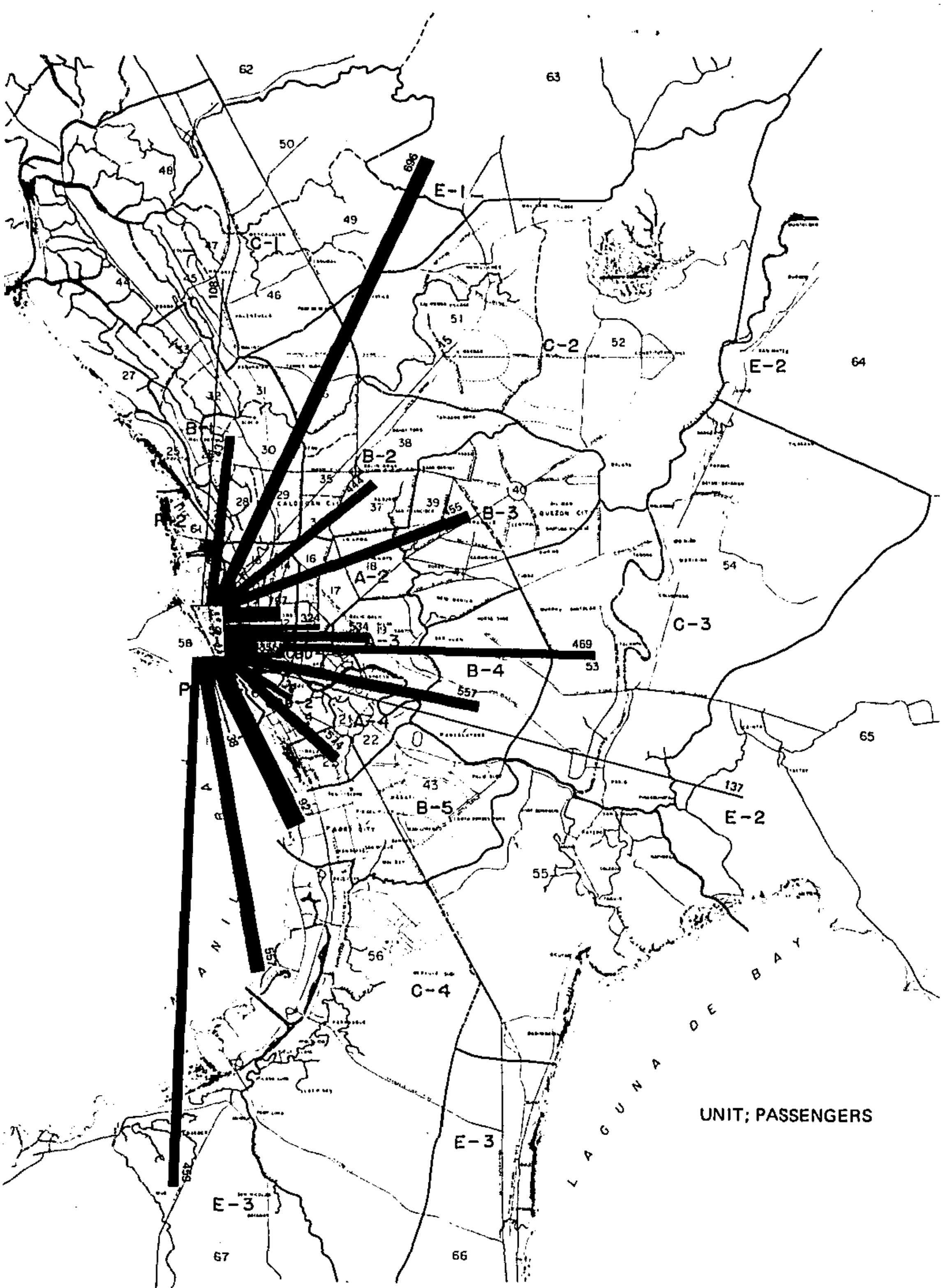


FIG. 3.2-4 DESIRED LINE OF FERRY PASSENGER FORM/TO NORTH HARBOR

CHAPTER 4

POPULATION AND LAND USE PLANS IN MMA

CHAPTER 4
POPULATION AND LAND USE PLANS IN MMA

4.1 General

The R-10 Project Roads are part of the MMA Major Thoroughfares System, which in turn is an integral part of the total overall transport system proposed by the UTSMMA for the area. The Project Roads are expected to exert a strong influence and have comprehensive effects not only on present and future development of the MMA, but more significantly on the major developmental projects within the immediate vicinity of the Project Roads themselves.

Accordingly, this chapter will discuss the development plans in the MMA which will provide the inputs for forecasting traffic on the Project Roads as treated in the following chapter. The three development plans in the MMA discussed in this chapter consist of the: (a) Manila Bay Metropolitan Region Strategic Plan (MBMRSP), (b) Major Developmental Plans in MMA, and (c) General Land Use Plan in MMA.

The MBMRSP is a United Nations Development Programme (UNDP) assisted project, which establishes the framework of the MMA as a higher-ranked priority plan. Several major development projects on the MMA level within this framework and which are presently being planned and implemented will be briefly described. Finally, future land use in the MMA will be discussed from the standpoint of determining the distribution of the resident population and daytime workers for the purpose of developing inputs for traffic projections.

Since there has been a revision in the land use plan proposed by the UTSMMA, the changes between both the original and the revised plans will also be discussed.

4.2 Manila Bay Metropolitan Region Strategic Plan

While the original MBMRSP population plan was based on following the natural trends of development in the MBMRSP Study Area and the MMA, the revised MBMRSP population plan on the other hand was prepared on the basis of attaining political planning targets of controlled population growth in the MMA.

Hence, the original plan projected MMA population in 1987 to be 7.5 million on the basis of past population data, while the revised plan as shown in Table 4.2-1 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 outside the MMA will be accomplished by fostering the intensive development of 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.

TABLE 4.2-1 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	44,020	1.20	49,630	1.35
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

Remarks:

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

MMA (1) – 29 Cities & Municipalities (BCS Definition)

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

Source: Manila Bay Metropolitan Region Strategic Plan Team

4.3 Major Development Projects in MMA

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

(1) The Tondo Urban Renewal Project,

(2) The Dagat-Dagatan Resettlement Project,

(3) The Manila-Cavite Road and Reclamation Project,

(4) The Manila International Marine Port Project,

(5) The Navotas Fisheries Port Project, and

(6) The Vitas Industrial Complex Project.

The location of these six development projects are shown in Fig. 4.3-1. A brief description

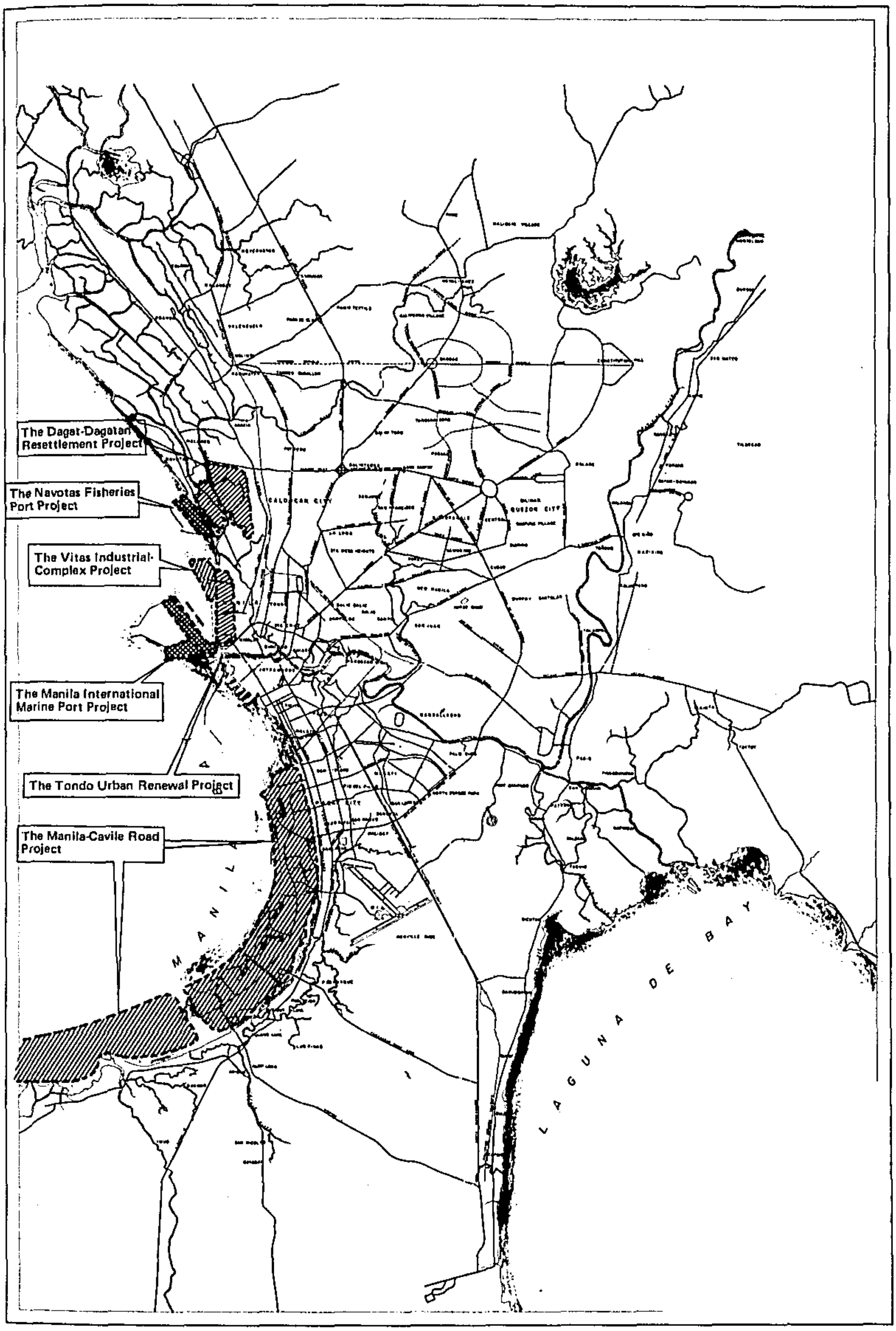


FIG. 4.3-1 METRO MANILA DEVELOPMENT PROJECTS

of each development project follows:

(1) The Tondo Urban Renewal Project

The renewal project aims to decongest and improve existing slum and squatter conditions in the Tondo Foreshore area with a present population of 25,712 families by the relocation of more than 60 percent of this population to the Dagat-Dagatan Resettlement area and leaving only about 9,000 families at the Tondo Foreshore area. This project is expected to be completed several years after resettlement to the Dagat-Dagatan area is finalized. The total renewal project area of 184.1 has. will be allocated in the following manner:

Land Use	Area (hectares)	
	Existing	Proposed
Residential:	147.0	113.6
Industrial/Commercial:	16.3	26.7
Others:	20.8	23.8
Total	184.1	184.1

(2) The Dagat-Dagatan Resettlement Project

This project is directly related with the Tondo Urban Renewal Project, since it will serve as resettlement area for the 19,985 families displaced from the Tondo Foreshore. Out of a total project area of 430 has., it will also provide 133.3 has. of land for industrial and commercial uses primarily related to the Navotas Fisheries Port as shown as follows:

Land Use	Proposed Area (hectares)
Residential:	232.9
Industrial/Commercial:	133.3
Others:	63.8
Total	430.0

The resettlement area will be bounded by R-10, C-3 and C-4, which will serve as the principal access thereof.

(3) The Manila-Cavite Road and Reclamation Project

This is an on-going project being undertaken by the Department of Public Highways involving the reclamation of 1,600 hectares along Manila Bay and the extension of Roxas Boulevard (R-1) to meet C-6 in Cavite. It includes the complete development of land and infrastructure facilities to provide for the expanding needs of a growing metropolis. This development project, which will have a great effect on adjoining existing uses of land, is described as follows:

Total Area	1,600 has.
Residential Area	621 has.
Residential-Commercial Area (Resort Hotels & Commercial Hotels)	138 has.
Commercial Area	224 has
Institutional Area	120 has.
Parks & Open Spaces	163 has.
Water Areas	143 has.
Sewage Treatment Area	11 has.
Roads	180 has.
Residential population	250,000 persons
Population density	160 persons/ha.
Target year	work on the project is estimated to be completed within 12 years.

(4) The Manila International Marine Port Project

This is an on-going project of the Bureau of Public works (BPW) with assistance from the Government of West Germany. The new port will be utilized primarily for handling containerized cargo which is expected to increase considerably in volume within the very near future.

(5) The Navotas Fisheries Port Project

The on-going reclamation work in Navotas will provide for the integration of facilities and the improvement of industries related to fisheries. This project is expected to be completed by June 1975.

(6) The Vitas Industrial Complex Project

The site of this project is presently being reclaimed, with reclamation work expected to be completed by 1975. The site will be initially utilized for the temporary resettlement of the people displaced from the Tondo Foreshore, and then will subsequently be used for industrial purposes.

4.4 General Land Use

In order to estimate future traffic volume, two future land use plans, one each for the years

1987 and 2000, were established by the MBMRSP in close coordination with the R-10 Study Team. The MBMRSP first estimated the total resident population and the total number of day-time and nighttime workers in the MMA for the two different years, i.e. 1987 and 2000, and used the projected population, together with the UTSMMA's land use plan for 1987, as the basis for the two future land use plans. UTSMMA estimates of future vehicle registration were also modified to conform to the future population projected by the MBMRSP.

4.4.1 Population Framework.

The night population of the MMA was 3.996 million in 1970 at a yearly growth rate of 4.8% during the period from 1960 to 1970. Using a yearly growth rate of 3% under the revised population plan, however, this population is expected to reach 5.758 million by 1987 and 7.452 million by the year 2000 (Table 4.4-1). This growth rate of 3% is expected to be maintained by the application of such government policies as dispersal of business and industry outside the MMA and complemented by control of population movements into the MMA. The projected worker population in the MMA during daytime and nighttime for the years 1987 and 2000 are shown in Table 4.4-2.

TABLE 4.4-1 PLANNED POPULATION

	1970	1987	2000
Population (Thousand persons)	3996	5758	7452
Growth (%) from 1970	1.00	1.44	1.86
Population density	66.7	94.8	122.7

TABLE 4.4-2 NUMBER OF WORKERS

(Thousand persons)

Years	Daytime (A)	Nighttime (B)	Difference (A) – (B)
1987	2376	2187	189
2000	3076	2831	245

4.4.2 Population Distribution and Land Use

The land use plan in the MMA for the year 2000 is almost identical to the UTSMMA plan for 1987 considering that both plans have almost the same population figures. Some modifications became necessary, however, because of the major development projects described in Section 4.3. Land use in the MMA for 1987 was established by interpolation between existing land use and the plan for the year 2000, without considering the improvement program of transport system.

(1) Population Density and Land Use Plan (2000)

Several minor changes were made on the 1987 UTSMMA land use plan to determine the plan for the year 2000, as follows:

A. Resident Population

(a) The 1987 UTSMMA population densities in the CBD and Ring 1 Area (CBD Sector and A Sector) which are very high were reduced from 600 to 500 persons per hectare in order to obtain a more conducive environment for residential purposes for the year 2000.

(b) A portion of the 1987 residential district in Novaliches was changed to open space.

(c) The 1987 increase in population in Zones 26, 46 and 48 in Ring 3 is relatively higher than the other zones and was accordingly reduced from 150 to 140 persons per hectare.

(d) Due to environmental considerations, the area south of the Manila International Airport was changed from a residential district in the 1987 plan to an open space for the year 2000.

(e) Corresponding changes were made to take the major development projects discussed in Section 4.3 into consideration.

B. Daytime Worker Population (2000)

(a) The population density of commercial workers in Ring 1 was reduced from 1000 persons per hectare in the 1987 plan to 900 persons per hectare.

(b) The number of industrial and commercial workers were decreased in proportion to the difference in residential population between the UTSMMA and this Study.

(c) All development projects discussed in Section 4.3 were considered for the land use plan for the year 2000.

(2) Population Density and Land Use Plan (1987)

The land use plan for 1987 was developed by interpolation between the existing land use in 1970 and the land use plan for the year 2000. Two assumptions in projecting land use for 1987 were considered by the MBMRSP and the R-10 Study Team, the first of which was adopted:

Assumption I:

The development process will follow its natural trends for the greater part of the period with planning controls effected only at the later stages in order to reach planned targets within a comparatively shorter period of time.

Assumption II:

The natural trends of the development process will be restrained by planning controls at the outset in order to reach planned development targets at a slower but more constant rate.

Figure 4.4-1 shows the conceptual methodology used for the two assumptions.

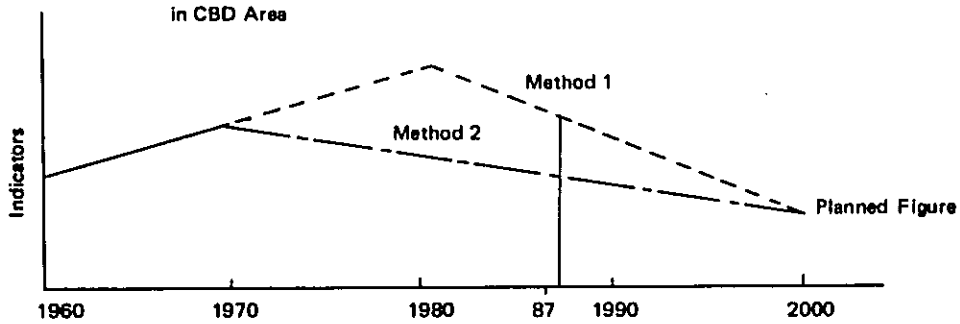


FIG. 4.4-1 INTERPOLATION METHOD

A. Resident Population (1987)

The methods used for calculating the resident population in 1987 are as follows:

(a) Population densities per zone were estimated by interpolation between present population density and the year 2000.

(b) Residential areas per zone were estimated by interpolation between the areas at present and areas in the year 2000.

(c) Resident population per zone were calculated by multiplying population density (a) by the residential area (b).

(d) Only some of the major development projects discussed in Section 4.3 whose target years are on or before 1987 were considered in the 1987 land use plan.

B. Daytime Worker Population (1987)

The methods used for calculating the daytime worker population in 1987 are as follows:

(a) Population densities in the CBD and Ring 1 were assumed to be 800 persons per hectare for commercial workers and 150 persons per hectare for industrial workers.

(b) The same population densities used for the year 2000 for commercial and industrial workers in Ring 2 and Ring 3 were adopted for 1987.

(c) Areas for commercial and industrial uses were obtained by interpolation from 1970 and the year 2000.

(d) Daytime worker population per zone was estimated from inputs obtained from (a), (b) and (c) above, according to the following formula:
Daytime Worker Population = Worker Density x Commercial-Industrial Area

(e) The primary worker population was obtained by adopting the same methodology and pattern used in the UTSMMA.

(3) Summary of Results

The land use plans for the years 1987 and 2000 obtained in accordance with the procedures described above are summarized in Figures 4.4-2 and 4.4-3, while the area of each land use, the resident population, the worker population, and the commerce-industry type are shown by zones in Appendix Tables 4.4-1, 4.4-2, 4.4-3 and 4.4-4.

4.4.3 Vehicle Registration

According to the MBMRSP, the numbers of vehicles in the area was 238,000 in 1970, and is estimated to be 680,000 by 1987 and 1.453 million by the year 2000 at a yearly growth rate of 17%. The figures showing the number of vehicles per year are shown in Table 4.4-3.

TABLE 4.4-3 NUMBER OF VEHICLES BY YEAR

(Thousand vehicles)

	1970	1987	2000
Vehicle Registration	238	680	1453
Growth	1.00	2.86	6.11

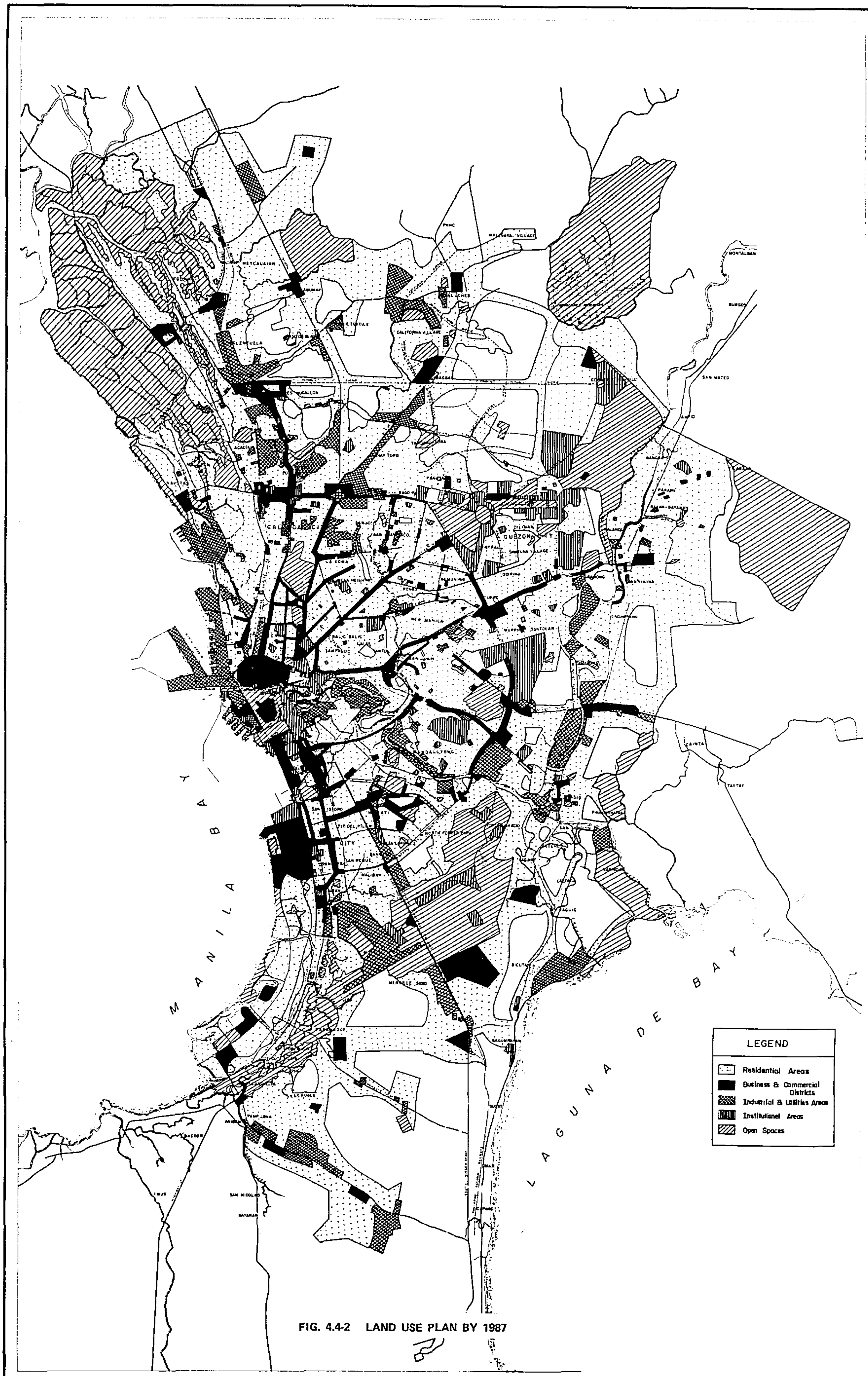


FIG. 4.4-2 LAND USE PLAN BY 1987

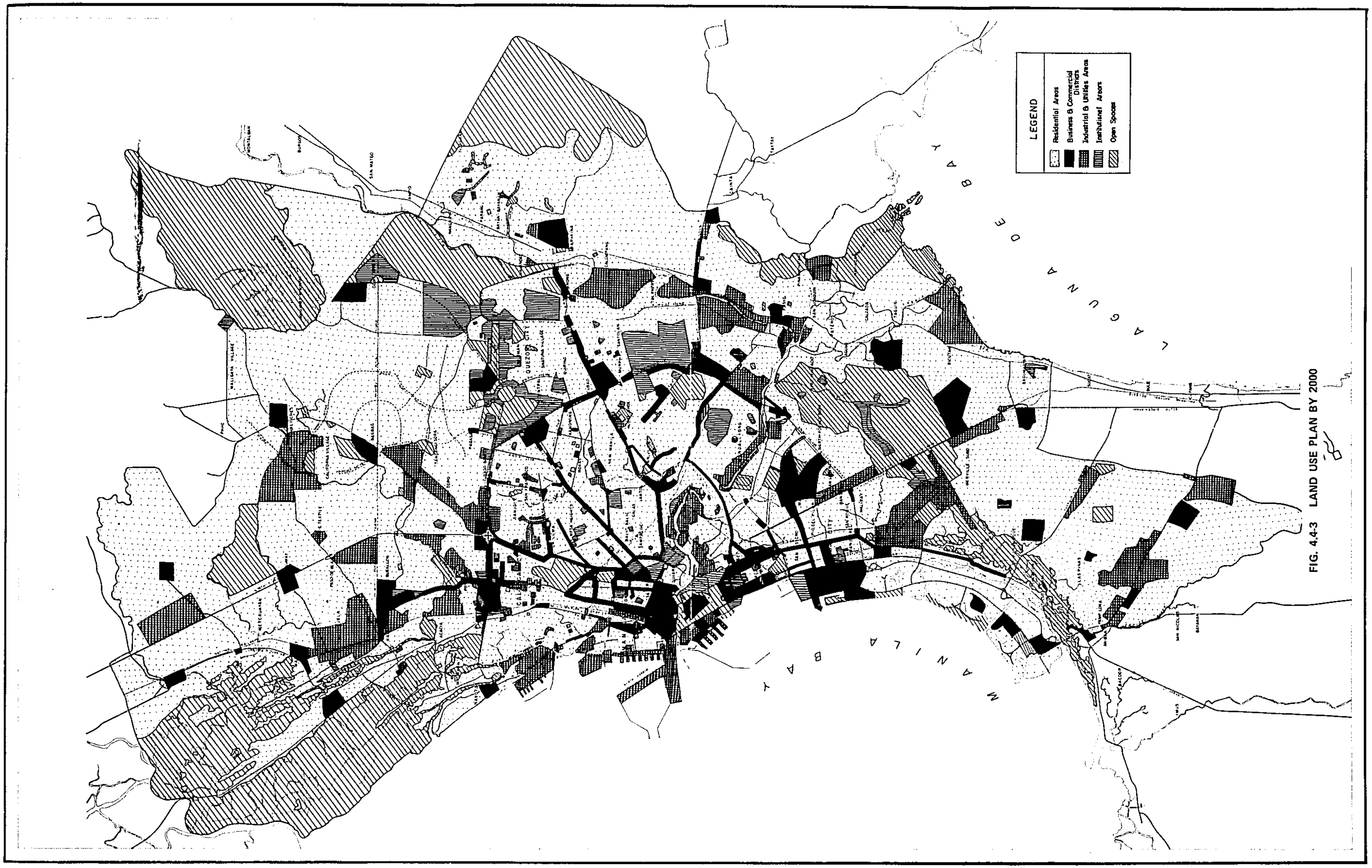


FIG. 4.4-3 LAND USE PLAN BY 2000

CHAPTER 5

ESTIMATION OF FUTURE TRAFFIC DEMAND

CHAPTER 5
ESTIMATION OF FUTURE TRAFFIC DEMAND

5.1 Method of Traffic Demand Estimation

5.1.1 Estimation Procedure

Traffic demand for the Project Roads was derived from the projected traffic for the major thoroughfares system within the MMA, considering that the roads are integral parts of this system. The estimate was made on the basis of person-trip-demand as shown in Fig. 5.1-1.

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 for this Study, namely:

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

Fig. 5.1-1 illustrates the entire traffic projection process while Fig. 5.1-2 shows details of part of this process from trip production to trip distribution.

Trip production in the MMA was obtained from the product of trips per capita and population, while trip generation and attraction were estimated on the basis of the distribution of the resident, worker and student population as related to each trip purpose.

The Entropy Method incorporated with the Gravity Model was applied in estimating trip distribution.

In the modal split, the trip interchange model was used because this model can be adapted to the introduction of urban rapid mass transit in the future as proposed in the UTSMMA. The modal split was determined by taking into account relative travel times between the two modes, i.e., mass transit and cars. Mass transit users were further subdivided into bus and jeepney, mass rapid transit users in determining traffic assignments, which were made in two separate analyses, the first by assigning traffic generated from the entire MMA and the second by assigning traffic generated from the Port of Manila. However, traffic generated from the Port of Manila was estimated separately from the aforementioned projections.

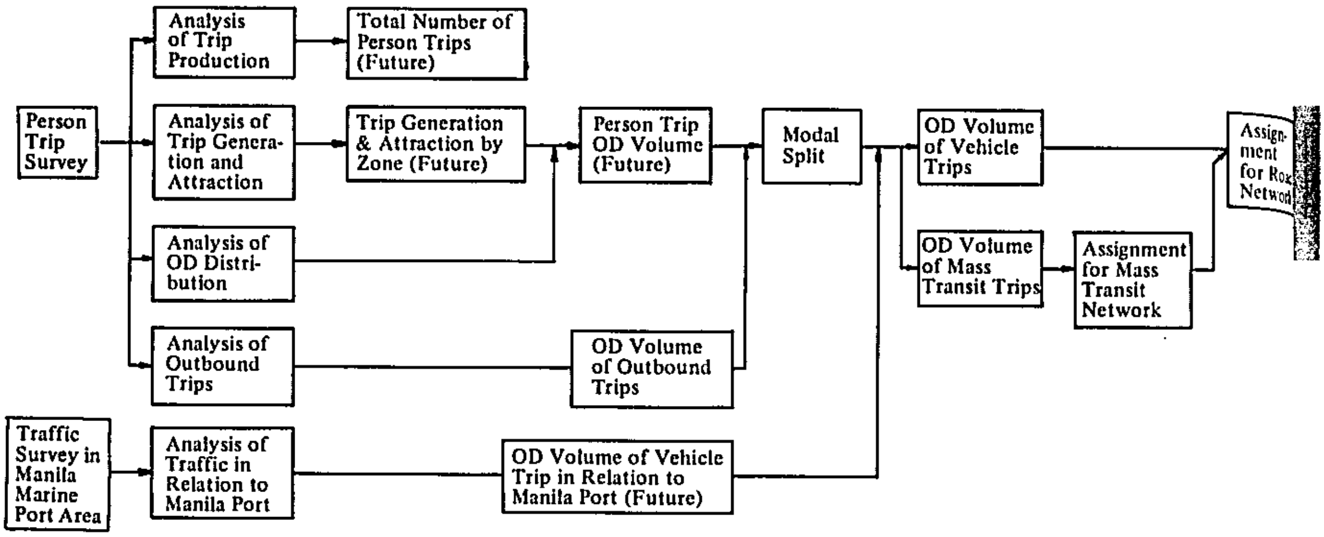
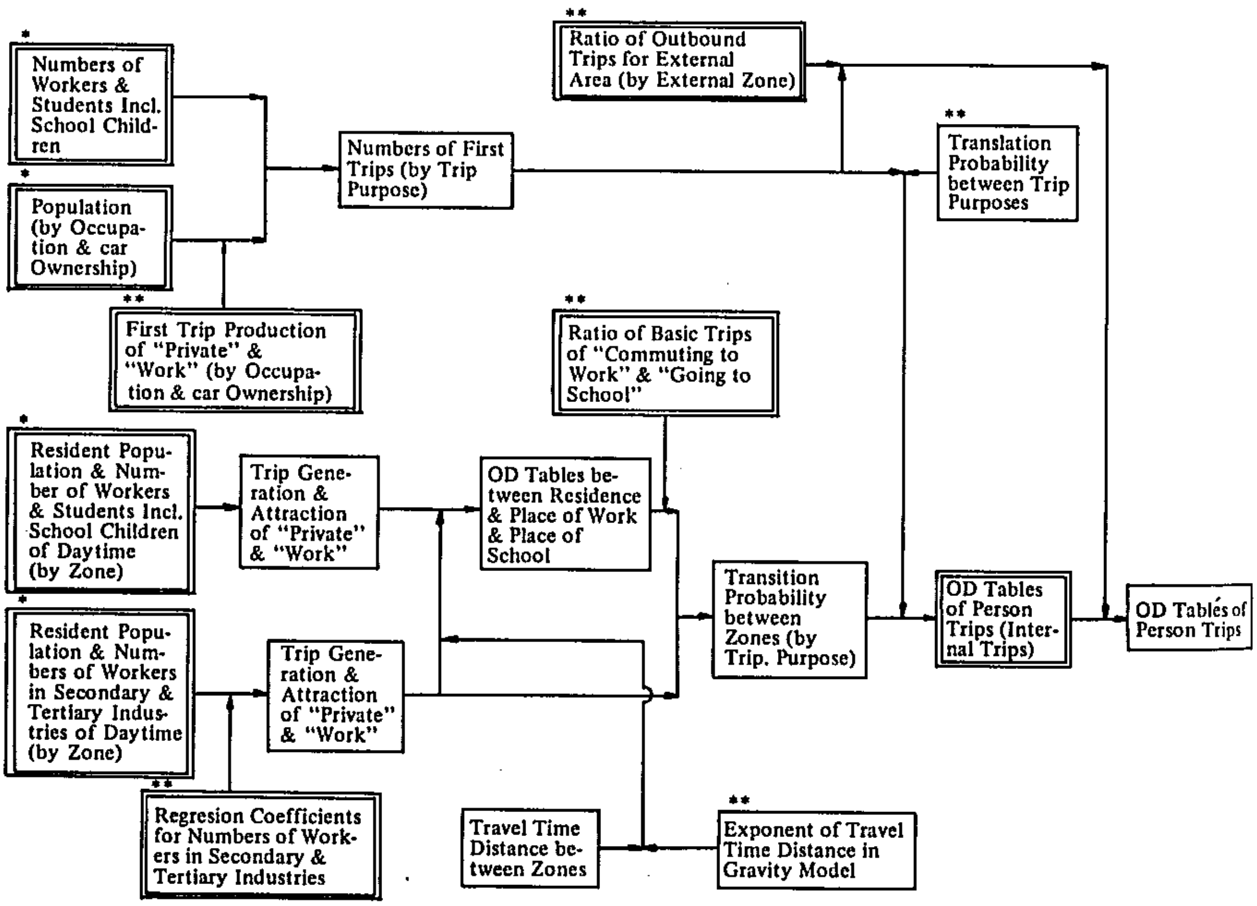


FIG. 5.1-1 PROCESS FOR ESTIMATION OF TRAFFIC PROJECTION



Remarks: Input data: * Decided by land use plan
** Given through analysis of traffic survey data

FIG. 5.1-2 FLOWDIAGRAM FROM PERSON TRIP PROJECTION TO OD DISTRIBUTION

The minimum time path and "all or nothing" method was used in traffic assignment. In this connection, traffic volume was divided into six parts taking the road capacity limit into consideration. Heavy trucks were assigned to main thoroughfares only with the exception of Roxas Blvd.

5.1.2 Study Area, Zoning and Projection Years

The UTSMMA study area was divided into 51 internal zones and six external zones (Fig. 5.1-3). The same zones were used in this Study only up to the modal split portion of the projection process.

Before traffic assignments were made, however, these 51 zones were increased to 61 while keeping the number of external zones at six (Fig. 5.1-4).

The same process was followed in projecting traffic for the years 1987 and 2000. Interpolations between the two O-D tables for the years 1971 and 1987 were used to estimate O-D tables for the years 1977, 1979 and 1981 which were assigned to the road network.

5.2 Trip Projection from Production to Distribution

5.2.1 Trip Projection

First trips per capita classified by car ownership and occupation were obtained from the results of person-trip surveys for the UTSMMA as shown in Appendix Table 5.2-1.

The ratio of car owners to total population was estimated based on total population and total vehicle registrations submitted by the MBMRSP which considered the following factors:

- Resident population
- Decrease in the average family size
- Rate of change of car ownership

The population by occupation and by car ownership is shown in Table 5.2-1.

The estimated total first trips were broken down into internal and external trips using the results of the person-trip surveys shown in Table 5.2-2.

5.2.2 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

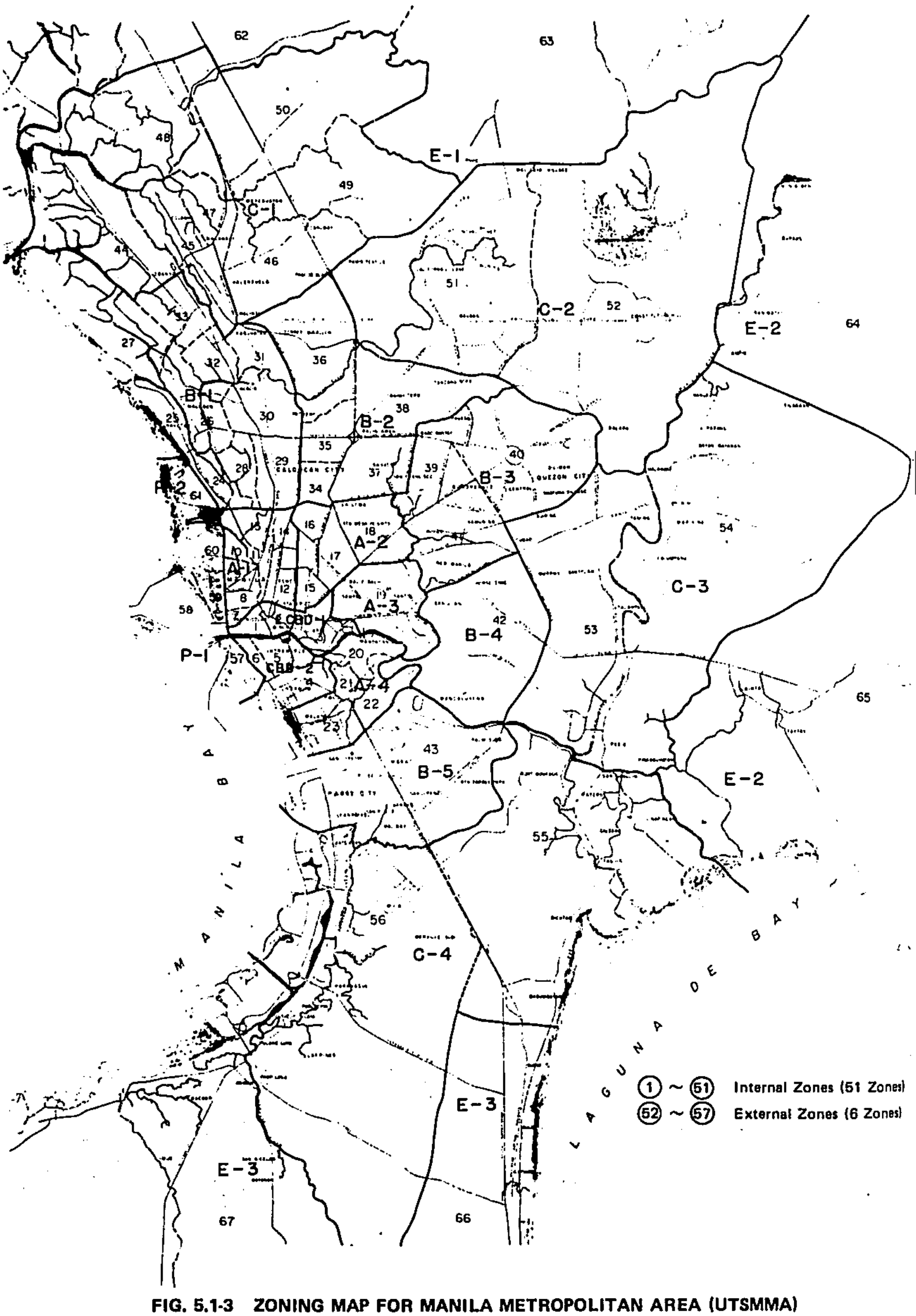


FIG. 5.1-3 ZONING MAP FOR MANILA METROPOLITAN AREA (UTSMMA)

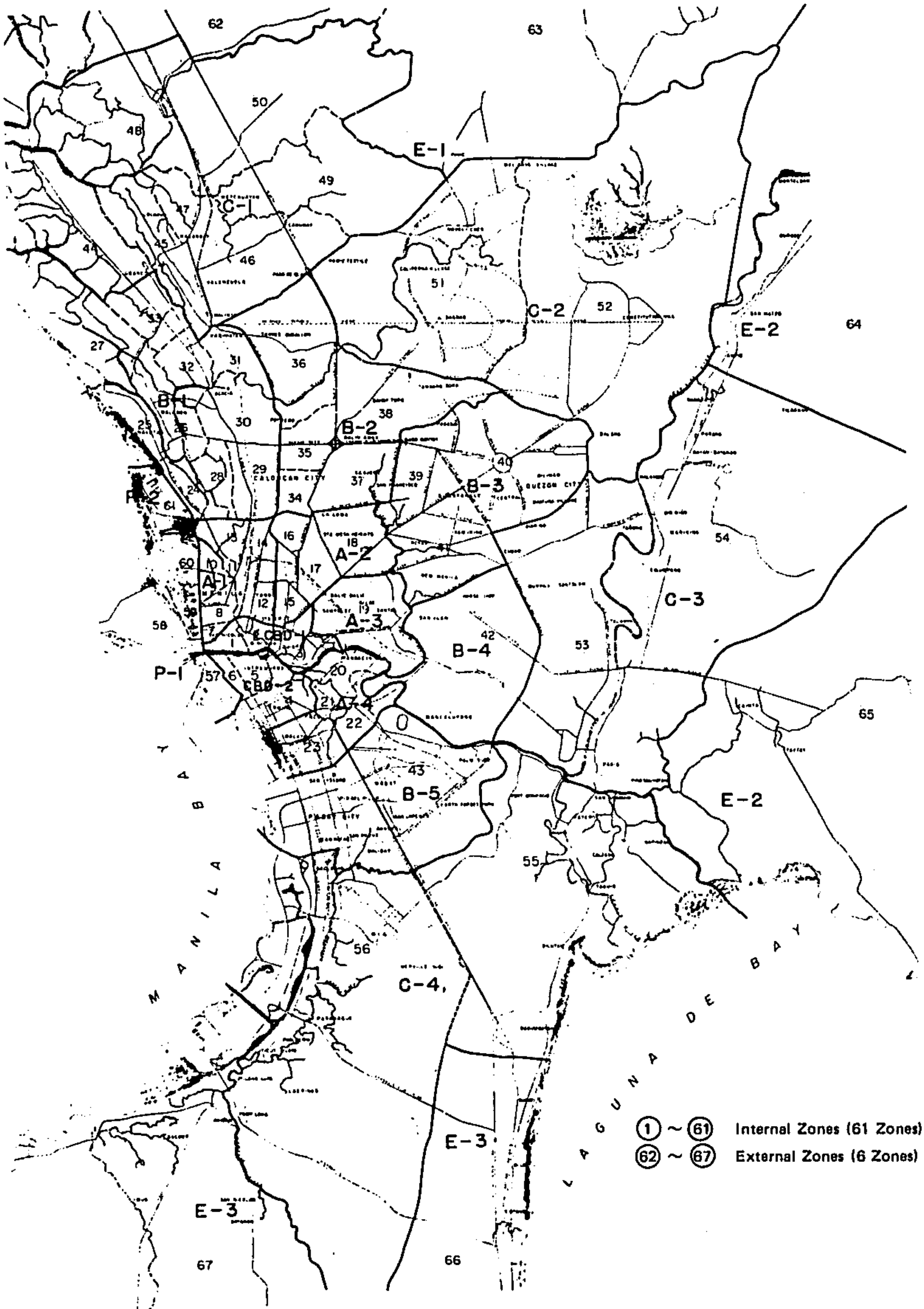


FIG. 5.1-4 ZONING MAP FOR MANILA METROPOLITAN AREA

TABLE 5.2-1 FUTURE POPULATION BY OCCUPATION AND CAR OWNERSHIP

(1000 Persons)

Occupation \ Ownership	1987			2000		
	Owners	Non-Owners	Total	Owners	Non-Owners	Total
Professional Workers	123	132	255	227	103	330
Administrative Workers	44	24	68	81	7	88
Clerical Workers	78	172	250	144	180	324
Sales Workers	77	152	229	143	153	296
Farmers	12	60	72	22	72	94
Workers in Transport	76	212	288	140	233	373
Craftsmen	65	448	513	120	544	664
Service Workers	267	245	512	495	168	663
School Children	119	369	488	221	411	632
Students	242	529	771	450	548	998
Housewives	207	739	946	384	840	1,224
Joblesses	41	163	204	75	189	1,488
Total	1,351	3,246	4,597	2,501	3,448	5,950

Source: Estimated by MBMRSP Team and broken down by Japanese Team.

TABLE 5.2-2 NUMBER OF FIRST TRIPS BY AREA

(1000 Trips)

Trip Purpose		1987			2000		
		Internal	Internal-External	Total	Internal	Internal-External	Total
Workers	Ratio	0.985	0.015	1.000	0.985	0.015	1.000
	Number	2,154	33	2,187	2,790	42	2,832
Student incl. School Children	Ratio	0.998	0.002	1.000	0.998	0.002	1.000
	Number	1,256	3	1,259	1,627	3	1,630
Private Trips	Ratio	0.975	0.025	1.000	0.975	0.025	1.000
	Number	1,101	28	1,129	1,559	40	1,599
Works Trips	Ratio	0.938	0.062	1.000	0.938	0.062	1.000
	Number	801	53	854	1,208	80	1,288

to the resident population, and the attraction of these trips are proportional to the number of workers and students, respectively. The trips generated for provate purposes are proportional to the resident population while attraction of these trips are proportional to the number of tertiary workers.

As far as work-trips are concerned, the generated and attracted trips are proportional to the number of workers. 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 workers at daytime. (Appendix Table 5.2-2)

Resident population and workers at daytime were determined in accordance with the land use plan of the MBMRSP as shown in Appendix Table 4.3-1 ~ 4.3-4.

5.2.3 Trip Distribution

The results of the Trip Purpose Correlation Method and the Entropy Method incorporated with the Gravity Model were used in determining trip distribution. These methods used the following inputs:

- Trip Production
- Trip Generation and Attraction
- Transition Probability between Trip Purposes (Appendix Table 5.2-3)
- Parameter in the Gravity Model (Appendix Table 5.2-4)
- Travel Time between Zones

Inasmuch as trip production and trip generation and attraction were already estimated in the previous section, the other inputs were obtained from UTSMMA, except for travel time between zones which was obtained from the assumed transportation network shown in Section 5.3-1.

5.2.4 Estimation of External Trips

The procedure in estimating total external trips is shown in Fig. 5.2-1. 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 5.2.1, while the latter was estimated by multiplying the result of the Cordon Line Survey for the UTSMMA with the future population growth in adjoining areas, as shown in Table 5.2-3.

The results of total external trips are shown in Table 5.2-4.

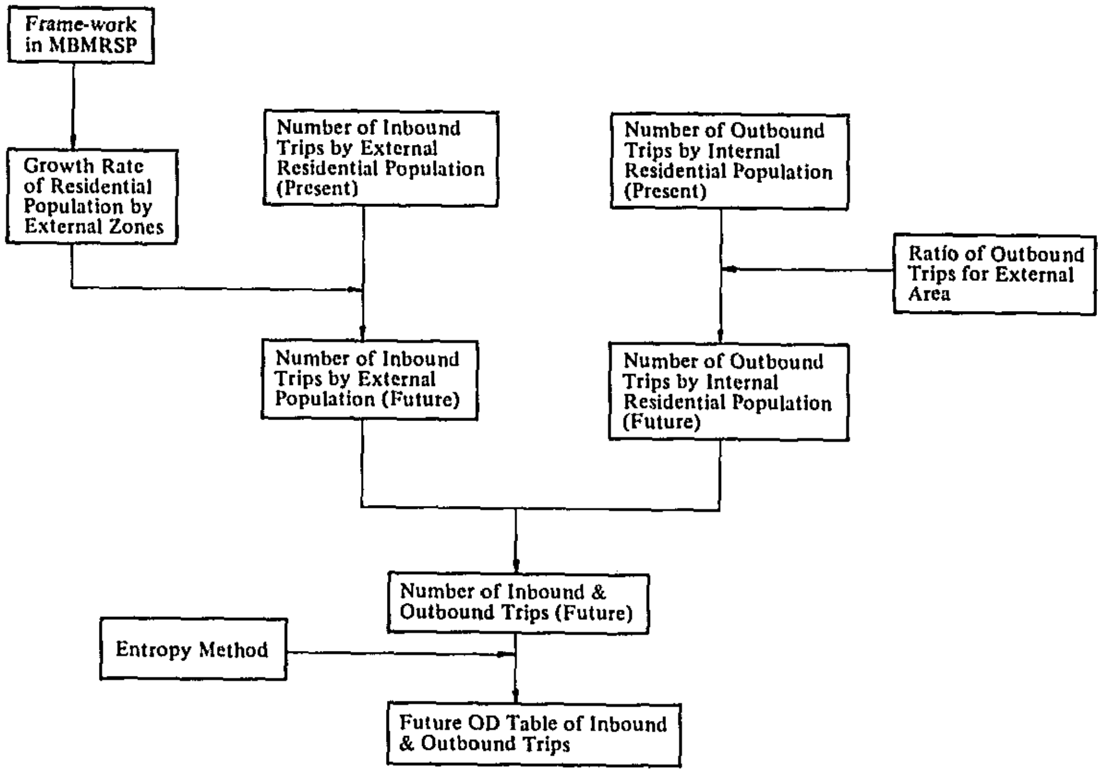


FIG. 5.2-1 FLOW DIAGRAM FOR ESTIMATION OF EXTERNAL TRAFFIC

TABLE 5.2-3 POPULATION OF EXTERNAL ADJACENT AREA

(Persons)

Zone Numbers	Areas \ Population	Present (1970)	Future (1987)	Future (2000)
E-1	Bulacan. St. Maria (1/2) Bocave. San Jose (1/8)	81,226 1.00	146,711 1.81	198,850 2.45
E-2	San Mateo Taytay Angono Calnta, Muntinlupa Antiplo	200,306 1.00	467,319 2.33	733,380 3.66
E-3	Kawit, Bacoor Novelete Rosario Imvs	154,950 1.00	223,776 1.44	299,190 1.93

Remarks: Upper; Number of Population
Lower; Growth Rates FY1970 ~ 87 and FY1970 ~ 2000

TABLE 5.2-4 NUMBER OF EXTERNAL TRIPS IN 1987, 2000

Trip Purpose	1987			2000		
	External Residents	Internal Residents	Total	External Residents	Internal Residents	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	400	244.1
Work	60.4	53.0	113.4	85.3	85.0	170.3
To Home	336.4	64.0	400.4	452.1	80.0	532.1

5.2.5 Results of Projection

The number of trips by trip purpose, trip generation and attraction, the desired lines of person trips and OD volume of person trip are shown in Table 5.2-5 and Fig. 5.2-2, 5.2-3 and 5.2-4 and Appendix Tables 5.2-5 and 5.2-6.

The following observations were made on trip production:

- The estimate of total trips is appropriate since it is almost in proportion to the growth of population.
- The share of private and work trips in the future total trips will be larger than the existing total trips, and will show faster rate of increase than population growth. This ia mainly due to the faster increase of car ownership projected.

TABLE 5.2-5 NUMBER OF TRIPS

	Internal	External	Total
1987	8,939,596	400,400	9,339,996
2000	12,504,202	532,100	13,036,302

5.3 Assumed Future Transportation Network

5.3.1 Total Transportation Network

The transportation 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 almost similar to that for the year 2000 in this Study. The proposed transport system for 1987 is composed of four alternative plans. The first plan considers bus service as the only available mode of mass transit. The second plan considers bus service and improved PNR facilities for commuter service. The third plan considers construction of Urban Rapid Mass Transit Line-1 in

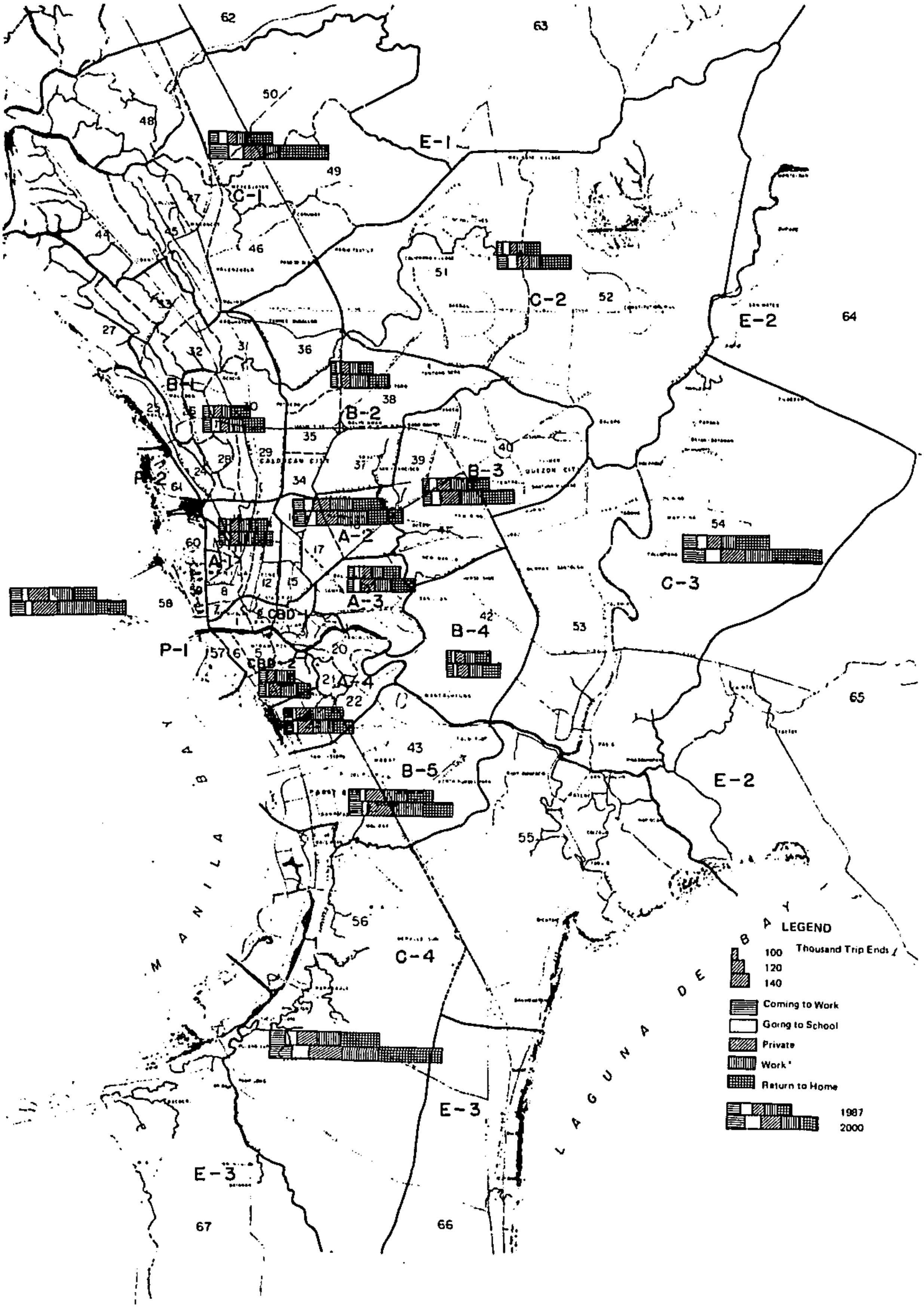


FIG. 5.2-2 GENERATION & ATTRACTION OF PERSON TRIPS BY TRIP PURPOSE & BY YEAR

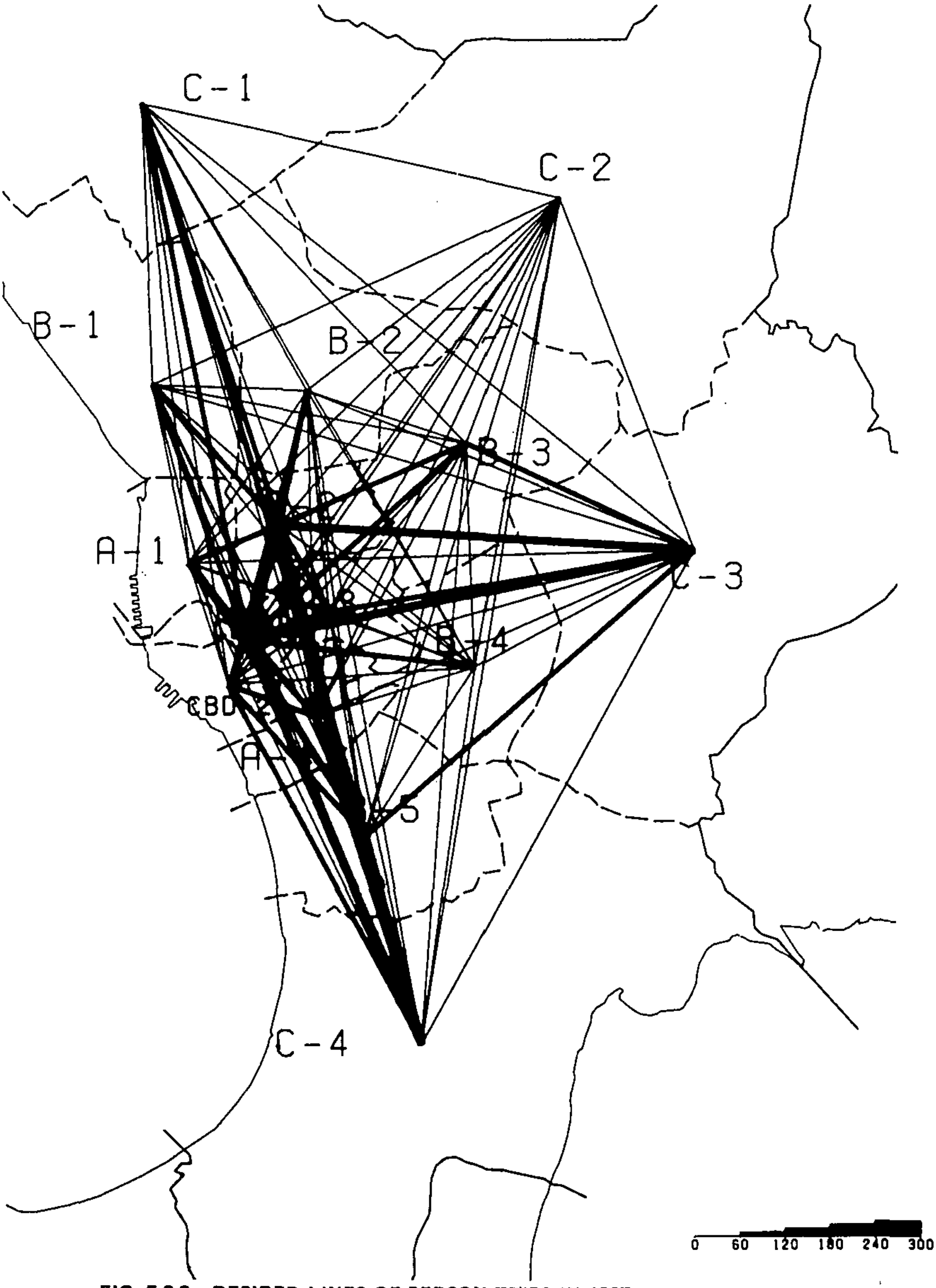


FIG. 5.2-3 DESIRED LINES OF PERSON TRIPS IN 1987

UNIT; 1,000 TRIPS

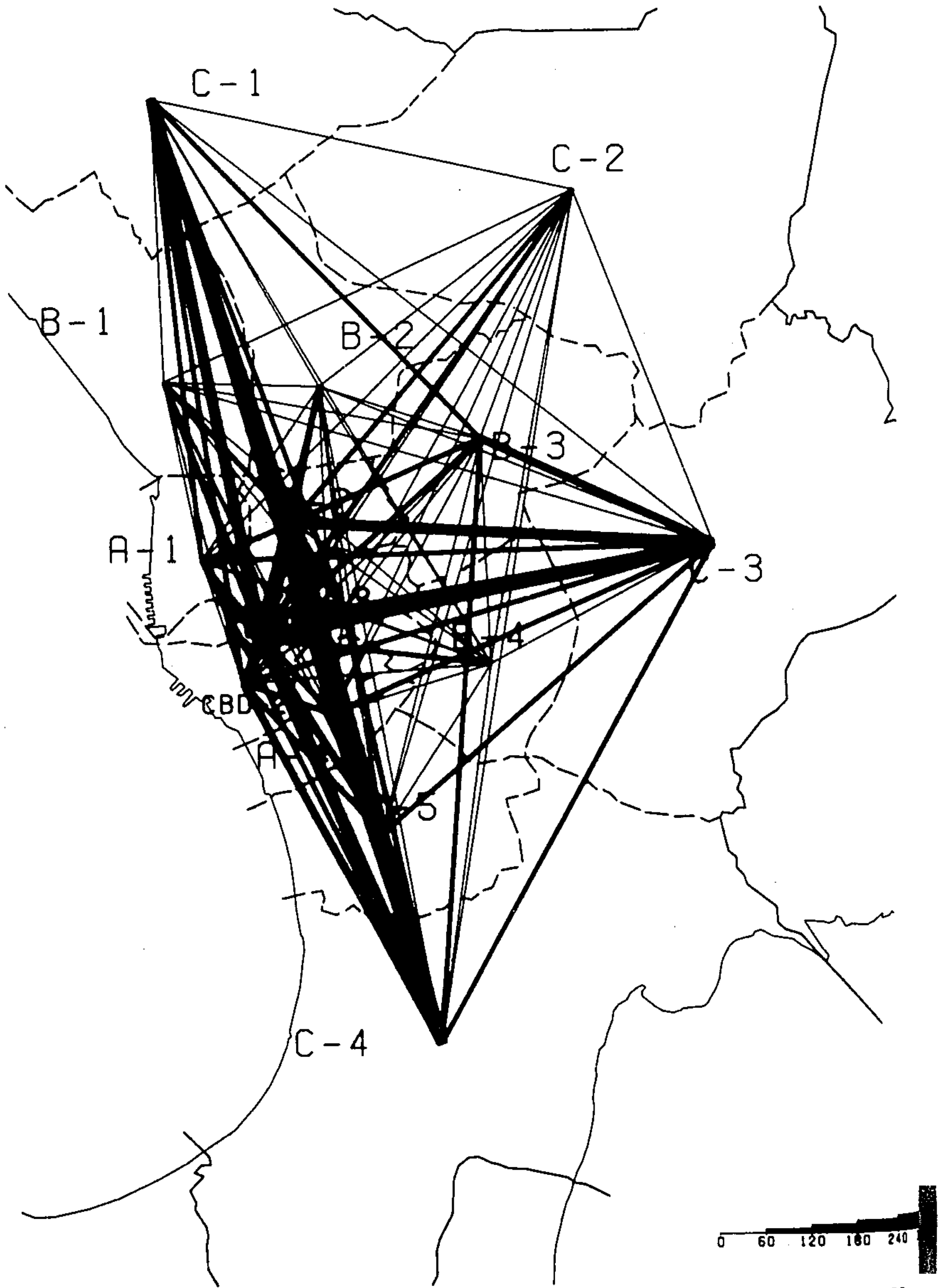


FIG. 5.2-4 DESIRED LINES OF PERSON TRIPS IN 2000 UNIT; 1,000 TRIPS

addition to the second plan. The fourth plan considers construction of Urban Rapid Mass Transit Line-2 in addition to the third plan. Details of the four plans are illustrated in Table 5.3-1.

TABLE 5.3-1 IMPROVEMENT PROGRAM OF TRANSPORT NETWORK

Year	Plan	Throughfare		Expressway	Mass Transit
		Project Road	Other Road		
1977	–	R-10 (C-2 ~ C-3) C-1, C-3 (R-9 ~ R-10)	C-2	No	Bus system Existing PNR
1979	–	R-10 (C-3 ~ C-4) C-4 (R-10 ~ R-9) C-2 (R-9 ~ R-10)	C-2	No	Do.
1981	–	Project roads completed	C-2	No	Do.
1987	Plan 1	Do.	C-3	No	Do.
	Plan 2	Do.	Do.	No	Bus, PNR to be Improved
	Plan 3	Do.	Do.	No	Bus, PNR to be completed, Subway 1
	Plan 4	Do.	Do.	Proposed expressway by UTSMMA completed	Bus, PNR to be completed, Subway 1, 2
2000	–	Do.	Proposed surface roads by UTSMMA completed	Do.	Proposed mass transit by UTSMMA to be completed

As far as the street system is concerned, no significant changes would be made up to 1981 except for the Project Roads and C-2. It was assumed that by 1987, C-3 will be made operational, while C-5 and C-6 are expected to be completed by the year 2000.

Expressways were assumed to be operational by 1987 only in the fourth alternative plan. In the case of the other three alternative plans, expessways were assumed to be operational by the year 2000.

Stage construction of the Project Roads is proposed in the manner shown in Fig. 5.3-1, which takes into account the related development projects and the urgent need to solve the existing traffic congestion.

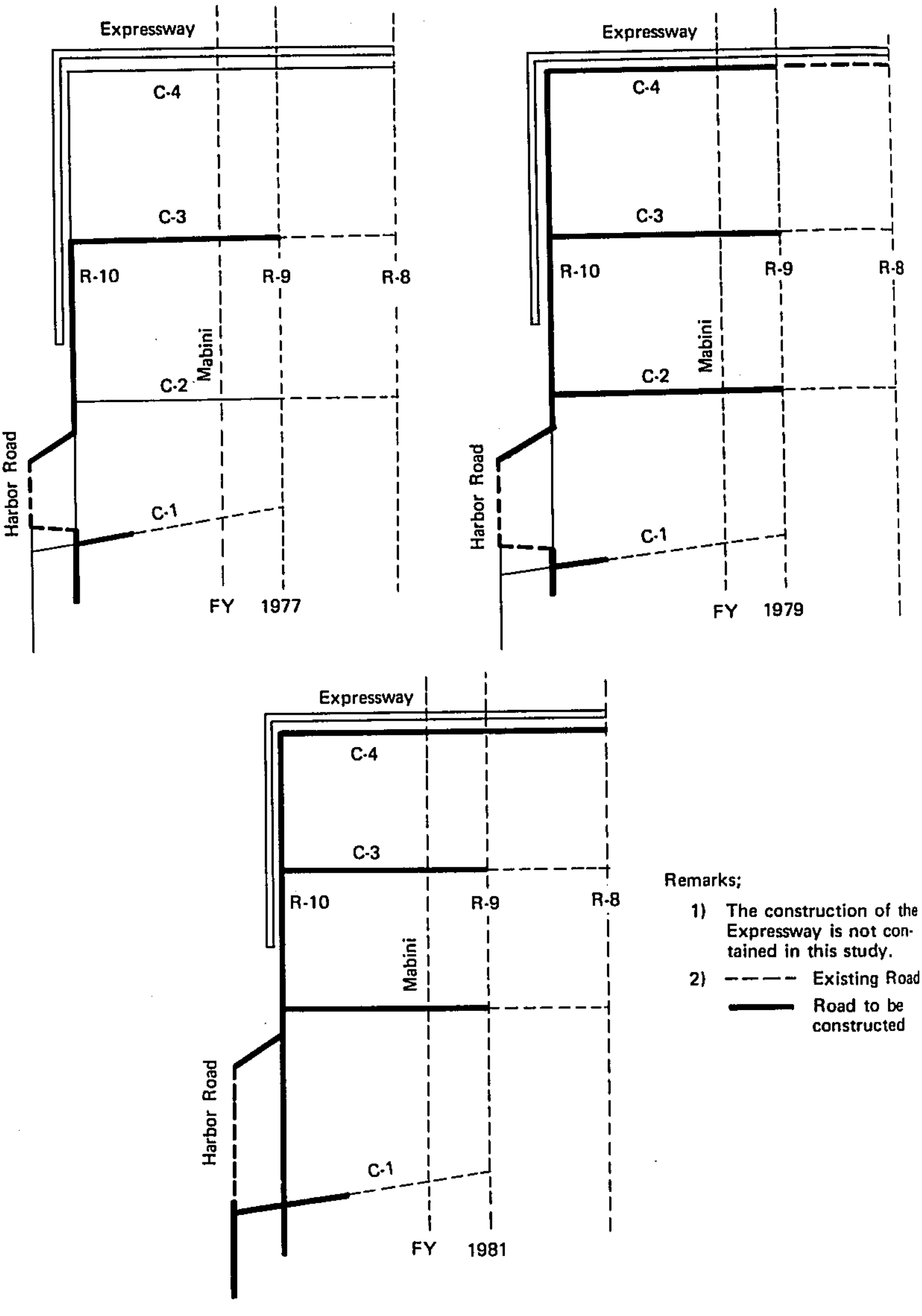


FIG. 5.3-1 STAGE CONSTRUCTION PLAN OF PROJECT ROADS

5.3.2 Road Classifications

The Project Roads were classified into six types based on AASHO standards and the Road Structural Standards in Japan, as follows:

Type A applies to expressways between principal localities, such as the Manila North and South Expressways.

Type B applies to urban expressways.

Type C applies to major thoroughfares located in the suburban areas with grade separations in most intersections, such as C-4, C-5 and C-6.

Type D applies to major thoroughfares located in suburban areas with at-grade crossings seen in intersections.

Type E applies to multi-lane roads within C-4 at many at-grade crossings.

Type F applies to 2-lane roads.

The average running speeds by types of road are shown in Table 5.3-2.

For the modal splits, travel time between zones were calculated based on the average speed by road links, as determined from the 1971 surveys, while the terminal time of cars and trucks was set at three minutes to look for and get in the vehicle and leave the parking area.

TABLE 5.3-2 AVERAGE RUNNING SPEED BY TYPES OF ROAD

Type of Road	Average Running Speed (km/h)	
	Car-Truck	Bus
A	60	50
B	55	45
C	35	20
D	20	15
E	15	10
F	12.5	8

5.3.3 Mass Transit Lines

The mass transit lines were classified into railway lines and bus lines with the following established travel speed:

PNR Mass Rapid Transit Line No. 1, No. 2, No. 4, No. 5 .... 33 km/h

Subway No. 3 .... 45 km/h

The travel speed for buses are shown in Table 5.3-2.

A side from average travel speed, the following travel time factors were also considered in the process:

Waiting Time:

PNR .... 3 minutes

Mass Rapid .... 2 minutes

Bus .... 5 minutes

Time in Changing Modes:

Railway to railway .... 5 minutes

Railway to/from bus .... 7 minutes

Walking Time to/from Mass Transit Terminals:

Railway .... 5 minutes

Bus .... 2.5 minutes

5.4 Modal Split

5.4.1 Methodology

The procedure for establishing the modal split is shown in Fig. 5.4-1. In this Study, it was assumed that two kinds of transport networks would be used in the modal split between zones. The first network would be composed of the roads used by cars and trucks, and the other network would be the roads and railway system used by the jeepney, bus and mass rapid transit. The minimum paths and travel times between zones were determined for each transport network. With this basis, the time ratio for the two modes were determined by applying the travel time of each mode according to the following formula:

$$\text{Time Ratio} = \frac{\text{Travel Time by Mass Transit}}{\text{Travel Time by Vehicle}} \fallingdotseq \frac{t^{MT}}{t^{VT}}$$

The diversion curve between the two modes of transport was obtained from statistical data from Japan modified to suit the results of the person-trip surveys for the UTSMMA shown in Fig. 5.4-2. The share of each mode was applied to the O-D table of person-trips by trip purposes to obtain the O-D table for each mode.

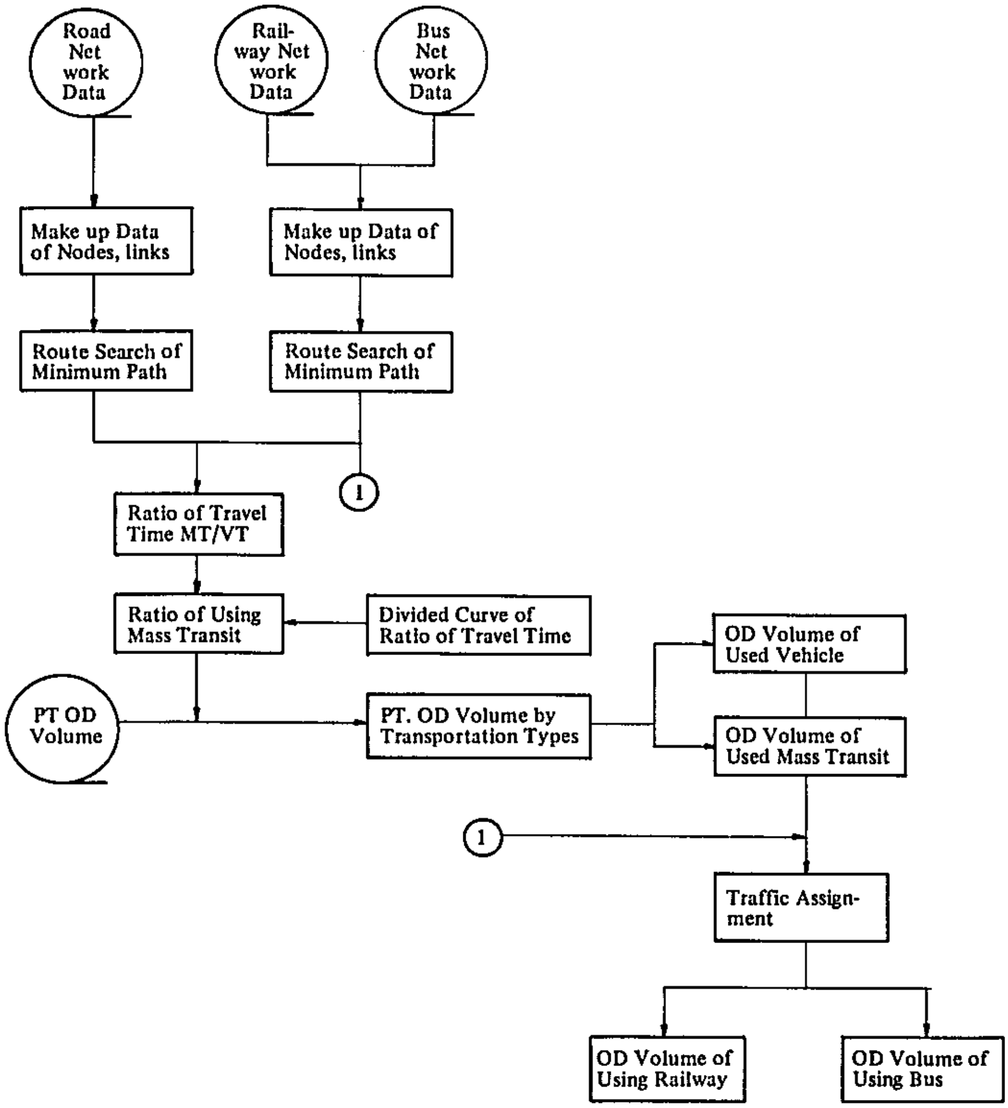


FIG. 5.4-1 FLOW DIAGRAM OF MODAL SPLIT

5.4.2 Result and Evaluation of Modal Split

The results of the modal split shown in Tables 5.4-1, and Fig. 5.4-3, may be summarized as follows:

(1) In Plan 1, the number of vehicle trips was estimated at around 5,723,000 or an increase of about 20% more than that of the year 2000. This situation indicates that there would be more trips using the mass transit system in the year 2000.

(2) In Plan 2, the ratio of person trips to total person trips is 58%.

(3) In Plan 3, the share of person trips using vehicles total trips is 51%.

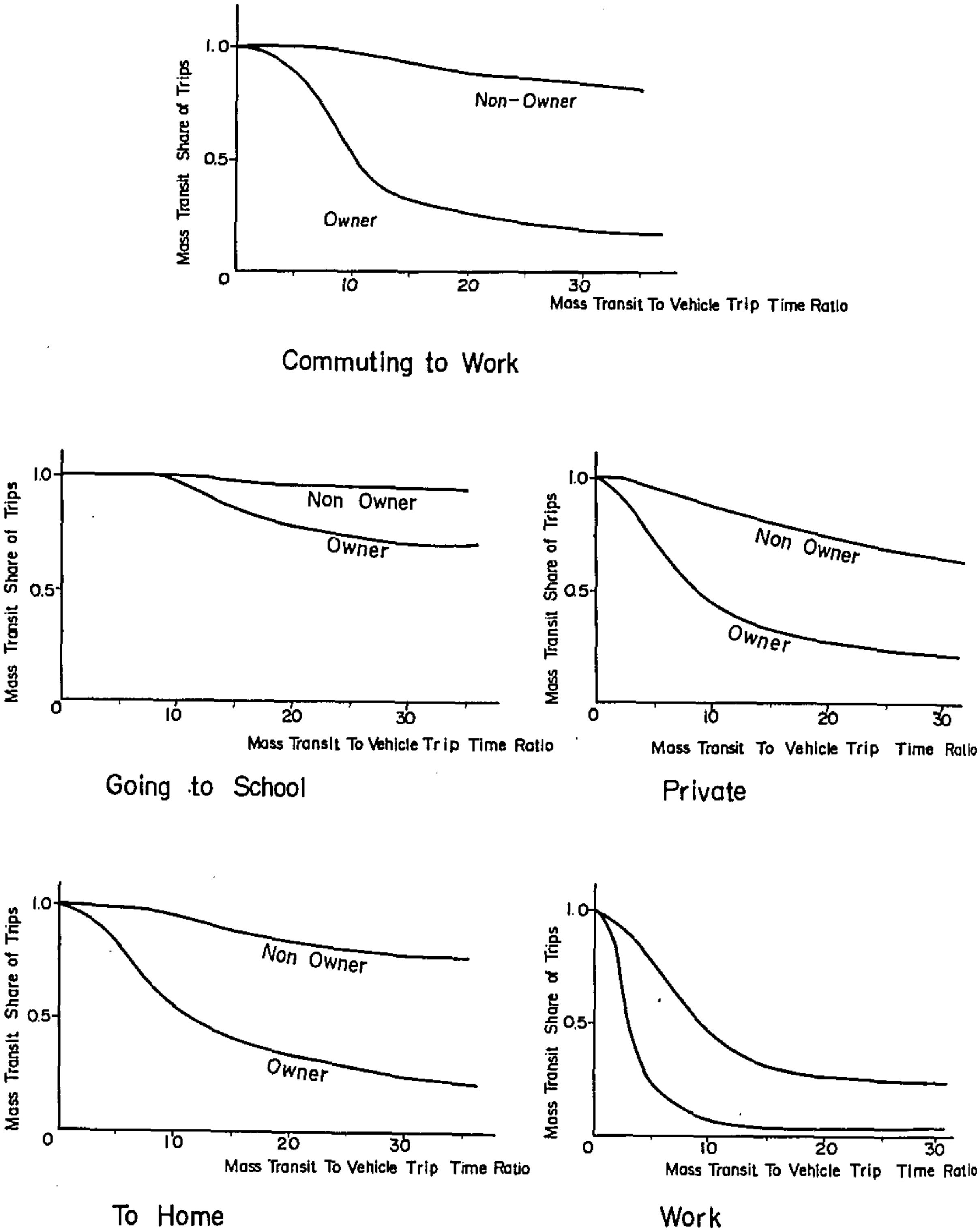


FIG. 5.4-2 MASS TRANSIT SHARE OF TRIPS BY TRAVEL TIME RATIO

TABLE 5.4-1 SUMMARY TABLE OF MODAL SPLIT

(1,000 Trips)

		Commuting to Work	Going to School	Private	Work	To Home	Total
1987 Plan 1	MT	582	586	481	202	1,366	3,217
	VT	657	275	1,301	1,820	1,669	5,723
	Total	1,239	861	1,782	2,022	3,035	8,940
1987 Plan 2	MT	657	620	642	303	1,548	3,769
	VT	582	241	1,140	1,719	1,487	5,171
	Total	1,239	861	1,782	2,022	3,035	8,940
1987 Plan 3	MT	731	654	820	404	1,790	4,400
	VT	508	207	962	1,618	1,245	4,540
	Total	1,239	861	1,782	2,022	3,035	8,940
1987 Plan 4	MT	793	689	962	485	1,973	4,902
	VT	446	172	820	1,537	1,062	4,038
	Total	1,239	861	1,782	2,022	3,035	8,940
2000	MT	1,156	979	1,712	913	3,028	7,789
	VT	501	171	807	2,128	1,109	4,715
	Total	1,657	1,150	2,519	3,041	4,137	12,504

Remarks: MT . . . . . Person Trips using Mass Transit – Including Bus and Jeepney Trips
VT . . . . . Person Trips using Vehicle – Excluding Bus and Jeepney Trips

(4) In Plan 4, the share of vehicle-using trips to total trips is 45%.

(5) In Plan 2000, the share of person trips using mass transit is 62% which is somewhat lower than that of UTSMMA. This difference is brought about by the use in this Study of higher growth rate of car ownership.

5.4.3 Bus and Railway Trips

The mass transit trips in the traffic assignments shown in Table 5.4-2 are subdivided into bus and railway trips, using the "all or nothing" method without capacity constrained, which are shown in Table 5.4-2.

5.5 *Traffic Generated from the Port of Manila and Navotas Fisheries Port*

The generated traffic from the Port of Manila and Navotas Fisheries Port was based on the traffic surveys conducted during the period from June 8th to June 14th in the vicinity of the ports.

TABLE 5.4-2 RESULT OF MODAL SPLIT BY MASS TRANSIT TYPES OF MASS TRANSIT TRIP

(1,000 Trips)

			Commuting to Work	Going to School	Private	Work	To Home	Total
1987	Plan 1	Railway	0	0	0	0	0	0
		Bus	582	586	481	202	1,366	3,217
		Total	582	586	481	202	1,366	3,217
1987	Plan 2	Railway	111	79	93	34	265	582
		Bus	546	541	549	269	1,283	3,188
		Total	657	620	642	303	1,548	3,769
1987	Plan 3	Railway	240	161	203	91	555	1,250
		Bus	491	493	617	313	1,235	3,149
		Total	731	654	820	404	1,790	4,400
1987	Plan 4	Railway	326	207	291	132	766	1,722
		Bus	467	482	671	353	1,207	3,180
		Total	793	689	962	485	1,973	4,902
2000		Railway	615	373	649	295	1,505	3,437
		Bus	541	606	1,063	618	1,523	4,351
		Total	1,156	979	1,712	913	3,028	7,789

Remarks: Railway . . . . . Person Trips using Railway
Bus . . . . Person Trips using Bus and Jeepney
Unlinked Trips

The procedures used in estimating traffic volume are shown in Fig. 5.5-1.

Traffic generated in the Ports of Manila and the Navotas Fisheries Port were classified as follows:

(1) Traffic generated by cargo,
(2) Traffic generated by ferry passengers, and
(3) Traffic generated by the workers.

5.5.1 Inputs

(1) Cargo

Fig. 5.5-2 also indicates the annual variation of cargo volume broken down into domestic and foreign cargoes.

An analysis was made between cargo volume and the following economic indicators:

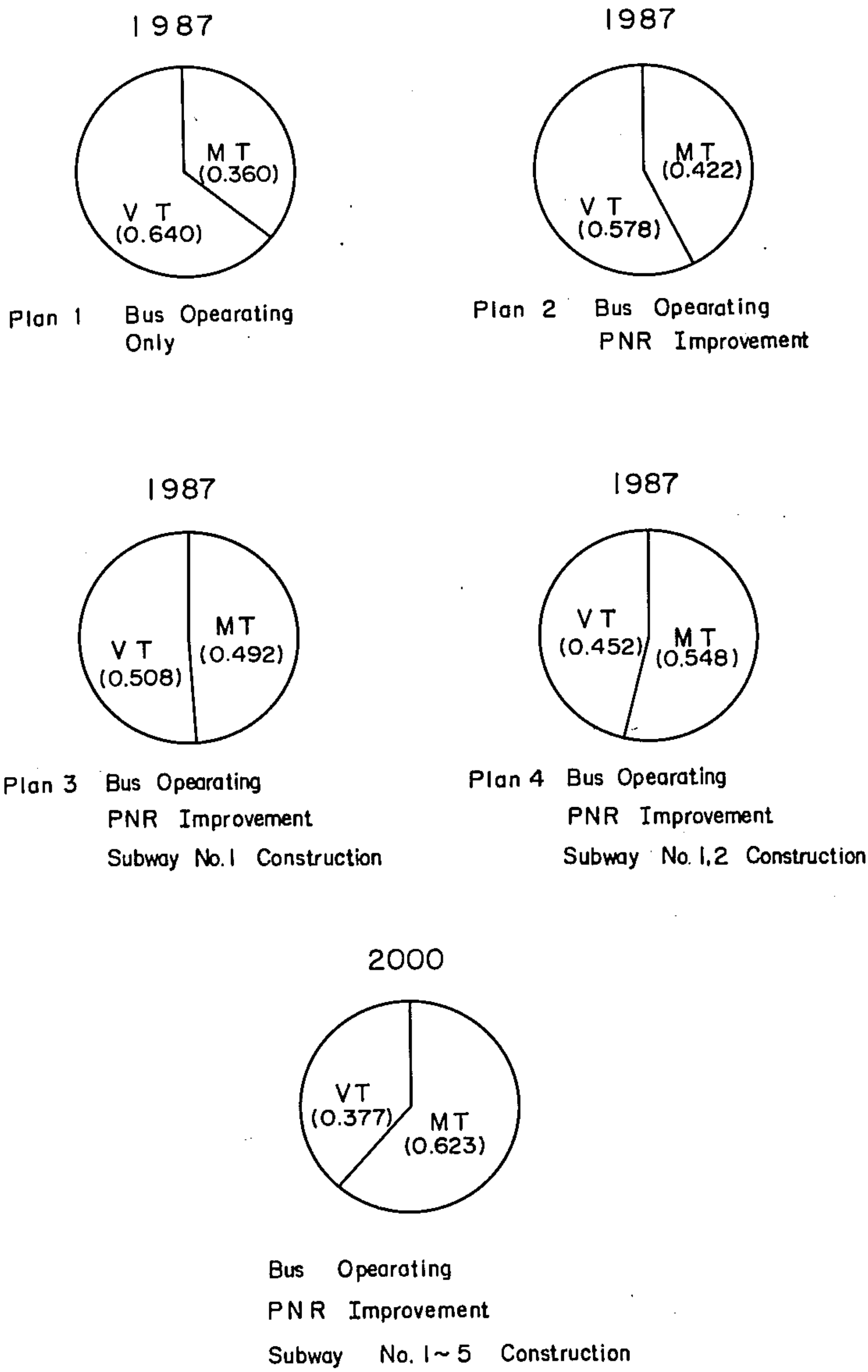


FIG. 5.4-3 THE RESULTS OF MODAL SPLIT

Foreign Trade:	export	GDP
	import	GNP
Domestic Trade:	incoming	GDP
	outgoing	GDP

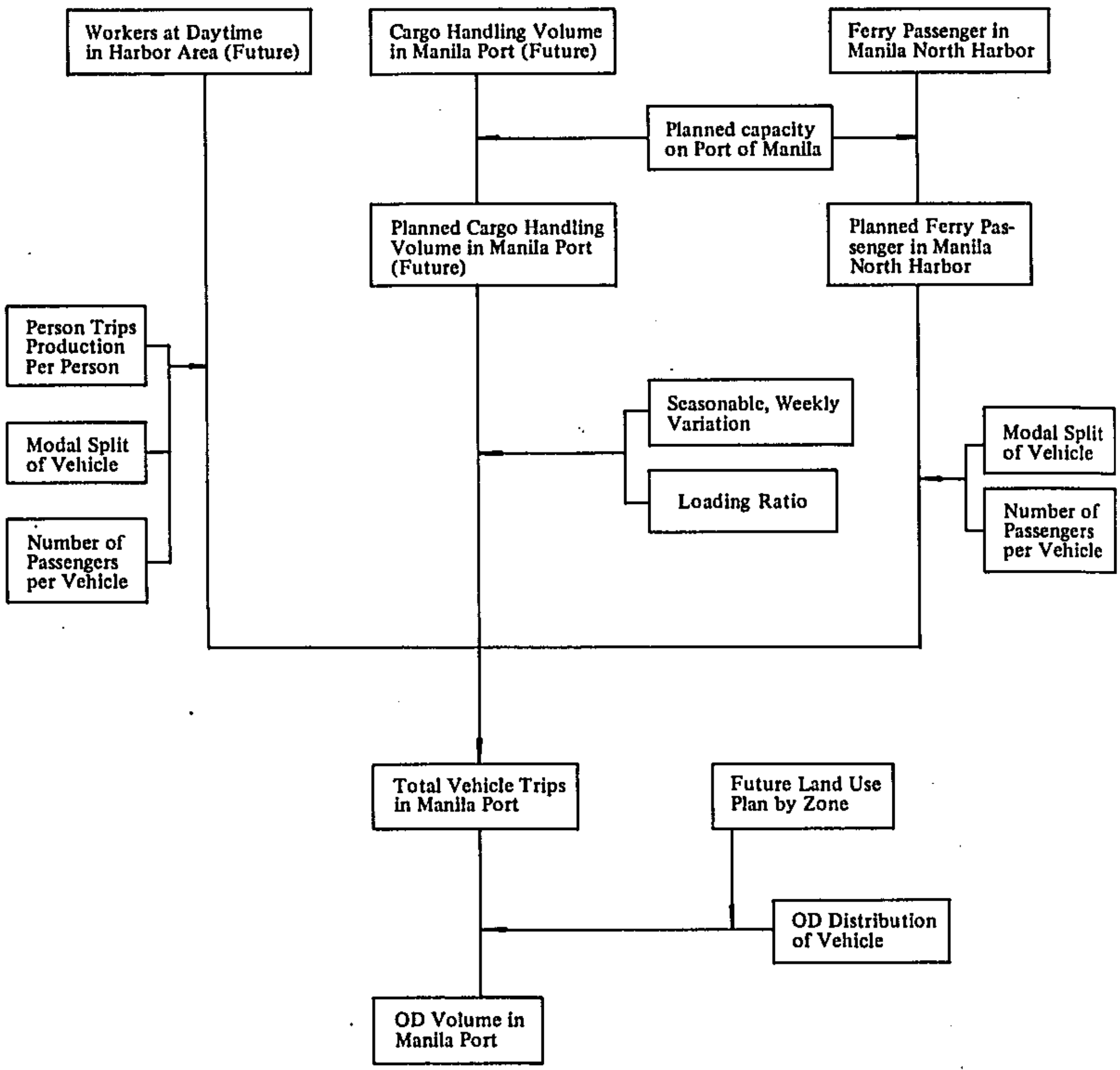


FIG. 5.5-1 PROCESS FOR ESTIMATION OF TRAFFIC VOLUME IN MANILA MALINE PORT

From this analysis, the elastic value was obtained as shown in Fig. 5.5-3.

The GNP and GDP shown in Table 5.5-1 were estimated by the MBMRSP team. The future cargo handling volume was obtained on the basis of the elastic value with the results shown in Fig. 5.5-4.

On the other hand, the capacity of cargo handling for the Port of Manila was estimated

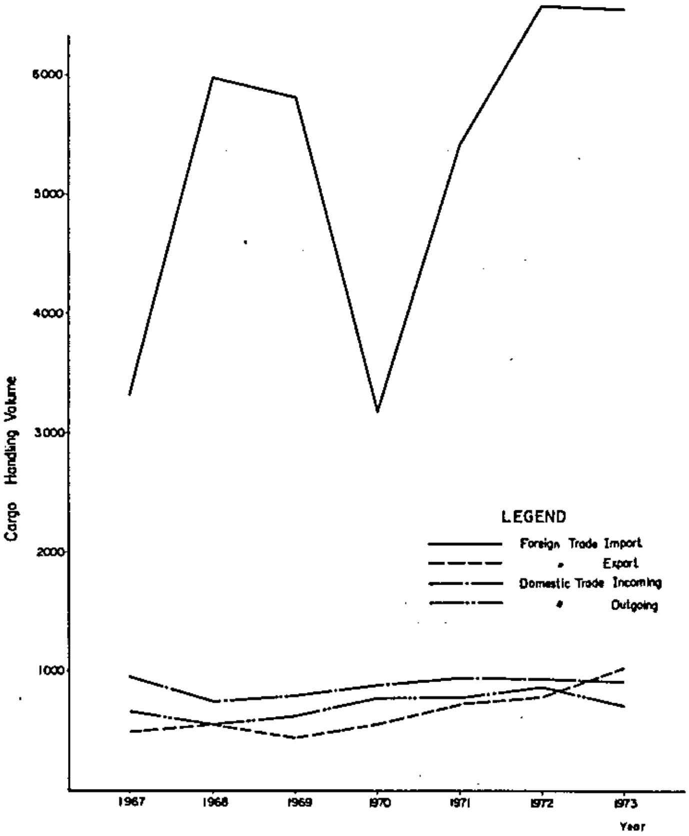


FIG. 5.5-2 PRESENT CARGO HANDLING VOLUME IN MANILA MARINE PORT

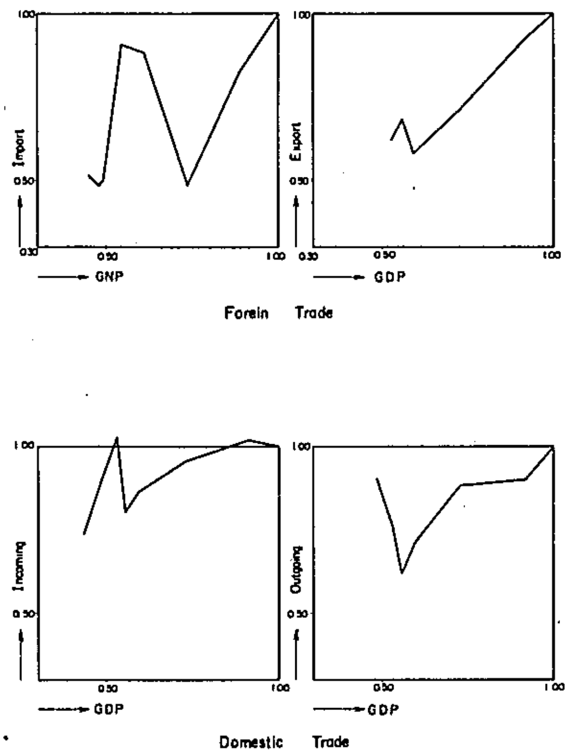


FIG. 5.5-3 ELASTICITY COEFFICIENT BETWEEN ECONOMIC FORCE AND CARGO HANDLING VOLUME

as follows:

(1) North Harbor

	Capacity (1000 tons/year)
(a) Existing capacity of Piers No. 2-14 and Slips No. 3-13	1,730
(b) Additional Capacity of under construction Pier No. 16 and Slip No. 15	385
(c) Proposed Container Port for domestic	1,120
	3,235

(2) South Harbor

	Capacity (1000 tons/year)
(a) Existing capacity capacity of Piers No. 5-15	4,810
(b) Existing capacity of Container Port Pier No. 3	300

(3) Container Harbor

	Capacity (1000 tons/year)
(a) Proposed Container Port	1,600
(b) Cement handling Volume within proposed Container Port	700
(c) General Cargoes handing volume within proposed Container Port	1,600

TABLE 5.5-1 FUTURE ECONOMIC ACTIVITIES (AT 1972 PRICES)

High Projections

(in Million Pesos)

	1972	1977	1979	1981	1987	2000
Gross National Product	55,900	121,300	153,200	191,300	337,000	800,700
Gross Domestic Product	55,200	117,550	148,090	184,380	322,900	762,900

Low Projections

	1972	1977	1979	1981	1987	2000
Gross National Product	55,900	84,200	96,000	107,800	143,400	220,300
Gross Domestic Product	55,200	81,600	92,800	103,900	137,400	209,900

Medium Projections

	1972	1977	1979	1981	1987	2000
Gross National Product	55,900	102,700	124,600	149,600	240,200	510,500
Gross Domestic Product	55,200	99,530	120,450	141,190	230,150	486,400

Source: MBMRSP Team

On the above basis, it is expected that demand will exceed capacity at both the North and South Harbors after 1980. In this Study, however, the maximum cargo volume to be handled after 1980 is supposed not to exceed the capacity of the ports.

The results of the ADB-assisted Study* by Scandiaconsult was used in determining the demand and capacity of the Navotas Fisheries Port as shown in Fig. 5.5-5.

* Government of the Republic of the Philippines "Philippines Fisheries Port Project".

(2) Ferry Passengers

The ferry passenger volume in the north harbor is estimated in this study. There are many variable factors that may be considered in estimating ferry passengers, such as:

(a) Increase of trips per capita,
(b) Increase of population, and
(c) Change in the share of modes of travel.

In this Study, however, the increase of population in the MMA was considered so that the maximum number of passengers will be reached in the same year as the maximum capacity of the domestic port (Table 5.5-2).

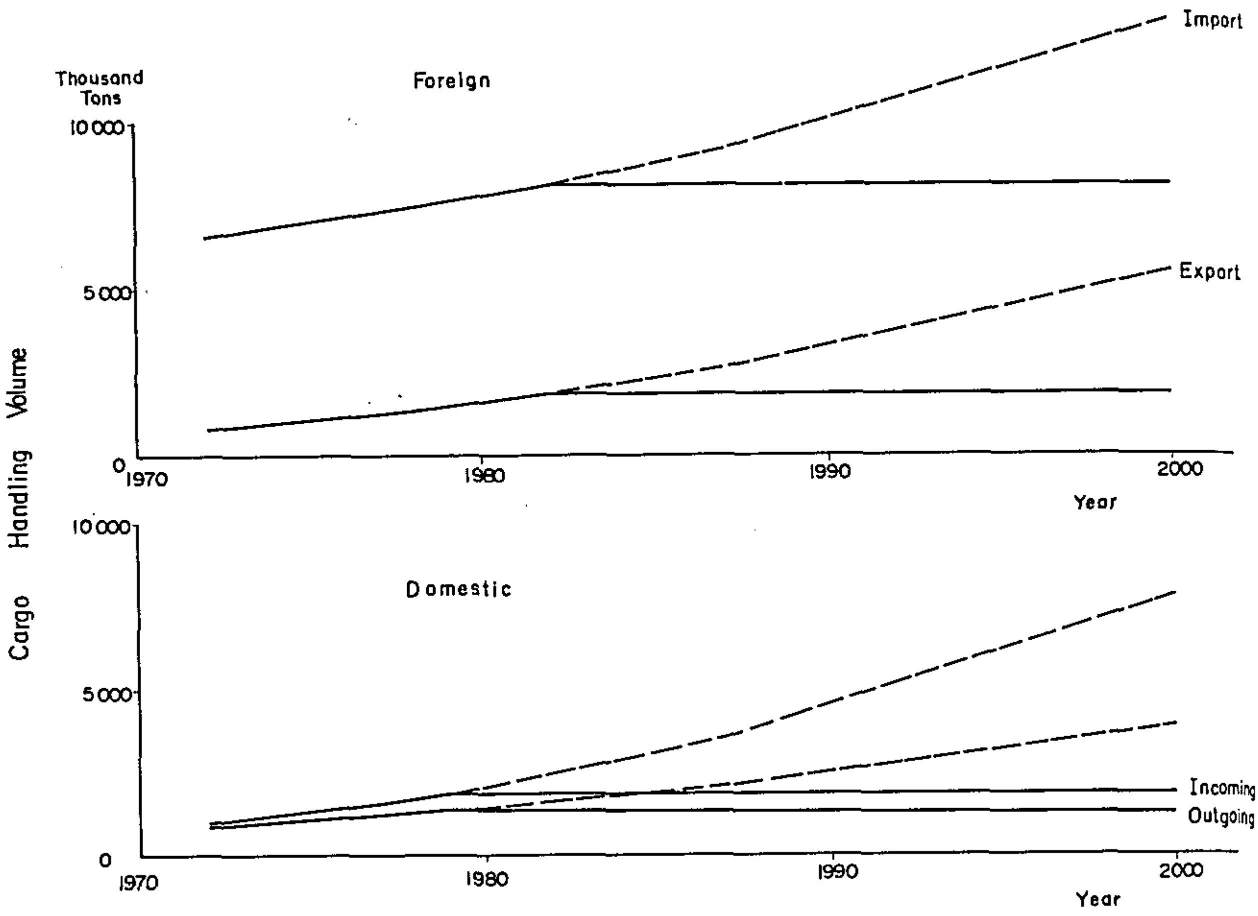


FIG. 5.5-4 FUTURE CARGO HANDLING VOLUME IN MANILA MARINE PORT

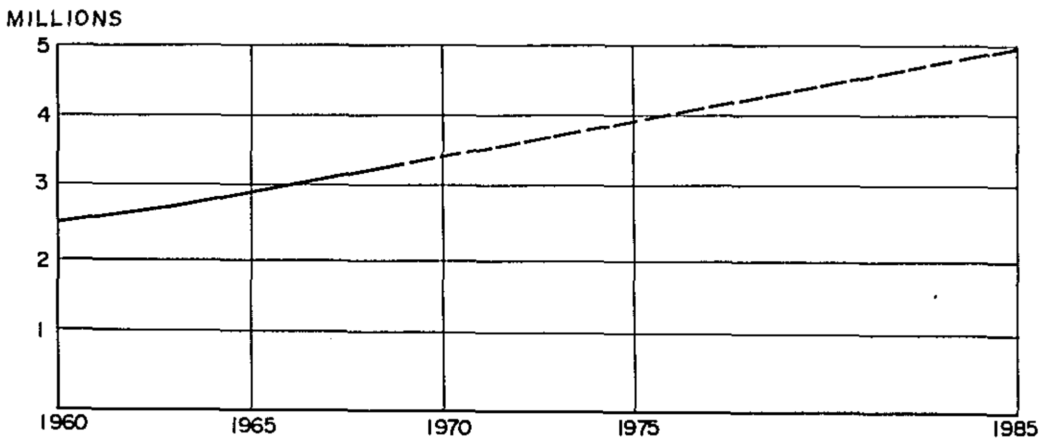


FIG. 5.5-5 FISH LANDING VOLUME IN NAVOTAS FISHERIES PORT

TABLE 5.5-2 NUMBER OF FERRY PASSENGER BY YEAR

(Persons)

	1972	1977	1979	1981	1987	2000
Ferry Passenger	4,197	4,740	4,960	5,000	5,000	5,000

(3) Workers

The number of workers in the future in the Port of Manila is forecast and shown in Table 5.5-3. This is estimated by assuming the land use area working population density.

It can be noted in this Fig. 5.5-1 that the first step is to estimate the number of workers related to the ports as shown in Fig. 5.5-3, taking into consideration the land use and working population density.

TABLE 5.5-3 DAYTIME WORKERS AT PORTS BY YEAR 2000

(Persons)

	South Harbor	North Harbor	Container Port	Navotas Fisheries
Port Facilities	480	550	2,780	–
Port Related Facilities*	4,950	2,850	700	–
Total	5,430	3,400	3,480	5,360

5.5.2 Traffic Volume

(1) South Harbor

The daily truck volume was estimated from the annual cargo volume taking into consideration the average loading ratio.

The traffic volume generated by workers by trip purpose was obtained on the basis of the unit trip production of the person trip surveyed for the UTSMMA.

In the modal split, the number of vehicles by trip purpose was estimated taking into consideration the share of each mode of travel and the average number of passengers per vehicle as estimated in Section 5.4. The results are shown in Table 5.5-4.

TABLE 5.5-4 GENERATED TRIPS IN SOUTH HARBOR IN YEAR 2000

(Vehicles)

Vehicle \ Trip Purpose	Commuting to Work	Private	Work	To Home	Cargo	Total
Car	2,140	580	1,330	4,050	–	8,100
Truck	–	–	–	–	6,810	6,810
Bus	–	–	–	–	–	260

(2) North Harbor

Traffic volume generated by workers and cargo in the North Harbor was estimated using the same method as in (1) preceding for South Harbor.

However, in the estimate of the modal split of ferry passenger trips, the existing share of each mode of travel was used, as shown in Table 5.5-5.

TABLE 5.5-5 GENERATED TRIPS IN NORTH HARBOR IN YEAR 2000

(Vehicles)

Vehicle \ Trip Purpose	Commuting to Work	Private	Work	To Home	Ferry Passengers	Cargo	Total
Car	1,340	360	840	2,540	7,440	–	12,520
Truck	–	–	–	–	–	5,840	5,840
Bus	–	–	–	–	–	–	1,040

(3) Container Port & Navotas Fisheries Port

The same method was used as in (1) and (2) preceding for the South Harbor and North Harbor in calculating traffic volume generated by the Container Port and Navotas Fisheries Port, the results of which are shown in Tables 5.5-6 and 5.5-7, respectively.

(4) Projected Traffic Volume Related to Ports

Based on the TAbles 5.5-4, 5.5-5, 5.5-6 and 5.5-7, the projected traffic volume related to ports were estimated for the years 1977, 1979, 1981, 1987 and 2000, the results of which are shown in Table 5.5-8. In this case the projected traffic generated by workers in the ports was estimated proportionally to the traffic generated by cargo and ferry passengers.

TABLE 5.5-6 GENERATED TRIPS IN CONTAINER PORT IN YEAR 2000

(Vehicles)

Trip Purpose / Vehicle	Commuting to Work	Private	Work	To Home	Cargo	Total
Car	1,380	370	850	2,600	–	5,200
Truck	–	–	–	–	6,000	6,000
Bus	–	–	–	–	–	130

TABLE 5.5-7 GENERATED TRIPS IN NAVOTAS FISHERIES PORT IN YEAR 2000

(Vehicles)

Trip Purpose / Vehicle	Commuting to Work	Private	Work	To Home	Cargo	Total
Car	2,110	550	1,320	3,980	–	7,960
Truck	–	–	–	–	5,360	5,360
Bus	–	–	–	–	–	260

TABLE 5.5-8 SUMMARY TABLE OF VEHICLE TRIPS RELATED TO PORT OF MANILA BY YEARS

(Vehicles)

	North Harbor	South Harbor	International Port	Navotas Fisheries Port
1977	17,600	12,200	10,100	6,800
1979	18,800	13,290	10,900	7,400
1981	19,430	13,840	11,280	8,100
1987	19,430	13,840	11,280	10,090
2000	19,430	13,840	11,280	10,090

5.6 Overall O-D Distribution of Vehicle Trips

The Overall O-D distribution of vehicle trips was based on the O-D tables of the entire MMA and the port zone.

5.6.1 O-D Distribution of Vehicle Trips in MMA

The O-D distribution of person trips using vehicles mentioned in Section 5.4 was projected for the years 1987 and 2000 on the basis of 51 internal zones. These person trips were converted to vehicle trips using the average number of passengers per vehicle type as shown in Table 5.6-1.

The vehicle trips in the 51 zones were modified to suit the 61 zones, while the vehicle trips in subdivided zones were projected proportionately to the future population of each zone.

Trip generation and attraction were projected for 1977, 1979 and 1981 by interpolation from the figures obtained for 1971 and 1987. The Fratar Method was used in estimating the O-D distribution based on the above generation and attraction.

TABLE 5.6-1 NUMBER OF PASSENGERS

(Persons/Vehicle)

Types of Vehicles / Trip Purposes	Passenger Cars 1)	Taxis		Buses
		Excl. Empty Vehicles	Incl. Empty Vehicles	
Commuting to Work	3.4	2.0	1.6	
Going to School	3.9	2.3	1.8	
Private	4.0	2.4	1.8	
Work	3.5	2.1	1.6	
Average	3.7	2.2 2)	1.7 3)	36.0

Remarks: 1) Source: Cordon Line Survey
2) Source: Screen Line Survey
3) Occupied Taxis: Empty Taxis = 1.00 : 0.30
(Source: Screen Line Survey)
4) Number of passenger per truck was adopted same as that of per passengers.

The O-D distribution was classified into bus, car and truck trips. Truck trips were subdivided into heavy and light trucks for traffic assignment using the existing share of each type.

The share of each of vehicle was used to calculate the running time and time force by type of vehicle.

5.6.2 O-D Distribution of Vehicle Trips Related to Ports

The gravity model was used in estimating O-D distribution, according to the following formula:

$$X_j = \alpha \ A_j \ t_j^{-\gamma}$$

where, X_j = traffic volume from port zone to zone j

A_j = trip attraction in zone j which was determined in proportion to the future population.

t_j = distance from zone j to port zone

α, γ = parameters which were obtained through the correlation analysis of the O-D survey.

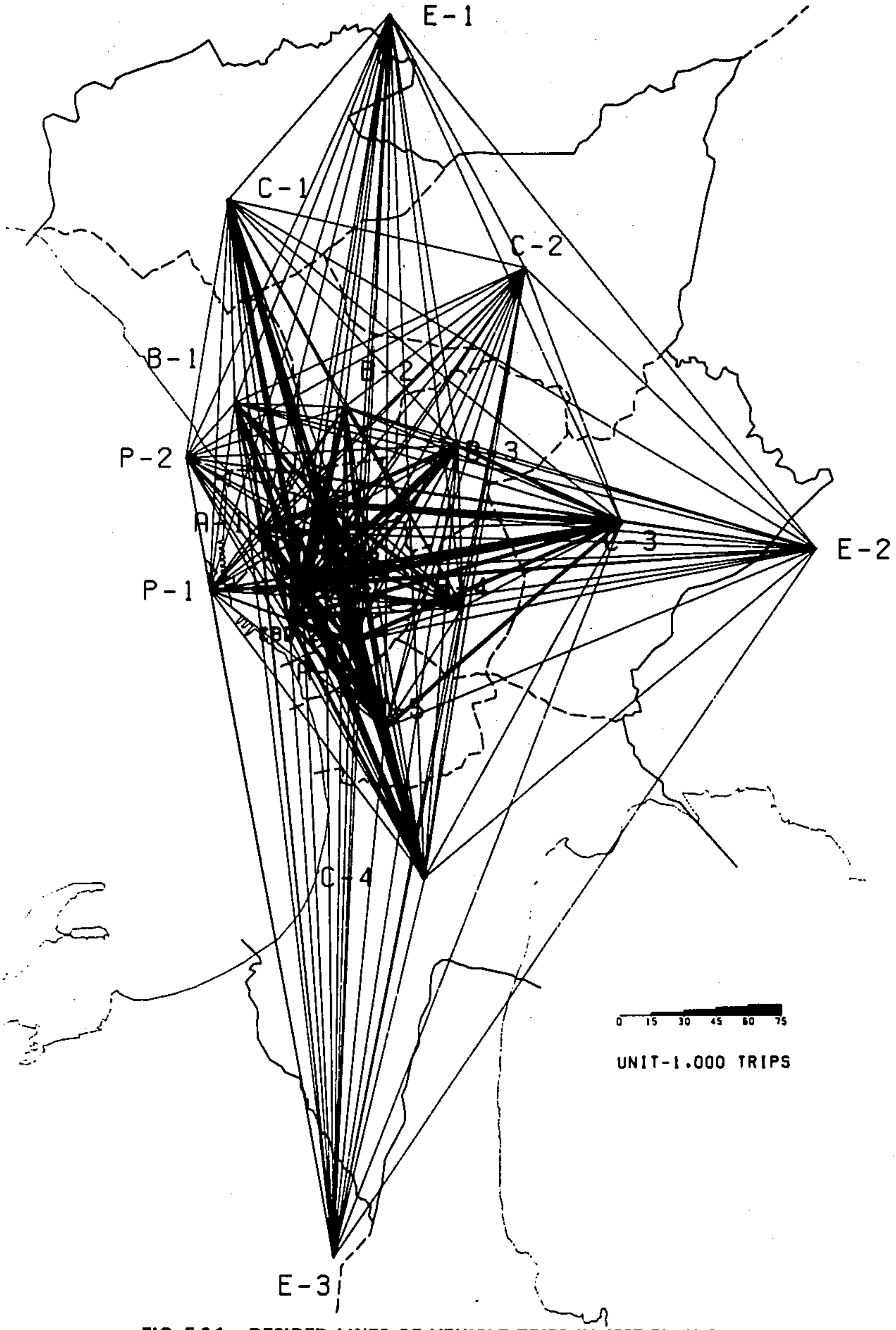


FIG. 5.6-1 DESIRED LINES OF VEHICLE TRIPS IN 1987 PLAN 2

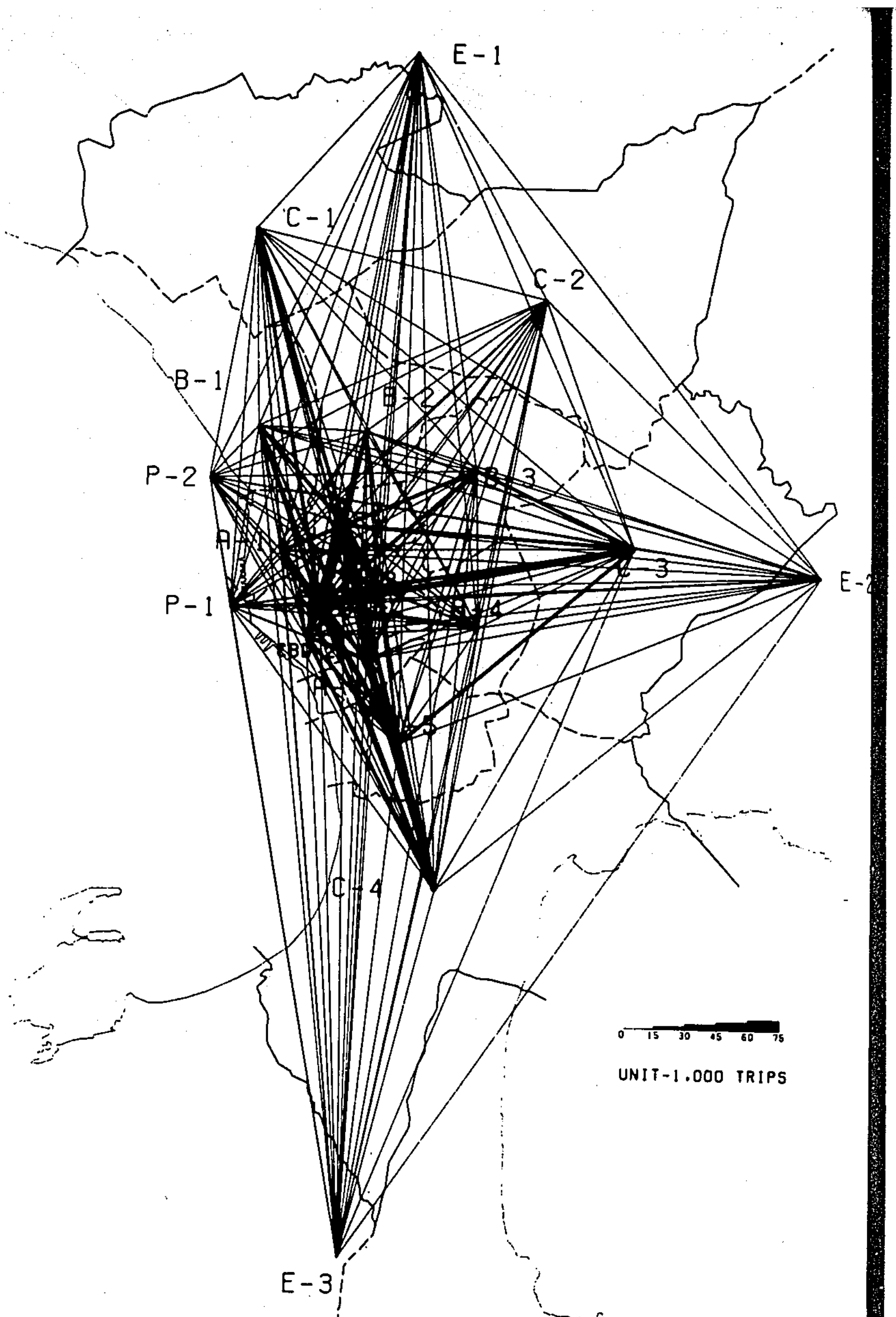


FIG. 5.6-2 DESIRED LINES OF VEHICLE TRIPS IN 1987 PLAN 4

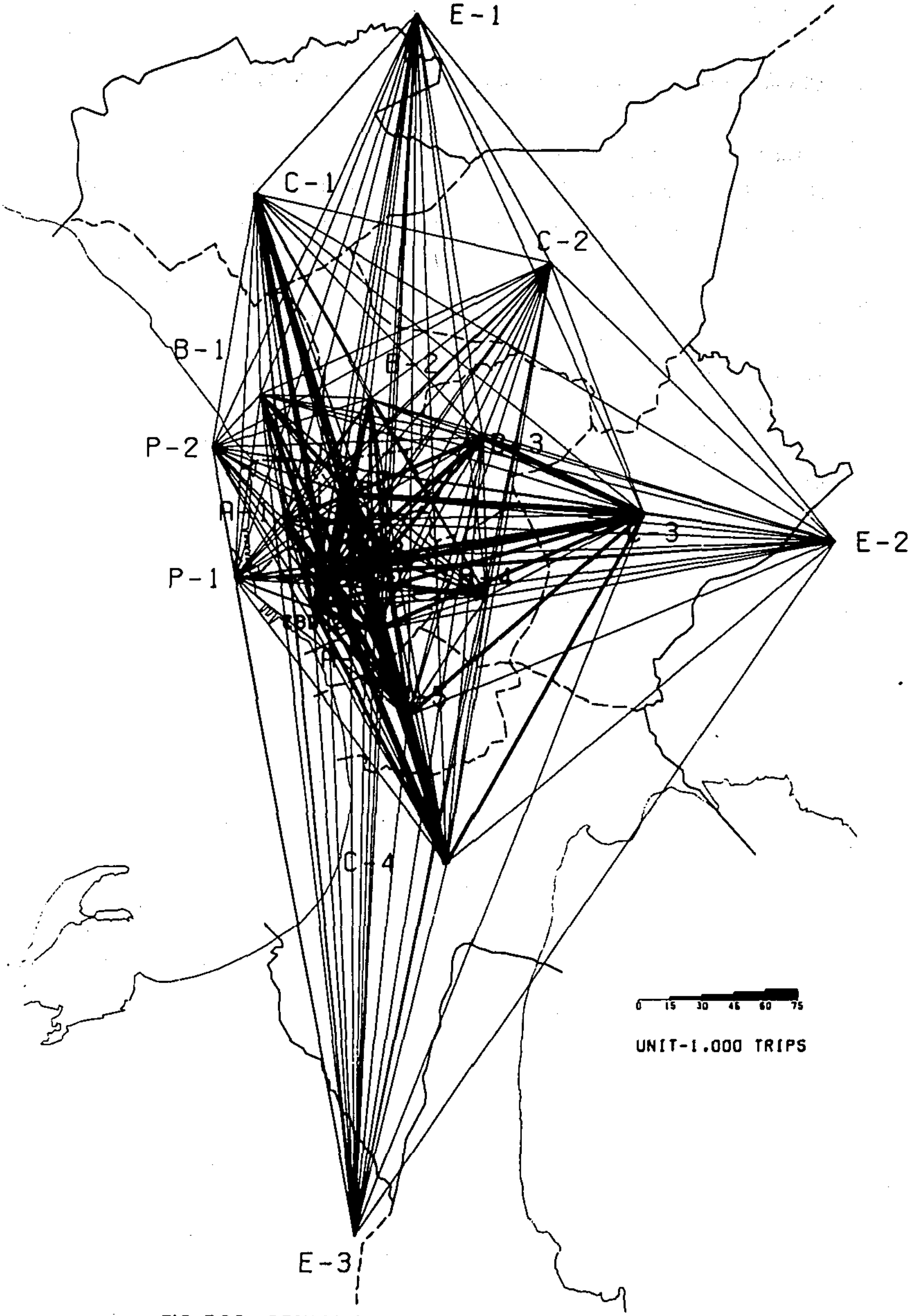


FIG. 5.6-3 DESIRED LINES OF VEHICLE TRIPS IN 2000

All truck trips in the ports were considered generated by heavy trucks.

5.6.3 Total O-D Distribution of Vehicle Trips

The total O-D distribution of vehicle trips was determined by incorporating the O-D distribution of trips related to ports to the O-D distribution of vehicle trips in the entire MMA. The results are shown in Figs. 5.6-1, 5.6-2, 5.6-3 and Appendix Tables 5.6-1, 5.6-2, 5.6-3, 5.6-4, 5.6-5 and 5.6-6.

5.7 Traffic Assignment

5.7.1 Methodology

The "all or nothing" method using capacity restaints was used in establishing the traffic assignments.

The first step taken was to assign heavy truck trips to major thoroughfares only, exclusive of Roxas Blvd. Bus trips were then assigned, and finally car and light truck trips. Cars, buses and light trucks were assigne to the entire MMA road network.

The car and light truck trips were divided into four parts and the Q-V (Quantity-Velocity) curve by road type shown in Fig. 5.7-1 was used to take capacity constraints into consideration.

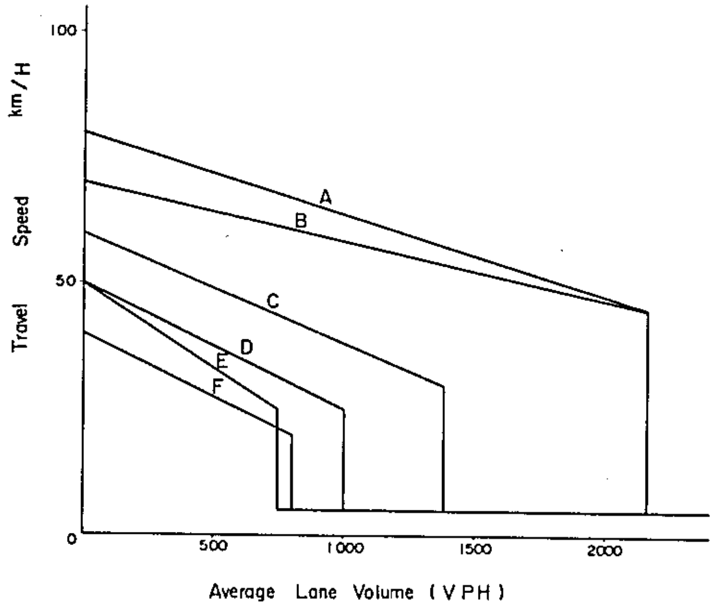
5.7.2 Results of Traffic Assignments in MMA

The results of traffic assignments in the MMA are shown in Table 5.7-1 and Figs. 5.7-2, 5.7-3, 5.7-4 and 5.7-5.

TABLE 5.7-1 RESULT OF TRAFFIC ASSIGNMENTS

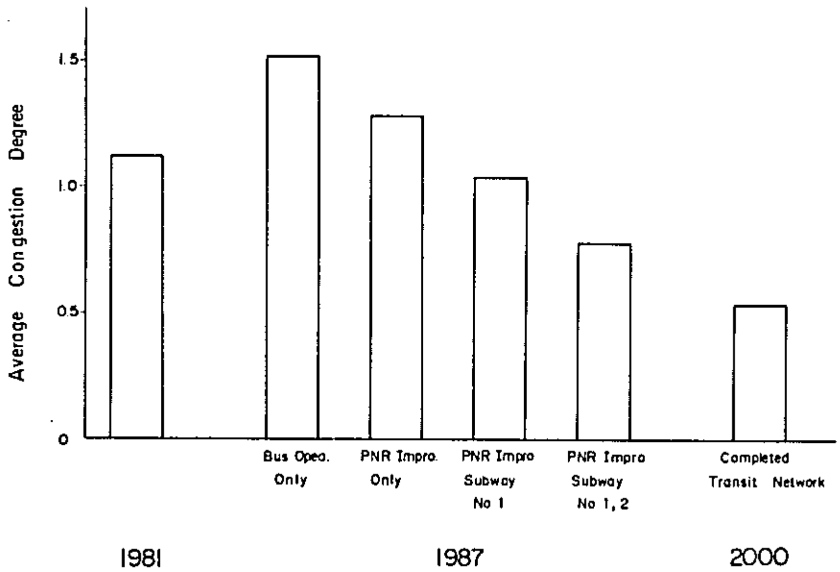
(Thousand Vehicles/km)

	Running Vehicles (km)	Capacity Vehicles (km)	Congestion Degree
1977	21,755	19,559	1.11
1979	22,795	20,252	1.12
1981	23,892	21,062	1.13
1987 Plan 1	32,014	21,062	1.52
1987 Plan 2	27,154	21,062	1.28
1987 Plan 3	22,747	21,062	1.08
1987 Plan 4	21,699	27,770	0.78
2000	24,795	46,083	0.54



Remark ; Type F is two lanes

FIG. 5.7-1 TYPICAL RELATIONSHIP BETWEEN AVERAGE LANE VOLUME AND TRAVEL SPEED



Remarks ; Average Congestion Degree on Road Network

$$= \frac{\text{Total Running Vehicles} \cdot \text{Kms.}}{\text{Total Capacity Vehicles} \cdot \text{Kms.}}$$

FIG. 5.7-2 AVERAGE CONGESTION DEGREE ON ROAD NETWORK BY YEAR

The following observations can be made from the above results:

(1) In case there are no road improvements made on the network by 1981, the degree of congestion will exceed 1.0. In this connection, it is deemed necessary that other roads in addition to the Project Roads in the network should also be improved.

(2) In case the improved PNR facilities and the Rapid Transit Line-1 are made operational by 1987, the average congestion of 1.0 will be maintained on the roads and streets in the MMA.

(3) By the year 2000, the average level of congestion will be lowest at 0.54.

5.7.3 Results of Traffic Assignment on the Project Roads

The results of the traffic assignment related to the Project Roads are shown in detail in Figs. 5.7-6 ~ 5.7-11 and the following observations can be made thereto:

(1) The projected traffic of the Project Roads was observed to be generally heavy;

(2) By 1977 and 1979, the degree of congestion for the Harbor Road and C-2 will be relatively bigger than the rest of the Project Roads;

(3) By 1981, the degree of congestion on most of the Project Roads will be maintained as not to exceed 1.0;

(4) In Plan 2, traffic volume was expected to exceed road capacity in most sections of the Project Roads;

(5) In the 1987 Plan 4 and the plan for the year 2000, the projected traffic demand generally balances the road capacity.

The above observations were made because of (a) there are plenty of traffic generators in CBD and other developmental projects; and (b) the absence of competing roads.

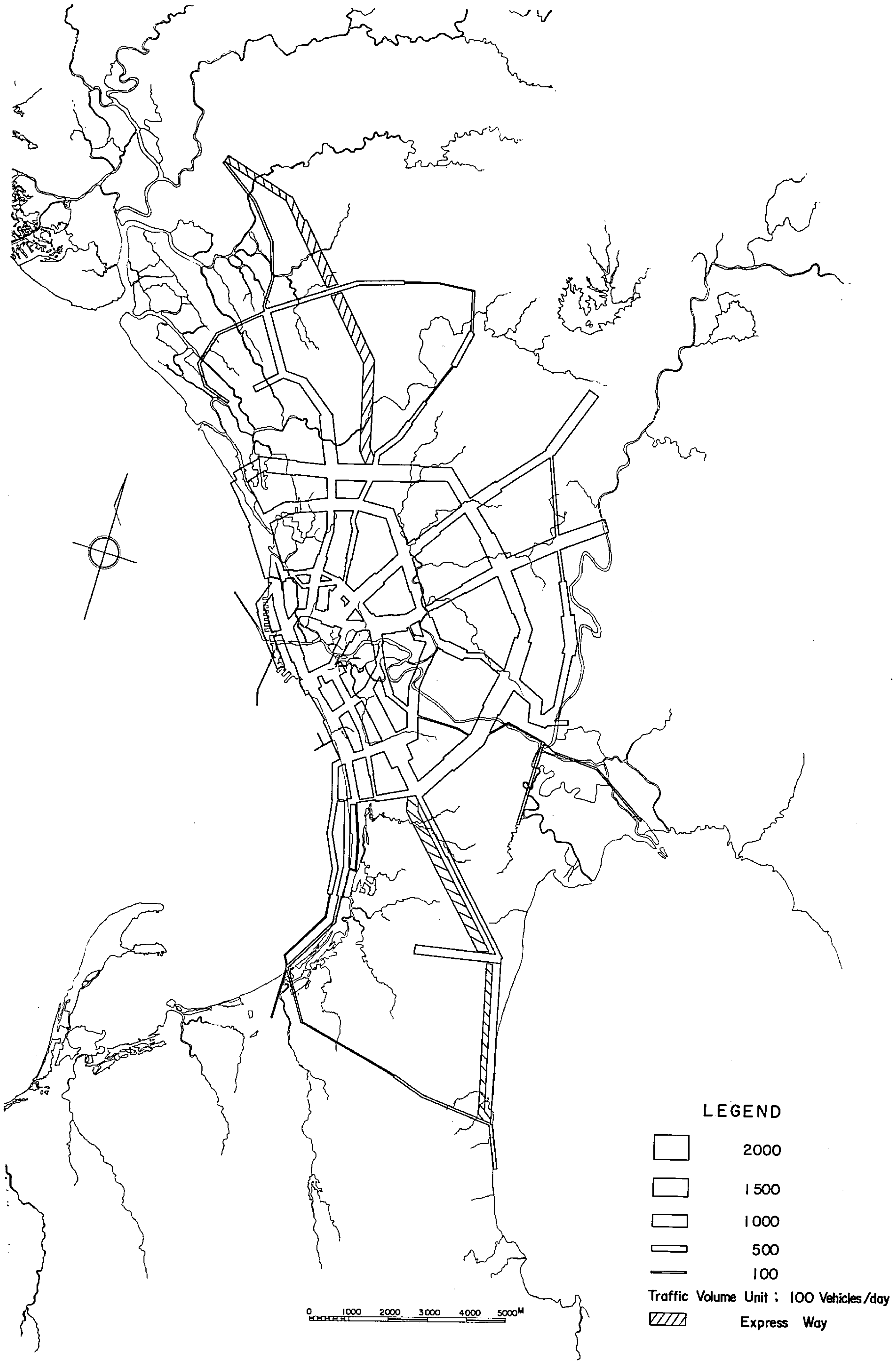


FIG. 5·7-3 FUTURE TRAFFIC VOLUME ASSIGNED TO ENTIRE MMA IN 1987 PLAN 2

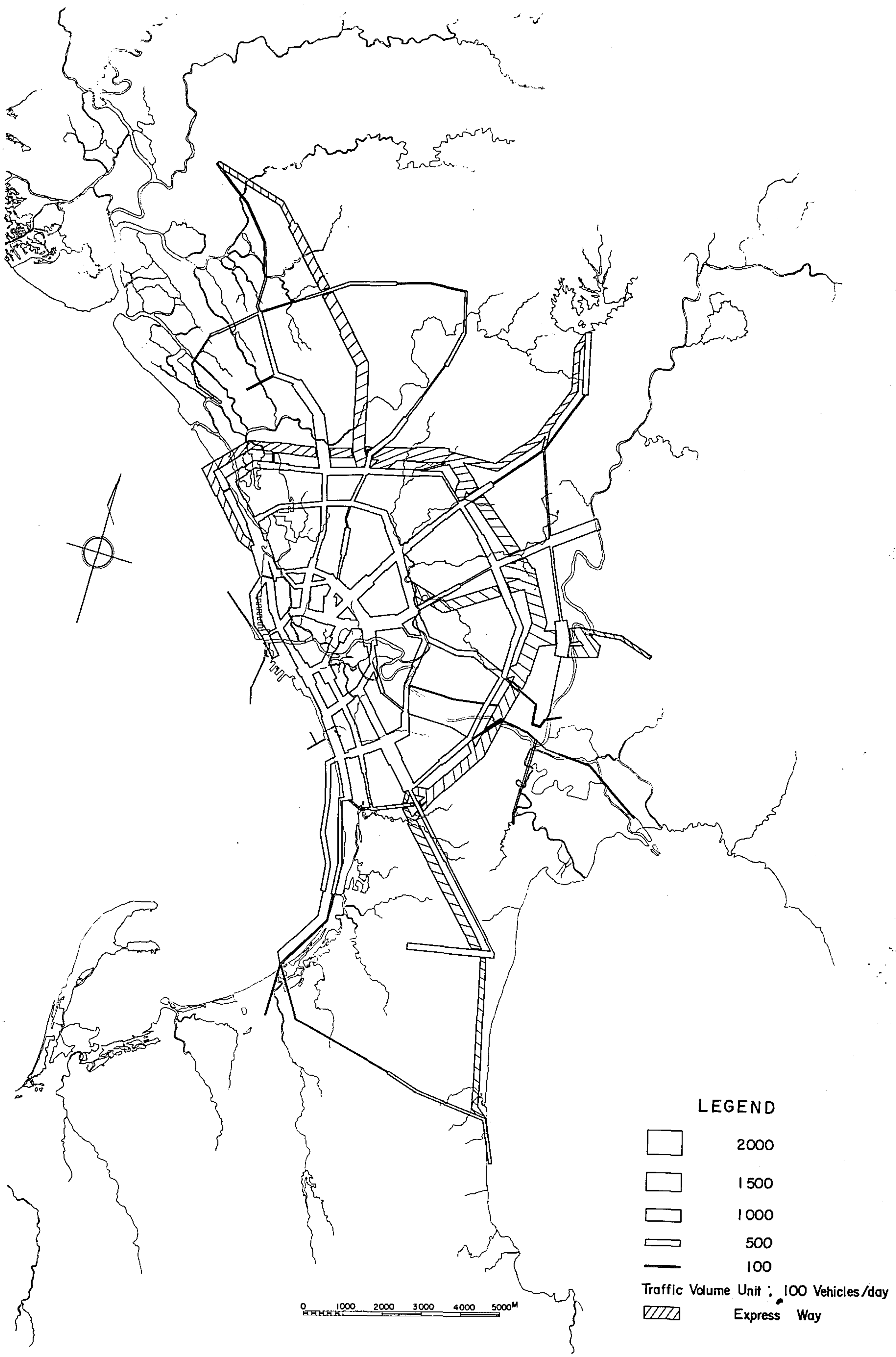


FIG. 5·7-4 FUTURE TRAFFIC VOLUME ASSIGNED TO ENTIRE MMA IN 1987 PLAN 4

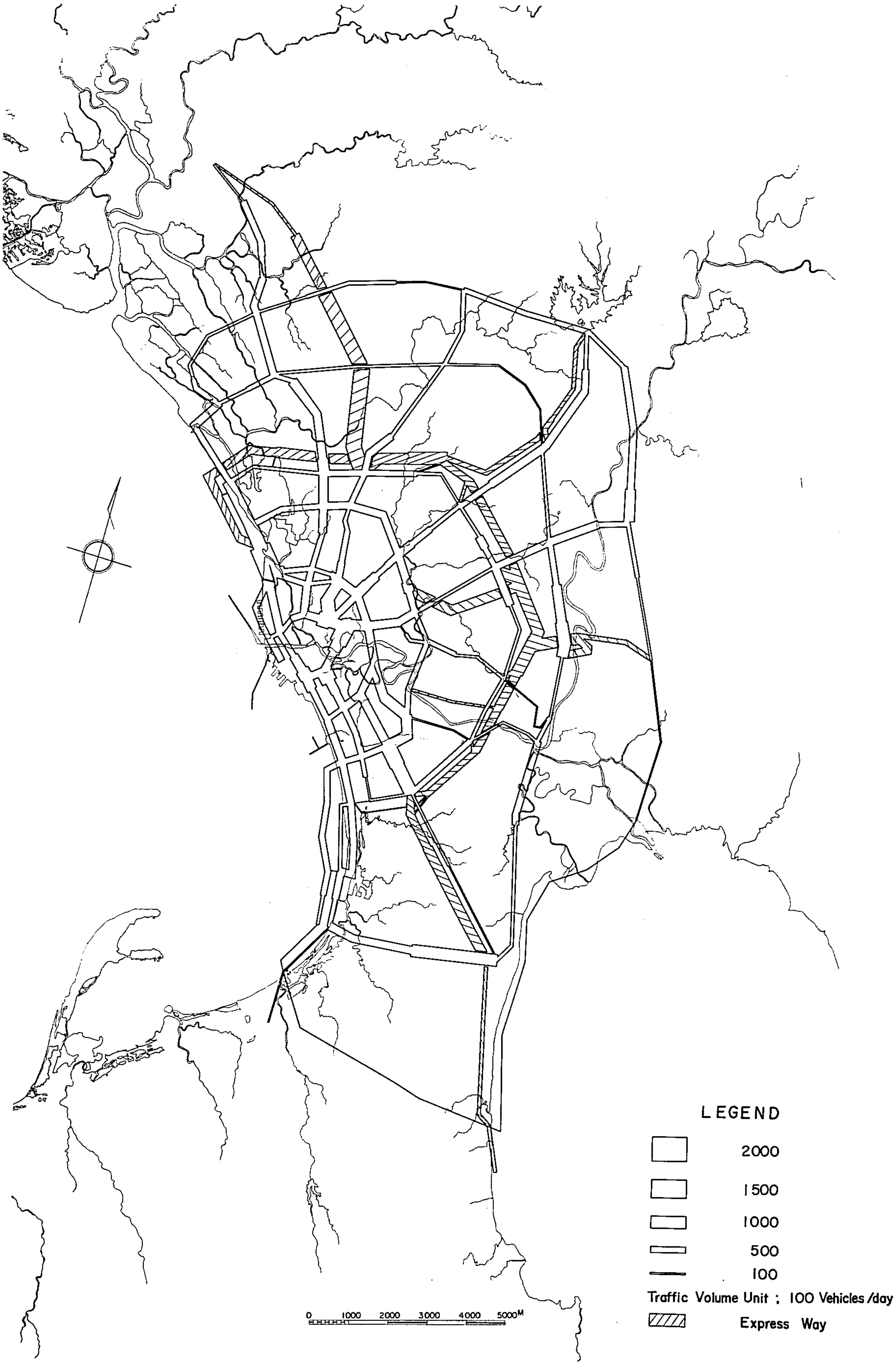


FIG. 5-7-5 FUTURE TRAFFIC VOLUME ASSIGNED TO ENTIRE MMA IN 2000

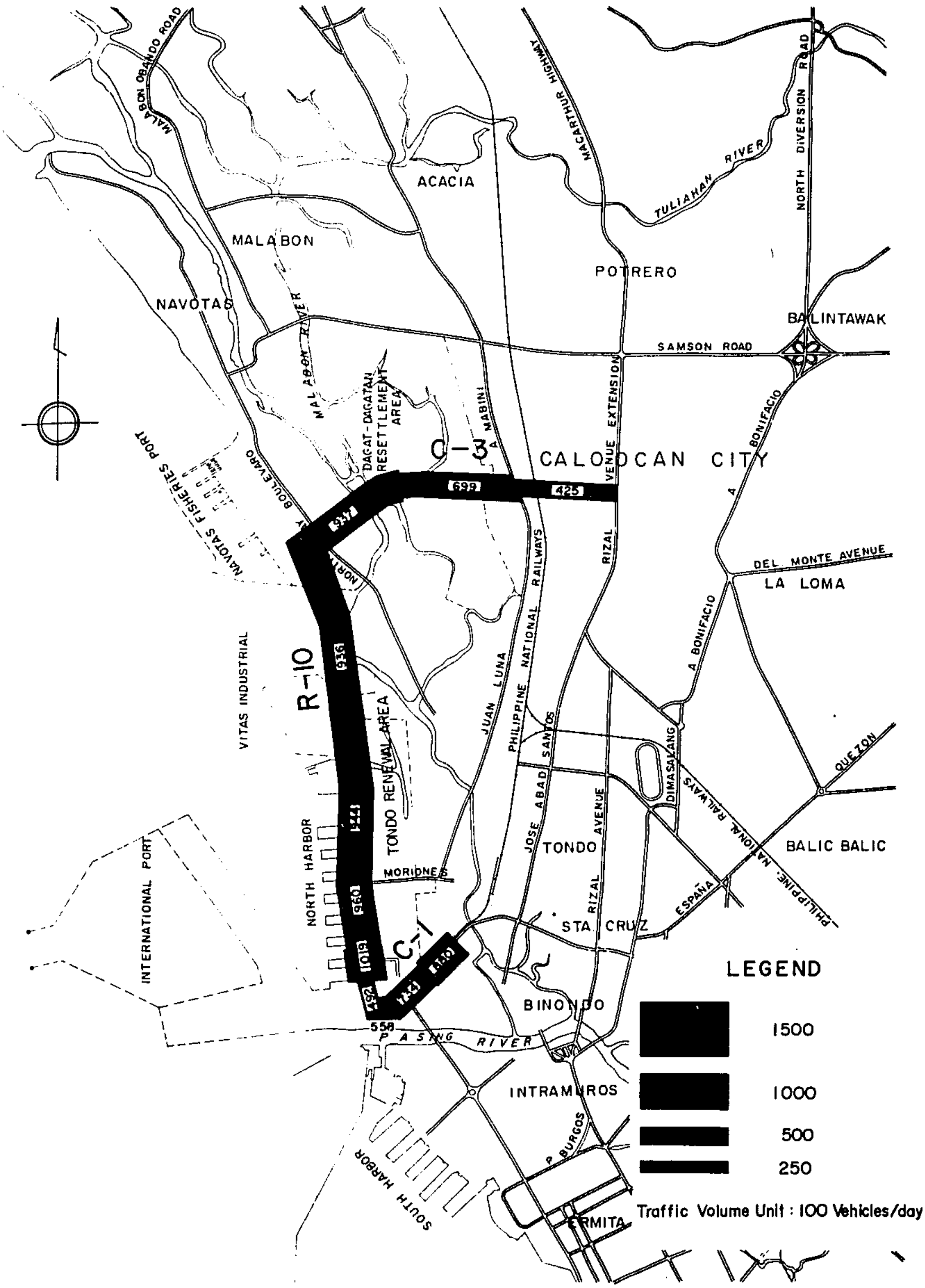


FIG. 5.7-6 FUTURE TRAFFIC VOLUME ASSIGNED TO PROJECT ROADS IN 1977

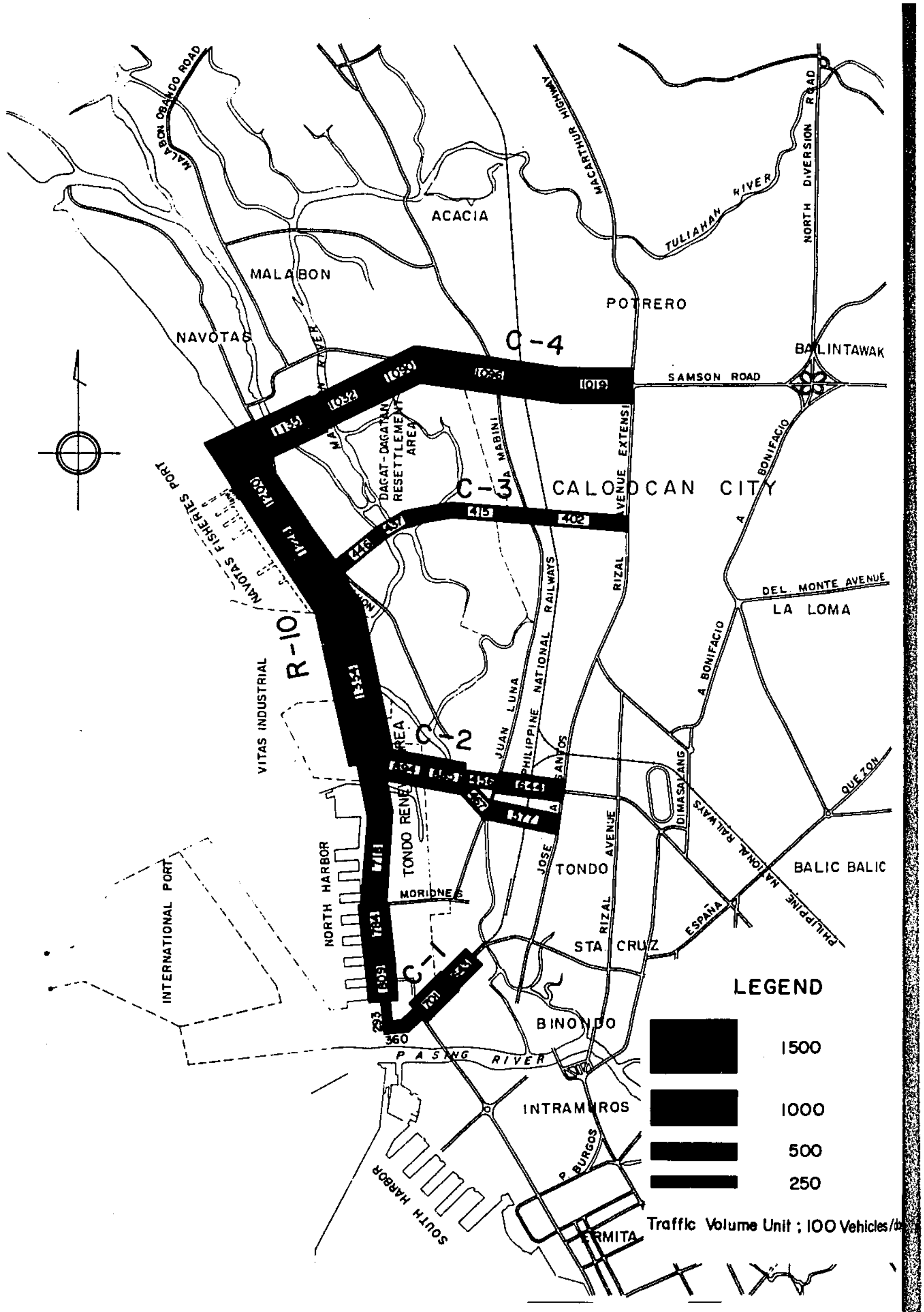


FIG. 5.7-7 FUTURE TRAFFIC VOLUME ASSIGNED TO PROJECT ROADS IN 1979

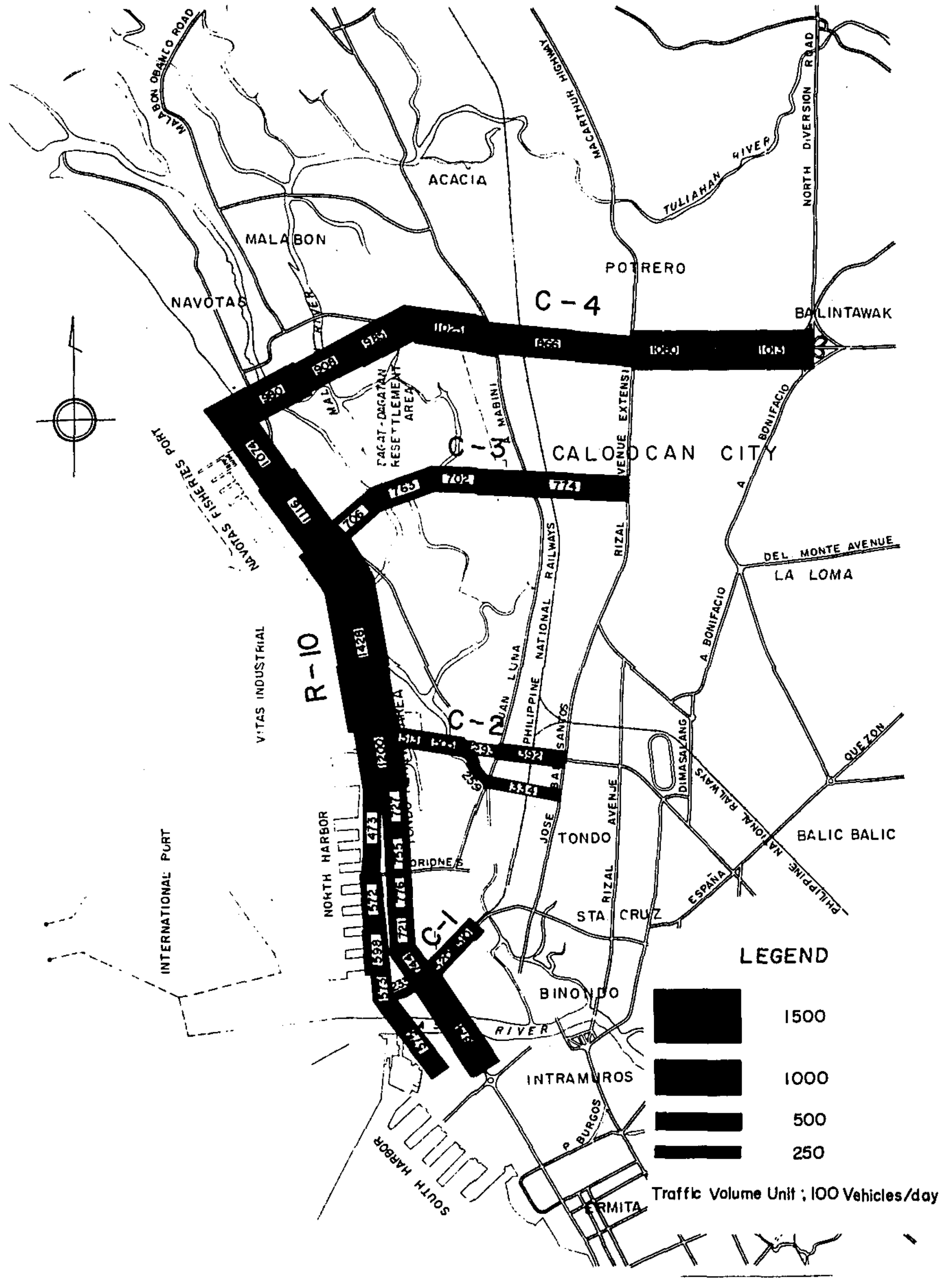


FIG. 5.7-8 FUTURE TRAFFIC VOLUME ASSIGNED TO PROJECT ROADS IN 1981

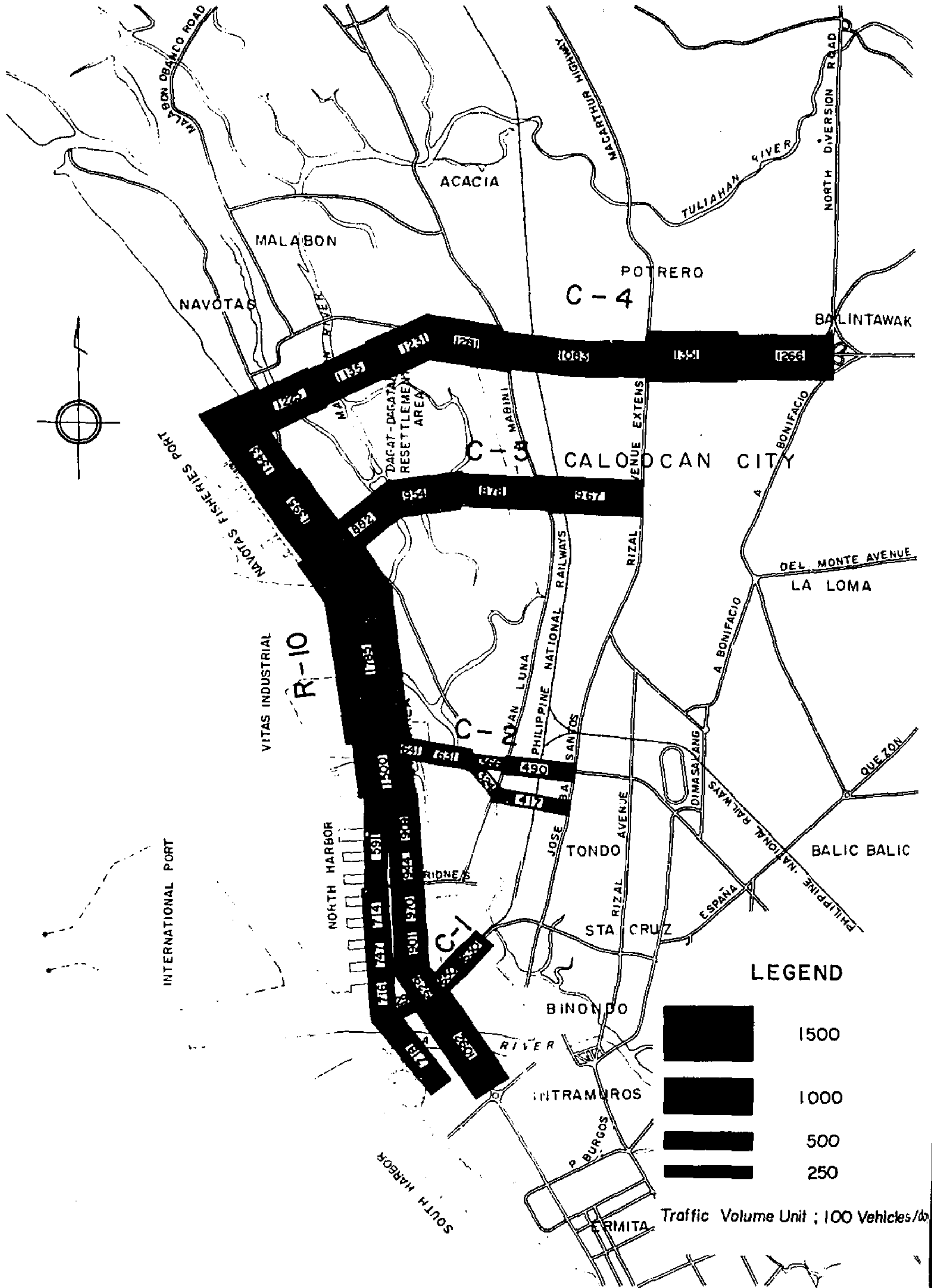


FIG. 5.7-9 FUTURE TRAFFIC VOLUME ASSIGNED TO PROJECT ROADS IN 1987 PLAN 2

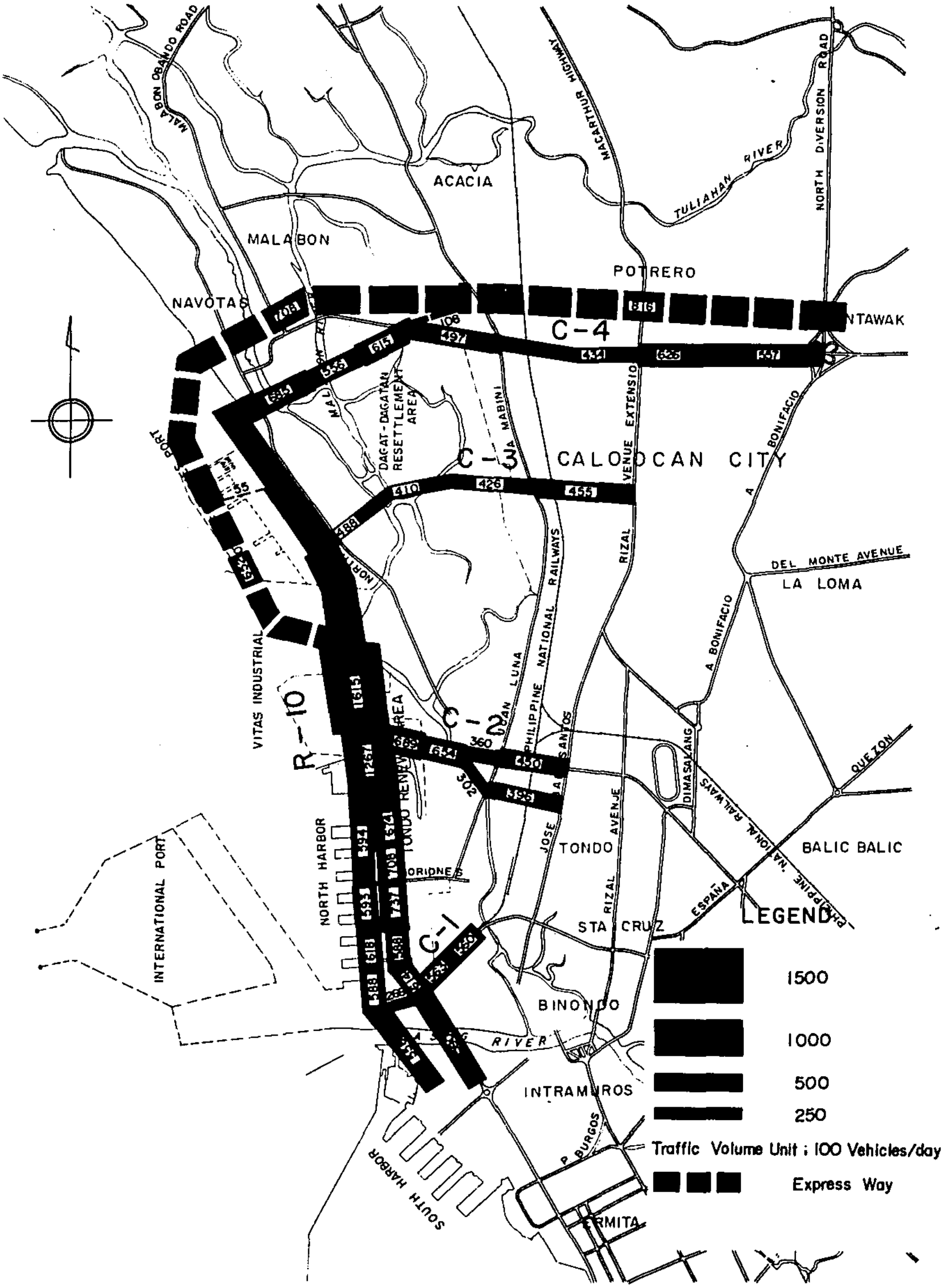


FIG. 5.7-10 FUTURE TRAFFIC VOLUME ASSIGNED TO PROJECT ROADS IN 1987 PLAN 4

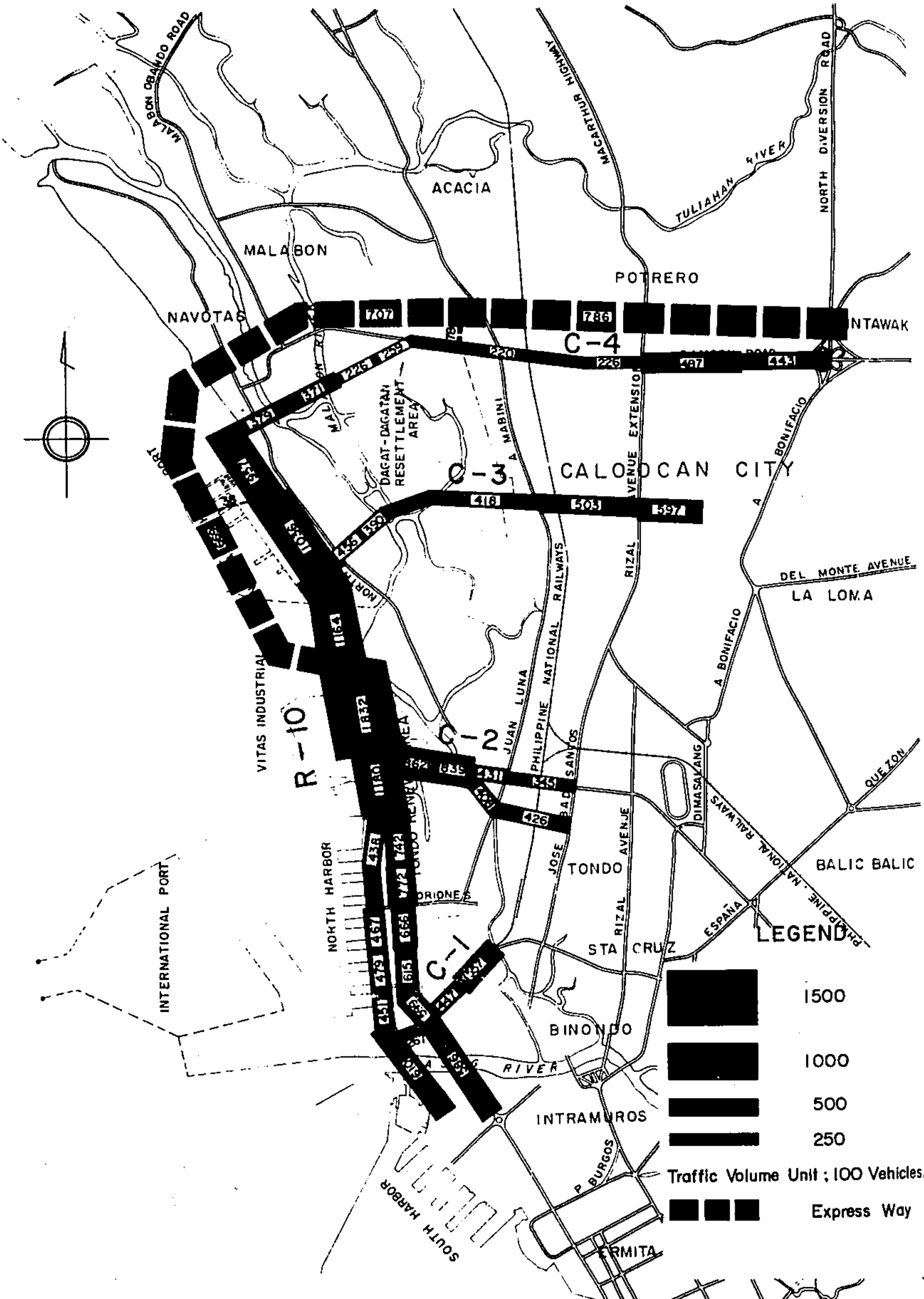


FIG. 5.7-11 FUTURE TRAFFIC VOLUME ASSIGNED TO PROJECT ROADS IN 2000

CHAPTER 6
PROPOSED ROAD PLAN

CHAPTER 6
PROPOSED ROAD PLAN

6.1 Basic Policies on Road Planning

In developing the plans for the R-10 Project Roads, the following basic policies were given primary consideration:

(1) Environmental factors were given due importance whenever possible by planning for wide road R-O-W, providing green areas and strips, and limiting the use of grade separated interchanges only where at-grade intersections would not effectively function:

(2) Any large scale destruction of existing improvements and a general nuisance to existing residential areas and communities were avoided whenever possible by limiting road R-O-W widths along existing built-up areas and by aligning the road to follow existing patterns.

Corollary to the above basic policies, it was assumed that such traffic engineering measures including the utilization of traffic aids, education of drivers on traffic courtesies, control of vehicle roadworthiness and other effective traffic measures would be practiced or applied in the R-10 Study area to maximize the efficient utilization of the Project Roads.

6.2 Route Description

(1) Radial Road R-10

Radial Road R-10 starts at the south approach of the existing Roxas (Del Pan) Bridge from where it will run generally northward and intersect Circumferential Road C-1 passing along a line parallel to and 260 m east of the North Harbor slipline (Fig. 6.2-1) up to the Don Bosco Compound. Thence, it will run further northward passing over the mouth of Estero de Vitas and east of the Navotas Fisheries Port approximately 150 m west of the existing North Bay Blvd. until it intersects C-4. Radial Road R-10 has a total length of 6.886 km up to C-4 and is planned to be extended further northward beyond C-4.

The proposed alignment of R-10 was strongly influenced by the need to provide an area adequate for port operations at the North Harbor. R-10 will consequently serve as a physical separator between the residential areas at the Tondo Foreshore Urban Renewal Project, its industrial area and the port zone. Further northward, its location was established primarily in consideration of the development plans for the Navotas Fisheries Port and the adjoining Dagat-Dagatan Resettlement Project.

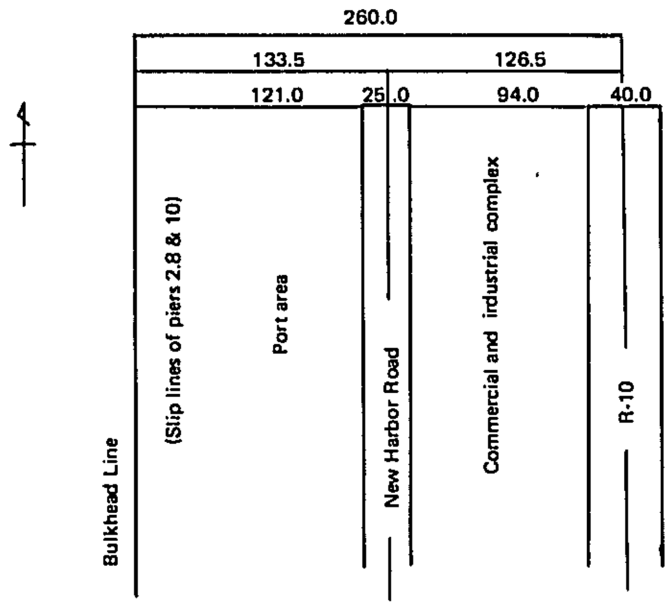


FIG. 6.2-1 LOCATION OF R-10 IN TONDO AREA

(2) Circumferential Road C-1

The C-1 segment of the Project Roads is a 483-m unfinished portion of Claro M. Recto Ave. starting from its intersection with Asuncion St. up to R-10. C-1 is to be further extended westward later on towards the manila International Port.

(3) Circumferential Road C-2

The C-2 segment has a total length of 2.959 km which branches off westward from Gov. Forbes Ave. into two lines, the first along the existing Tayuman St. and thence curving northwestward along the northern bank of Estero de la Reina towards Estero de Vitas, and the second skirting the San Lazaro Racetrack and thence running westward along Tayabas St. Both lines converge immediately west of Juan Luna St., where C-2 proceeds further westward until its intersection with R-10 where the main access to the proposed Vitas Industrial Complex is located.

The existing heavy roadside developments along Tayuman St. were the primary factors influencing adoption of this alignment.

(4) Circumferential Road C-3

The C-3 segment has a total length of 3.215 km which starts from R-9 and runs westward along 5th Ave. After passing thru the Dagat-Dagatan area, it curves southwestward towards its intersection with R-10 near the Navotas Fisheries Port Project. The existing La Loma and North Cemetery served as major controls in the establishment of the C-3 alignment.

(5) Circumferential Road C-4

The C-4 segment with a total length of 5.851 km starts from the Balintawak Cloverleaf Interchange at the intersection with R-8 and runs westward through R-9 along the existing E. de los Santos Ave. (C-4). Thence, it runs westward along Samson Road and Letre Road, and at the Caloocan-Malabon Boundary curves southwestward through the Dagat-Dagatan area, and thence to Navotas where it intersects R-10 offshore from the exising shoreline.

The prime considerations in establishing this alignment were a maximum utilization of existing rights-of-ways while avoiding existing residential and commercial areas.

(6) New Harbor Road

The New Harbor Road with a total length of 1.083 km will start at 2nd St. in the south port of manila, thence run northward over the Pasig River along a line parallel to the alignment of the existing Roxas Bridge and 133.50 m east of the North Harbor slipline, and thence run eastward along Herbosa St. until it intersects R-10.

Existing permanent structures and road patterns as well as the operational characteristics of the coastal zone area were the main factors which influenced the above alignment.

6.3 Road Characteristics

In general, each road segment will assume the road characters recommended in the UTSMMA, which are briefly described as follows:

(1) Radial Road R-10

R-10 will assume the character of a major road with partial control of access within the section of the road from Roxas Bridge to the proposed North Harbor Road, i.e., intersections with other major roads will be grade-separated while those with secondary roads (Moriones and Herbosa) will be at-grade. All other roads will not be allowed to cross but may be provided with access.

Two road types will be developed within the road right-of-way limits from the new Harbor Road intersection up to C-4. One will assume the character of an expressway and the other a major road. The expressway will have full control of access and will be grade-separated at intersections with other expressways and major roads; all other roads will not be provided direct access to the expressway. The major road within this section will have partial control of access and will be grade-separated at intersections with other major roads and at-grade at intersections with secondary roads. All other roads will not be allowed to cross but may be provided with access.

As a major road, R-10 will have a design speed of 60 kph considering existing roadside, conditions as well as planned development along the area.

(2) Circumferential Roads C-1, C-2 and C-3

C-1, C-2 and C-3 will assume the character of major roads with partial control of access. Higher degree of control of access will be adopted within sections along newly planned areas such as the Dagat-Dagatan Resettlement area.

C-1 and C-2 will have a design speed of 50 kph, while C-3 will be 60 kph considering their relative distances from the inner core of the MMA and the conditions of existing as well as planned development along the areas traversed.

(3) Circumferential Road C-4

Two road types, a major road and an expressway, will be developed within the C-4 road right-of-way similar to that section of R-10 between the North Harbor Road intersection and C-4.

Since C-4 will just be an extension of R-10, it will also have a design speed of 60 kph.

(4) New Harbor Road

Considering that the New Harbor Road will primarily serve as access to the ports and will not be a part of the major thoroughfares system, it will assume the character of a local road with a design speed of 40 kph.

6.4 Road Design Policies

Standards prescribed in "A Policy of Urban Highways and Arterial Streets," 1973 Edition of the Association of American State Highway Officials (AASHO) were used as principal reference for the geometric design of all roads and for the structural design of highway pavements and bridges. Standards of the DPH and/or Japanese Ministry of Construction were used as secondary references for cases not covered by the AASHO.

6.4.1 Geometric Design Standards

Based on the design policies adopted, the geometric design standards shown in the following Table 6.4-1 were used for the Project Roads.

TABLE 6.4-1 DESIGN STANDARDS

Design Speed		Kph (mph)	40 (25)	48 (30)	64 (40)
Minimum Radius of Curvature		m (ft.)	90 (300)	130 (430)	170 (561)
Maximum Super-elevation		%	4	4	4
Super-elevation Run-off		%	0.66	0.62	0.58
Sight Distance	Stopping	m (ft.)	60 (200)	80 (265)	90 (300)
	Passing	m (ft.)	340 (1100)	410 (1350)	460 (1500)
Maximum Road Gradient		%	6	5	5
Critical Length of Grade Design		m (ft.)	300 (1000)	420 (1390)	580 (1900)
Crest		m (ft.)	9A (28A)	17A (55A)	17A (55A)
Length of Vertical Curve Sag		m (ft.)	11A (35A)	17A (55A)	17A (55A)

A – Algebraic difference in grades, %

6.4.2 Typical Roadway Sections

Typical roadway sections for the Project Roads as shown in Fig. 6.4-1 have been determined on the basis of the following considerations:

(1) Road Right-of-Way

Due to space limitations in the Tondo Foreshore area, a limited R-O-W of 40 m was provided for R-10 from its point of origin at Roxas (Del Pan) Bridge to the new Harbor Road intersection, while a 60-m R-O-W was proposed up to the interchange with C-4 in order to provide for the future expressway. A 40-m R-O-W was provided for C-1 to conform with the existing width of Claro M. Recto Ave., while a 20-m R-O-W was generally adopted for C-2, along both Tayuman St. and Tayabas St. (both proposed to be one-way roads) because of the existing built-up areas. Beyond the converging point of the two one-way roads along C-2 in Tondo up to the intersection with R-10 as well as along the entire length of C-3, however, a 50-m R-O-W was adopted because of the relative facility of acquiring R-O-W and because of environmental considerations.

R-O-W widths of 50 m, 65 m and 80 m were adopted along the various sections of C-4 between R-8 and R-10 because of one or the other or a combination of the following reasons:

(a) the proposed expressway,

(b) environmental considerations,

(c) variable conditions of roadside development,

(d) total construction costs.

A 25-m R-O-W was provided for the new Harbor Road to accommodate the traffic needs of the port area.

(2) Lane Width

The minimum width of a traffic lane will be 3.35 m for the main roads and 3.05 m for other roads such as service roads.

(3) Side Strips

All roads will be provided with inner side strips of 0.25 m width and outer side strips of 0.50 m width which will also serve as gutters. Outer side strips will be omitted, however, where there are auxiliary lanes.

(4) Median

The minimum width of medians for long bridges, interchanges and other special sections like the North Harbor Road will be 1.0 m, while it will be normally 4.00 m for other sections.

(5) Road Separator

As a general rule, the width of separators (the island separating the traffic lanes from the service roads) will be 2 m.

(6) Service Roads and Ancillary Lanes

Service roads will be provided for roads that traverse already developed areas. Normally, the lane width of the service roads will be 3.35 m, but in some special sections this will be reduced to 3.05 m. In sections along new areas, ancillary lanes will be provided instead of service roads. The width of ancillary lanes will be 3 m considering that they will also serve as bus stops. Where space is limited, however, the width of ancillary lances will be reduced to 1.5 m.

(7) Sidewalk

Generally, the width of sidewalks will be 4.00 m considering the large volume of urban pedestrians.

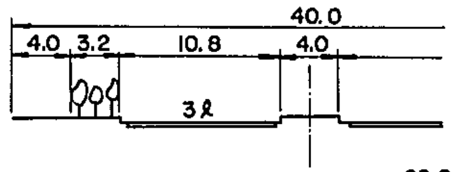
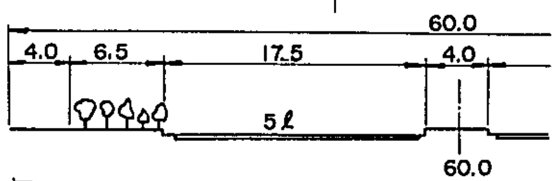
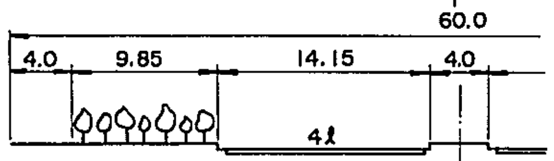
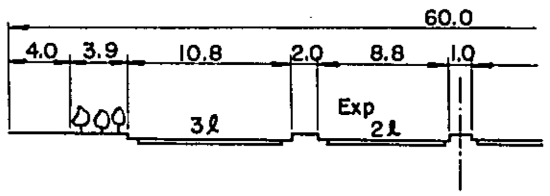
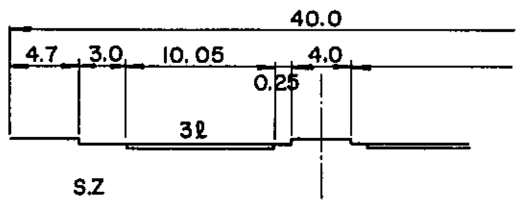
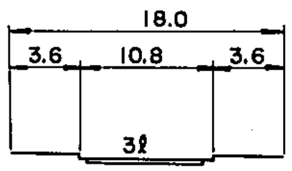
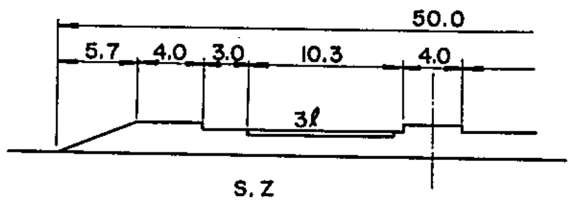
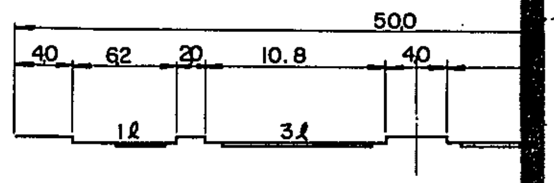
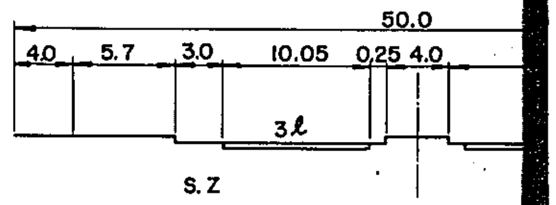
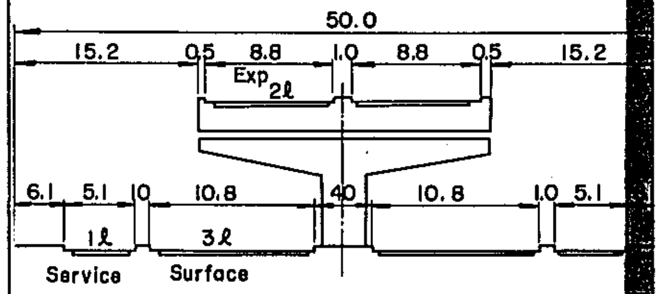
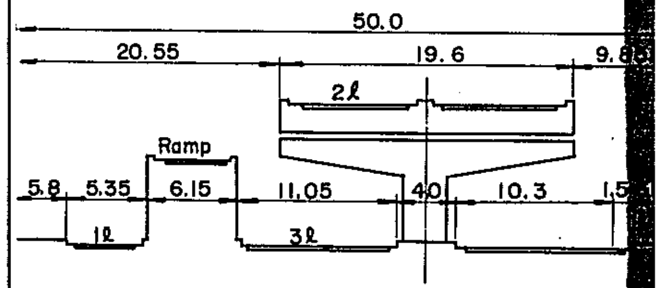
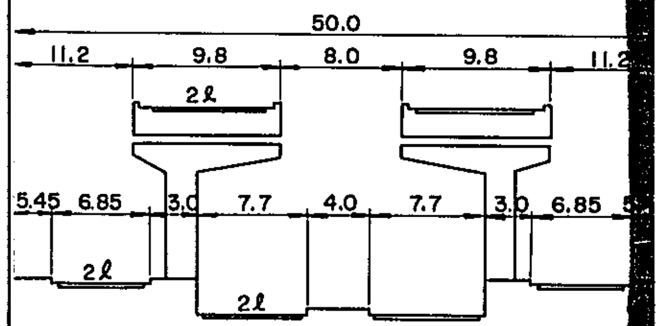
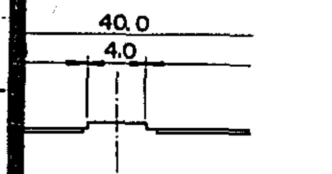
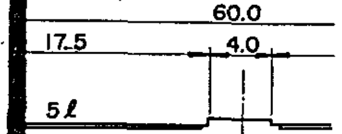
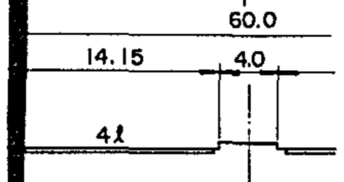
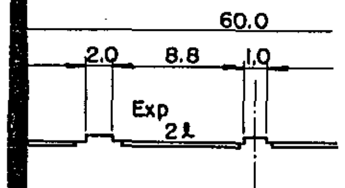
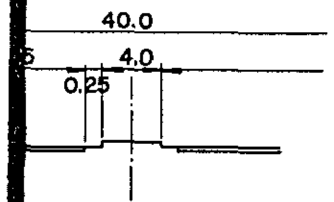
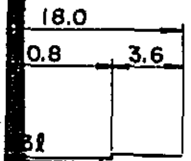
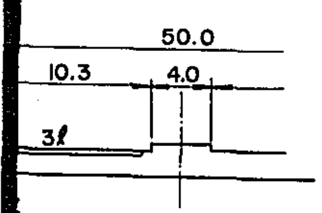
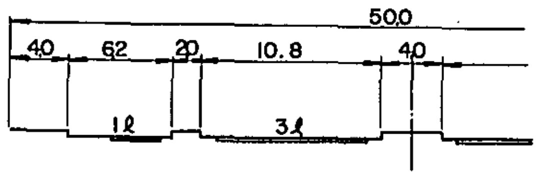
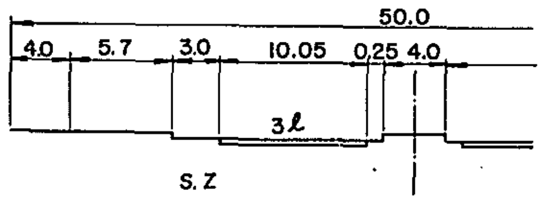
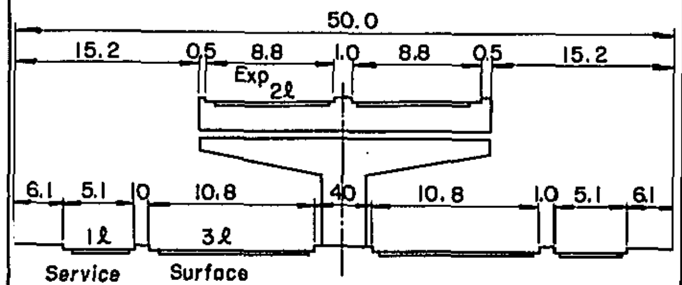
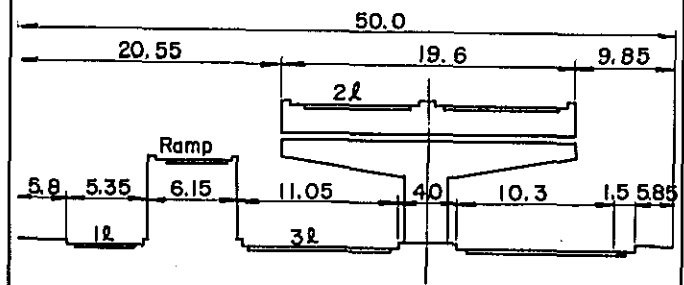
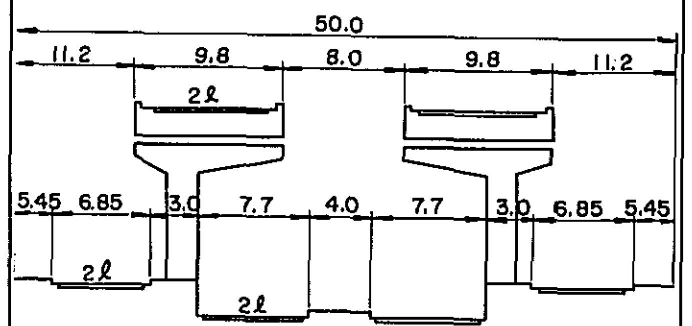
Route	Section	Right of Way (m)	Number of Lanes	Typical Cross Section
R-10	North Side of existing Roxas Br ~ Don Bosco	40	6	
	Don Bosco ~ C2	60	10	
	C2 ~ Biginning point of Exp.	60	8	
	Biginning point of Exp ~ C4	60	Surface 6 Exp. 4	
C - 1		40	6	
C - 2	2 - One Wey (Gov Forbes ~ Tondo)	20 ~ 18	3	
	Two Way	50	6	
C - 3	R9 ~ Fish Pond	50	Surface 6 Service 2	
	Fish Pond		6	
C - 4	R8 ~ R9	50	Surface 6 Service 2 Exp. 4	
		50	Surface 6 Service 1 Exp. 4	
		50	Surface 4 Service 4 Exp 4	

FIG. 6.4 - 1 TYPICAL ROADWAY SECTIONS

...oss Section








Route	Section	Right of Way (m)	Number of Lanes	Typical Cross Section
C – 3	R9 ~ Fish Pond	50	Surface 6 Service 2	
	Fish Pond		6	
C – 4	R8 ~ R9	50	Surface 6 Service 2 Exp. 4	
		50	Surface 6 Service 1 Exp. 4	
		50	Surface 4 Service 4 Exp 4	

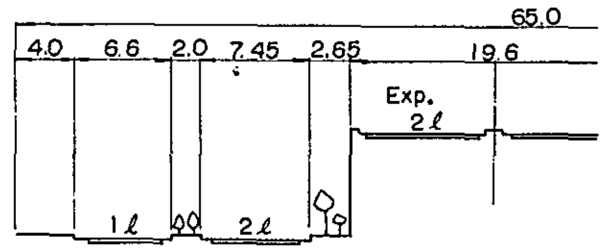
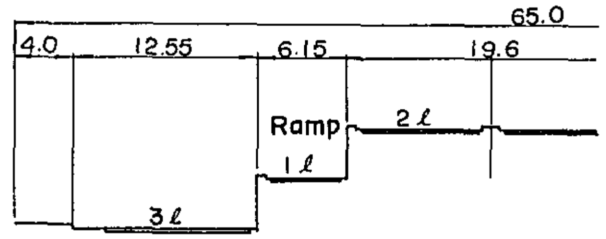
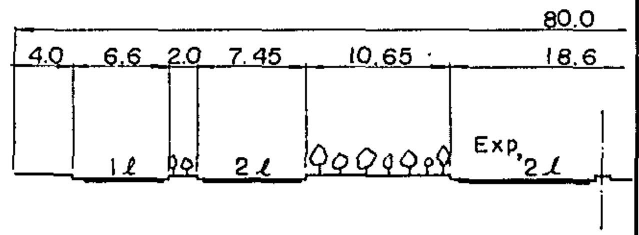
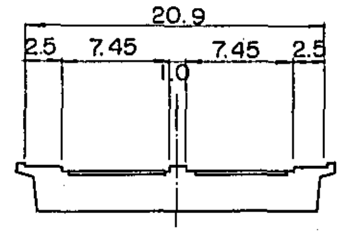
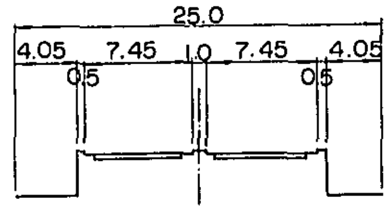
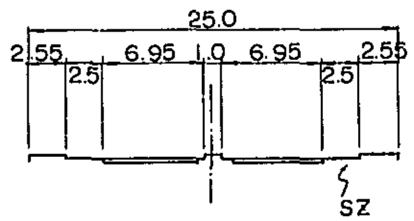
Route	Section	Right of Way (m)	Number of Lanes	Typical Cross Section
C-4	R9 ~ Mabini St.	65	Surface 4 Service 2 Exp. 4	
	Ramp Section	65		
	Mabini St. ~ R10	80	Surface 4 Service 2 Exp. 4	
New Harbor-Road	Bridge Section	20.9	4	
	Approach Section	25	4	
	Standard Section	25	4	

FIG. 6.4 - 1 TYPICAL ROADWAY SECTIONS

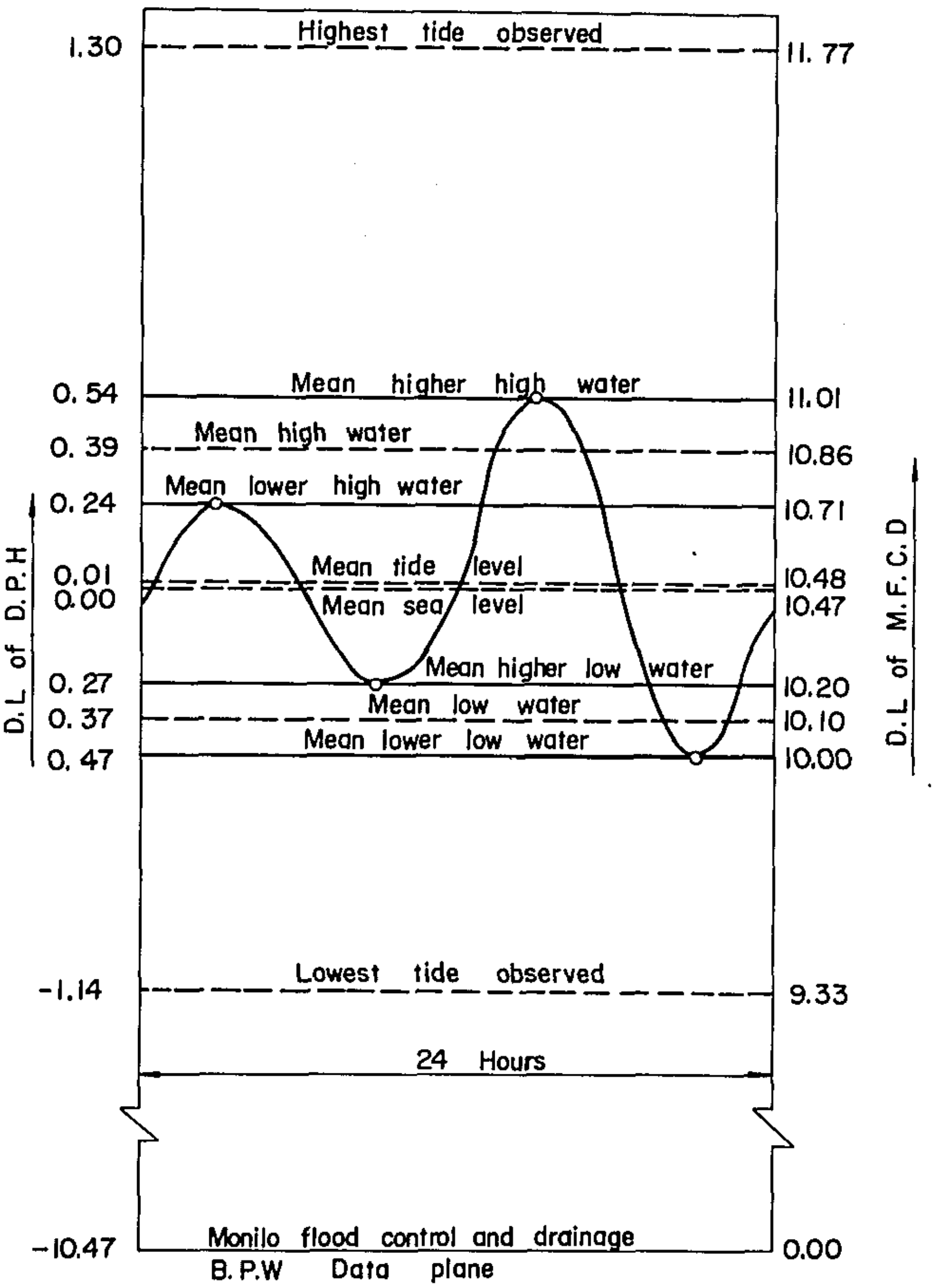


FIG. 6.4-2 DATUM ELEVATIONS

(8) Green Zone

For aesthetic and environmental considerations, wide green zones will be provided whenever possible.

6.4.3 Design Controls

(1) Datum Height

Fig. 6.4-2 illustrates the different datum elevations used by different government agencies in the Philippines. For this Study, a datum elevation of 0.00 equal to Mean Sea Level (MSL) was used.

(2) Vertical Clearance

The minimum vertical clearance for roads will be 4.88 m (16 ft). For waterways (under bridges), the minimum vertical clearance will be 1.50 m measured from High Water Level (HWL) up to the bottom of the bridge superstructure. HWL is 1.55 m above MSL (Refer to Fig. 6.4-3).

(3) Planned Elevations

Based on the datum elevation equal to MSL used as design controls, the planned elevation of the reclaimed portions of related development projects are as follows:

Project	Elevation
Vitas Industrial Complex	2.33 m
Navotas Fisheries Port	2.13 to 2.33 m
Dagat-Dagatan Resettlement	2.53 m

6.5 Preliminary Design of Roads

6.5.1 General

On the basis of the design controls and criteria and other factors discussed in the previous paragraphs, preliminary design of the Project Roads was undertaken for the Study as shown in Appendix 2 – Drawings. A brief description of the design work undertaken follows:

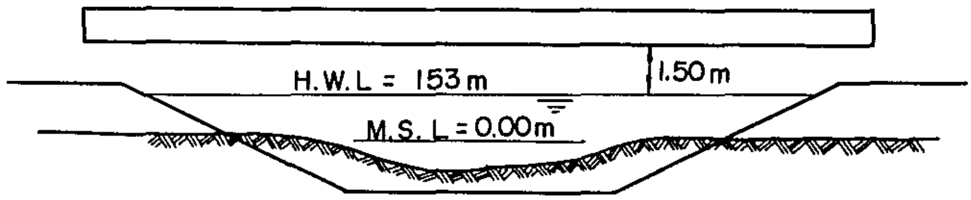


FIG. 6.4-3 MINIMUM VERTICAL CLEARANCE

(1) Horizontal and Vertical Alignments

All beginnings, points of intersections and ends of each project road were established on the ground and plotted by coordinates on a map with scale 1:1,000. At intersections of tangents, simple curves or combinations of circular curves with spiral transitionings were introduced.

The existing ground profile along the centerline of the proposed roads were taken in the field by differential levelling at 50-m intervals. Based on the existing profile, the proposed road profiles were established utilizing the design controls and criteria discussed earlier.

(2) Cross-Sections

Considering the heavy rainfall in the study area, a pavement cross slope of 2% was used. A maximum superelevation of 4% was adopted along curves considering the design speed of the Project Roads, while side slopes of 1.5:1 were adopted for embankments. In cases of high embankments, concrete cribs were used for slope protection in order to confine the embankment within the road right-of-way.

(3) Subgrade

Soil tests conducted in the Dagat-Dagatan and Fisheries Port areas show the low shearing strength of the material in the area. It is expected that when the area is reclaimed and the embankments are constructed, consolidation of this material will take considerable lengths of time. Since the embankments have to be constructed soon after reclamation, a more thorough investigation of subsurface character and conditions should be made during the final design stage. The need for this detailed soils investigation is more critical where embankments are over 3 m high, such as at the bridge approaches. Considering the short period of two years after reclamation within which the roads have to be completed, the consolidation of underlying soil should be expedited during reclamation with the use of the overburden method and the use of sand piles and sand mats for high embankments, as shown in Fig. 6.5-2.

(4) Pavement

The use of cement concrete pavement was adopted primarily because of the high traffic volume, the availability of materials, repair and maintenance cost factors, and the character of the Project Roads. CBR tests conducted on embankment material from sources in the vicinity of the project showed a CBR value of about 3%, while materials from the Fisheries Port and Dagat-Dagatan areas were 3% or less, while those taken from the higher ground which is predominantly tuff were assumed at 10% or more.

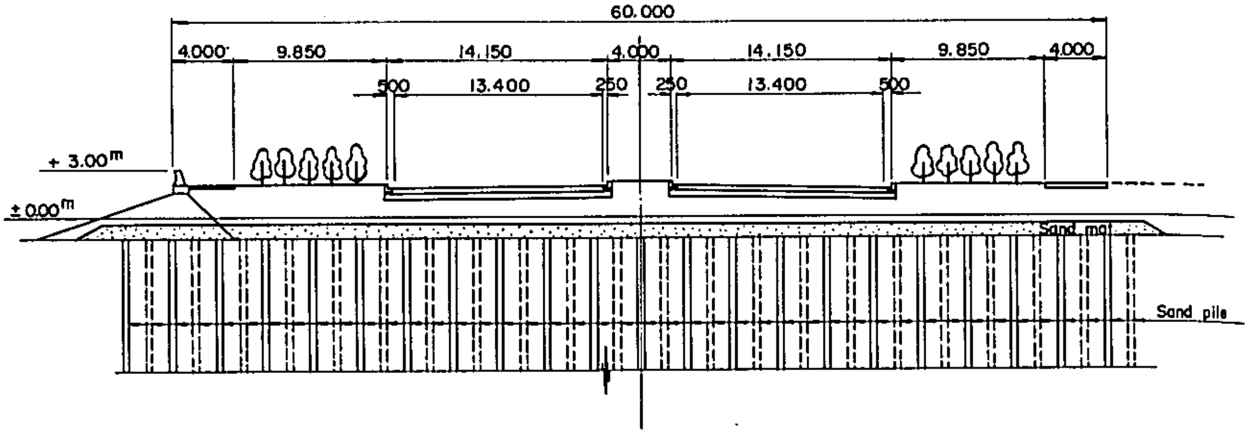
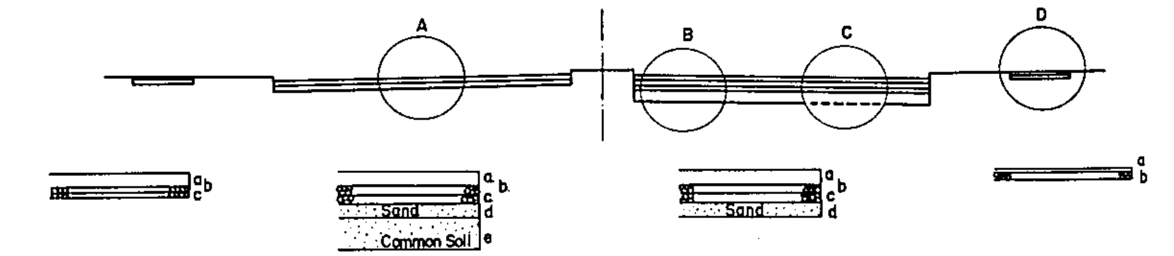


FIG. 6.5-1 TYPICAL CROSS-SECTION OF EMBANKMENT IN OFF-SHORE



Pavement A

- a. Pavement slab 30cm
- b. Upper subbase couse 10 "
- c. Lower " " 10 "

Pavement B

- a. Pavement slab 30cm
- b. Upper subbase course 20 "
- c. Lower " " 20 "
- d. Filter course 30 "
- e. Displaced 70 "

Pavement C

- a. Pavement slab 30cm
- b. Upper subbase course 20 "
- c. Lower " " 20 "
- d. Filter course 30 "

Pavement D

- a. Pavement slab 5cm
- b. Subbase course 15 "

FIG. 6.5-2 STANDARD THICKNESS OF PAVEMENT

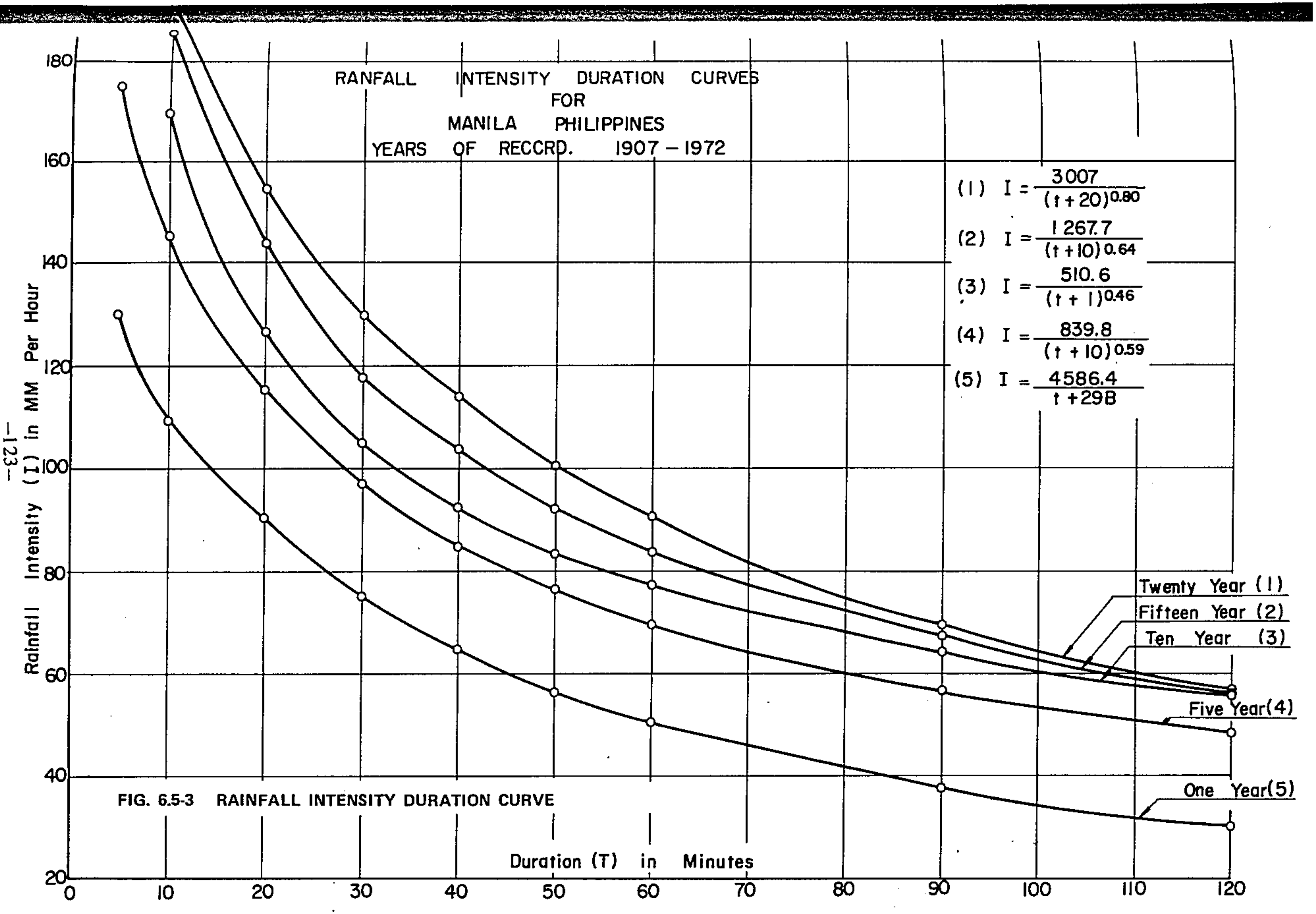


FIG. 6.5-3 RAINFALL INTENSITY DURATION CURVE

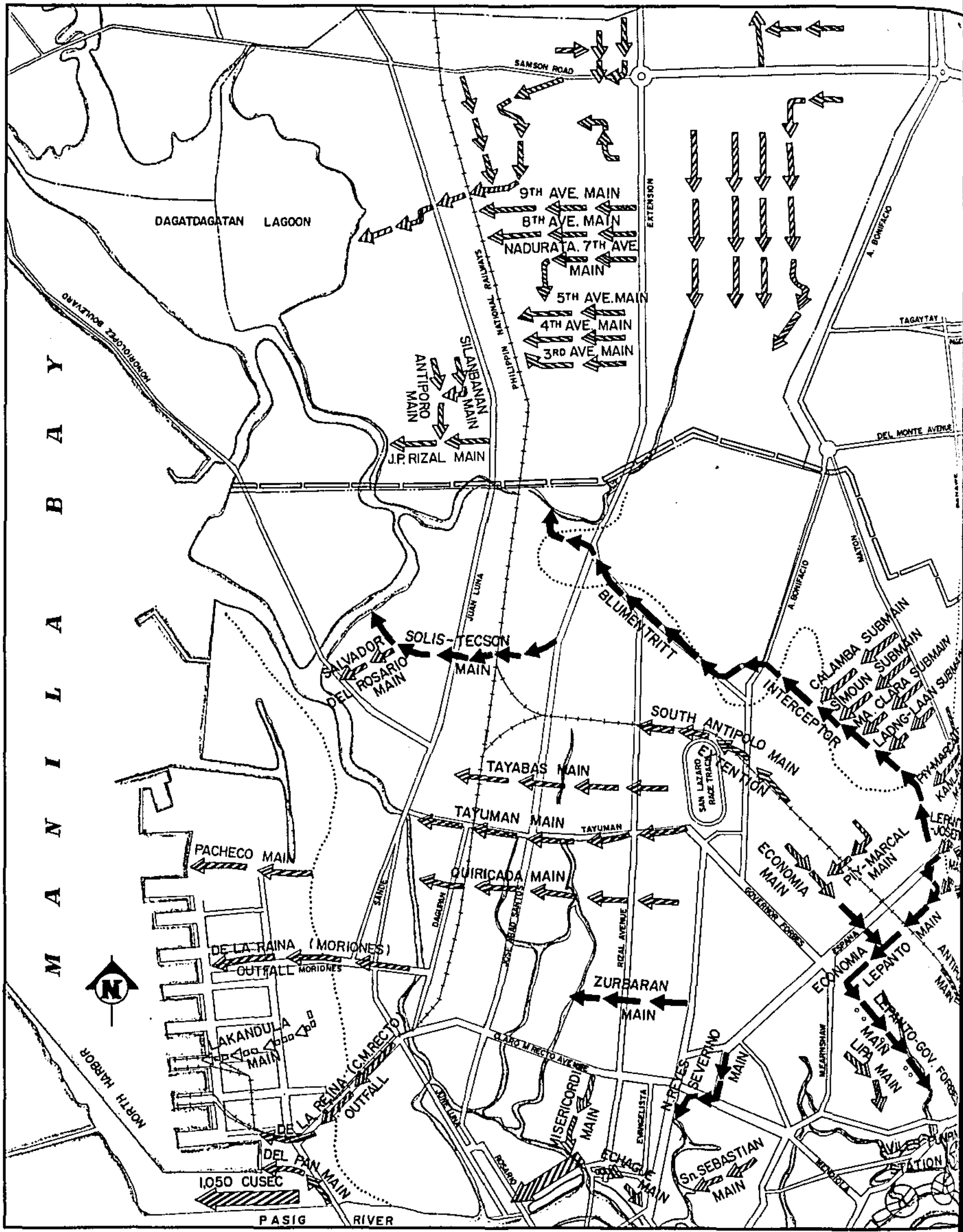


FIG. 6.5-4 FLOOD CONTROL & DRAINAGE PROGRAM IN MMA

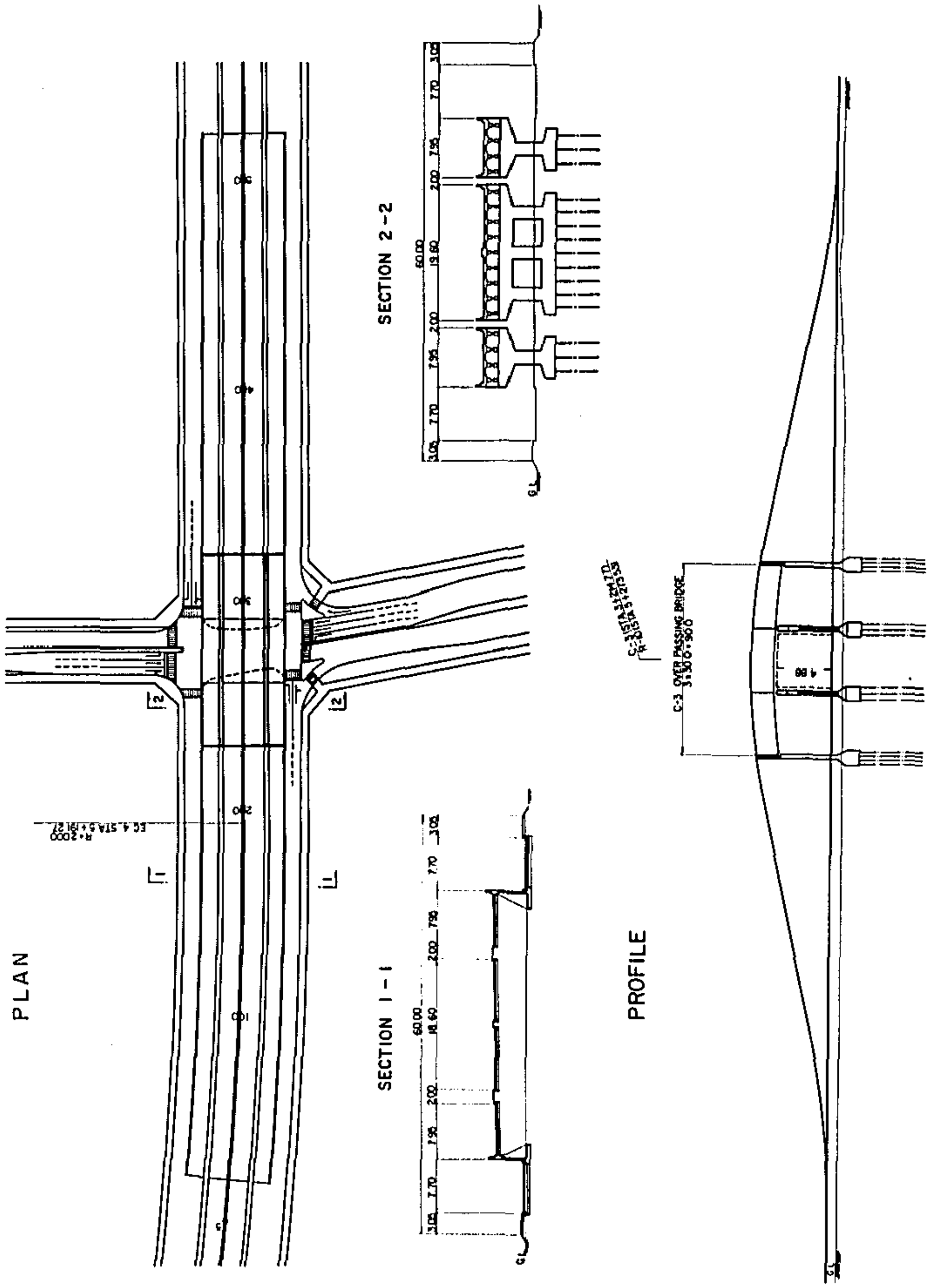


FIG. 6.5-5 GRADE-SEPARATED INTERCHANGE ON R-10

Since large sections of the Project Roads will be on reclaimed land where large and delayed settlement is expected in view of the long period of time to consolidate the underlying soil, it is recommended that the adoption of flexible rather than rigid pavements should be seriously considered prior to accomplishing detailed engineering design. A minimum CBR value of 3% was adopted for subgrade material in the low or reclaimed areas.

For purposes of this Study and in the absence of a more thorough soil survey, a 30-cm thick concrete pavement was used with base and subbase materials of 40 cm thickness in the reclaimed areas and 20 cm in the hilly areas.

(5) Drainage

The four-year Manila & Suburbs Flood Control & Drainage Program is presently being implemented by the Bureau of Public Works (BPW) with the assistance of the Overseas Economic Cooperation Fund of Japan and is scheduled for completion by 1978. Concurrent with this program is the development of the Pasig River which is scheduled to be completed in 1976 as part of the overall flood control program for Metropolitan Manila.

The drainage system of the Project Roads should therefore be principally designed for the surface run-off from the roads themselves, except in areas where the roads would prevent the efficient flow of run-off from adjoining areas. It may be necessary prior to the completion of the pertinent portion of the BPW's Flood Control Program that certain drainage works must be provided temporarily in order to prevent unnecessary flooding of the area.

The run-off was determined by using the Rational Formula as follows:

$$Q = .227\ CIA$$

where,
- Q = Run-off, cu m/sec (cumecs)
- C = Run-off coefficient
- I = Rainfall intensity, mm/hr
- A = Run-off Area, sq km

Run-off coefficients used were:

- C = 0.8 for paved surfaces
- C = 0.5 for unpaved surfaces.

A 10-year frequency of rainfall was used in the design of the main pipes, with rainfall intensity for the different times of concentration shown as follows:

Duration (t)	Rainfall Intensity (I)
10 minutes	169 mm/hr
15 minutes	142 mm/hr
20 minutes	127 mm/hr
25 minutes	114 mm/hr
30 minutes	105 mm/hr

Fig. 6.5-3 shows Rainfall Intensity Duration Curves.

6.5.2 Treatment of Intersection

The main considerations used for selection of the type of intersection were the character of the intersecting road, its traffic characteristics and its operational adaptability, the type of development in the area, and the availability of road right-of-way.

On the basis of the foregoing, all intersections of circumferential roads with R-10, except for C-4, will be grade-separated with uninterrupted flow along the direction of the major flow on R-10. All other movements will be at-grade and controlled with traffic signals. The intersections of C-4 with the two radial roads, R-8 and R-9, will be grade-separated because of the future expressway along C-4 in addition to the other factors mentioned above. Intersections of the circumferential roads with other radial roads, however, will all be at-grade because of the relatively developed condition of the areas adjacent to these intersections.

6.5.2.1 Along Radial Road R-10

(1) C-1 Intersection

This intersection is situated in a high density business district where the acquisition of large areas for road right-of-way would be very costly and difficult. The PNR also has an existing single-line railway track here which primarily services the ports and is directly connected to the Tutuban Central Terminal. At this intersection, C-1 is proposed to be widened to six lanes like R-10. Primarily because of the PNR tracks and the high traffic volume in the area (C-1 is proposed to be extended farther westward to service the International Port which is presently under construction) an interchange is proposed at this intersection. The type of interchange to be adopted is the diamond type with R-10 overpassing C-1 because of R-10's relative importance.

(2) New Harbor Road Intersection

Ideally, the New Harbor Road should be directly connected with C-2. However, since a

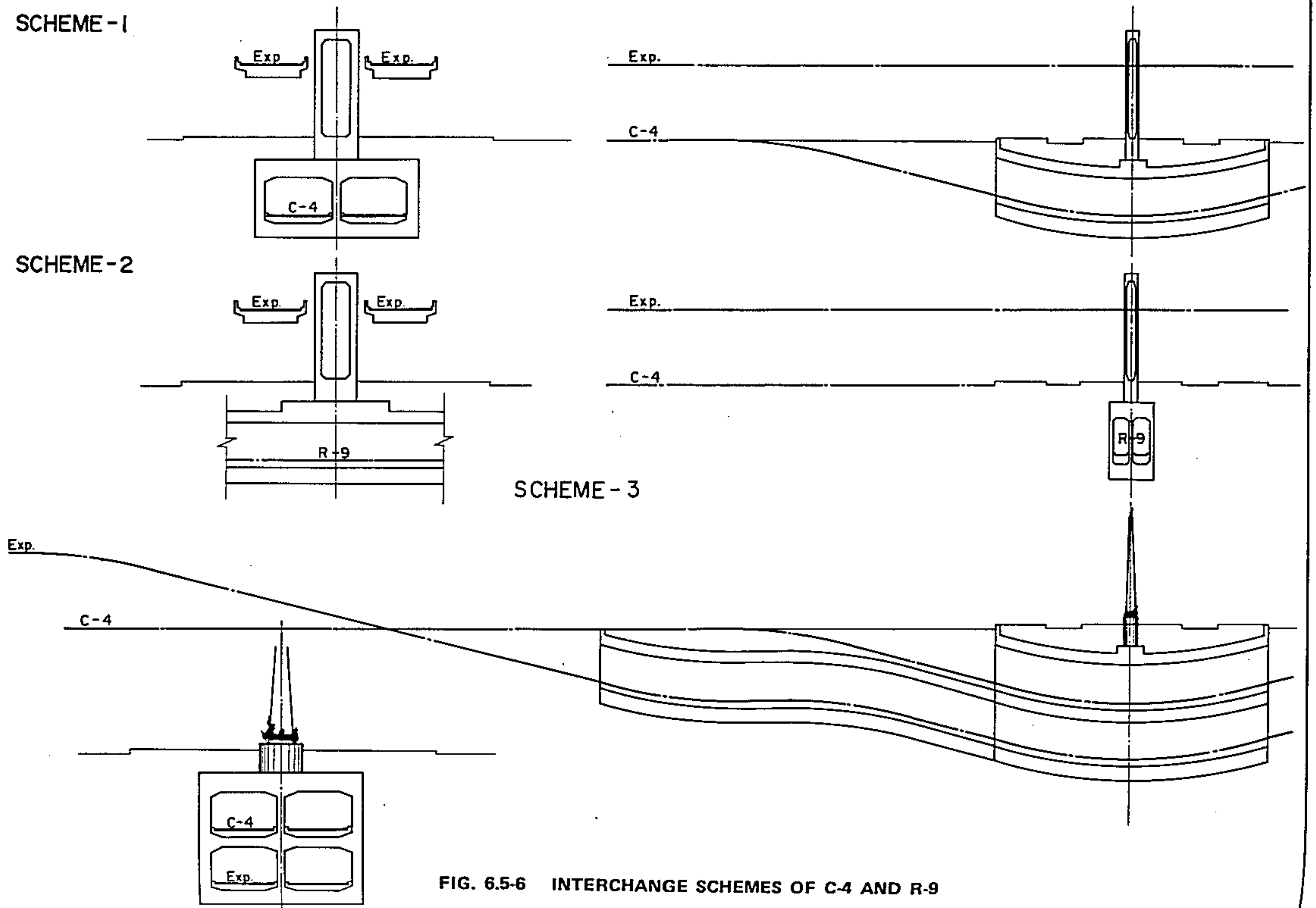


FIG. 6.5-6 INTERCHANGE SCHEMES OF C-4 AND R-9

direct link would create an intersection with five legs because of the access road leading to the Vitas Industrial Complex, the intersection of the New Harbor Road with R-10 will be shifted southward by approximately 500 m from the intersection of C-2 with R-10. The shifted location of the New Harbor Road intersection was determined primarily on the basis of weaving distance requirements. Since the two intersections are quite near to each other, traffic can be processed by a synchronized signal control system.

(3) C-2 Intersection

C-2 and the main access road of the Vitas Industrial Complex will form a 4-legged intersection with R-10. This intersection will be located within the proposed Tondo Foreshore Urban Renewal Project area where the acquisition of extensive rights-of-way would be a major constraint. Both C-2 and R-10 will be six-laned. A diamond type interchange is proposed for this intersection, with R-10 overpassing C-2, considering that the major traffic flow will be along R-10 and that there will be a relatively low volume of left-turn traffic, among others.

(4) C-3 Intersection

The intersection of C-3 with R-10 will be four-legged because of the main access road to the Navotas Fisheries Port. On the basis of the limited R-O-W in the area and because of the traffic voulume, the advantages of operational uniformity, and the relative importance of R-10, a diamond type of interchange will be adopted, with R-10 overpassing C-3.

(5) C-4 Intersection

This intersection is located in an area to be reclaimed about 850 m north of the Navotas Fisheries Port which is presently under construction.

The proposed extension of R-10 further northward to Bulacan will begin at this intersection. Considering that the future elevated expressway will be constructed at this intersection, a rotary type interchange is proposed which will contain the interchange within the central island of the rotary.

6.5.2.2 Along C-2

Intersections of C-2 with Rizal Ave., Jose Abad Santos Ave. and Juan Luna St. will each be at two points, the first west bound along Tayabas St. and the second east bound along Tayuman St. All these intersections will be at-grade considering the highly developed existing roadside conditions. The introduction of minor improvements are expected.

6.5.2.3 Along C-3

The major intersections along C-3 with R-9, A. Mabini St. and the two main roads at the Dagat-Dagatan Resettlement Project will be at-grade and controlled with traffic signals.

6.5.2.4 Along C-4

(1) R-8

The existing interchange at this intersection at Balintawak is the full cloverleaf type. The interchange is proposed to serve also the movements along the future expressway along C-4. Access of expressway traffic to the interchange will be through the on-and-off ramps provided before and after the interchange.

(2) R-9

A rotary type intersection exists at this junction with the historical Bonifacio Monument at the central island of the rotary constituting a major constraint in developing a proper type of intersection which will also serve the interchange movements of the future expressway along C-4. While the relocation of the monument was considered, the idea was abandoned because of the historical importance of the monumnet. Hence, it became necessary to study the most appropriate type of intersection at this junction without the need for relocation of the monument.

Three schemes, each maintaining the existing rotary type intersection for the surface roads, were developed and a comparative analysis made for each alternative.

Scheme 1 proposed that through surface road traffic along C-4 would be depressed and pass through a tunnel under the central island. The future expressway would be elevated to pass over the rotary intersection. Since the view of the monument would be obstructed by the expressway, the monument would be raised.

Scheme 2 called for C-4 to remain at surface and R-9 to be depressed; the expressway along C-4 would be elevated as in Scheme 1 and the monument raised.

For Scheme 3, C-4 is proposed as in Scheme 1 to be depressed and run under the central island together with the expressway while R-9 would remain at surface and the monument would remain at its present elevation.

After evaluating the different schemes from the points of view of the R-O-W requirements, adaptability to the location, user's cost, and the relative ease of construction, a conclusion was reached to adopt Scheme 1. Under this scheme, the depressed C-4 will be protected by retaining walls and the roadway will pass through a two-cell tunnel structure under the central island. Some substructure elements of the future expressway should also be integrated with the construction of the depressed roadway and the underground structure. The scheme calls for the temporary removal of the monument during the construction period and its subsequent restoration.

(3) Mabini Street and Two Main Roads of the Dagat-Dagatan Resettlement Project
These two intersections will be at-grade and will be controlled by traffic signals.

6.5.2.5 General Treatment of At-Grade Intersection

As a general rule, all existing at-grade intersections will be modified for the purpose of increasing their capacities and enhancing their safety features. Capacities will be increased by addition of a sufficient number of lanes and, where space limitations allow, by providing left-turn storage lanes and exclusive lanes for right-turn vehicle movements. Safety features as intersections will be enhanced through the effective use of traffic aids such as road signs and pavement markers.

6.5.2.6 PNR Crossing

In anticipation of the grade separation of the PNR lines in the future, all circumferential roads, with the exception of the expressway along C-4, will cross the PNR lines at-grade. At each crossing, proper signal control systems, preferably automatically activated from the railroad tracks, should be provided.

6.5.2.7 Alternative Plans Analyzed for C-2

Two alternative plans were developed for C-2. The first plan was to widen the existing Tayabas St. to a two-way road with a 40-m R-O-W. The second plan was to utilize both Tayabas St. and Tayuman St. to operate as one-way streets within that section of C-2 from Gov. Forbes to a point just west of Juan Luna St. The roadway section for the two plans are shown in Figs. 6.5-7(1), 6.5-7(2) while construction and land improvement costs of the two alternative plans are shown in the following Table 6.5-1.

TABLE 6.5-1 COMPARISON OF C-2 ROUTE BY COST (1000 Pesos)

Plan	Land Cost	Construction Cost	Total
(1) 2-way	43,577	18,847	62,424
(2) 1-way	23,367	23,736	47,103

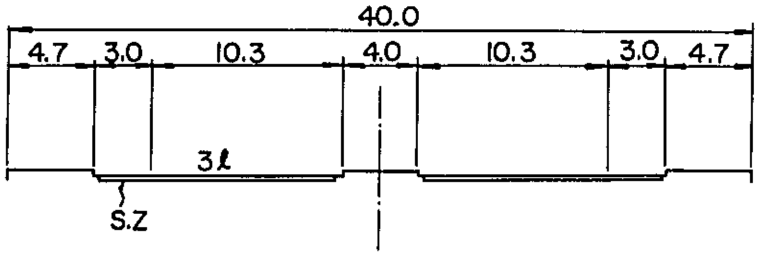


FIG. 6.5-7 (1) ROADWAY SECTION OF TAYABAS ST. (2-WAY PLAN)

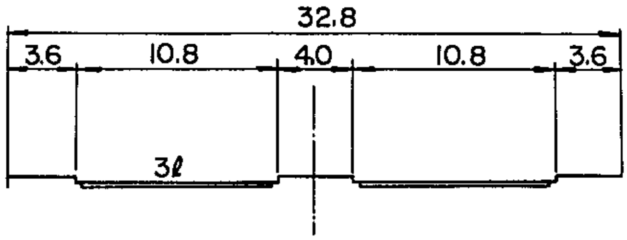


FIG. 6.5-7 (2) EXISTING GOVERNOR FORBES SECTION (C-2)

As shown above, the total cost of the second plan is much lower by about 15 million or about 25% less than the first plan primarily because of the lower R-O-W cost of land and improvements. On the basis of this analysis, the second plan was adopted for this Study.

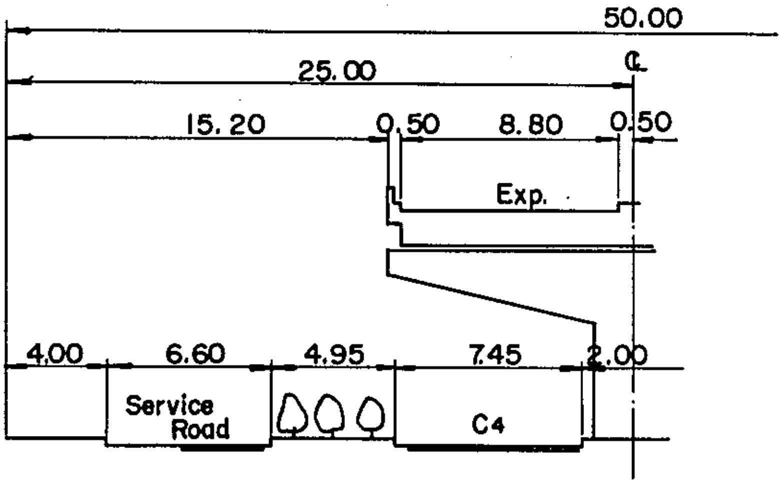
During the detailed engineering stage of this project, however, another alternative should be examined which calls for the two-way road to run along the existing Camarines St. rather than along Tayabas St., considering that conditions of present developments along Camarines St. are relatively more favorable for a two-way road than those along Tayabas.

6.5.2.8 Comparative Analysis of the Critical Section of C-4

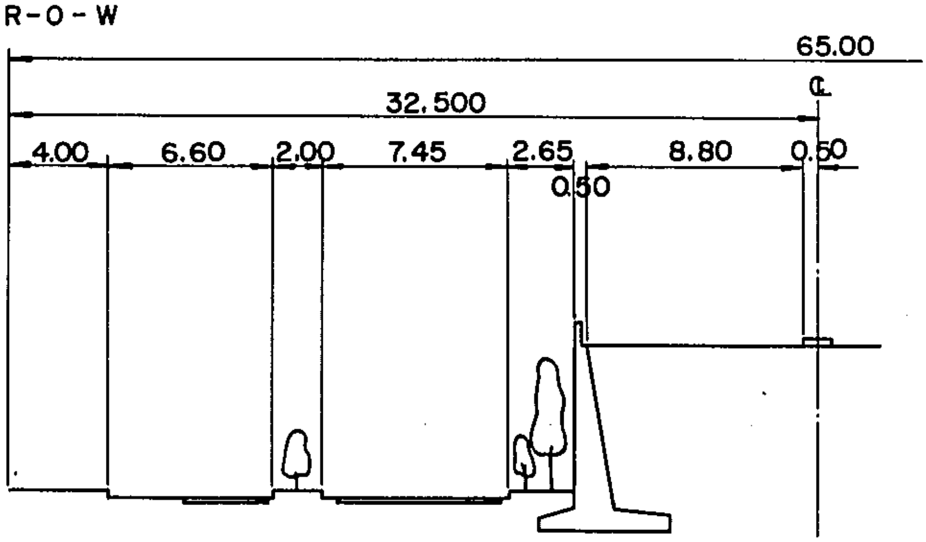
Certain sections of C-4 will pass through an already developed area where R-O-W acquisition would be costly and difficult, taking into account the existing narrow R-O-W widths and roadside improvements to be affected. On the other hand, to adopt the widest R-O-W possible would result to better environmental conditions. An analysis is therefore necessary in arriving at the most economical roadway section treatment during both the initial stages and when the final sections of C-4 are developed.

This critical section of C-4 starts from the intersection with R-9 up to where it diverts from the existing road in a southwestward direction into the Dagat-Dagatan Resettlement area.

Case 1. 50 m R-O-W



Case 2. 65 m R-O-W



Case 3. 80 R-O-W

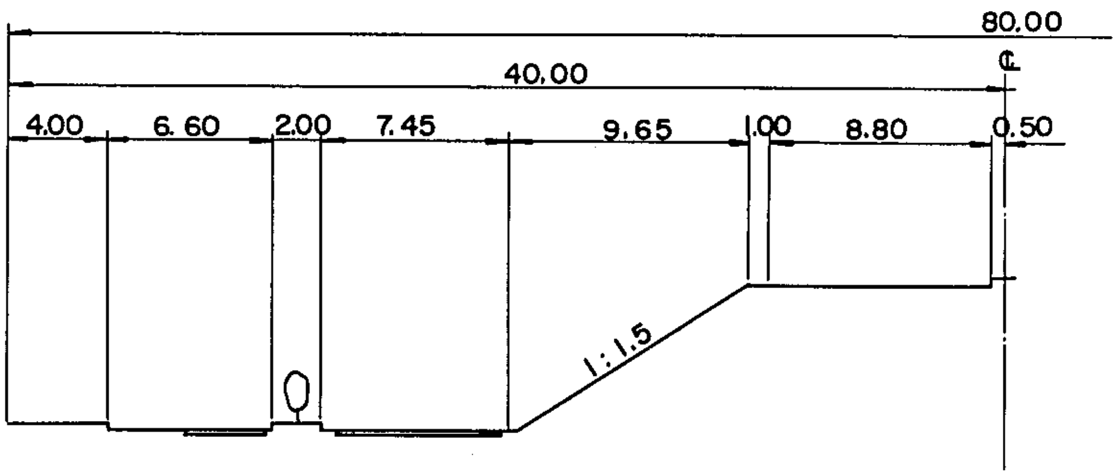


FIG. 6.5-8 ROADWAY CROSS SECTIONS

Three possible case studies were developed and analyzed. Case 1 would have a 50-m R-O-W with the future expressway on a viaduct. Case 2 would have a 65-m R-O-W with the future expressway on an embankment protected by retaining walls. Case 3 would have an 80-m R-O-W with the expressway also on an embankment but without any retaining walls. The roadway sections under each case are shown in Fig. 6.5-8. Table 6.5-2 following shows the construction and land improvement costs of each case per 100 m.

TABLE 6.5-2 COMPARISON OF ROAD R-O-W BY COST

(million pesos/100 m)

Case	R-O-W	Land Cost	Construction Cost	Total
1	50 m	3.3	7.1	10.4
2	65 m	4.2	1.8	6.0
3	80 m	5.3	0.9	6.2

From the above figure, it was shown that Case 2 would be the most economical from the point of view of the two primary cost factors considered, and on this basis was adopted for this Study.

However, other factors should be considered before a final decision on this is made, as follows:

(1) Relative Ease of Construction – The construction of a viaduct on a limited 50-m R-O-W would require strict traffic control;

(2) Environmental Factors – From this standpoint, Case 3 is the most preferable because of the wider R-O-W. On the other hand, Case 2 and Case 3 would provide better ventilation and more sunlight and would not obstruct the view as much as Case 1 because the expressway is elevated:

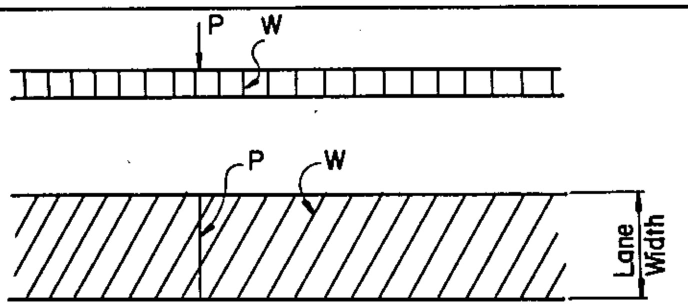
(3) R-O-W Acquisition – This factor is quite serious since it is very difficult to acquire R-O-W along developed areas;

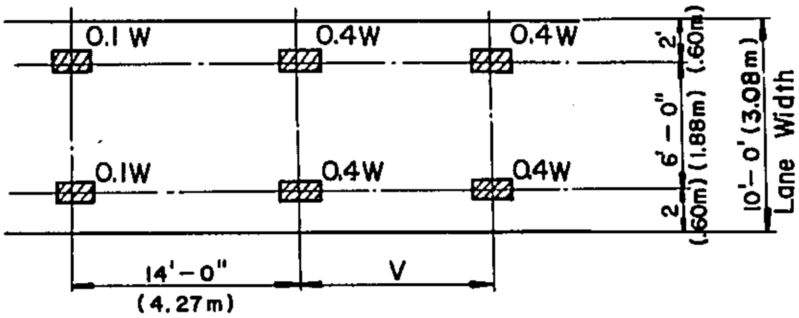
(4) Expressway On-and-Off Ramps – The location of on-and-off ramps near the intersection of Mabini Street in the event Case 1 or Case 2 would be adopted may influence the final decision.

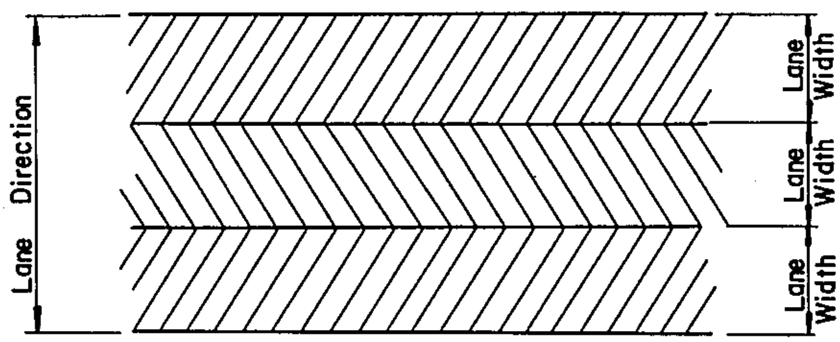
6.6 Bridge Design Criteria

This section deals with the design guidelines, specified loads and other design considerations for bridges and similar structures on the Project Roads.

TABLE 6.6-1 LIVE LOAD STANDARDS FOR ROADWAY

<table>
<tr><th>Item</th><th>Loab Diagram</th></tr>
<tr><td>UNIFORM LANE LOAD, PER LANE OF 10-FT (3-M) WIDTH</td><td>


W = 640 lb per linear ft (290 kg per linear m) of Load Lane
P = Concentrated live load per lane, 18.000 lb (8.165 kg) for moment, 26.000 lb (11.790 kg) for shear.
</td></tr>
<tr><td>TRUCK LOAD, PER LANE OF 10-FT (3-M) WIDTH</td><td>


W = 40.000 lb (18.200 kg)
V = 14 ft (4.27 m) to 30 ft (9.14 m) inclusive. Use spacing that will produce maximum stress.
</td></tr>
<tr><td>LOAD REGION (WIDTH DIRECTION)</td><td>


</td></tr>
</table>

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(1) Basic Design Guidelines

The Standard Specifications for Highway Bridges (11th Edition, 1973), adopted by the Association of American State Highway Officials (AASHO) were used as principal guidelines for the structural design of the bridges. In cases not covered by these standards, DPH and Japanese Ministry of Construction standards were adopted.

Other design guidelines used were as follows:

(a) Travelled way width on the bridge shall be the width of the road approach minus the widths of green belts and ancillary roads. This width of the bridge shall be carried 5 m out from the abutment backwalls and tapered to meet the full width of the road.

(b) Abutments of bridge must be located on the top of the channel banks.

(c) Bridges at tangent sections must have a roadway cross slope of 1.5% and bridges on curved sections shall be superelevated in accordance with the design speed of the route.

(2) Conversion of AASHO Loading Standards to Metric System

(a) Tables 6.6-1 and 6.6-2 show the metricated AASHO live load standards for roadways and sidewalks.

TABLE 6.6-2 LIVE LOAD STANDARDS FOR SIDE WALK

Members Considered	Load on Sidewalk
1. Sidewalk floor, and immediate supports	85 lb/ft^2 (416 kg/m^2)
2. Girders, trusses, arches and other members	1. Spans, 0 to 25 ft (0 to 7.6 m) long 85 lb/ft^2 (416 kg/m^2) 2. Spans, 26 to 100 ft (7.9 m to 30 m) long, 60 lb/ft^2 293 kg/m^2) 3. Spans over 100 ft (30 m) long $P(ft) = (30 + \frac{3000}{L})(\frac{55 - W}{50})$ $P(m) = (146.4 + \frac{4464.6}{L})(\frac{16.76 - W}{15.24})$ P(ft) = Live Load per sq ft (max. 60 lb/ft^2) P(m) = Live Load per sq m (max. 293 kg/m^2) L = Loaded Length of Sidewalk (ft or m) W = Width of Sidewalk (ft or m)

(b) Table 6.6-3 shows the converted AASHO Dead Load Standard converted to the metric system

TABLE 6.6-3 DEAD LOAD STANDARD

Material	AASHO Unit Wt.	
	lb/ft³	kg/m³
Steel (Cast or Forged)	490	7,850
Cast Iron	450	7,210
Timber (Treated or Untreated)	50	800
Reinforced Concrete	150	2,400
Stone	200	2,720
Bitumen Pavement	150	2,400

(c) The AASHO Standard Impact Coefficient (i) is converted in the following manner:

$$i = \frac{50}{125 + L} \qquad \text{L in ft}$$

$$i = \frac{15.24}{38.10 + L} \qquad \text{L in m}$$

(3) Loads due to earthquakes were determined by adopting the DPH standards for the same:

(a) Load to Superstructure – 10% of the dead load plus 10% of 1/2 the live load (all lanes fully loaded) applied at the bridge bearings.

(b) Load to Substructure – 10% of the dead load applied at the center of gravity of the section.

6.7 Preliminary Design of Bridge and Overpass Structures

6.7.1 General

Preliminary design plans of the bridge and overpass structures are shown in Appendix 2 – Drawings.

The Study calls for the construction of 11 bridges over waterways and three overpass structures with a combined total length of 1,230 m. The longest bridge with a total length of 250 m will be along the New Harbor Road spanning the Pasig River, while the bridge along C-4 across the Malabon River will be 120 m long and the bridge along R-10 crossing the Marala River 100 m in length. Four other bridges are each 90 m long while one is 70 m, five are 60 m and one is 30 m long.

6.7.2 Locations and Parameters of Bridge and Overpass Structures

The locations and structural parameters of the bridges and overpass structures along the Project Roads are briefly described as follows:

(1) Bridge 1

Br-1 will be situated along R-10 about 130 m east of the existing (wooden) Marcos Bridge crossing the Fishermen's Passage. A 60-m long bridge (two 30-m spans) is proposed to cross the channel at 25° left foot forward skew. The results of the boring tests show that piles will have to be driven to 20-m depths measured from the channel bed.

Existing roads running parallel to R-10 will be used as access to the Br-1 site for transporting construction materials and equipment.

(2) Bridge 2

Br-2 will be located along R-10 at the mouth of Estero de Vitas and between the two interchanges at C-2 and C-3. A structure of two 30-m spans sufficient for the required waterway opening and approaches will be built on fill and supported by retaining walls on both sides. Br-2 will cross the waterway at a skew of 20° left foot forward. Boring test results indicate the need for foundation piles of at least 20-m lengths to be driven below the seabed in order to reach suitable dense bearing strata with a minimum N-value of 50 blows.

Since there is no existing road to this site, the construction of a temporary access road for transporting construction materials and equipment will be necessary until the embankment of R-10 within the vicinity will be completed.

(3) Bridge 3

Br-3 will be located along R-10 at the mouth of the Marala River on the seaside and between the City of Manila garbage dump area and the C-3 interchange. The deeper portion of the sea channel with an approximate water depth of 5 m is on the interchange side of the Br-2 site while the shallower portion of about 1 m depth is on the garbage dump area side. The waterway opening under the bridge should be kept sufficiently wide for draining flood waters from the Dagat-Dagatan Resettlement area. Hence, a 100-m long bridge on piles running at a 27° left foot forward skew is proposed. Piles of about 20-m length will be required based on boring test results.

A temporary access road to the site for transporting construction materials and equipment must be constructed from North Bay Blvd. at the Isla de Cocomo area.

(4) Bridges 4 and 5.

Both Br-4 and Br-5 will be located along C-4 and will cross the Malabon and Navotas Rivers, respectively. Four 30-m spans crossing the channel at a 15° left foot forward skew are proposed for Br-4 and two 30-m spans at a 20° right foot forward skew for Br-5. Piles for foundation will also be needed for these two structures just like the other bridges. Existing roads nearby provide accessibility to the site.

(5) Bridges 6, 7 and 8

Br-6, Br-7 and Br-8 will be located along C-3 in the proposed Dagat-Dagatan Resettlement area. The waterways crossed by these bridges are very important main drainage channels of the planned resettlement area, and hence adequate waterway openings conforming with BPW drainage plans are to be provided. A 90-m length (three 30-m spans) bridge running 51° left foot forward skew is proposed for Br-6, while Br-7 will be 60 m (two 30-m spans) long on normal crossing, and Br-8 will be 70 m (20 m + 30 m + 20 m) at an 8° right foor forward skew. All three bridges will be similarly founded on piles. Since there are no existing roads linking the three sites, the construction of temporary access roads will be necessary during construction.

(6) Bridges 9 and 10

Br-9 and Br-10 will be located along C-2 between Juan Luna St. and R-10. Br-9 will span across Estero de Vitas at 11° right foot forward skew while Br-10 will cross the Fishermen's Basin at 32° right foot forward skew. Br-9 will be 30-m long (one 30-m span) and Br-10 will have a total length of 60 m (two 30-m span). Like the other proposed bridges, the substructure of Br-9 and Br-10 will be on piles to provide structurally sound foundations. There are several existing roads within the vicinity which can serve as access to the sites.

(7) Bridge 11

The site of Br-11 is about 500 m downstream of the existing Roxas (Del Pan) Bridge crossing the Pasig River. This bridge will connect the North and South Harbor areas and will cross the Pasig River on a skew line more or less parallel to the alignment of the existing Roxas Bridge. A total bridge length of 250 m is proposed for Br-11 consisting of three 65-m + 70-m + 65-m spans continuous steel box girders and a 25-m prestressed concrete approach span on each end. A vertical clearance of 9.15 m between the HWL and the girders was provided considering the importance of the channel to navigation.

The analysis of boring test results indicate that the design of the substructure should be footings supported on piles of approximately 25-m lengths each.

The site can easily be reached thru either road or river channel during construction.

The pertinent data on the above bridges are summarized in Table 6.7-1, as follows:

TABLE 6.7-1 BRIDGES

Route Designation	Name of Channel	Bridge Width (m)	Spans and Total Length (m)	Area of Bridge (m^2)
R-10 Br-1	Fishermen's Passage	43.0	2 x 30 = 60	2,580
R-10 Br-2	Estero de Vitas	36.3	2 x 30 = 60	2,178
R-10 Br-3	Marala River	29.6	20 + 30 + 30 + 20 = 100	2,960
C-4 Br-4	Malabon River	29.6	4 x 30 = 120	3,552
C-4 Br-5	Navotas River	29.6	2 x 30 = 60	1,776
C-3 Br-6	Dagat-Dagatan Channel	29.6	3 x 30 = 90	2,664
C-3 Br-7	Malabon River	29.6	2 x 30 = 60	1,776
C-3 Br-8	Navotas River	29.6	20 + 30 + 20 = 70	2,072
C-2 Br-9	Estero de Vitas	29.6	1 x 30 = 30	888
C-2 Br-10	Fishermen's Basin	29.6	2 x 30 = 60	1,776
New Harbor Road Br-11	Pasig River	19.9	25 + 65 + 70 + 65 + 25 = 250	4,975
Total Area				27,197 m^2

(8) Overpass Structures

Overpass structures along R-10 will be each provided at the intersections with C-1, C-2 and C-3 to permit continuous thru traffic flows on R-10. A 90-m length (three 30-m spans) structure for each overpass was planned to give sufficient horizontal clearance underneath for a cross road, while a vertical clearance of 4.88 m (16 ft) from the top of the roadway to the bottom of the girders of the superstructure was considered. Foundation piles similar to the other bridges will be required with lengths to be determined from the results of soil boring tests. Access to the sites during construction will be thru existing nearby roads.

The pertinent data on the overpass structures are summarized in Table 6.7-2, as follows:

TABLE 6.7-2 OVERPASS STRUCTURES

Route Designation	Overpass Route	Structure Width (m)	Total Length (m)	Area of Structure (sq.m)
R-10 OP-1	C-1	14.9	3 x 30 = 90	1,341
R-10 OP-2	C-2	21.6	3 x 30 = 90	1,944
R-10 OP-3	C-3	14.9	3 x 30 = 90	1,341

Total Area = 4,626 m^2

6.8 Factors Affecting Design and Selection of Types of Structures

There are several suitably qualified local producers of various construction materials as well as fabricators of structural steel members in the Philippines. The use of locally produced materials such as cement, aggregates and reinforcing steel were considered in the Study. The following were the factors considered affecting the design and selection of the types of structures:

(a) The material considered most suitable is prestressed concrete since this is readily available locally as pretensioned or posttensioned structural members. There are various standard shapes according to use, but the common and standard for bridges are the AASHO type girders that can be made composite with cast-in-place concrete slab.

The superstructure girders of all bridge and overpass structures, except the center spans of the Harbor Bridge (Br-11), are proposed to be the AASHO type of different lengths to meet the individual span requirements. Spans varying from 20 m to 30 m in length have been proposed. The New Harbor Bridge (Br-11) will cross the Pasig River which is an important navigable channel and will require considerable vertical and horizontal clearances underneath the structure in order to maintain the present use for navigation of that section of the channel. Considering the characters of the bridge roadway, including the channel traffic and the acceptable approach grade among others, the center span will be provided with 3-span (65 m + 70 m + 65 m) continuous steel box girders, for which high strength steel material will be imported and locally fabricated.

(b) Bridges along C-2, C-3 and C-4, particularly those located in populated areas, will be provided with R.C. parapet (solid wall) type railings to provide protection against air and sound pollution. For those bridge structures along the shore, standard R.C. railings (single rail with posts interval of ± 2 m) commonly used on bridges in the Philippines are proposed because of their lighter weight compared with the parapet type while coincidentally relieving motorists and pedestrians from claustrophobia or the feeling of being confined within the structure.

(c) The type of abutment for most bridges will be the box type to provide for pedestrian underpasses across the Roads. Other structures including the New Harbor Bridge (Br-11) and overpass structures, will be provided with the breastwall type or the inverted T-type abutments because of the adjacent underpass cross roads.

(d) Intermediate supports or piers of river crossing bridges, except for Br-11, will be pile bent type piers which are the most economical and practical type of piers. This type is also capable of carrying the designed load considering the moderately long and low height of the bridges. The piers of Br-11 will be the columned type founded on piles due to its very long spans and high vertical clearance. Overpass structures will likewise be on columned piers for aesthetic considerations.

(e) Bearing piles of various types and of different kinds of materials are locally produced. Factory-cast prestressed concrete piles with square or round cross-sections are proposed to be used for bridges located at sites readily accessible for delivery of long precast piles, while concrete filled segmental tubular steel piles are proposed for all other bridges.

On account of the height and long spans of Br-11, concrete filled spiral steel piles with large diameters will be the most appropriate.

(f) Aside from those previously considered, other factors in determining the bridge type will also be taken into account such as the availability of local technical knowhow for design and construction, the geographic conditions of the site, practical and convenient construction methods to be adopted, and the cost of the required maintenance.

The comparative construction cost of prestressed concrete bridge structures as against steel bridge structures is shown in Fig. 6.8-1 based on span lengths of 20 m, 25 m and 30 m. The cost comparison is decisively in favor of the prestressed concrete type except for exceptionally long spanned bridges where massive structural members will be required.

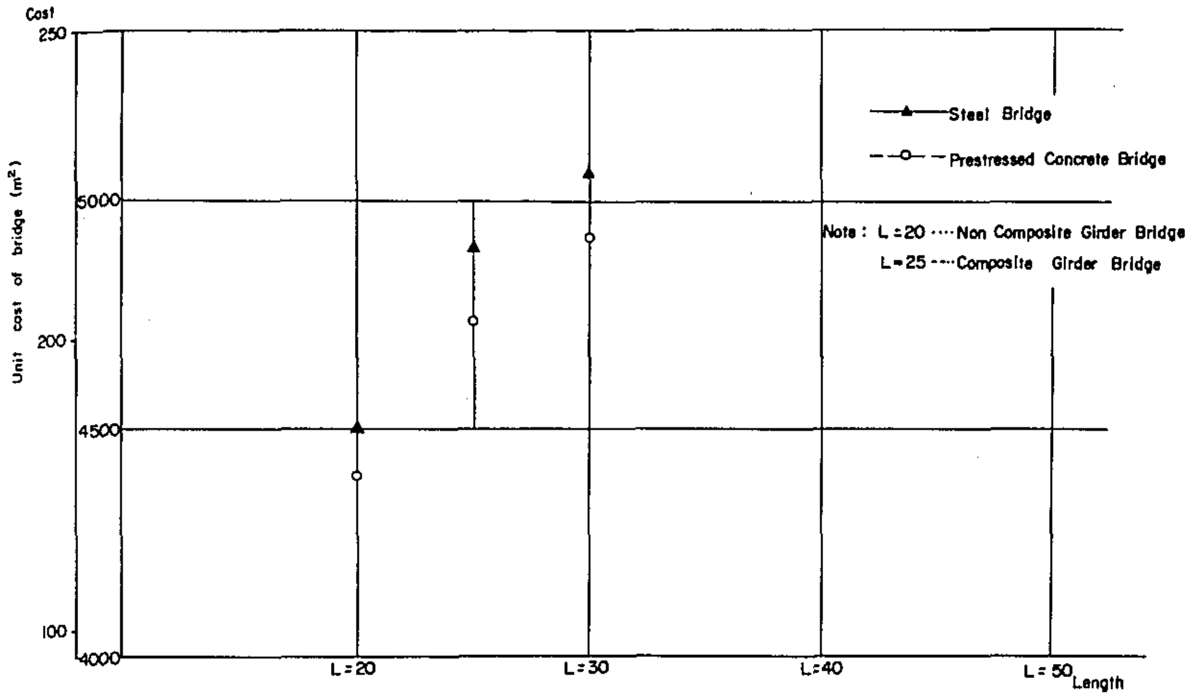

FIG. 6.8-1 COST COMPARISON OF PRESTRESSED CONCRETE BRIDGE AND STEEL BRIDGE

6.9 Expressway

An expressway system was included in the transport system for the MMA proposed by the UTSMMA Study. Since part of this expressway will be along C-4 and R-10, it is therefore necessary to include a brief discussion on the subject in this Study.

The total length of the expressway proposed along the Project Roads is 8,100 m, of which 5,900 m will be along C-4 and 2,200 m along R-10.

The R-O-W width proposed for C-4 and R-10 was determined primarily on the need to accommodate the expressway within the R-O-W. Similarly, the design of the intersection of R-10 with C-4 was influenced greatly by the need to provide a high type interchange at each intersection between expressways, including that of the future extension of R-10.

The design road standards of the expressway and the location of rampways as recommended in the UTSMMA was generally adopted. However, in the process of finalizing the plans of the Project Roads, it is necessary that the UTSMMA proposal should be re-studied as to the location of the rampways considering the ultimate plan to be adopted for the Dagat-Dagatan area and the decision that will be finally made on the type of intersection for R-8 and R-9.

CHAPTER 7
CONSTRUCTION COST

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CONSTRUCTION COST

7.1 Basic Unit Cost Analysis

Prior to 1973, commodity prices in the MMA were relatively stable. In October 1973, however, a worldwide oil crisis dislocated the economies of consumer countries causing rapid fluctuations and escalations of prices and hence making it very difficult to estimate construction material costs for this Study in June 1974. Price variations of such construction materials as reinforcing steel bars and fine graded aggregates during the months of May, June and July 1974 are shown below:

	May	June	July
Reinforcing Steel Bars (kg)	₱ 3.54	₱ 3.46	₱ 6.40
Fine Aggregate (CM)	₱22.00	₱30.00	₱35.00

Price fluctuation during the months of June in 1972, 1973 and 1974 may be seen in the construction material price indices shown in Fig. 7.1-1.

TABLE 7.1-1 UNIT CONSTRUCTION COSTS

Items	Unit	Unit Prices (pesos)	Distribution of Unit Price (%)		
			Tax	Others	Foreign
Portland cement	tons	275	15	35	50
Sand	m^3	35	15	45	40
Gravel	m^3	35	15	45	40
Selected aggregate	m^3	45	15	45	40
Reinforcing steel bar	tons	6,500	10	50	40
Structural steel	tons	20,000	15	35	50
Gasoline	liter	1.1	20	20	60
Motor oil	liter	0.7	20	20	60
Structural fabricated steel materials of box girder	tons	16,400	13	41	46
Steel pipe pile	m	1,700	13	41	46
Tabular steel pile filled with reinforcing concrete	m	720	12	40	48
Stressed concrete	m^3	500	10	55	35
Reinforced concrete of sub-structure	m^3	450	10	55	35
Hand rail	m	125	15	35	50
Prestressed wire	tons	19,500	30	15	55
Excavation for structure	m^3	35	5	60	35

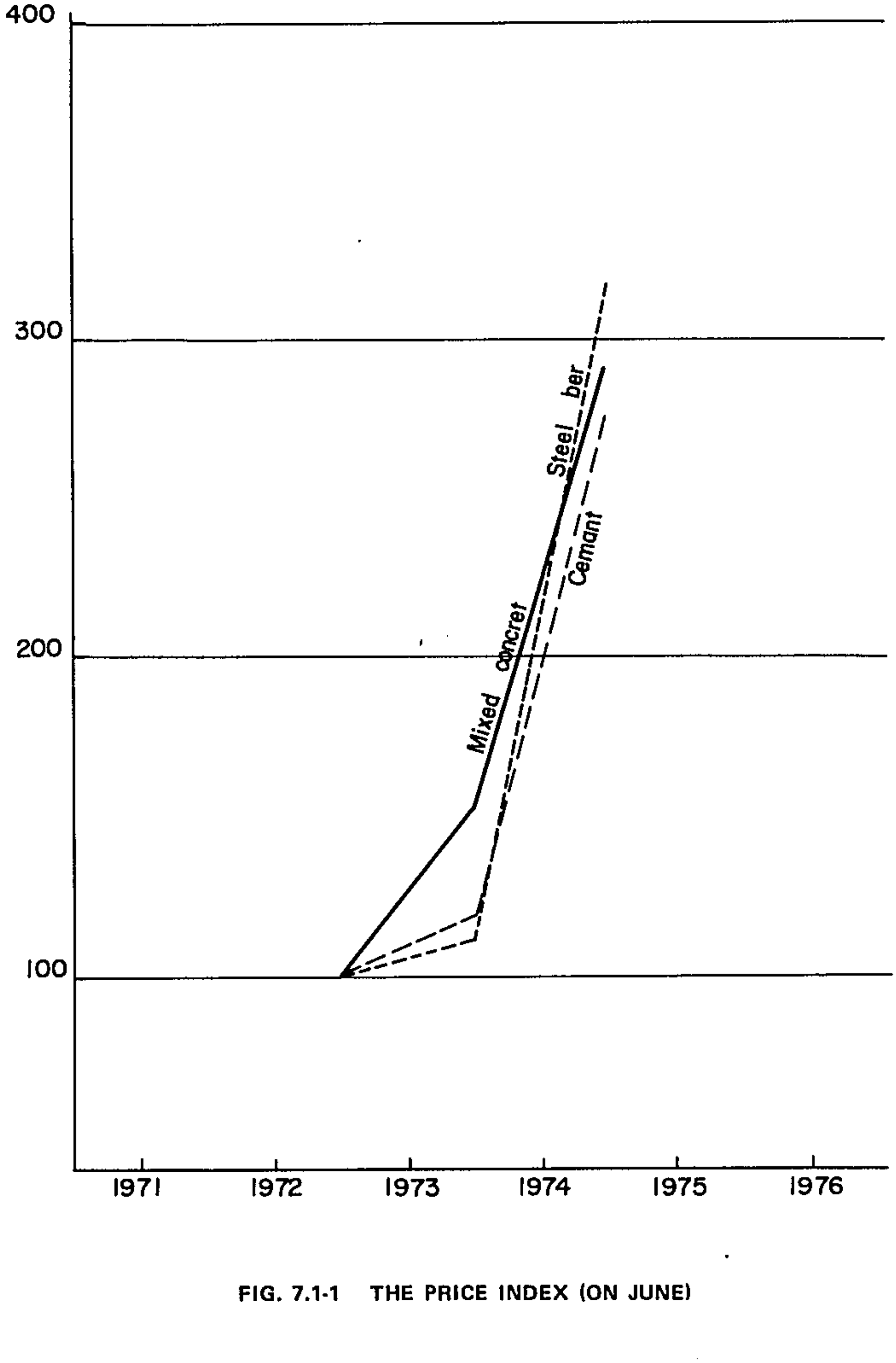

FIG. 7.1-1 THE PRICE INDEX (ON JUNE)

Future prices of commodities can hardly be estimated with reasonable accuracy considering their volatility under the above circumstances. For the purpose of the Study, therefore, calculations of unit prices of construction materials were based on prices prevailing in June 1974. Resultant unit construction costs are shown in Table 7.1-1.

7.2 Construction Cost Estimates

7.2.1 Basis of Calculations

For purposes of this Study, estimates of construction costs were based on the following premises:

(1) Radial Road R-10

(a) Existing road pavements will be removed and repaved utilizing the existing subgrade.

(b) Along the Tondo Foreshore area, the existing ground will be excavated to a depth of one meter below the proposed finished grade elevation and replaced with suitable subgrade materials.

(c) In the Navotas Fisheries Port area, land was reclaimed using dredged material from Manila Bay. Excavations will have to be made 1.70 m below the proposed finished grade to remove and replace the reclaimed materials which are not acceptable for use as subgrade.

(d) The seaside portion of the proposed road will be protected by a seawall constructed with boulders.

(2) Circumferential Road C-1

(a) Existing road pavements will be removed and repaved utilizing the existing subgrade.

(b) On the proposed improvements alongside the existing road, excavations will be made to a depth one meter below the proposed finished grade elevation and replaced with suitable subgrade materials.

(c) The existing PNR railway line will be removed, and a new spur line provided later along the median of the proposed road.

(3) Circumferential Road C-2

The works proposed for Items (a) and (b) for both R-10 and C-1 will be similarly adopted for C-2.

TABLE 7.2-1 CONSTRUCTION ELEMENT LIST

Items	Unit	R-40	C-1	C-2	C-3	C-4	Harbor Road	Total
Formation of embankment	m^3	872,419	4,441	79,137	172,462	140,568	11,469	1,280,496
Excavation of soft rock	m^3	–	–	–	29,577	85,169	–	114,746
Excavation of common soil	m^3	328,123	20,295	62,579	112,041	82,687	14,169	619,894
Excavation of garbage	m^3	–	–	–	–	–	–	–
Excavation of existing pavement	m^2	27,087	11,329	27,552	–	11,614	–	77,582
Sand piling	m	34,694	–	7,417	10,595	4,504	1,005	58,215
Sand mat	m^3	77,071	–	16,468	20,645	10,000	2,230	126,414
Rip rap	m^3	38,603	–	–	–	–	–	38,603
Pavement new reclamation area	m^2	46,717	–	–	42,946	61,758	–	151,421
Pavement underloped area	m^2	203,519	23,131	62,364	8,546	–	14,836	312,396
Pavement soft rock area	m^2	–	–	–	30,060	65,540	–	95,600
Side walk	m^2	52,293	7,425	39,979	20,108	46,763	2,496	169,064
L-type gutter	m	17,666	1,570	5,522	8,128	14,435	2,115	49,436
Concrete curb	m	19,123	1,570	5,411	8,156	17,368	2,115	53,743
Catch basins	era	1,091	105	368	542	916	141	3,163
Lightning	era	183	15	94	64	109	17	482
Traffic sign	era	94	8	49	32	52	10	245
Traffic sign board	era	25	10	12	16	8	4	75
Guard rail	m	1,988	–	–	400	–	478	2,866
Road marking	m	92,346	9,520	23,580	48,730	59,988	7,404	241,568
Sodding and plantation	m^2	147,205	236	7,132	29,165	117,684	800	302,222
Slope sodding	m^2	3,080	–	–	6,552	2,406	–	12,038
Slope guard	m^2	2,232	–	–	2,706	–	–	4,938
Retaining wall less than 3mH	m	819	–	–	–	590	186	1,595
Retaining wall 3 ~ 5 mH	m	244	–	–	50	–	172	466
Retaining wall more than 5mH	m	376	–	–	110	–	120	606
Drain with 12 inches pipe	m	2,206	–	–	–	–	516	2,722
Drain with 18 inches pipe	m	3,795	–	–	1,890	1,650	667	8,002
Drain with 24 inches pipe	m	4,941	1,030	1,573	2,880	4,350	881	15,655
Drain with 36 inches pipe	m	3,840	–	–	916	3,560	333	8,649
Drain with 48 inches pipe	m	1,590	–	–	430	620	–	2,640
Culvert 2m x 2m	m	–	–	1,440	–	–	–	1,440
Culvert 2.5m x 2.5m	m	–	831	1,688	–	–	–	2,519
Culvert 3m x 3m	m	–	–	600	–	–	–	600
Concrete manhole 1.2m	era	222	26	39	124	149	45	605
Concrete manhole 1.5m	era	139	–	–	30	104	7	280
Replacement of PNR		–	830	–	–	–	–	830
Bonifacio monument	era	–	1	–	–	–	–	1
Under passing work	era	–	–	–	–	1	–	1

(4) Circumferential Road C-3

The works proposed for Items (a) and (b) for both R-10 and C-1 will be similarly adopted for C-3, except in that portion between R-9 and the PNR line where the existing ground will be excavated to a depth of only 0.70 m below the proposed finished grade elevation.

(5) Circumferential Road C-4

(a) The works proposed for Items (a) and (b) for both R-10 and C-1 will be similarly adopted for C-4.

(b) The Bonifacio Monument will be temporarily removed. To hasten excavation work for the underground road beneath the monument, H-piles will be driven to serve as columns for temporary retaining walls by using 45-cm diameter drills. After completion of the underground road, the monument will be restored to its original position.

7.2.2 Work Items and Quantities

The principal items and quantities of work considered in the construction cost calculations for roads and bridges are shown in Table 7.2-1 and Appendix Tables 7.2-1 ~ 7.2-2.

7.2.3 Construction Cost Estimates

The economic and financial construction costs were calculated based on the unit prices indicated in Table 7.1-1. The results of such economic and financial calculations are shown in Tables 7.2-2 and 7.2-3 and Appendix Tables 7.2-1 ~ 7.2-2.

Construction costs were estimated at the assumption that all works would be done by domestic contractors. And each unit cost was broken down to tax, foreign, and other domestic elements. Foreign elements were calculated based on Cost Insurance Freight (CIF) value about imported equipment, materials, fuels, etc. Tax was calculated based on custom code of Philippines, etc.

7.3 Right-of-Way Acquisition

7.3.1 Existing Land and Improvements

In July and August 1974, an assessment survey of land costs, houses and households were conducted at the R-10 project site in order to obtain the necessary data for estimating the cost of acquiring the project roads right-of-way. The data obtained were classified as follows:

(1) Owner, area and cost of land.

(2) House occupant, floor area, year constructed, type of improvement and assessed value.

TABLE 7.2-2 ECONOMIC COST

(Thousand pesos)

Year	Acquisition of Right of Way	Construction Cost			Total
		Bridge	Roadway	Sub Total	
1975	64,554	–	–	–	64,554
1976	80,000	28,971	23,120	52,091	132,091
1977	58,764	25,686	40,652	66,338	125,102
1978	47,953	14,177	35,709	49,886	97,839
1979	29,515	15,036	35,831	50,867	80,382
1980	–	22,647	44,564	67,211	67,211
1981	–	39,428	23,622	63,050	63,050
Total	280,786	145,945	203,498	349,443	630,229

Remark: Cost in 1974

TABLE 7.2-3 INVESTMENT REQUIREMENT

(Thousand pesos)

Year	Acquisition of Right of Way	Construction Cost			Total
		Bridge	Roadway	Sub Total	
1975	69,202				69,202
1976	91,934	45,526	37,131	82,657	174,591
1977	72,393	46,255	70,106	116,361	188,754
1978	63,328	25,590	65,994	91,584	154,912
1979	41,784	31,164	70,628	101,792	143,576
1980	–	75,021	60,737	135,758	135,758
1981	–	63,357	100,185	163,542	163,542
Total	338,641	286,913	404,781	691,694	1,030,335

Remarks: 1. Cost in 1974

2. Price increase 7.2% per year

(3) Number of households

For evaluating the cost of affected improvements, the following values per unit of floor area were used:

R.C. Building (5-storey and over)	₱1,000/sq m
R.C. Building (4-storey and less)	750/sq m
Concrete Hollow Block Houses	600/sq m
Steel Framed Structures	500/sq m
Wooden Houses	400/sq m
Shanties	100/sq m

7.3.2 Reclaimed Land

The project roads will traverse thru areas to be reclaimed for related developmental projects such as the Vitas Industrial Complex, Navotas Fisheries Port and the Dagat-Datagan Resettlement Area. Acquisition cost of road right-of-way within these areas were estimated as the sum of the prevailing land cost in the area plus reclamation costs. Within the Fisheries Port, acquisition cost was estimated at ₱30/sq m, considering an average volume of 4 cu m/sq m. On the other hand, acquiring right-of-way within the Dagat-Dagatan area was estimated at ₱25/sq m, based on an average volume of 3 cu m/sq m.

7.4 Maintenance Cost

The average annual maintenance cost in the Philippines for a 2-lane road of 6.10 to 6.70-m roadway width is ₱6,420 per km. For this Study, additional costs for the maintenance of road lighting, repair of bridge joints, periodic coating of steel bridges, etc. were included. Taking the above into account, annual maintenance cost for a six-lane road was estimated at ₱58,000 per km.

7.5 Stage Construction Plan

Stage construction of the project roads should be planned to take into consideration the following factors:

(1) Since the project roads are closely connected to the Dagat-Dagatan Resettlement and other development projects, the timing of construction of the project roads should be coordinated with the schedule of implementation of all related development projects;

(2) Any project road or part thereof to be constructed in stages should be so constructed so that each stage section will be fully functional;

(3) The each stage section to be constructed should he determined on the basis of comparative analysis of economical view points;

(4) Existing traffic bottlenecks should be improved;

(5) Construction costs should be distributed equally among the different stages of construction.

The three-stage construction plan for this Study is shown in Fig. 5.3-1. The years indicated therein are expected completion dates. By 1977, vital sections of R-10 and all the related sections of C-1 and C-3 are scheduled to be completed to coincide with the expected completion of the related Dagat-Dagatan Resettlement Project and Navotas Fisheries Port Project. By 1979, most of the project roads are to be completed except for the New Harbor Road, and that section of R-10 traversing the proposed Tondo Urban Renewal Project area and C-4 between R-8 and R-9, which are three sections scheduled to be completed by 1981.

CHAPTER 8
ENVIRONMENTAL IMPACTS

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ENVIRONMENTAL IMPACTS

8.1 General

While it is desirable to show that the impact of the R-10 Project on the environment has been considered and that adequate provisions for mitigation have been made, the R-10 Project is so closely inter-related to five other large development projects in the area that a truly comprehensive environmental impact analysis cannot be made separately but must be considered in relation to each of the other projects. Moreover, the proposed roads will mostly pass through existing open spaces which have been or will be reclaimed for other development purposes. Any negative ecological or social impacts would therefore be insignificant particularly if only the R-10 Project is considered. Certain steps should be taken by the GOP in the future however, to ensure that R-10 will be environmentally acceptable.

8.2 Description and Alternatives

Descriptions of the R-10 Project and of the existing physical environment are given in other chapters of this Study. Alternative schemes, alignments, locations, structures and solutions have also been discussed and analysed in their respective individual sections, while a "no project" alternative would involve using the existing road networks which is clearly inadequate for the present and future development projects in the area. The cost of the R-10 Project of ₱1,030,346,000 could be used for other priority infrastructure and development projects planned in the Philippines, but the resulting traffic congestion throughout MMA and the inefficient use and unrealized benefits of the development projects, far outweigh the costs to be incurred.

8.3 Project Impacts

(1) The physical features of the Tondo Foreshore area and Dagat-Dagatan Resettlement area will be modified by reclamation of approximately 184.1 hectares.

Mitigation:
The impact of R-10 on physical features of the Tondo Foreshore and Dagat-Dagatan area will be offset by the creation of a new and much improved road network for the transport of persons and goods.

(2) The existing residential and commercial developments along the sections of C-1, C-2, C-3 and C-4 will have to be removed and modified in accordance with R-O-W requirements of

the Project.

Mitigation:

The value of the land and improvements to be removed are relatively low on the average and will be compensated by acquisition of new land and/or dwellings and resettlement for the displaced families consisting of about 25,000 persons.

(3) Construction of the Project Roads will modify the existing surface drainage pattern in the areas and cause flooding. The roads will intersect 10 creeks and waterways draining towards Manila Bay.

Mitigation:

No drainage and flooding problems will be created since adequate conduits, pipes and other provisions will be installed in and around the Project Roads to take care of surface run-off and prevent flooding.

(4) About 430 hectares of fishponds will be removed from production and thus reduce productivity of fish in the area correspondingly.

Mitigation:

The entire Dagat-Dagatan fishpond area will be reclaimed for the resettlement project which has very high social impacts to offset the loss in food productivity.

(5) The Project Roads will cut through many parcels of land which may decline in value correspondingly.

Mitigation:

The effect of cutting up these properties will be offset by providing direct access to a major thoroughfare. All severed properties will be compensated adequately. Land use plans along the Project Roads were not finalized by other agencies prior to this Study, so that this factor should be considered when these plans are finalized.

(6) The surrounding communities will be inconvenienced during construction by noise, gas fumes, dust and dirt, and by general nuisance caused by unstable and abnormal conditions associated with construction activity.

Mitigation:

While nuisance and inconvenience cannot be completely offset, they can be significantly reduced by proper construction management and supervision and the use of proper construction equipment and methods so as to minimize the conditions described above.

(7) During construction, the labor force and their families may settle in open areas resulting in extreme congestion and the establishment of new slum areas with its adverse social implications.

Mitigation:
The construction contractor should be required to provide the necessary housing and other facilities for migratory labor during construction and to remove all temporary structures and accommodations at the land.

(8) The influx of workers during construction will strain existing and already inadequate public services and facilities in the area so that public health could deteriorate.

Mitigation:
The Government and the contractors should collaborate in providing the necessary services and facilities, since additional income will be generated to support the costs of such services and facilities.

(9) Construction of the C-4 segment will entail temporary removal and possibly cause permanent damage to the Bonifacio Monument which has very high historical and cultural values.

Mitigation:
The plan to be adopted for removing the monument should be double-checked to determine its soundness and to reduce the possibility of permanent damage. The necessary precautions should be taken during the dismantling of the monument and its restoration.

(10) Providing a major access to areas traversed by the Project Roads would encourage their transformation to residential, commercial and industrial communities which may lead to congestion and disorderly development. While growth is desirable, it may have serious long-range consequences unless it is properly planned.

Mitigation:
Zoning regulations should be properly enforced by Government so that development would be environmentally acceptable.

(11) The surrounding communities will be inconvenienced by the noise, air pollution, vibration and other nuisance factors caused by the increase in vehicular movement along the Project Roads.

Mitigation:
Buffer zones and green belts will be provided and will be designed in the proper number,

dimensions and locations (such as near hospitals and schools) to reduce the effects of airborne dust, noise, etc.

(12) The project is estimated to cost 1,030 Million ₱ as of 1974 to be incurred over a period of 7 years, while annual operation and maintenance costs are estimated to be 6 Million ₱ starting 1978.

Mitigation:
The benefits of the Project have been found to be well in excess of its costs, and the per capita annual burden for the beneficiaries of the Project Roads in the MMA will be insignificant and will be very much within their capacities.

8.4 Favorable Impacts

(1) The Project Roads would handle the expected large flow of traffic in the area due to existing and proposed developments.

(2) The diversion of cargo traffic directly to a major thoroughfare will relieve the present traffic congestion in the Tondo-Binondo area, directly benefiting over 563 thousand persons.

(3) The smoother flow of traffic in the MMA will result in considerable reduction of losses in man-hours, fuel, depreciation, etc.

(4) The R-10 Project would generate employment for about 1,251 thousand persons.

(5) Land values surrounding the Project Roads will be greatly enhanced and new areas will be opened and made accessible.

(6) Savings in fuel and other items requiring foreign currency will strengthen the country's balance of payment and foreign exchange position.

(7) Technical skills and expertise will be further developed during the design and execution stages of the Project.

(8) The construction and construction materials industries will be greatly benefited by implementation of this Project by the generation of a considerable demand for goods and services.

(9) The smoother flow of goods to and from the ports will mean corresponding reductions in selling prices at their markets to the benefit of consumers in the MMA and elsewhere.

8.5 Other Environmental Conditions

The R-10 Project would have no impact on natural vegetative cover since it is located in an urban area. Wildlife and endangered or protected species would not be impacted. There would be very insignificant effects on marine life and species in the foreshore area, and no known historical or cultural sites, except for the Bonifacio Monument, are found at the project site.

8.6 Recommendations

The following recommendations are made to ensure that the Project will be environmentally acceptable during and after construction:

(1) Every significant environmental impact should be identified and appropriate mitigation measures specified during the final design of the Project.

(2) Construction specifications should be so prepared so as to reduce or eliminate the usual nuisance effects of construction.

(3) The contractors should be required to provide adequate housing and sanitary facilities for their work force, and that proper sanitary habits are practiced.

(4) Expropriated properties should be properly compensated and displaced families resettled satisfactorily.

CHAPTER 9

TRAFFIC COST

CHAPTER 9
TRAFFIC COST

9.1 General

As per agreement between the Government of the Philippines and the Japanese Study Team, traffic costs indicated in the Reconnaissance Report of the Road Feasibility Studies II prepared in 1972 by Norconsult A.S. of several UNDP/IBRD assisted road projects in Luzon for the GOP were used as the basis for the determination of traffic costs for this Study.

In this study, vehicles were classified into cars, buses and trucks in determining the traffic cost by type. However, the average traffic cost for buses was further broken down to big buses, mini-buses and jeepneys by classifying present vehicle registrations into weight categories.

Taxes were excluded from traffic cost calculations to determine the net benefits.

9.2 Components of Traffic Cost

In this Study, traffic costs were limited to two components, i.e. running cost and time cost, excluding other costs such as accident and opportunity costs.

(1) Running Cost

Running costs were classified into distance determined costs and time-determined costs. The former consists those of fuel, tyres, vehicle depreciation, maintenance and repair while the latter personnel expenses, vehicle depreciation and maintenance. The distance-determined costs are further classified by the type of roads. (Table 9.2-1)

Vehicle depreciation costs were broken down to distance-determined deterioration and time-determined deterioration (Table 9.2-1) in which the former was further classified into two types: those dependent on and those independent of road conditions. Other data related to the vehicle depreciation such as vehicle prices and lifetimes were also included.

(2) Time Cost

The time cost is the time value of car drivers, car passengers and bus passengers.

TABLE 9.2-1 VEHICLE DEPRECIATION

Vehicle Types			Cars	Buses	Trucks
Prices (1,000 Pesos)	Including Tax		23.7	67.5	84.8
	Excluding Tax		18.4	54.8	68.2
Deterioration (%)	Distance-Determined	Dependent on road conditions	50	50	
		Independent of road conditions	10	25	
	Time-Determined		40	25	
	Total		100	100	
Lifetimes (1,000 km)	Road Type A		455	760	625
	Road Type B		180	505	395
	Road Type C		180	455	355
	Road Type D		120	305	235
	Road Type E		110	120	215
	Road Type F		110	120	.215
	Average of A to F				
Annual running distance (1,000 km)			16	75	33
Annual running time (hr)			2,250	3,000	2,500

Source: Norconsult Reconnaissance Report

9.3 Running Cost

9.3.1 Distance-Determined Running Cost

(1) Fuel Cost

The fuel prices in Manila as of February 1974 are shown in Table 9.3-1.

Fuel consumption per kilometer varies with road conditions and running speed. The relation of fuel consumption with the vehicle speed by road type was established based on the data determined from survey in Japan as shown in Table 9.3-2.

Fuel cost was calculated by the following formula:

Fuel Cost = UCF x FC

where, UCF = unit cost of fuel as shown in Table 8.3-1

FC = fuel consumption as shown in Table 8.3-2 taking into consideration the vehicle speed obtained from the traffic assignment.

TABLE 9.3-1 RETAIL FUEL PRICES IN MANILA

(Pesos/Liter)

Fuel Types	Automotive Diesel	Regular Gasoline
Price Excluding Tax	0.61	0.61
Price Including Tax	0.81	0.96

Source: Norconsult Reconnaissance Report

(2) Oil Cost

Oil prices in Manila as of February 1974 are shown in Table 9.3-3.

The difference of prices for cars and other vehicles were considered due to various brands and suppliers.

(3) Tire Cost

Tire life by road type was obtained by the following formula:

$$Lpi = Lji \times \frac{ALp}{ALj}$$

where, Lpi = Tire life for the road type i in the Philippines

i = Type of Roads (A to F)

Lji = Tire life for the road type i in Japan

ALp = Average tire life in the Philippines

ALj = Average tire life in Japan

The results of the above calculations including tire prices are shown in Table 9.3-4.

TABLE 9.3-2 CORRELATION BETWEEN AVERAGE SPEED AND AVERAGE FUEL CONSUMPTION

Unit: cc/km

Vehicle Type km/h	Mini Car (360 cc)	Small Car (1200 cc)	Medium Car (2000 cc)	Small Truck (2 ~ 4 ton) gasoline	Heavy Truck (6 ~ 8 ton) diesel	Bus (70 ~ 86 persons) diesel
4	119	170	245	328	415	421
6	112	160	233	321	410	417
8	104	149	220	311	403	410
10	97	139	208	297	391	400
12	90	130	196	285	375	387
14	85	122	185	273	358	374
16	80	115	175	262	343	362
18	76	109	166	253	332	350
20	73	104	160	244	321	339
22	70	100	154	235	312	329
24	68	96	149	228	303	320
26	66	94	144	220	294	312
28	64	91	140	213	286	303
30	63	88	135	208	280	296
32	61	85	131	202	271	288
34	60	82	127	196	264	282
36	58	80	123	191	258	276
38	57	77	120	186	252	268
40	56	75	116	181	245	262
42	55	73	113	176	240	256
44	54	72	111	173	235	251
46	54	70	108	170	231	246
48	54	69	106	167	227	242
50	53	68	105	165	223	238
52	53	67	103	163	220	235
54	53	66	101	161	218	232
56	54	66	100	161	216	230
58	55	66	99	161	213	228
60	55	65	98	161	211	227
62	56	65	97	162	210	228
64	56	65	97	163	212	230
66	57	66	96	163	214	232
68	58	66	96	164	216	234
70	59	67	95	165	219	237
72	60	67	95	167	222	240
74	61	68	94	170	225	243
76	62	69	94	173	229	246
78	63	70	93	176	233	249
80	65	71	93	179	237	253

TABLE 9.3-3 OIL PRICES (Pesos/Liter)

Vehicle Types	Cars	Buses & Trucks
Price Excluding Tax	2.87	2.37
Price Including Tax	3.25	2.75

Source: Norconsult Reconnaissance Report

TABLE 9.3-4 TIRE SET PRICES AND TIRE LIFETIMES BY ROAD TYPES

	Tire set prices (Pesos)		Tire lifetimes (1000 km)						
Vehicle Type	Including Tax	Excluding Tax	A	B	C	D	E	F	Average of A to F
Car	660	610	41	61	54	54	51	51	52
Bus	3200	2980	61	79	74	70	66	66	69
Truck	3640	4000	86	97	91	88	81	81	87

(4) Distance-Determined Vehicle Depreciation Cost

Vehicle depreciation cost is obtained by the following formula:

$$Cvd = \frac{d_1 \times Cc}{A_{Lrt}} + \frac{d_2 \times Cc}{A_L}$$

where, Cvd = vehicle depreciation cost

Cc = capital cost excluding tax

d_1 = distance-determined depreciation value dependent on road condition, in %

d_2 = distance-determined depreciation value independent of road condition, in %

A_{Lrt} = average vehicle life dependent on road condition, in km

A_L = average vehicle life independent of road condition, in km

Data necessary for the above calculations are shown in Table 9.2-1.

(5) Maintenance and Repair Costs

Maintenance costs in this section consist of distance-determined maintenance & repair costs and time-determined maintenance & repair costs. The latter was included because it was considerably small. Table 8.3-5 shows maintenance & repair requirements.

All the above costs include costs for labor and parts.

TABLE 9.3-5 MAINTENANCE AND REPAIR REQUIREMENTS

Items \ Vehicle Types	Cars	Buses	Trucks
Labor Cost* (hr/yr)	50	200	150
Parts Cost (% of vehicle cost)	2.5	5.0	10.0

* Unit labor cost was estimated at ₱2.5/hr including allowance for basic tools and overhead.

Source: Norconsult Reconnaissance Report.

(6) Total Running Cost

The total distance-determined running cost is the sum of all the aforementioned costs as shown in Table 9.3-6.

9.3.2 Time-Determined Running Cost

Table 9.2-1 shows the annual running time by vehicle type necessary to estimate time-determined running costs.

(1) Crew Cost

The crew cost is calculated separately for bus and truck drivers, bus conductors and truck loaders. The hourly crew cost described in the Norconsult Reconnaissance Report was ₱2.00 for truck and bus drivers, ₱1.00 for conductors, and ₱1.00 for truck loaders. Since these figures were estimated for the rural areas, they were modified because of the disparity between incomes in the MMA and in rural areas. Since average income of workers in 1972 was ₱5,202 in the MMA and ₱2,454 in rural areas, this 2:1 ratio was applied to the calculation of crew costs shown in Table 9.3-7.

(2) Time-Determined Depreciation Cost

The time-determined depreciation cost was obtained by the following formula:

$$C = P \times a \div L \div R$$

where, C = time-determined depreciation cost

P = capital cost of vehicles

a = Rate of time-determined deterioration

L = Vehicle life

R = Annual running time

All the data necessary for the calculation of time-determined depreciation cost are shown in Table 9.2-1.

TABLE 9.3-6 DISTANCE-DETERMINED RUNNING COST

Vehicle Types / Road Types / Items of Cost	Cars						Buses						Trucks					
	A	B	C	D	E	F	A	B	C	D	E	F	A	B	C	D	E	F
Fuel Costs	0.064	0.061	0.061	0.061	0.064	0.070	0.130	0.120	0.114	0.114	0.120	0.130	0.174	0.159	0.154	0.154	0.161	0.178
Oil Costs	0.005	0.003	0.004	0.004	0.004	0.004	0.009	0.005	0.006	0.008	0.008	0.008	0.007	0.005	0.007	0.008	0.008	0.008
Tire Costs	0.015	0.010	0.011	0.011	0.012	0.012	0.049	0.038	0.040	0.043	0.045	0.045	0.042	0.038	0.040	0.042	0.045	0.045
Depreciation	0.021	0.054	0.054	0.081	0.088	0.088	0.034	0.050	0.056	0.083	0.207	0.207	0.052	0.079	0.089	0.132	0.147	0.147
Maintenance & Repair Costs	0.016	0.039	0.039	0.048	0.051	0.051	0.055	0.088	0.092	0.130	0.139	0.139	0.055	0.088	0.092	0.130	0.139	0.139
Total	0.121	0.167	0.169	0.205	0.219	0.225	0.277	0.301	0.308	0.378	0.519	0.529	0.330	0.369	0.382	0.466	0.500	0.517

TABLE 9.3-7 CREW COSTS

	Crew Costs
Truck and Bus Drivers	4.0 per hour
Conductors	3.2 per hour
Truck Guards & Loaders	2.0 per hour

(3) Overhead Cost

The overhead cost of commercial vehicles was assumed to be ₱1,000/vehicle/year, divided by the annual running hours of the vehicle.

(4) Total Time-Determined Running Cost

The total time-determined running cost is the sum of the three above-mentioned costs as shown in Table 9.3-8.

TABLE 9.3-8 TIME-DETERMINED RUNNING COSTS

(Unit: Pesos/Hour)

Vehicle Type	Share (%)	Time-Determined Depreciation Costs	Crew Costs	Miscellaneous Costs	Time-Determined Running Costs
Car	63	0.10	0.00	0.05	0.15
Bus	9	0.70	7.20	0.53	8.43
Truck	28	0.59	4.85	0.70	6.14
Total	100	0.29	2.01	0.28	2.57

9.4 Time Cost

In this section the time cost for car drivers, car passengers and bus passengers was estimated based on the following assumptions:

Commuting to work:	Half value of worker's income per hour
Going to school:	No value
Private:	Quarter value of worker's income per hour
Work:	Whole value of worker's income per hour

The value of commuting to work trips was assumed to be one-half of a worker's income because a worker has two choices for using extra time either for productive or non-productive uses.

The time cost was considered only for workers, but not for students, housewives and jobless.

The time cost for private trips is one-fourth of worker's income/hour because of the nature of private trips which consist of those trips made equally by workers and non-workers.

The time cost per worker in the MMA was estimated to be ₱4.00/hour based on NEDA's (National Economic Development Authority) Annual Report for 1974.

Assuming that the time value of workers using passenger cars is higher than that of ordinary workers, their time cost was set at ₱6.00/hour which is 50% higher than the cost of ordinary workers.

The time cost for bus passengers was assumed at ₱2.00/hour.

The time cost per vehicle unit per hour was obtained based on the average number of passengers per vehicle by type and the share of each trip purpose to the total trips by vehicle type. The average time cost of all types of vehicles was determined for estimating benefits based on the weighted average time cost of each type of vehicle.

CHAPTER 10

ECONOMIC EVALUATION

CHAPTER 10
ECONOMIC EVALUATION

10.1 Evaluation Method

10.1.1 Economic Indicators

The economic need of the Project Roads was evaluated based on the following indicators:

(1) Net present worth (NPW)

(2) Benefit-cost ratio (B/C)

(3) Internal rate of return (IRR)

10.1.2 Discount Rate

In this Study, a discount rate of 15% was assumed considering the prevailing market rate of interest and the opportunity cost of capital in the Philippines.

10.1.3 Project Life

The project life was set at 20 years used in other road feasibility studies prepared for the IBRD considering the practice of maintaining and operating roads in the Philippines.

10.1.4 Economic Life

The economic life of a project is defined as the period for which the B/C ratio becomes 1.

10.2 Benefits

10.2.1 Types of Benefits

The benefits derived from the road project consist of direct and indirect benefits.

In this Study, the direct benefits were made up of savings in running time and reduction of running cost, while the indirect benefits consisted of enhanced land development, enhanced trade and commerce, and more effective utilization of vehicles. In this study, only the direct benefits were considered.

Both road users and non-road users will be the beneficiaries of the Project Roads as indicated in Study. Road users will receive benefits derived from the direct use of the road, while non-road users will also receive benefits derived from improvement in the running condition of vehicles on existing roads.

10.2.2 Method of Benefit Estimates

The time benefit was calculated from the following formula:

$$TB = \sum_{ij} (t_{ij}^{w} - t_{ij}^{wo}) \cdot X_{ij} \cdot V$$

where, TB = Time Benefit

t_{ij}^{w} = Travel time between zones in case the project is implemented

t_{ij}^{wo} = Travel time between zones in case the project is not implemented

X_{ij} = Traffic volume between zones

V = Time value

The distance-determined running benefit was calculated from the following formula:

$$RB1 = \sum_{ij} (C_{ij}^{w} - C_{ij}^{wo}) \cdot X_{ij}$$

where, $RB1$ = Distance-determined running benefit

C_{ij}^{w} = Running cost between zones in case the project is implemented

C_{ij}^{wo} = Running cost between zones in case the project is not implemented

X_{ij} = Traffic volume between zones

The time-determined running benefit was calculated from the following formula:

$$RB2 = \sum_{ij} (t_{ij}^{w} - t_{ij}^{wo}) \cdot X_{ij} \cdot C$$

where, $RB2$ = Time-determined running benefit

t_{ij}^{w} = Travel time between zones in case the project is implemented

t_{ij}^{wo} = Travel time between zones in case the project is not implemented

X_{ij} = Traffic volume between zones

C = Time-determined running cost per travel time

10.2.3 Results of Calculations

Table 10.2-1 shows the result of traffic assignments with and without the project roads. The estimated benefits calculated on the basis of Table 10.2-1 are shown in Table 10.2-2 and that of each road section are shown in Table 10.2-3.

In other studies the running benefit is sometimes higher than the time benefit. In this Study, however, the share of the running benefit to the total benefit is about 40%, while that of the time benefit is about 60%. The reason for this is that trips in urban areas are shorter both in terms of distance and travel time.

TABLE 10.2-1 RESULT OF TRAFFIC ASSIGNMENTS FOR BENEFIT CALCULATIONS

		Running • Vehicles • km		Running • Vehicles • Times	
		With R-10	Without R-10	With R-10	Without R-10
1977		21,755	21,796	3,332	3,519
1979		22,795	22,838	3,559	3,899
1981		23,892	23,937	3,675	4,240
1987	Plan 2	27,154	27,205	4,717	5,797
1987	Plan 4	21,699	21,740	2,465	3,005
2000		24,795	25,448	2,022	2,210

Units: Running • Vehicles • km; Thousand • Vehicles • km
Running • Vehicles • times; Thousand • Vehicles • hour

TABLE 10.2-2 BENEFITS BY YEAR (1974 PRICE)

(Million Pesos)

Year \ Benefit	Time	Running	Total
1977	236.0	149.8	385.8
1979	428.3	264.6	692.9
1981	712.1	435.8	1147.9
1987 Plan 2	1361.2	823.9	2185.1
1987 Plan 4	681.4	432.8	1114.2
2000	236.9	230.2	467.3

TABLE 10.2-3 BENEFITS BY ROAD SECTIONS

(Million Pesos)

Stage \ Year / Distance (km)		1977	1979	1981	1987		2000
					Plan 2	Plan 4	
Stage 1	7.011	385.7 55.0	367.2 52.4	478.7 68.3	911.1 129.9	493.7 70.4	226.5 32.3
Stage 2	7.253	–	325.7 44.9	424.7 58.6	808.4 111.5	383.4 52.9	123.8 17.1
Stage 3	5.165	–	–	244.5 47.3	465.5 90.1	237.4 45.9	116.7 22.6

Remarks: Upper; Benefits (Million Pesos)
Lower; Benefits per kilometer (Million Pesos)

In Table 10.2-2 the total benefits derived from the Project Roads increase from 1977 to 1981 and gradually decrease from 1987 to the year 2000 due to the introduction of other urban transport systems.

10.3 Comparative Analysis

10.3.1 Analysis of the Project Roads

The following observations with respect to the economic feasibility of the project were made from the results shown in Table 10.3-1 and Fig. 10.3-1.

(1) The net present worth is ₱4,957 million at a discount rate of 15% for Plan 2 and ₱3,601 million at a discount rate of 15% for Plan 4. This indicates that the project is highly feasible.

(2) The benefit-cost ratio calculated at the discount rate of 15% is 12.06 for Plan 2, and 9.03 for Plan 4, also indicating that the project is highly feasible.

(3) The internal rate of return for Plans 2 and 4 over the project life of 20 years are 85.0% and 83.5% respectively, which are both high enough to make the project abnormally feasible.

TABLE 10.3-1 FEASIBILITY INDICATORS

(Unit: million pesos)

Plan \ Benefits and Costs	Benefit			Project Costs	Net Present Worth	B/C Ratio	Internal Rate of Return (%)
	Time	Running	Total				
2	3,343	2,063	5,406	449	4,957	12.06	85.0
4	2,482	1,568	4,050	449	3,601	9.03	83.5

Basis: (1) Discount Rate: 15%

(2) Project Life: 20 years

A high NPW, B/C ratio and IRR were obtained because of the following reasons:

(1) The Project Roads will increase the capacity of the major radial thoroughfares and major circumferential thoroughfares by 75% and 400%, respectively.
As a result, the running condition of vehicles will be correspondingly improved thus increasing the benefits for the Project Roads:

(2) There are five major development projects within the influence area of the Project Roads which will generate the traffic necessary to provide enormous benefits.

10.3.2 Analysis of Each Stage Section

Table 10.3-2 shows the economic feasibilities by each stage section and the following observations can be said:

The Net Present Worth (NPW) and the Benefit-cost ratio of 1st stage are ₱1,962 and 11.95, those of 2nd ₱1,485 and 7.09 and those of 3rd ₱926 and 7.88. The economic indicator of 1st stage is the most feasible, the second comes next and the third stage has the lowest feasibility in in three stage.

TABLE 10.3-2 FEASIBILITY INDICATORS BY STAGE

(Unit: Million Pesos)

Stage \ Benefits and costs	Benefits by Stage	Project Costs by Stage	Net Present Worth	B/C Ratio
1	2,141	179	1,962	11.95
2	1,729	244	1,485	7.09
3	1,061	135	926	7.88

Basis: (1) Discount Rate: 15%
(2) Project Life: 20 years
(3) Transportation System in 1987: Plan 4

10.4 Sensitivity Analysis

10.4.1 Analysis Procedures

Sensitivity analysis was made by varying the following parameters: the economic project cost, discount rate, project life, traffic volume, time and road user's benefits.

10.4.2 Details of Analysis by Parameter

(1) Economic Project Cost and Discount Rate

The economic cost was made to vary in six cases from 0.7 to 2.0 times the estimated project cost, and the discount rate from 10% to 100%. The results of this analysis are shown in Figures 10.4-1 and 10.4-2. The project life in this case was set at 20 years.

The results clearly indicate that the project is highly feasible even if the project costs and discount rate are greatly increased.

(2) Economic Life

The relation between the project life and the benefit-cost ratio in which the traffic volume in Plan 4 was used is shown in Fig. 10.4-3.

The economic life referred to in this Study means the number of years required for the benefit-cost ratio to become 1.0, and it can be said that the shorter the economic life, the more feasible is the project.

Within a few years after completion of the project the benefit-cost ratio will become 1.0 as shown in Fig. 10.4-3. From this economic standpoint, it can be safely concluded that the project is highly feasible.

(3) Traffic Volume

The benefits derived from the project will also change as the traffic volume varies. Despite the changes in traffic volume shown for both Plans 2 and 4, it was observed that the benefits derived using these two plans would still make the project feasible.

(4) Time Benefits

After time benefits were each reduced to 80%, 60% and 40% for both Plans 2 and 4, it was observed that any reduction in time benefits would not affect the feasibility of the project.

(5) Road User's Benefits

Benefits should be computed for both users and non-users of the Project Roads. However, since such benefits are occasionally interpreted as user's benefit only, economic evaluation based on user's benefit alone was estimated. The results nonetheless indicate that the project is still feasible.

An analysis of data shown in Table 10.4-1 and Fig. 10.4-4 fully support the project's feasibility.

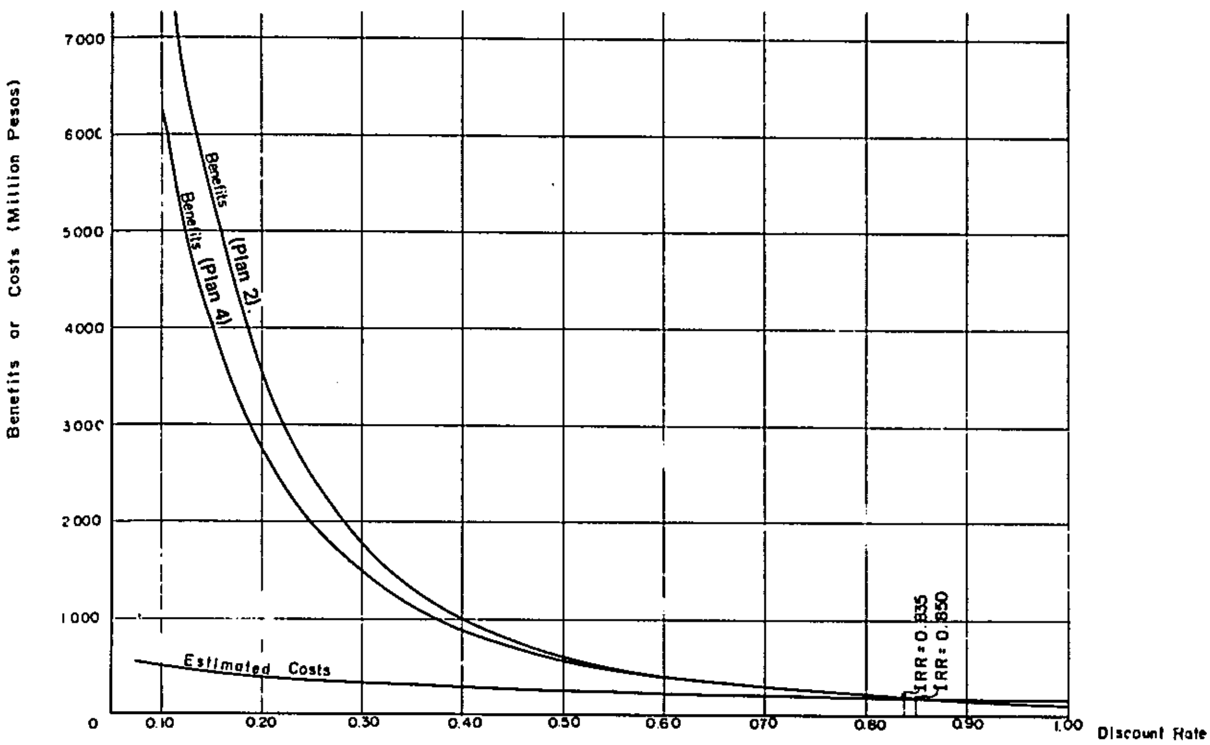


FIG. 10.4-1 RELATION BETWEEN COSTS, BENEFITS AND DISCOUNT RATE

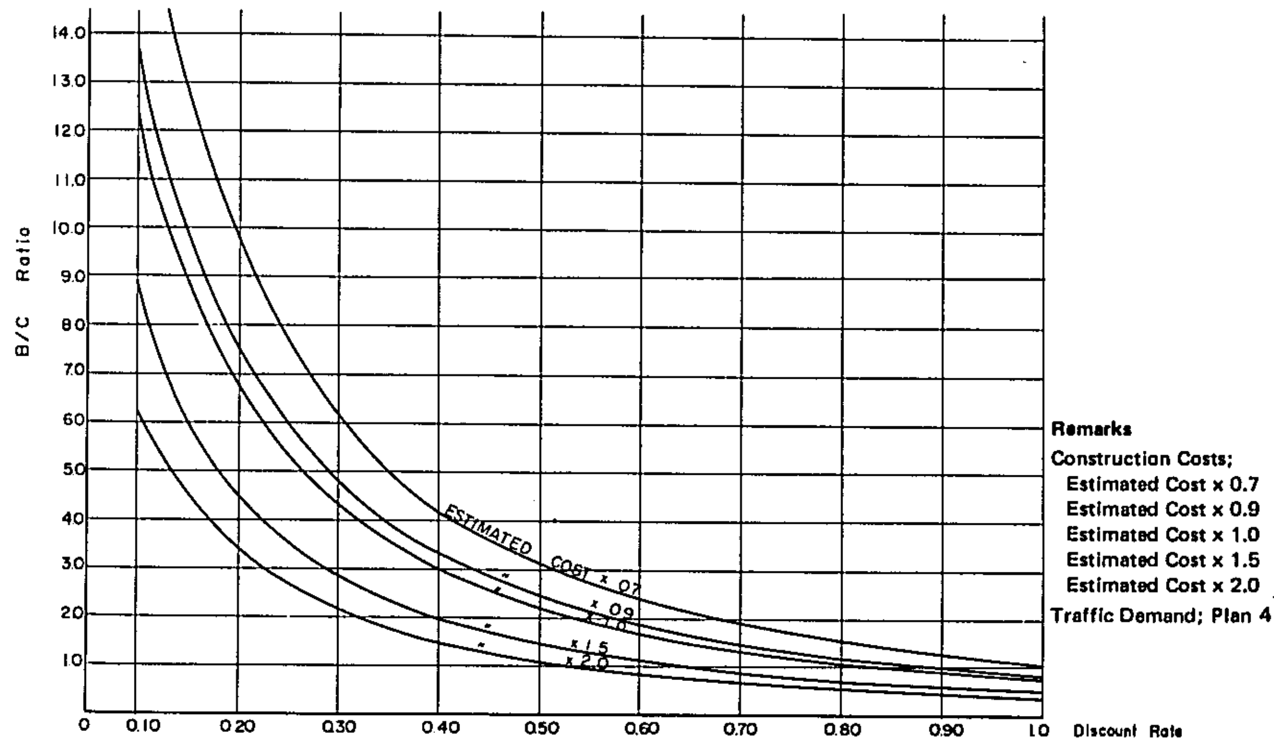


FIG. 10.4-2 SENSITIVITY ANALYSIS REGARDING TO B/C RATIO BETWEEN CONSTRUCTION COSTS AND DISCOUNT RATE

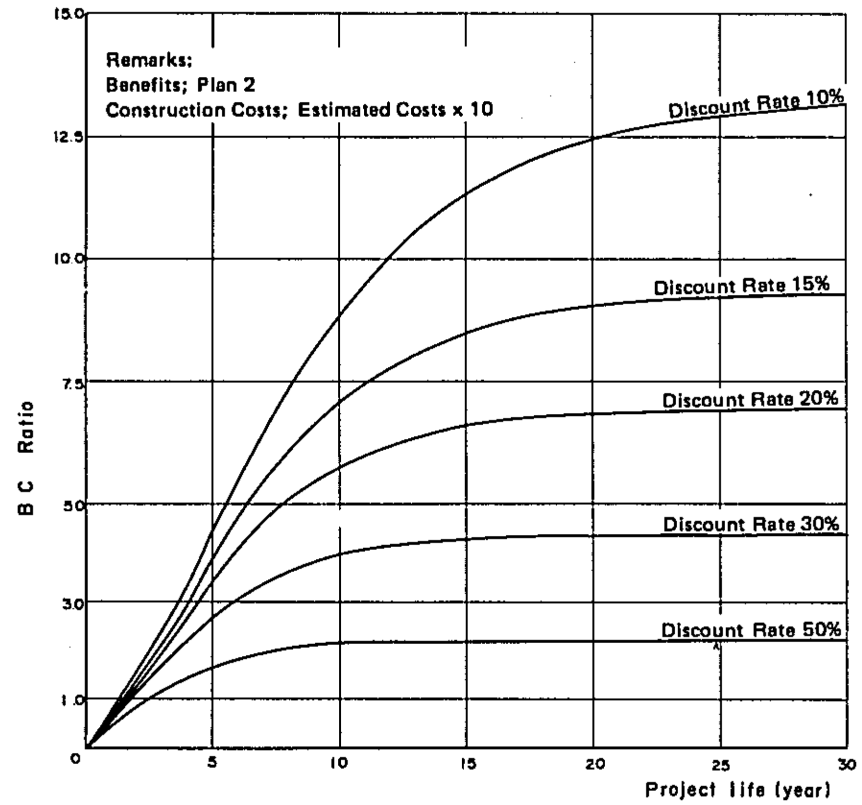


FIG. 10.4-3 SENSITIVITY ANALYSIS REGARDING TO B/C RATIO BETWEEN DISCOUNT RATE AND PROJECT LIFE

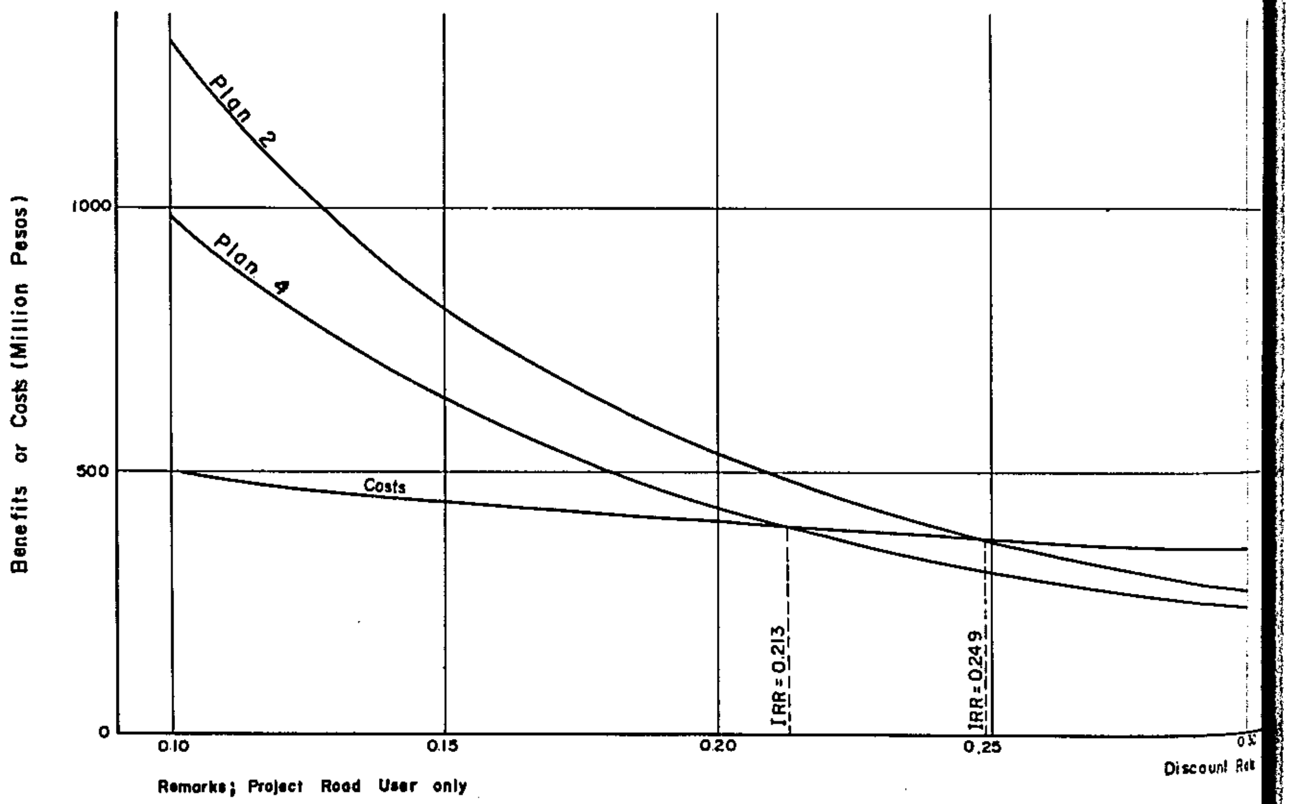


FIG. 10.4-4 SENSITIVITY ANALYSIS REGARDING TO ROAD USER'S BENEFITS

TABLE 10.4-1 NET PRESENT WORTH, B/C RATIO, and IRR BY USER'S BENEFITS

(Unit: Million Pesos)

Benefit and Cost	Benefit			Project Costs	Net Present Worth	B/C Ratio	IRR (%)
	Time	Running	Total				
Plans							
2	582	236	818	449	319	1.82	24.9
4	433	209	642	449	143	1.43	21.3

Basis: Discount Rate: 15%
Project Life: 20 years

(6) Benefifs by the Development Projects

Along the project roads, there are five important development projects. Among them, the Manila International Marine Port, the Navotas Fisheries Port and the Vitas Industrial Complex are now being constructed, but the Tondo Urban Renewal Project and the Dagat-Dagatan Resetlement Project are still in the planning stages and benefits by these two projects are not clearly calculated. Therefore, benetits by the latter two projects are not taken into consideration. From the computation, a Net Present Worth and Benefits-Costs Ratio are ₱2,995 Million and 8.56 Based on the discount rate of 15% and the project life of 20 year. Howere, it was observed that any neglect in the development project's benefits would not affect the feasibility of the project.

10.4.3 Conclusion.

Based on the above discussions, the R-10 Project proves to be more than sufficiently feasible within the possible range of the factors affecting feasibility. It can be concluded, therefore, from the national economic standpoint that the R-10 Project has sufficient and urgent justification and should be given a high priority.

10.5 Unquantifiable Benefits

A brief explanation is given below on some major benefits not quantitatively analyzed in the foregoing economic evaluation.

(1) Enhanced Land Development.

There are several development projects proposed in the area such as the Tondo Foreshore Urban Renewal, Manila International & Domestic Marine Port, Navotas Fisheries Port and Dagat-Dagatan Resettlement. The R-10 Project Roads are intended to serve as important access roads for these development projects.

For example, the Project Roads will be indispensable for the proposed residential community in the Dagat-Dagatan Project which has an area of 434 hectares and is planned to accommodate 20,000 families.

The completion of the Project Roads will strongly contribute to the development of all the abovestated development projects and will result in intensive development and use of land.

(2) Enhanced Trade & Commerce

The Project Roads will provide the means for the smooth and efficient distribution of goods from the ports to their markets, resulting in a wider market area.

(3) Effective Utilization of Vehicles

The construction of the Project Roads will shorten the travel time of vehicles per trip and thus improve the turnover of vehicles and increase the number of vehicle trips per vehicle.

10.6 Investment Program

10.6.1 Exigency of the Project

From the result of the economic evaluations discussed in the previous sections, it becomes evident that there exists an urgent need to complete the project at the earliest possible time. On this basis, a stage construction plan was developed for this Study as discussed in Chapter 7.

10.6.2 Annual Investment Requirements

Table 10.6-1 shows the annual investment requirements for implementing the Project Roads. The amount of annual investment required for each year consists of the construction cost and R-O-W cost. The construction cost will only involve that section of the Project Roads programmed for that particular year in accordance with the stage construction plan, while the cost of acquisition of right-of-way will only involve the roads scheduled for construction for the succeeding year. The annual investment for the initial year of the project, however, will only involve R-O-W acquisition cost for roads to be constructed the next year. The amounts of annual investment do not include the costs of project preparation such as detailed engineering, but includes direct construction costs, contractor's tax, engineering supervision and contingencies based on 1974 prices and a 7.2% annual price increase adjustment for inflation for each succeeding year from 1974.

The total investment requirements for each year were broken down into local and foreign components based on the estimation of costs discussed in Chapter 7.

TABLE 10.6-1 INVESTMENT PROGRAM

(Thousand Pesos)

YEARS	ANNUAL INVESTMENT	COMPONENTS	
		LOCAL	FOREIGN
1975	69,202	69,202	–
1976	174,591	134,692	39,899
1977	188,754	131,231	57,523
1978	154,912	108,815	46,097
1979	143,576	92,548	51,028
1980	135,758	70,247	65,511
1981	163,542	82,239	81,303
TOTAL	1,030,335	688,974	341,361

CHAPTER 11

FINALIZATION OF PLANS

CHAPTER 11
FINALIZATION OF PLANS

11.1 Physical Factors

Out of the five development projects being undertaken within the study area which greatly influence the R-10 Project, three are at present under construction while the other two are still in the planning stages. Pertinent data for the two projects still in the planning stage, which were merely assumed and would require verification during final engineering, include the following:

(1) Height of the proposed finished ground elevation and soil condition in the proposed reclamation area:

(2) Final development plans of the Dagat-Dagatan Resettlement Project:

(3) The final plan for the Fishermen's Basin; if the basin is to be reclaimed, vertical alignment in this area can be lowered due to the elimination of the bridge:

(4) The improvement plans for the drainage system; and

(5) Final plans of the Vitas Industrial Complex.

11.2 Additional Field Investigations

Although the field data utilized in this Study can be used in the final engineering, additional field work for the following will still be necessary:

(1) Soil and Material Investigation,
(2) Foundation Investigations,
(3) Location Surveys, and
(4) Final Assessment Survey.

11.3 Factors Affecting Construction Schedule

To offset the delays usually occurring during the property acquisition process, the Government should carry out the acquisition of the necessary right-of-way well in advance of the commencement of actual construction. The construction schedule should also provide an allowance for the expected long consolidation period within the reclaimed areas.

APPENDIX

LISTS OF TABLE

LISTS OF FIGURE

TABLE 2·3 - 1

BILL OF ACTUAL ACCOMPLISHED QUANTITIES

ROUTE	HOLE NO	DRILL DATE BEGIN	DRILL DATE COMPLETED	FIELD WORK: MOBILIZATION SITE TO SITE	MOBILIZATION HOLE TO HOLE	PROVIDE BARGE	DRILLING BETWEEN 0-20m	DRILLING OVER 20m	DRILLING TOTAL DEPTH m	SAMPLING SHELBY (U.D)	SAMPLING JAR (D)	SAMPLING BULK (D)	IN SITU TEST SPT	IN SITU TEST PMT	LABORATORY TESTING: UNIT WEIGHT	MOIST CONT	PLASTIC INDEX	SIEVE and HYDROMTR	UNCON-FINED COMPR-SN	TRIAXIAL COMPRSN CU	CONSO-LIDATION	COM-PACTION	CBR
	1	7 09 74	7 15 74				20.0	15.1	35.1	9	26		25		9	32	26	34	7				
	2	8 02 74	8 04 74				20.0	5.0	25.0	3	22		22		3	25	25	25	3				
	3	8 04 74	8 05 74				20.0	2.8	22.8	3	20		19	5	3	20	22	22	3				
	4	7 19 74	7 27 74				20.0	3.3	23.3		26		26	3		26	19	24					
	5	6 10 74	6 21 74				20.0	10.0	30.0	2	31		31	5	2	17	15	14	1				
	6	6 20 74	6 25 74				20.0	10.0	30.0	3	31		31		3	25	26	25	1				
R-10	7	6 22 74	6 25 74	1	13	1	20.0	10.0	30.0	3	27		27	3	3	23	22	25	2				
	8	7 14 74	7 17 74				20.0		20.0	7	14		14	4	4	21	17	20	3				
	9	7 07 74	7 13 74				20.0		20.0	6	14		14		6	19	19	19	3	1	1		
	10	6 29 74	7 02 74				20.0	2.0	22.0	5	17		17	2	3	18	16	18	2		2		
	11	6 26 74	6 28 74				20.0	10.0	30.0	5	27		27		5	23	22	32	5	1	3		
	12	7 03 74	7 05 74				20.0	1.5	21.5	9	17		12		8	22	20	22	6	1	3		
	13	8 12 74	8 15 74				20.0		20.0	4	16		16		4	20	20	20	4				
	14	7 07 74	7 09 74				19.3		19.3	2	20		11	3	2	21	17	20	2	1	1		
C-2	15	7 20 74	7 12 74	1	4		19.7		19.7	2	20		12		3	22	19	22	2	1	1		
	16	7 12 74	7 15 74				20.0	1.9	21.9		23		18	3	3	17	16	17					
	17	7 19 74	7 21 74				20.0	4.6	24.6	3	22		19		3	24	19	24	3		1		
	18	7 27 74	7 28 74				19.5		19.5	6	14		13		6	20	20	20	6	1	1		
	19	7 27 74	7 28 74				11.0		11.0		11		8			11	6	11					
C-3	20	7 22 74	7 24 74	1	4		15.0		15.0		15		11			12	9	12					
	21	7 28 74	7 28 74				10.0		10.0		10		5			5	5	5					
	22	7 16 74	7 18 74				20.0	4.2	24.2	8	17		11	1	6	20	14	20	5	1	4		
	23	7 23 74	7 26 74				19.8		19.8		17		11		2	19	14	18	2	1	1		
C-4	24	7 18 74	7 27 74	1	5		16.8		16.8	2	17		10		2	17	9	16	2	1	2		
	25	7 24 74	7 27 74				10.0		10.0		10		10	1		10	9	10					
	26	8 16 74	8 21 74				8.0		8.0		8		5										
MATERIAL SOURCES												15										15	15
TOTALS				4	26	1	469.1	80.4	549.5	83	492	15	425	30	80	489	426	495	62	9	23	15	15

TABLE 2·3-2 SUMMARY OF SOIL TEST (Mechnical Soil Test)

Project R-10 Feasibility Study Job No. ______ Boring No. 1 . 2 3

Location of project ______

		S₁-1	S₁-2	S₁-3	S₁-5	S₁-6	S₁-7	S₁-9		S₂-1	S₂-2	S₂-3		S₃-1	S₃-2	S₃-3
Sample depth		3.50 m – 4.10 m	6.50 m – 7.10 m	9.90 m – 10.50 m	13.00 m – 13.60 m	13.60 m – 14.20 m	22.40 m – 23.00 m	23.60 m – 24.10 m	m – m	0.40 m – 1.00 m	1.40 m – 2.00 m	2.40 m – 3.00 m	m – m	0.40 m – 1.00 m	1.40 m – 2.00 m	2.40 m – 3.00 m
Condition of sample		~~Disturbed~~ Undisturbed	~~Disturbed~~ Undisturbed	~~Disturbed~~ Undisturbed	~~Disturbed~~ Undisturbed	~~Disturbed~~ Undisturbed	~~Disturbed~~ Undisturbed	~~Disturbed~~ Undisturbed	Disturbed Undisturbed	~~Disturbed~~ Undisturbed	~~Disturbed~~ Undisturbed	~~Disturbed~~ Undisturbed	Disturbed Undisturbed	~~Disturbed~~ Undisturbed	~~Disturbed~~ Undisturbed	~~Disturbed~~ Undisturbed
Natural water content, %		83.3	62.0	59.0	63.0	38.0	65.7	57.0		56.0	62.0	55.0		37.0	37.0	62.0
Specific gravity		2.570	2.490	2.604	2.650	2.670	2.617	2.660		2.560	2.590	2.630		2.450	2.520	2.580
Wet density, g/cm³		1.537	1.780	1.650	1.810	2.070	1.575	1.440		1.480	1.540	1.620		1.300	1.430	1.440
Dry density, g/cm³		0.839	1.099	1.038	1.110	1.500	0.951	0.917		0.949	0.951	1.045		0.949	1.044	0.889
Natural void ratio		2.065	1.266	1.509	1.387	0.780	1.753	1.900		1.698	1.723	1.517		1.582	1.414	1.902
Degree of saturation, %		100	100	100	100	100	98.1	79.8		84.4	93.4	95.4		57.3	65.9	84.1
Atterberg limits	Liquid limit, %	89	70	60	53	45	56	48		38	41	45		35	38	46
	Plastic limit, %	33	38	28	25	24	28	32		26	24	25		27	26	24
	Plasticity index	56	32	32	28	21	28	16		12	17	20		8	12	22
Grain size analysis	Gravel, %	9	6	3	0	0	5	11		2	0	0		7	5	2
	Sand, %	8	8	20	12	48	21	16		53	20	2		47	76	12
	Silt, %	61	50	57	36	25	45	62		43	47	52		42	18	58
	Clay & colloid, %	22	36	20	52	27	29	11		2	33	46		4	1	28
	Max. diameter, mm	9.52	19.1	4.76	0.59	2.00	9.52	12.70		12.70	4.00	0.42		12.70	12.70	12.70
	Diam. at 60%	0.032	0.090	0.058	0.009	0.120	0.032	0.050		0.1498	0.0109	0.0064		0.270	0.380	0.013
	Diam. at 10%	–	–	–	–	–	–	0.0045		0.014	0.0019	0.0019		0.015	0.04	0.0018
Visual soil description																
Unified soil classification		CH	OH	CH	CL	CL	CH	ML		SM	CL	CL		SM	SM	CL
Unconfined compression test	Undisturbed sample, kg/cm²	0.075	0.188	0.150	0.547	0.449	0.116	0.144		0.092	0.181	0.246		0.176	0.124	0.219
	Remoulded sample, kg/cm²															
	Sensitivity ratio															
	Strain at failure, %	11.0 15.0	5.0	15.0	6.0	5.0	8.0~14.0	3.0		4.5	3.5	4.0		6.0	6.0	4.5
Triaxial compression test	Angle of internal friction															
	Cohesion, kg/cm²															
	Condition of drainage															
Consolidation test	Preconsolidation pressure, kg/cm²	0.23		0.35			0.73									
	Compression index	0.476		0.421			0.447									
Shear test	Angle of internal friction															
	Cohesion, kg/cm²															
	Condition of drainage															

Remarks:

TABLE 2·3-3 SUMMARY OF SOIL TEST (Mechanical Soil Test)

Project R-10 Feasibility Study Job No. ______ Boring No. 2 . 3 . 7 . 8 . 9

Location of project ______

Sample no.		S_5-2		S_6-3		S_7-1	S_7-3		S_8-5	S_8-6	S_8-7		S_9-3	S_9-5	S_9-6	
Sample depth		10.10 m ~ 11.00 m	~ m	4.50 m ~ 5.00 m	~ m	5.80 m ~ 6.40 m	8.00 m ~ 8.60 m	~ m	4.00 m ~ 4.60 m	5.00 m ~ 5.60 m	6.00 m ~ 6.60 m	~ m	2.40 m ~ 3.00 m	4.40 m ~ 5.00 m	5.40 m ~ 6.00 m	~ m
Condition of sample		~~Disturbed~~ Undisturbed	Disturbed Undisturbed	~~Disturbed~~ Undisturbed	Disturbed Undisturbed	~~Disturbed~~ Undisturbed	~~Disturbed~~ Undisturbed	Disturbed Undisturbed	~~Disturbed~~ Undisturbed	~~Disturbed~~ Undisturbed	~~Disturbed~~ Undisturbed	Disturbed Undisturbed	~~Disturbed~~ Undisturbed	~~Disturbed~~ Undisturbed	~~Disturbed~~ Undisturbed	Disturbed Undisturbed
Natural water content, %		55.0		48.0		44.0	44.0		52.0	42.0	37.0.		61.2	52.0	58.0	
Specific gravity		2.450		2.530		2.700	2.670		2.600	2.660	2.680		2.642	2.590	2.600	
Wet density, g/cm³		1.720		1.690		1.770	1.770		1.720	1.910	1.980		1.637	1.770	1.570	
Dry density, g/cm³		1.110		1.142		1.181	1.181		1.132	1.345	1.445		1.016	1.164	0.994	
Natural void ratio		1.207		1.215		1.286	1.261		1.297	0.978	0.885		1.602	1.225	1.616	
Degree of saturation, %		100		99.9		92.4	93.2		100	100	100		100	100	93.3	
Atterberg limits	Liquid limit, %	62		49		48	45		47	44	40		60	43	43	
	Plastic limit, %	40		27		25.	20		30	23	22		29	27	28	
	Plasticity index	22		22		23	25		17	21	18		31	16	15	
Grain size analysis	Gravel, %	7		0		0	4		1	0	0		0	0	0	
	Sand, %	10		21		31	30		28	17	2		5	25	13	
	Silt, %	72		56		64	54		61	72	76		66	56	53	
	Clay & colloid, %	11		23		15	12		10	11	21		29	19	34	
	Max. diameter, mm	12.70		2.00		2.00	4.76		4.76	2.00	2.00		0.84	2.00	2.00	
	Diam. at 60%	0.042		0.054		0.053	0.068		0.055	0.048	0.033		0.021	0.049	0.04	
	Diam. at 10%	0.0048		0.0023		0.0038	0.0023		0.005	0.0048	0.0025		—	0.0029	0.0019	
Visual soil description																
Unified soil classification		O H		C L		C L	C L		O L	C L	C L		C H	O L	O L	
Unconfined compression test	Undisturbed sample, kg/cm²	0.125		0.301		0.366	0.122		0.553	0.233	0.233		0.152	0.189	0.117	
	Remoulded sample, kg/cm²															
	Sensitivity ratio															
	Strain at failure, %	6.0		8.7		6.0	6.5		5.0	3.5	3.5		14.0	3.5	2.5	
Triaxial compression test	Angle of internal friction												23°00′			
	Cohesion, kg/cm²												0.07			
	Condition of drainage												C U			
Consolidation test	Preconsolidation pressure, kg/cm²												0.27			
	Compression index												0.480			
Shear test	Angle of internal friction															
	Cohesion, kg/cm²															
	Condition of drainage															

Remarks:

TABLE 2·3-4 SUMMARY OF SOIL TEST (Mechanical Soil Test)

Project R-10 Feasibility Study Job No. ______ Boring No. 10 , 11 , 12

Location of project ______

		S10-1	S10-2	S10-4	S10-5		S11-1	S11-2	S11-3	S11-4	S11-5		S12-3	S12-4	S12-5	S12-6
Sample depth		2.90 m ~ 3.50 m	3.90 m ~ 4.50 m	5.90 m ~ 6.60 m	6.70 m ~ 7.50 m	m ~ m	4.60 m ~ 5.00 m	5.00 m ~ 5.60 m	5.60 m ~ 6.20 m	6.20 m ~ 6.80 m	6.80 m ~ 7.40 m	m ~ m	5.00 m ~ 5.60 m	6.00 m ~ 6.60 m	7.00 m ~ 7.60 m	8.00 m ~ 8.60 m
Condition of sample		~~Disturbed~~ Undisturbed	~~Disturbed~~ Undisturbed	~~Disturbed~~ Undisturbed	~~Disturbed~~ Undisturbed	Disturbed Undisturbed	~~Disturbed~~ Undisturbed	~~Disturbed~~ Undisturbed	~~Disturbed~~ Undisturbed	~~Disturbed~~ Undisturbed	~~Disturbed~~ Undisturbed	Disturbed Undisturbed	~~Disturbed~~ Undisturbed	~~Disturbed~~ Undisturbed	~~Disturbed~~ Undisturbed	~~Disturbed~~ Undisturbed
Natural water content, %		40.0	45.0				46.9	37.6	40.0	51.8	54.0		73.0		61.0	48.0
Specific gravity		2.630	2.680				2.640	2.693	2.690	2.627	2.700		2.639		2.690	2.680
Wet density, g/cm³		1.910	1.790				1.768	1.867	1.770	1.652	1.640		1.526		1.640	1.730
Dry density, g/cm³		1.364	1.234				1.204	1.357	1.264	1.088	1.065		0.882		1.019	1.169
Natural void ratio		0.928	1.172				1.194	0.985	1.128	1.414	1.535		1.992		1.640	1.293
Degree of saturation, %		100	100				100	100	95.4	96.2	95.0		96.7		100	99.5
Atterberg limits	Liquid limit, %	38	48				46	36	41	51	48		84		45	48
	Plastic limit, %	25	24				27	23	23	26	24		30		24	25
	Plasticity index	13	24				19	13	18	25	24		54		21	23
Grain size analysis	Gravel, %	2	4				0	7	3	1	0		0		3	0
	Sand, %	54	11				31	56	21	25	1		9		1	6
	Silt, %	36	49				50	24	46	50	79		57		70	51
	Clay & colloid, %	5	36				19	13	30	24	20		34		26	43
	Max. diameter, mm	4.76	4.76				0.84	9.52	12.7	4.76	4.76		2.00		12.7	2.00
	Diam. at 60%	0.128	0.102				0.059	0.180	0.040	0.045	0.032		0.029		0.035	0.016
	Diam. at 10%	0.0066	0.0024				—	0.0022	0.0015	—	0.0023		—		0.002	0.0013
Visual soil description																
Unified soil classification		SM	CL				ML	SC	CL	CH	CL		CH		CL	CL
Unconfined compression test	Undisturbed sample, kg/cm²	0.083	0.235				0.255	0.279	0.165	0.089	0.126		0.094		0.197	0.312
	Remoulded sample, kg/cm²															
	Sensitivity ratio															
	Strain at failure, %	5.5	6.5				7.0	3.5 6.0	6.0	15.0	4.0		12.5		5.0	3.0
Triaxial compression test	Angle of internal friction						17°00′						23°00′			
	Cohesion, kg/cm²						0.30						0.05			
	Condition of drainage						CU						CU			
Consolidation test	Preconsolidation pressure, kg/cm²			0.48	0.51		4.80	1.24		0.31			0.23	0.28		
	Compression index			0.23	0.30		0.223	0.223		0.349			0.650	1.21		
Shear test	Angle of internal friction															
	Cohesion, kg/cm²															
	Condition of drainage															

Remarks:

TABLE 2·3-5	SUMMARY OF SOIL TEST (Mechanical Soil Test)														
Project R-10 Feasibility Study	Job No.								Boring No. 12 . 13 . 14 . 15						
Location of project															
Sample no.		S_{12}-7	S_{12}-8	S_{12}-9		S_{13}-1	S_{13}-2	S_{13}-3	S_{13}-4		S_{14}-1	S_{14}-2		S_{15}-1 (UP)	S_{15}-1 (DW)	S_{15}-2
Sample depth		9.00 ~ 9.60 m	12.00 ~ 12.60 m	12.60 ~ 13.20 m	~ m	0.40 ~ 1.00 m	1.40 ~ 2.00 m	2.40 ~ 3.00 m	3.40 ~ 4.00 m	~ m	5.00 ~ 5.60 m	6.00 ~ 6.80 m	~ m	3.40 ~ 3.80 m	3.80 ~ 4.40 m	4.40 ~ 5.00 m
Condition of sample		~~Disturbed~~ Undisturbed	~~Disturbed~~ Undisturbed	~~Disturbed~~ Undisturbed	Disturbed Undisturbed	~~Disturbed~~ Undisturbed	~~Disturbed~~ Undisturbed	~~Disturbed~~ Undisturbed	~~Disturbed~~ Undisturbed	Disturbed Undisturbed	~~Disturbed~~ Undisturbed	~~Disturbed~~ Undisturbed	Disturbed Undisturbed	~~Disturbed~~ Undisturbed	~~Disturbed~~ Undisturbed	~~Disturbed~~ Undisturbed
Natural water content, %		73.2	46.0	44.0		37.0	50.0	50.0	69.0		40.0	58.3		27.2	30.5	40.0
Specific gravity		2.624	2.700	2.690		2.580	2.610	2.630	2.650		2.640	2.627		2.693	2.672	2.650
Wet density, g/cm³		1.549	1.810	1.800		1.840	1.560	1.420	1.620		1.800	1.650		1.884	1.918	1.800
Dry density, g/cm³		0.894	1.240	1.250		1.343	1.040	0.947	0.959		1.286	1.042		1.481	1.470	1.286
Natural void ratio		1.934	1.177	1.152		0.921	1.510	1.777	1.763		1.053	1.520		0.818	0.818	1.061
Degree of saturation, %		99.3	100	100		100	86.4	74.6	100		100	100		89.5	99.6	99.9
Atterberg limits	Liquid limit, %	72	46	44		35	42	47	45		36	52		29	37	33
	Plastic limit, %	29	26	26		22	22	24	30		24	26		20	21	24
	Plasticity index	43	20	18		13	20	23	15		12	26		9	16	9
Grain size analysis	Gravel, %	0	0	1		3	0	0	0		9	1		8	33	10
	Sand, %	19	13	19		12	8	3	44		64	14		62	39	75
	Silt, %	52	72	52		52	55	57	44		27	65		19	24	15
	Clay & colloid, %	29	15	28		33	37	40	12		0	20		11	4	0
	Max. diameter, mm	0.42	1.19	4.76		4.76	2.00	0.40	12.70		12.7	4.76		9.52	1.91	1.91
	Diam. at 60%	0.040	0.055	0.066		0.011	0.009	0.0085	0.085		0.152	0.041		0.176	0.550	0.210
	Diam. at 10%	—	0.004	—		0.0022	0.0018	—	0.0045		—	—		0.0023	0.028	—
Visual soil description																
Unified soil classification		C H	C L	C L		C L	C L	C L	M L		S M	C H		S C	S C	S M
Unconfined compression test	Undisturbed sample, kg/cm²	0.073	0.117	0.095		0.084	0.063	0.053	0.074		0.168	0.189			0.055	0.168
	Remoulded sample, kg/cm²															
	Sensitivity ratio															
	Strain at failure, %	15.0	3.5	2.5		5.0	5.0	4.0	6.5		4.5	10.5			15.0	4.5
Triaxial compression test	Angle of internal friction											15°00'		37°00'		
	Cohesion, kg/cm²											0.10		0.22		
	Condition of drainage											C U		C U		
Consolidation test	Preconsolidation pressure, kg/cm²	0.55										0.31			0.35	
	Compression index	0.496										0.476			0.204	
Shear test	Angle of internal friction															
	Cohesion, kg/cm²															
	Condition of drainage															
Remarks:																

TABLE 2·3·6 SUMMARY OF SOIL TEST (Mechanical Soil Test)

Project R-10 Feasibility Study Job No. ______ Boring No. 17 18 22

Location of project ______

Sample no.		$S_{17}-1$	$S_{17}-2$	$S_{17}-3$		$S_{18}-1$	$S_{18}-2$	$S_{18}-3$	$S_{18}-4$	$S_{18}-5$	$S_{18}-6$		$S_{22}-2$	$S_{22}-3$	$S_{22}-4$	$S_{22}-6$
Sample depth		10.40 m ~ 11.00 m	11.40 m ~ 12.00 m	12.00 m ~ 12.60 m	~ m	0.00 m ~ 1.00 m	2.00 m ~ 2.60 m	2.60 m ~ 3.20 m	3.20 m ~ 3.80 m	3.80 m ~ 4.40 m	4.40 m ~ 5.00 m	~ m	2.00 m ~ 2.40 m	3.00 m ~ 3.60 m	4.00 m ~ 4.60 m	6.00 m ~ 6.00 m
Condition of sample		~~Disturbed~~ Undisturbed	~~Disturbed~~ Undisturbed	~~Disturbed~~ Undisturbed	Disturbed Undisturbed	~~Disturbed~~ Undisturbed	~~Disturbed~~ Undisturbed	~~Disturbed~~ Undisturbed	~~Disturbed~~ Undisturbed	~~Disturbed~~ Undisturbed	~~Disturbed~~ Undisturbed	Disturbed Undisturbed	~~Disturbed~~ Undisturbed	~~Disturbed~~ Undisturbed	~~Disturbed~~ Undisturbed	~~Disturbed~~ Undisturbed
Natural water content, %		42.0	45.0	45.8		132.2	53.0	50.0	64.0	49.0	53.0		19.5	17.5	25.3	24.4
Specific gravity		2.640	2.670	2.732		2.524	2.540	2.580	2.570	2.580	2.620		2.718	2.746	2.695	2.700
Wet density, g/cm³		1.780	1.760	1.768		1.336	1.490	1.560	1.560	1.570	1.620		1.882	1.834	1.901	1.920
Dry density, g/cm³		1.254	1.214	1.213		0.575	0.974	1.040	0.951	1.054	1.059		1.575	1.561	1.517	1.543
Natural void ratio		1.105	1.199	1.253		3.387	1.608	1.481	1.702	1.448	1.474		0.726	0.759	0.776	0.749
Degree of saturation, %		100	100	99.9		98.5	83.7	87.1	96.6	87.3	94.2		73.0	63.3	87.8	87.9
Atterberg limits	Liquid limit, %	40	46	61		131	50	42	49	49	47		N P	N P	N P	N P
	Plastic limit, %	18	22	22		39	30	29	32	29	30		N P	N P	N P	N P
	Plasticity index	22	24	39		92	20	13	17	20	17					
Grain size analysis	Gravel, %	14	16	20		0	0	6	0	15	13		12	10	4	3
	Sand, %	45	40	43		8	9	10	6	18	9		75	79	77	80
	Silt, %	13	20	29		53	70	66	69	54	41		13	11	10	7
	Clay & colloid, %	28	24	8		39	21	18	25	13	37		0	0	9	10
	Max. diameter, mm	12.7	12.7	9.52		0.84	12.7	12.7	2.00	12.7	4.76		19.1	19.1	9.52	9.52
	Diam. at 60%	0.175	0.150	0.740		0.031	0.035	0.046	0.030	0.064	0.012		0.290	0.270	0.208	0.208
	Diam. at 10%	—	0.0018	0.0099		—	0.0031	0.0033	0.0029	0.0041	0.0019		0.053	0.068	0.007	0.0041
Visual soil description																
Unified soil classification		S C	S C	S C		C H	O L	O L	O L	O L	O L		(S C)	SP-SM	(S C)	(S C)
Unconfined compression test	Undisturbed sample, kg/cm²	0.190	0.148	0.120		0.072	0.054	0.053	0.042	0.063	0.021		0.205		0.206	0.261
	Remoulded sample, kg/cm²															
	Sensitivity ratio															
	Strain at failure, %	4.0	4.0	15.0		8.5~15.0	2.5	3.0	5.0	5.0	2.5		2.0		3.5	2.5
Triaxial compression test	Angle of internal friction					20°00′								38°00′		
	Cohesion, kg/cm²					0.02								0.05		
	Condition of drainage					C U								UU(drained)		
Consolidation test	Preconsolidation pressure, kg/cm²			0.34		0.166							—	—	—	—
	Compression index			0.576		1.545							0.123	0.102	0.189	0.131
Shear test	Angle of internal friction															
	Cohesion, kg/cm²															
	Condition of drainage															

Remarks:

TABLE 2·3-7 SUMMARY OF SOIL TEST (Mechnical Soil Test)

Project R-10 Feasibility Study Job No.______ Boring No. 22, 23, 24

Location of project ______

	Sample no.	S_{22}-7	S_{22}-8		S_{23}-1	S_{23}-2		S_{24}-1	S_{24}-2							
	Sample depth	7.00 m ~ 7.60 m	8.00 m ~ 8.60 m	m ~ m	3.40 m ~ 4.00 m	5.00 m ~ 5.30 m	m ~ m	3.00 m ~ 3.60 m	4.00 m ~ 4.60 m	m ~ m	m ~ m	m ~ m	m ~ m	m ~ m	m ~ m	m ~ m
	Condition of sample	~~Disturbed~~ Undisturbed	~~Disturbed~~ Undisturbed	Disturbed Undisturbed	~~Disturbed~~ Undisturbed	~~Disturbed~~ Undisturbed	Disturbed Undisturbed	~~Disturbed~~ Undisturbed	~~Disturbed~~ Undisturbed	Disturbed Undisturbed	Disturbed Undisturbed	Disturbed Undisturbed	Disturbed Undisturbed	Disturbed Undisturbed	Disturbed Undisturbed	Disturbed Undisturbed
	Natural water content, %	28.0	34.0		41.0	27.1		122.6	119.9							
	Specific gravity	2.670	2.620		2.680	2.708		2.514	2.500							
	Wet density, g/cm³	1.810	1.850		1.710	1.962		1.423	1.374							
	Dry density, g/cm³	1.414	1.381		1.213	1.544		0.639	0.625							
	Natural void ratio	0.888	0.897		1.209	0.754		2.933	3.001							
	Degree of saturation, %	84.2	99.3		90.9	97.3		100	99.9							
Atterberg limits	Liquid limit, %	35	36		36	26		113	131							
	Plastic limit, %	19	20		26	20		35	36							
	Plasticity index	16	16		10	6		78	95							
Grain size analysis	Gravel, %	9	7		6	4		1	1							
	Sand, %	68	56		54	67		10	12							
	Silt, %	23	37		40	19		52	44							
	Clay & colloid, %	0	0		0	10		37	43							
	Max. diameter, mm	12.70	4.76		12.7	9.52		4.76	4.76							
	Diam. at 60%	0.280	2.20		0.298	0.195		0.020	0.0116							
	Diam. at 10%	—	—		—	0.0038		—	—							
	Visual soil description															
	Unified soil classification	SC	SC		SM	SM-SC		CH	CH							
Unconfined compression test	Undisturbed sample, kg/cm²	0.254	0.158		0.084	0.168		0.051	0.121							
	Remoulded sample, kg/cm²															
	Sensitivity ratio															
	Strain at failure, %	4.0	4.0		4.5	4.5		15.0	9.0							
Triaxial compression test	Angle of internal friction					34°00′			21°00′							
	Cohesion, kg/cm²					0.10			0.04							
	Condition of drainage					CU			CU							
Consolidation test	Preconsolidation pressure, kg/cm²					—		0.195	0.215							
	Compression index					0.177		0.850	1.620							
Shear test	Angle of internal friction															
	Cohesion, kg/cm²															
	Condition of drainage															

Remarks:

TABLE 2·4-1

SUMMARY OF RESULTS FROM MATERIAL SOURCE (Bulk Samples)

SITE	MATERIAL SOURCE NO.	DESCRIPTION of MATERIALS	SIEVE ANALYSIS % PASSING						NAT. MOIST CONT.	ATTERBERG LIMITS			SPECIFIC GRAVITY	MAX. DRY DENSITY gm/cc			OPTIMUM MOIST. CONT.			% SWELL			SOAKED CBR 95% MDD
			1/2"	NO 4	NO 10	NO 40	NO 100	NO 200		LL	PL	PI		12 BLOWS	26 BLOWS	55 BLOWS	12 BLOWS	26 BLOWS	55 BLOWS	12 BLOWS	26 BLOWS	55 BLOWS	
1	1	A-2-5(0) Buff brown silty sand.	94	77	60	46	39	35	31	43	33	10	2.66	1.41	1.52	1.58	21.0	18.0	16.4	2.85	3.00	3.11	3.3
	2	A-1-a (0) Buff brown tuffaceous gravel and sand.	88	60	35	21	16	14	29	21	16	5	2.63	1.43	1.51	1.57	20.0	17.2	18.3	2.80	2.95	3.12	3.0
	3	A-7-6(8) Chocolate brown silty clay.	98	89	80	72	63	58	14	42	24	18	2.58	1.42	1.50	1.56	19.5	17.2	14.8	2.80	3.00	3.18	3.1
	4	A-6 (3) Brown silty clay.	100	86	74	60	47	42	42	38	21	17	2.61	1.39	1.47	1.54	19.5	17.2	14.6	2.60	2.96	3.16	2.9
	5	A-2-4(0) Chocolate brown silty sand.	95	82	60	46	36	30	40	39	29	10	2.62	1.44	1.51	1.57	15.0	13.4	12.5	2.70	2.94	3.14	3.2
2	6	A-2-4(0) Brownish silty gravel and sand.	95	61	51	39	30	26	49	29	20	9	2.60	1.47	1.55	1.63	16.2	14.0	12.2	2.00	2.40	2.81	4.1
	7	A-2-4 (0) Dark brown silty sand.	100	86	65	47	34	30	59	33	23	10	2.59	1.50	1.59	1.65	15.5	13.2	11.8	1.85	2.10	2.92	4.3
3	8	A-5 (3) Light brown sandy silt.	100	87	74	60	51	47	29	44	35	9	2.63	1.39	1.50	1.57	18.5	16.0	13.8	1.89	2.31	2.98	3.3
	9	A-6 (4) Light brown fine sandy clay.	100	89	74	57	47	42	27	40	22	18	2.64	1.41	1.51	1.60	18.5	16.0	14.2	1.92	2.15	2.85	4.0
	10	A-4 (0) Brownish sandy silt.	97	72	57	46	39	36	32	40	30	10	2.61	1.37	1.44	1.51	20.1	18.5	16.0	1.78	2.01	2.38	2.7
4	11	A-2-5(0) Grayish silty sand.	94	83	64	44	38	35	41	41	31	10	2.60	1.57	1.65	1.72	16.2	14.0	12.3	1.53	1.92	2.10	4.8
	12	A-2-5(0) Grayish silty gravel.	74	51	43	38	37	35	33	42	33	9	2.58	1.53	1.68	1.71	16.5	14.5	12.7	1.28	1.51	2.00	4.6
5	13	A-7-6 (7) Reddish brown silty clay.	100	99	91	69	56	52	40	49	30	19	2.59	1.38	1.49	1.59	19.4	17.0	14.6	2.12	2.71	3.01	3.6
6	14	A-7-5 (16) Brownish clay.		100	99	94	80	72	52	64	42	22	2.61	1.45	1.55	1.64	18.5	16.5	15.0	2.08	2.65	3.00	4.2
7	15	A-7-6 (7) Reddish brown silty clay.	99	95	85	73	58	53	42	40	21	19	2.59	1.44	1.52	1.59	18.7	17.0	15.6	1.71	2.02	2.98	3.8

TABLE 4.4-1 NUMBER OF POPULATION AND WORKERS BY INDUSTRIES BY ZONES IN 1987

(Persons)

Ring	Sector	Zone	Residential Population	Primary Worker	Secondary Worker	Tertiary Worker	Total	Number of Students & School Children
CBD	CBD1	1	14,690	0	0	84,130	84,130	1,660
		2	17,610	0	3,300	40,120	43,420	1,910
		12	49,000	0	6,900	120,640	127,540	68,690
		S.T	81,300	0	10,200	244,890	255,090	72,260
	CBD2	17	12,130	0	3,150	65,180	68,330	2,090
		19	9,170	0	5,400	48,480	53,880	2,830
		S.T	21,300	0	8,550	113,660	122,210	4,920
		Total	102,600	0	18,750	358,550	377,300	77,180
1st Ring	A-1	3	63,200	0	6,150	23,900	30,050	20,650
		4	83,470	0	0	39,290	39,290	15,620
		5	46,190	0	5,250	6,310	11,560	8,750
		6	54,160	0	0	8,540	8,540	13,160
		7	58,630	0	300	12,880	13,180	12,440
		S.T	305,650	0	11,700	90,920	102,620	70,620
	A-2	8	37,580	0	0	91,430	91,430	102,360
		9	39,970	0	0	26,990	26,990	7,730
		11	111,730	0	0	44,470	44,470	23,720
		24	110,100	0	0	47,150	47,150	30,940
		S.T	299,380	0	0	210,040	210,040	164,750
	A-3	10	215,360	0	0	84,910	84,910	99,460
		13	54,540	0	11,400	34,410	45,810	11,150
		S.T	269,900	0	11,400	119,320	130,720	110,610
	A-4	14	56,410	0	14,400	13,930	28,330	11,270
		15	93,570	0	4,350	27,800	32,150	19,700
		16	44,810	0	450	15,090	15,540	10,740
		18	79,970	0	0	81,980	81,980	15,840
		S.T	457,210	0	19,200	138,800	158,000	57,550
		Total	1,332,140	0	42,300	559,080	601,380	403,530

TABLE 4.4-1 CONT'D

(Persons)

Ring	Sector	Zone	Residential Population	Primary Worker	Secondary Worker	Tertiary Worker	Total	Number of Students & School Children
2nd Ring	B-1	20	190,420	0	3,150	19,010	22,160	29,940
		21	169,230	0	24,700	19,840	44,540	12,420
		22	76,480	260	12,700	16,060	29,020	8,870
		40	36,990	1,350	1,900	3,950	7,200	4,920
		S.T	473,120	1,610	42,450	58,860	102,920	56,150
	B-2	23	159,950	0	16,600	46,940	63,540	26,580
		25	219,480	0	32,550	29,470	62,020	56,610
		S.T	379,430	0	49,150	76,410	125,560	83,190
	B-3	27	126,710	0	2,550	25,770	28,320	31,110
		28	110,990	0	100	70,900	71,000	65,540
		29	156,230	0	2,850	50,020	52,870	41,390
		S.T	393,930	0	5,500	146,690	152,190	138,040
	B-4	31	199,200	0	3,600	64,970	68,570	24,300
		33	146,780	0	16,050	23,440	39,490	9,680
		S.T	345,980	0	19,650	88,410	108,060	33,980
	B-5	34	99,350	0	6,600	18,930	25,530	11,820
		35	70,720	0	4,300	138,360	142,660	6,260
		36	64,770	0	4,100	6,870	10,970	4,780
		37	133,210	0	0	44,410	44,410	25,720
		S.T	368,050	0	15,000	208,570	223,570	48,580
		Total	1,960,510	1,610	131,750	578,940	712,300	359,940
3rd Ring	C-1	41	119,610	22,150	0	9,640	31,790	23,780
		42	33,570	3,250	5,400	3,830	12,480	6,300
		43	58,470	0	14,600	9,880	24,480	11,610
		44	37,210	1,390	1,300	7,410	10,100	6,960
		45	94,820	0	7,100	6,000	13,100	18,850
		46	182,870	22,820	900	11,770	35,490	36,390
		47	162,870	0	9,600	10,430	20,030	33,120
		S.T	689,420	49,610	38,900	58,960	147,470	137,010
	C-2	26	315,030	0	23,800	61,950	85,750	108,510

TABLE 4.4-1 CONT'D

(Persons)

Ring	Sector	Zone	Residential Population	Primary Worker	Secondary Worker	Tertiary Worker	Total	Number of Students & School Children
3rd Ring	C-3	30	106,110	0	300	30,660	30,960	20,790
		32	77,640	0	6,600	14,040	20,640	20,140
		48	367,060	0	13,600	48,960	62,560	35,190
		49	128,450	0	35,200	27,780	62,980	10,040
		S.T	679,260	0	55,700	121,440	177,140	86,160
	C-4	38	50,620	0	500	7,030	7,530	16,780
		39	275,460	5,150	4,000	87,290	96,440	20,200
		50	182,550	7,910	20,600	69,870	98,380	16,030
		51	365,210	8,120	26,500	37,690	72,310	33,660
		S.T	873,840	21,180	51,600	201,880	274,660	86,670
		Total	2,557,550	70,790	170,000	444,230	685,020	418,350
		G.T	5,758,000	72,400	362,800	1,940,800	2,376,000	1,259,000

TABLE 4.4-2 NUMBER OF POPULATION AND WORKERS BY INDUSTRIES BY ZONES IN 2000

(Persons)

Ring	Sector	Zone	Residential Population	Primary Worker	Secondary Worker	Tertiary Worker	Total	Number of Students & School Children
CBD	CBD1	1	550	0	0	105,180	105,180	150
		2	0	0	4,500	53,150	57,650	0
		12	27,500	0	3,450	154,290	157,740	85,200
		S.T	28,050	0	7,950	312,620	320,570	85,350
	CBD2	17	6,050	0	4,050	86,570	90,620	1,700
		19	14,300	0	6,150	60,660	66,810	4,020
		S.T	20,350	0	10,200	147,230	157,430	57,200
		Total	48,400	0	18,150	459,850	478,000	142,550
1st Ring	A-1	3	63,200	0	6,150	27,820	33,970	25,120
		4	51,150	0	0	44,760	44,760	14,390
		5	29,150	0	5,250	7,350	12,600	8,210
		6	56,650	0	0	10,110	10,110	15,940
		7	47,300	0	300	14,910	15,210	13,310
		S.T	247,450	0	11,700	104,950	116,650	76,960
	A-2	8	19,800	0	0	110,640	110,640	129,510
		9	26,400	0	0	30,610	30,610	7,430
		11	80,200	0	0	50,780	50,780	24,230
		24	161,100	0	0	55,030	55,030	43,110
		S.T	287,500	0	0	247,060	247,060	204,280
	A-3	10	219,450	0	0	104,240	104,240	123,720
		13	40,700	0	15,300	39,120	54,420	11,450
		S.T	260,150	0	15,300	143,360	158,660	135,170
	A-4	14	40,150	0	15,750	15,990	31,740	11,280
		15	74,250	0	4,350	31,920	36,270	20,890
		16	45,650	0	450	17,360	17,810	12,850
		18	58,300	0	0	94,550	94,550	16,400
		S.T	218,350	0	20,550	159,820	180,370	61,420
		Total	1,013,450	0	47,550	655,190	702,740	477,830

TABLE 4.4-2 CONT'D

(Persons)

Ring	Sector	Zone	Residential Population	Primary Worker	Secondary Worker	Tertiary Worker	Total	Number of Students & School Children
2nd Ring	B-1	20	149,810	0	2,100	30,690	32,790	29,240
		21	94,890	0	30,700	26,710	57,410	8,550
		22	85,000	340	13,600	23,450	37,390	10,900
		40	52,400	1,750	1,900	4,400	8,050	6,930
		S.T	382,100	2,090	48,300	85,250	135,640	55,620
	B-2	23	160,880	0	24,400	62,150	86,550	30,870
		25	288,250	0	38,700	38,400	77,100	75,570
		S.T	449,130	0	63,100	100,550	163,650	106,440
	B-3	27	144,300	0	2,250	31,540	33,790	39,060
		28	148,000	0	100	91,850	91,950	86,260
		29	201,300	0	1,800	64,480	66,280	54,760
		S.T	493,600	0	4,150	187,870	192,020	180,080
	B-4	31	242,100	0	2,550	79,870	82,420	31,370
		33	120,600	0	20,550	24,750	45,300	9,940
		S.T	362,700	0	23,100	104,620	127,720	41,310
	B-5	34	118,800	0	7,200	32,850	40,050	9,800
		35	112,200	0	4,350	155,710	160,060	9,250
		36	70,400	0	4,100	7,120	11,220	5,800
		37	89,700	0	0	52,360	52,360	24,910
		S.T	391,100	0	15,650	248,040	263,690	49,760
		Total	2,078,630	2,090	154,300	726,330	882,720	433,210
3rd Ring	C-1	41	218,800	28,690	0	15,980	44,670	39,000
		42	58,000	4,210	7,800	5,960	17,970	10,080
		43	106,800	0	24,000	18,590	42,590	19,040
		44	59,400	1,800	1,400	12,030	15,230	10,590
		45	177,900	0	9,600	10,270	19,870	31,430
		46	328,800	29,570	900	18,450	48,920	59,030
		47	317,100	0	16,100	16,980	33,080	56,240
		S.T	1,266,800	64,270	59,800	98,260	222,330	225,410
	C-2	26	584,420	0	34,600	99,260	133,860	163,050

TABLE 4.4-2 CONT'D

(Persons)

Ring	Sector	Zone	Residential Population	Primary Worker	Secondary Worker	Tertiary Worker	Total	Number of Students & School Children
3rd Ring	C-3	30	125,600	0	300	44,320	44,620	26,530
		32	99,400	0	10,400	17,890	28,290	16,320
		48	674,250	0	30,300	78,450	108,750	55,470
		49	162,750	0	40,500	51,340	91,840	13,250
		S.T	1,062,000	0	81,500	192,000	273,500	111,570
	C-4	38	83,000	0	500	9,980	10,480	24,160
		39	396,600	6,670	4,500	107,000	118,170	28,790
		50	260,400	10,250	27,700	103,820	141,770	22,390
		51	649,200	10,520	40,700	61,710	112,930	52,510
		S.T	1,389,200	27,440	73,400	282,510	383,350	127,850
		Total	4,302,420	91,710	249,300	672,030	1,013,040	627,880
		G.T	7,442,900	93,800	469,300	2,513,400	3,076,500	1,681,470

TABLE 4.4-3 LAND USE PLAN IN 1987

(has)

Ring	Sector	Zone	Residential Area	Commercial Area	Industrial Area	Institutional Area	Open Space	Total
CBD	CBD1	1	6	105	0	5	1	117
		2	27	50	22	6	7	112
		12	77	45	23	74	8	227
		S.T	110	200	45	85	16	456
	CBD2	17	32	79	27	87	51	276
		19	28	59	41	33	57	218
		S.T	170	338	113	205	124	950
		Total	280	538	158	290	140	1,406
1st Ring	A-1	3	195	23	41	14	9	282
		4	95	45	0	42	1	183
		5	47	6	35	5	9	102
		6	105	7	0	10	9	131
		7	86	13	2	10	0	111
		S.T	528	94	78	81	28	809
	A-2	8	36	56	0	19	0	111
		9	48	32	0	5	120	205
		11	164	50	0	4	0	218
		24	352	50	0	30	6	438
		S.T	600	188	0	58	126	972
	A-3	10	386	41	0	34	18	479
		13	110	40	76	22	12	260
		S.T	496	81	76	56	30	739
	A-4	14	103	15	96	1	6	221
		15	151	30	29	9	8	227
		16	83	16	3	4	0	106
		18	148	100	0	33	26	307
		S.T	485	161	128	47	40	861
		Total	2,109	524	282	242	224	3,381

TABLE 4.4-3 CONT'D

(has)

Ring	Sector	Zone	Residential Area	Commercial Area	Industrial Area	Institutional Area	Open Space	Total
2nd Ring	B-1	20	346	51	14	26	107	544
		21	270	85	307	15	1,215	1,892
		22	425	71	136	11	90	733
		40	262	11	19	4	292	588
		S.T	1,303	218	476	56	1,704	3,757
	B-2	23	804	183	244	101	65	1,397
		25	1,153	55	258	14	4	1,484
		S.T	1,957	238	502	115	69	2,881
	B-3	27	481	55	15	42	10	603
		28	740	175	1	530	44	1,490
		29	671	103	12	41	0	827
		S.T	1,892	333	28	613	54	2,920
	B-4	31	807	143	17	88	151	1,206
		33	402	38	137	161	34	772
		S.T	1,209	181	154	249	185	1,978
	B-5	34	396	61	48	25	114	644
		35	374	171	29	7	6	587
		36	352	20	41	3	112	528
		37	299	92	0	33	8	432
		S.T	1,421	344	118	68	240	2,191
		Total	7,782	1,314	1,278	1,101	2,252	13,727
3rd Ring	C-1	41	1,094	35	0	4	260	1,393
		42	290	15	78	5	293	681
		43	712	53	240	3	105	1,113
		44	297	34	14	14	0	359
		45	1,186	20	96	1	390	1,693
		46	1,644	34	9	2	0	1,689
		47	2,114	31	161	1	205	2,512
		S.T	7,337	222	598	30	1,253	9,440
	C-2	26	4,445	174	346	353	5,057	10,375

TABLE 4.4-3 CONT'D

(ha)

Ring	Sector	Zone	Residential Area	Commercial Area	Industrial Area	Institutional Area	Open Space	Total
3rd Ring	C-3	30	541	80	3	118	161	903
		32	368	10	66	270	280	994
		48	3,192	135	136	49	2,375	5,887
		49	851	84	352	43	823	2,153
		S.T	4,952	309	557	480	3,639	9,937
	C-4	38	352	7	5	18	418	800
		39	1,664	382	40	71	855	3,012
		50	1,074	212	206	122	3,427	5,041
		51	2,114	119	265	11	1,545	4,054
		S.T	5,204	720	516	222	6,245	12,907
		Total	18,936	1,229	1,700	1,039	19,755	42,659
		G.T	29,447	3,330	3,219	2,528	22,649	61,173

TABLE 4.4-4 LAND USE PLAN IN 2000

(has)

Ring	Sector	Zone	Residential Area	Commercial Area	Industrial Area	Institutional Area	Open Space	Total
CBD	CBD1	1	1	105	0	5	6	117
		2	0	53	30	6	23	112
		12	50	45	23	74	35	227
		S.T	51	203	53	85	64	456
	CBD2	17	11	84	27	87	67	276
		19	26	59	41	33	59	218
		S.T	37	143	68	120	126	494
		Total	88	346	121	205	190	950
1st Ring	A-1	3	195	23	41	14	9	282
		4	93	45	0	42	3	183
		5	53	6	35	5	3	102
		6	103	7	0	10	11	131
		7	86	13	2	10	0	111
		S.T	530	94	78	81	26	809
	A-2	8	36	56	0	19	0	111
		9	48	32	0	5	120	205
		11	164	50	0	4	0	218
		24	358	50	0	30	0	438
		S.T	606	188	0	58	120	972
	A-3	10	399	41	0	34	5	479
		13	74	40	102	22	22	260
		S.T	473	81	102	56	27	739
	A-4	14	73	15	105	1	27	221
		15	135	30	29	9	24	227
		16	83	16	3	4	0	106
		18	106	100	0	36	65	307
		S.T	397	161	137	50	116	861
		Total	2,006	524	317	245	289	3,381

TABLE 4.4-4 CONT'D

(ha)

Ring	Sector	Zone	Residential Area	Commercial Area	Industrial Area	Institutional Area	Open Space	Total
2nd Ring	B-1	20	467	30	21	26	0	544
		21	846	63	247	15	721	1,892
		22	432	48	127	11	115	733
		40	287	7	19	4	271	588
		S.T	2,032	148	414	56	1,107	3,757
	B-2	23	500	136	166	92	503	1,397
		25	878	42	217	14	333	1,484
		S.T	1,378	178	383	106	836	2,881
	B-3	27	480	46	17	33	27	603
		28	716	105	1	416	252	1,490
		29	676	80	19	41	11	827
		S.T	1,872	231	37	490	290	2,920
	B-4	31	870	117	24	88	107	1,206
		33	471	38	107	152	4	772
		S.T	1,341	155	131	240	111	1,978
	B-5	34	430	57	44	25	88	644
		35	368	171	29	7	12	587
		36	388	20	41	3	76	528
		37	313	79	0	30	10	432
		S.T	1,499	327	114	65	186	2,191
		Total	8,122	1,039	1,079	957	2,530	13,727
3rd Ring	C-1	41	1,091	18	0	4	280	1,393
		42	269	9	54	5	344	681
		43	440	26	146	3	498	1,113
		44	267	20	13	14	45	359
		45	784	9	71	1	828	1,693
		46	1,418	18	9	2	242	1,689
		47	1,392	15	96	1	1,008	2,512
		S.T	5,661	115	389	30	3,245	9,440
	C-2	26	3,119	85	238	307	6,626	10,375

TABLE 4.4-4 CONT'D

(has)

Ring	Sector	Zone	Residential Area	Commercial Area	Industrial Area	Institutional Area	Open Space	Total
3rd Ring	C-3	30	629	119	3	118	34	903
		32	497	12	104	343	38	994
		48	4,495	225	325	49	793	5,887
		49	1,085	160	438	43	427	2,153
		S.T	6,706	516	870	553	1,292	9,937
	C-4	38	469	12	5	34	280	800
		39	1,931	444	45	84	508	3,012
		50	1,736	319	277	161	2,548	5,041
		51	3,247	192	429	121	65	4,054
		S.T	7,383	967	756	400	3,401	12,907
		Total	25,871	1,879	2,570	1,336	11,003	42,659
		G.T	35,747	4,063	4,286	2,887	13,734	60,717

TABLE 5.2-1 FIRST TRIP PRODUCTION AS ANALYSED

(Trips/Person)

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

* As Surveyed under UTSMMA.

TABLE 5.2-2 FACTORS ESTIMATING TRIP GENERATION AND ATTRACTION OF FIRST TRIPS

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

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

$Y = 1050 + 0.185 X_1 + 0.486 X_2$

$R = 0.93$

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

As analyzed under UTSMMA

TABLE 5.2-3 TRANSITION PROBABILITY BETWEEN TRIP PURPOSES

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

Remark: * As analyzed under UTSMMA

TABLE 5.2-4 EXPONENT OF TRAVEL TIME

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

The Gravity Model is as follows:

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

- X_{ij} : Number of Trips between Zones i and j
- w_i : Sum of Trip Generation and Attraction in Zone i
- t_{ij} : Travel Time between Zones i and j
- α : Constant of Proportion
- γ : Exponent of Travel Time

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

As analyzed under UTSMMA.

TABLE 8.2-6 OD VOLUME OF PERSON TRIP IN 1987

** COMMUTING TO WORK -1987- ***

	CBD-1	CBD-2	A-1	A-2	A-3	A-4	B-1	B-2
CBD-1	10117.	2676.	2048.	4997.	2083.	1973.	245.	565.
CBD-2	1813.	2514.	314.	841.	256.	2565.	76.	188.
A-1	20711.	4678.	14122.	12595.	3462.	3235.	1133.	1628.
A-2	16920.	4501.	3568.	17020.	5679.	3325.	673.	1547.
A-3	13658.	2275.	1997.	8863.	8206.	1969.	465.	814.
A-4	6503.	11418.	1079.	3197.	1502.	12560.	360.	715.
B-1	19923.	9108.	6736.	13112.	6593.	7855.	21379.	4380.
B-2	12572.	5983.	2533.	9831.	2748.	4595.	1200.	9813.
B-3	13466.	5734.	3120.	9017.	4520.	4500.	635.	2154.
B-4	9509.	6556.	1604.	4629.	4495.	4961.	330.	679.
B-5	7395.	8772.	1182.	3327.	1680.	11155.	247.	665.
C-1	28073.	10608.	5453.	16181.	7131.	9479.	2389.	4370.
C-2	10389.	4420.	1792.	6600.	2350.	3529.	459.	2170.
C-3	25888.	12648.	5434.	16259.	8346.	9311.	1032.	2441.
C-4	17522.	14739.	2996.	8440.	3262.	14035.	629.	1487.
TOTAL	214359.	106630.	53979.	134909.	62313.	95047.	31252.	33616.

	B-3	B-4	B-5	C-1	C-2	C-3	C-4	TOTAL
CBD-1	1115.	442.	2124.	46.	32.	872.	565.	29900.
CBD-2	337.	210.	1765.	12.	9.	374.	350.	11624.
A-1	2707.	841.	4492.	147.	66.	1943.	1208.	72968.
A-2	3270.	956.	4293.	118.	69.	1898.	1171.	64908.
A-3	2436.	958.	3338.	78.	45.	1438.	685.	47225.
A-4	1413.	974.	13922.	63.	36.	1657.	1862.	56861.
B-1	4079.	1303.	7790.	449.	116.	2621.	1986.	107430.
B-2	3221.	652.	3794.	140.	142.	1375.	1074.	59673.
B-3	24529.	959.	4152.	99.	57.	2583.	1277.	76802.
B-4	2107.	18334.	4079.	66.	29.	2899.	1892.	62169.
B-5	1167.	656.	42424.	64.	28.	1717.	3863.	84342.
C-1	6082.	1968.	14724.	36624.	465.	3344.	3292.	150183.
C-2	1599.	451.	2782.	87.	28294.	900.	778.	66600.
C-3	10995.	2809.	10659.	152.	93.	66796.	4133.	176987.
C-4	2579.	1192.	25108.	125.	77.	2311.	77026.	171528.
TOTAL	67636.	32705.	145037.	38270.	29558.	92728.	101162.	1239200.

*** GOING TO SCHOOL -1987- ***

	CBD-1	CBD-2	A-1	A-2	A-3	A-4	B-1	B-2
CBD-1	7707.	108.	1918.	9783.	4323.	290.	101.	775.
CBD-2	1974.	444.	511.	3157.	827.	1542.	74.	620.
A-1	1282.	72.	18192.	7546.	2374.	170.	223.	556.
A-2	3621.	60.	1287.	24374.	5288.	186.	127.	898.
A-3	2162.	20.	335.	2836.	17341.	90.	57.	223.
A-4	3895.	879.	856.	6055.	2269.	15854.	181.	1142.
B-1	5380.	231.	4726.	14049.	7099.	865.	20168.	3090.
B-2	1458.	60.	705.	4289.	1357.	188.	175.	22835.
B-3	1101.	48.	419.	2599.	1716.	128.	33.	353.
B-4	7760.	494.	1787.	10219.	7645.	1722.	180.	1021.
B-5	7292.	862.	1764.	10296.	5603.	5935.	191.	1367.
C-1	1234.	44.	510.	2847.	1242.	166.	119.	427.
C-2	7.	0.	2.	17.	6.	0.	0.	5.
C-3	9878.	552.	3186.	19550.	11426.	1778.	300.	1647.
C-4	19355.	1687.	5125.	29543.	10893.	6640.	506.	3237.
TOTAL	76106.	5561.	41323.	147160.	79409.	35554.	22435.	38196.

	B-3	B-4	B-5	C-1	C-2	C-3	C-4	TOTAL
CBD-1	2096.	21.	82.	7.	2051.	263.	74.	29599.
CBD-2	1625.	26.	303.	4.	1461.	223.	185.	12976.
A-1	1944.	15.	49.	6.	1484.	256.	42.	36211.
A-2	2422.	18.	46.	5.	1794.	276.	43.	40645.
A-3	1108.	25.	18.	2.	713.	160.	17.	25107.
A-4	334.	59.	965.	9.	2997.	393.	450.	39347.
B-1	6075.	43.	131.	58.	5724.	591.	123.	68353.
B-2	2511.	9.	34.	8.	3133.	168.	32.	36962.
B-3	32586.	7.	15.	2.	512.	364.	14.	39897.
B-4	6856.	16477.	153.	15.	2552.	1384.	128.	58393.
B-5	5237.	78.	18603.	25.	3500.	726.	1325.	62804.
C-1	1133.	7.	41.	77642.	2366.	104.	35.	87917.
C-2	6.	0.	0.	0.	41560.	0.	0.	41603.
C-3	15342.	162.	314.	18.	4160.	54274.	208.	122795.
C-4	13017.	209.	3214.	56.	10756.	1989.	52287.	158514.
TOTAL	95301.	17156.	23960.	77857.	84963.	61171.	54963.	861123.

TABLE 5.2-5 CONT'D

*** PRIVATE -1987- ***

	*	CBD-1	CBD-2	A-1	A-2	A-3	A-4	B-1	B-2
CBD-1	*	50077.	6851.	6069.	14712.	6409.	5924.	808.	1415.
CBD-2	*	6834.	9751.	1482.	3930.	1297.	8594.	350.	659.
A-1	*	17969.	4381.	31334.	12460.	3924.	3528.	1113.	1403.
A-2	*	21658.	5890.	5601.	66209.	8454.	5096.	985.	1875.
A-3	*	13405.	2637.	2588.	10798.	47713.	2508.	621.	883.
A-4	*	9179.	12265.	1905.	5460.	2428.	44647.	578.	945.
B-1	*	15801.	7014.	6068.	12418.	6083.	6751.	30715.	3413.
B-2	*	12673.	5781.	3281.	10976.	3520.	5127.	1218.	39103.
B-3	*	11934.	4862.	3325.	9478.	4769.	4467.	640.	1601.
B-4	*	8897.	5528.	1931.	5399.	4099.	4725.	388.	652.
B-5	*	9149.	8876.	1956.	5221.	2615.	12418.	402.	826.
C-1	*	24376.	9223.	6050.	16847.	7594.	9161.	2272.	3578.
C-2	*	8639.	3574.	1894.	6265.	2454.	3264.	445.	1490.
C-3	*	21005.	10206.	5408.	15150.	7810.	8746.	1011.	1945.
C-4	*	15784.	11496.	3445.	9262.	3791.	12262.	707.	1382.
TOTAL	*	247380.	108335.	82337.	204593.	112960.	137218.	42253.	61170.

	*	B-3	B-4	B-5	C-1	C-2	C-3	C-4	TOTAL
CBD-1	*	4652.	1800.	6997.	92.	211.	2289.	1994.	110300.
CBD-2	*	1963.	968.	7067.	33.	88.	1183.	1689.	45888.
A-1	*	3882.	1192.	5126.	83.	152.	1845.	1379.	89771.
A-2	*	5894.	1821.	6737.	103.	231.	2561.	2001.	135116.
A-3	*	3822.	1795.	4426.	58.	125.	1715.	961.	94055.
A-4	*	2999.	1689.	16544.	57.	128.	1704.	2804.	103332.
B-1	*	5165.	1712.	7602.	206.	238.	2202.	1911.	107299.
B-2	*	4911.	1159.	4940.	95.	319.	1570.	1356.	96029.
B-3	*	75445.	1540.	4590.	64.	133.	2835.	1257.	126940.
B-4	*	2872.	50929.	4467.	47.	76.	2000.	1494.	93504.
B-5	*	2345.	1216.	100173.	60.	91.	1511.	4022.	150881.
C-1	*	7732.	2840.	14607.	38079.	698.	3027.	3347.	149431.
C-2	*	2151.	655.	2972.	56.	44021.	841.	827.	79548.
C-3	*	11157.	3873.	10811.	95.	200.	67884.	3354.	168663.
C-4	*	3878.	1834.	21935.	85.	180.	2112.	143141.	231344.
TOTAL	*	138868.	75023.	219044.	39213.	46891.	95279.	171537.	1782101.

*** WORK -1987- ***

	*	CBD-1	CBD-2	A-1	A-2	A-3	A-4	B-1	B-2
CBD-1	*	81633.	14601.	16004.	29691.	14742.	12692.	6018.	7789.
CBD-2	*	14492.	19789.	4642.	9390.	3735.	16552.	2892.	3894.
A-1	*	15711.	4584.	31907.	11233.	4360.	3800.	3268.	3140.
A-2	*	29591.	9435.	11433.	77846.	13034.	8362.	5171.	7195.
A-3	*	14604.	3730.	4422.	12981.	49988.	3885.	2727.	2849.
A-4	*	12630.	16614.	3975.	8355.	3896.	51046.	2885.	3538.
B-1	*	5627.	2739.	3155.	4860.	2580.	2712.	38633.	2862.
B-2	*	7401.	3746.	3067.	6881.	2731.	3375.	2914.	45274.
B-3	*	11666.	5392.	4633.	10109.	5595.	5080.	2484.	3922.
B-4	*	6641.	4062.	2149.	4661.	3845.	3943.	1211.	1435.
B-5	*	13368.	13178.	4565.	9144.	5087.	17906.	2677.	3291.
C-1	*	2657.	1133.	1035.	2067.	1029.	1144.	989.	938.
C-2	*	2612.	1209.	877.	2068.	941.	1108.	547.	1167.
C-3	*	10712.	5934.	4049.	8327.	4756.	5300.	2032.	2579.
C-4	*	7236.	6163.	2382.	5048.	2231.	6443.	1318.	1690.
TOTAL	*	236581.	112300.	98195.	202661.	118550.	143348.	75766.	91563.

	*	B-3	B-4	B-5	C-1	C-2	C-3	C-4	TOTAL
CBD-1	*	11786.	6865.	13217.	3099.	2885.	11264.	7587.	239873.
CBD-2	*	5392.	4155.	12970.	1303.	1311.	6159.	6333.	113000.
A-1	*	4575.	2170.	4386.	1150.	935.	4159.	2418.	97796.
A-2	*	10166.	4798.	8968.	2397.	2269.	8723.	5253.	204641.
A-3	*	5596.	3916.	4952.	1182.	1026.	4950.	2313.	119121.
A-4	*	5161.	4043.	17659.	1333.	1221.	5551.	6672.	144419.
B-1	*	2333.	1167.	2420.	1023.	549.	1994.	1259.	73913.
B-2	*	3768.	1405.	3055.	1000.	1191.	2579.	1655.	90042.
B-3	*	77101.	2948.	4498.	1159.	944.	6681.	2464.	144676.
B-4	*	2879.	51070.	3305.	623.	435.	3773.	1913.	91947.
B-5	*	4623.	3480.	115293.	1698.	1043.	5743.	9155.	210251.
C-1	*	998.	567.	1384.	63021.	365.	820.	638.	78785.
C-2	*	861.	410.	905.	380.	51756.	700.	507.	66046.
C-3	*	6426.	3702.	5340.	880.	721.	73046.	3012.	136816.
C-4	*	2373.	1920.	8641.	721.	543.	3094.	161340.	211143.
TOTAL	*	143978.	92616.	206991.	80971.	67194.	139236.	212519.	2022469.

TABLE 5.2-5 CONT'D

*** RETURN TO HOME -1987- ***

*	CBD-1	CBD-2	A-1	A-2	A-3	A-4	B-1	B-2
CBD-1 *	14474.	2327.	33527.	25346.	21811.	14671.	39087.	24139.
CBD-2 *	2663.	2117.	7534.	6507.	3972.	15182.	14735.	10097.
A-1 *	3024.	519.	42867.	6524.	3960.	3146.	16459.	6097.
A-2 *	9359.	2032.	28018.	55032.	17305.	12043.	39032.	23084.
A-3 *	4215.	625.	9056.	13421.	40289.	5462.	19729.	7701.
A-4 *	2395.	2570.	6476.	5827.	4002.	40522.	15135.	9323.
B-1 *	344.	106.	2078.	1205.	920.	892.	55894.	2276.
B-2 *	950.	395.	3295.	2942.	1683.	2295.	10282.	50478.
B-3 *	2536.	997.	7940.	8245.	6057.	6396.	16046.	10439.
B-4 *	613.	221.	1881.	1937.	2056.	2056.	3178.	1873.
B-5 *	2767.	1780.	9131.	7849.	6568.	22117.	16470.	9254.
C-1 *	59.	14.	272.	211.	161.	150.	756.	293.
C-2 *	981.	540.	1876.	1862.	923.	2768.	6502.	3682.
C-3 *	1073.	405.	3612.	3273.	2665.	3006.	5524.	3128.
C-4 *	813.	445.	2651.	2376.	1588.	3945.	4563.	2750.
TOTAL *	46259.	15093.	160214.	142557.	113960.	134651.	263392.	164614.

*	B-3	B-4	B-5	C-1	C-2	C-3	C-4	TOTAL
CBD-1 *	22486.	24258.	19552.	50996.	17695.	53110.	51220.	414699.
CBD-2 *	8714.	10556.	13244.	18518.	7156.	20472.	24589.	166053.
A-1 *	5980.	5229.	4160.	12031.	3700.	13620.	11828.	139144.
A-2 *	18711.	20056.	16207.	36572.	12659.	50116.	48219.	388441.
A-3 *	9861.	15392.	8404.	16820.	5057.	27259.	18900.	202191.
A-4 *	8065.	10602.	21788.	19077.	6665.	19240.	31183.	202870.
B-1 *	1210.	932.	766.	4406.	910.	2384.	1987.	76312.
B-2 *	3745.	2463.	2600.	8249.	3464.	6210.	6430.	105481.
B-3 *	82367.	11855.	7941.	16310.	4240.	36456.	20635.	238460.
B-4 *	2232.	58402.	1667.	4967.	1220.	6390.	3444.	92137.
B-5 *	8554.	8934.	85248.	20096.	6410.	22383.	47676.	285237.
C-1 *	211.	180.	182.	131233.	184.	377.	374.	134657.
C-2 *	977.	2865.	3307.	4181.	91612.	5033.	11438.	138547.
C-3 *	4864.	5839.	3471.	6795.	1894.	149113.	6701.	201363.
C-4 *	2635.	3626.	7750.	7429.	1885.	8083.	198571.	249110.
TOTAL *	180612.	181189.	196289.	367680.	164751.	420246.	483195.	3034702.

*** TOTAL OF ALL TRIP PURPOSE -1987- ***

*	CBD-1	CBD-2	A-1	A-2	A-3	A-4	B-1	B-2
CBD-1 *	164008.	26563.	59566.	84529.	49368.	35550.	46259.	34683.
CBD-2 *	27773.	34606.	14483.	23825.	10087.	44435.	18127.	15458.
A-1 *	60697.	14234.	138422.	50358.	18080.	13879.	22196.	12824.
A-2 *	81045.	21918.	49907.	240481.	49760.	29012.	45988.	34599.
A-3 *	48044.	9287.	18398.	48899.	163537.	13914.	23599.	12470.
A-4 *	34602.	43746.	14191.	28894.	14097.	164629.	19139.	15663.
B-1 *	47075.	19198.	22763.	45644.	23275.	19075.	166789.	16021.
B-2 *	35054.	15965.	12881.	34919.	12039.	15580.	15789.	167503.
B-3 *	40703.	17033.	19437.	39448.	22657.	20571.	19838.	18469.
B-4 *	33420.	16861.	9352.	26845.	22140.	17407.	5287.	5660.
B-5 *	39971.	33468.	18598.	35837.	21553.	69531.	19987.	15403.
C-1 *	56399.	21022.	13320.	38153.	17157.	20100.	6525.	9606.
C-2 *	22628.	9743.	6441.	16812.	6674.	10669.	7953.	8514.
C-3 *	68556.	29745.	21689.	62567.	35003.	28141.	9899.	11740.
C-4 *	60710.	34530.	16599.	54669.	21765.	43325.	7723.	10546.
TOTAL *	820685.	347919.	436047.	831880.	487192.	545818.	435098.	389159.

*	B-3	B-4	B-5	C-1	C-2	C-3	C-4	TOTAL
CBD-1 *	42135.	33386.	41972.	54240.	22874.	67798.	61440.	824371.
CBD-2 *	18031.	15915.	35349.	19870.	10025.	28411.	33146.	349541.
A-1 *	19088.	9447.	18213.	13417.	6337.	21823.	16875.	435890.
A-2 *	40463.	27649.	36251.	39195.	17222.	63574.	56687.	833751.
A-3 *	22823.	22086.	21136.	18140.	6966.	35522.	22876.	487699.
A-4 *	[illegible]	17367.	70478.	20539.	11047.	28545.	42971.	546829.
B-1 *	18862.	5157.	18711.	6142.	7537.	9792.	7266.	433307.
B-2 *	18156.	5688.	14423.	9492.	8249.	11902.	10547.	388187.
B-3 *	292028.	17309.	21196.	17634.	5886.	48919.	25647.	626775.
B-4 *	16946.	195212.	13671.	5720.	4312.	16446.	8871.	398150.
B-5 *	21926.	14364.	361741.	31943.	11072.	32080.	66041.	793515.
C-1 *	16156.	5562.	30938.	346599.	4078.	7672.	7686.	600973.
C-2 *	5594.	4381.	9964.	4704.	257243.	7474.	13550.	392344.
C-3 *	48784.	16385.	30586.	7940.	7068.	411113.	17408.	806624.
C-4 *	24482.	8781.	66698.	8416.	13441.	17589.	632365.	1021639.
TOTAL *	626395.	398689.	791329.	603991.	393357.	808660.	1023376.	8939596.

TABLE 6.2-6 OD VOLUME OF PERSON TRIP IN 2000

*** COMMUTING TO WORK -2000- ***

*	CBD-1	CBD-2	A-1	A-2	A-3	A-4	B-1	B-2
CBD-1 *	7190.	1840.	1538.	3518.	1763.	1399.	372.	474.
CBD-2 *	2116.	2966.	439.	938.	342.	2737.	200.	255.
A-1 *	15811.	3446.	12651.	9332.	2894.	2458.	2212.	1627.
A-2 *	15459.	4634.	3795.	16242.	6326.	3369.	1346.	1734.
A-3 *	13063.	2121.	2204.	8278.	8555.	1942.	1008.	965.
A-4 *	5592.	10191.	1051.	2671.	1392.	10817.	695.	729.
B-1 *	12255.	5320.	4366.	7489.	4386.	4696.	24024.	3288.
B-2 *	14854.	6948.	3202.	11402.	3451.	5279.	2829.	12640.
B-3 *	16647.	6822.	4421.	10709.	6257.	5573.	1778.	3078.
B-4 *	8810.	5320.	1653.	4102.	5131.	4475.	750.	822.
B-5 *	7226.	7963.	1354.	3254.	2030.	10565.	648.	874.
C-1 *	58119.	21800.	13189.	33027.	16685.	19894.	12750.	11970.
C-2 *	23767.	10022.	4736.	14951.	6047.	8059.	2515.	5857.
C-3 *	40947.	19110.	9682.	25169.	14694.	14535.	3902.	4917.
C-4 *	34697.	28728.	6829.	16446.	7263.	27098.	3183.	3735.
TOTAL *	276553.	137231.	71110.	167528.	87216.	122896.	58212.	52965.

*	B-3	B-4	B-5	C-1	C-2	C-3	C-4	TOTAL
CBD-1 *	745.	397.	1328.	23.	15.	802.	366.	21770.
CBD-2 *	400.	316.	1828.	10.	7.	585.	349.	13488.
A-1 *	1930.	796.	2910.	82.	34.	1924.	863.	58970.
A-2 *	3180.	1140.	3452.	80.	42.	2323.	947.	64069.
A-3 *	2220.	1020.	2639.	53.	29.	1746.	605.	46448.
A-4 *	1137.	1040.	9839.	39.	20.	1884.	1421.	48518.
B-1 *	2259.	938.	3980.	227.	48.	1998.	1096.	76370.
B-2 *	3486.	874.	3581.	114.	112.	1965.	1059.	71796.
B-3 *	30298.	1337.	4305.	88.	47.	4022.	1503.	96085.
B-4 *	2131.	20624.	3355.	49.	19.	3477.	1760.	62478.
B-5 *	1168.	863.	43226.	51.	18.	2423.	3760.	85423.
C-1 *	11964.	4872.	26033.	55130.	639.	9087.	6449.	301608.
C-2 *	3487.	1249.	5476.	144.	43853.	2686.	1667.	134516.
C-3 *	16223.	4718.	14464.	176.	99.	104502.	6269.	279407.
C-4 *	4863.	2893.	43290.	187.	104.	5965.	109799.	295080.
TOTAL *	85491.	43077.	169706.	56453.	45086.	145389.	137913.	1656826.

*** GOING TO SCHOOL -2000- ***

*	CBD-1	CBD-2	A-1	A-2	A-3	A-4	B-1	B-2
CBD-1 *	6747.	86.	1947.	8994.	4354.	294.	139.	767.
CBD-2 *	2219.	489.	787.	3888.	1106.	1948.	139.	811.
A-1 *	2018.	48.	16517.	5137.	1703.	135.	228.	416.
A-2 *	3056.	59.	1438.	24591.	5017.	197.	162.	875.
A-3 *	1889.	17.	370.	2605.	18048.	94.	77.	213.
A-4 *	3057.	674.	877.	5259.	1843.	14605.	226.	1046.
B-1 *	8150.	304.	6477.	19226.	10119.	1438.	40438.	4704.
B-2 *	1340.	52.	788.	4264.	1309.	199.	223.	27490.
B-3 *	1247.	60.	621.	3206.	2227.	181.	60.	403.
B-4 *	6655.	357.	1899.	8814.	8029.	1723.	243.	1031.
B-5 *	7828.	807.	2537.	11647.	7687.	8124.	344.	1794.
C-1 *	5380.	195.	3050.	13118.	6404.	922.	803.	2335.
C-2 *	22.	0.	7.	52.	19.	2.	1.	18.
C-3 *	15469.	846.	6637.	34182.	21742.	3200.	785.	3279.
C-4 *	29369.	2382.	10379.	47964.	19044.	11526.	1246.	5859.
TOTAL *	94446.	6372.	54331.	192947.	108651.	44588.	45114.	51041.

*	B-3	B-4	B-5	C-1	C-2	C-3	C-4	TOTAL
CBD-1 *	1745.	23.	95.	3.	1059.	178.	48.	26479.
CBD-2 *	1937.	39.	482.	2.	1004.	220.	161.	15232.
A-1 *	1249.	12.	45.	2.	566.	130.	20.	28226.
A-2 *	2099.	20.	54.	3.	998.	203.	28.	38796.
A-3 *	536.	24.	19.	1.	356.	101.	10.	24760.
A-4 *	2578.	58.	1090.	3.	1405.	244.	286.	33251.
B-1 *	8462.	83.	323.	71.	7028.	560.	170.	107553.
B-2 *	2231.	9.	37.	3.	1680.	85.	20.	39730.
B-3 *	39063.	11.	22.	1.	329.	351.	12.	47794.
B-4 *	6364.	19060.	153.	5.	1304.	768.	81.	56486.
B-5 *	6012.	120.	18360.	12.	2359.	517.	1048.	69196.
C-1 *	5797.	58.	249.	116835.	8452.	356.	129.	164083.
C-2 *	14.	0.	0.	0.	72205.	1.	0.	72341.
C-3 *	26818.	312.	604.	15.	4145.	68812.	252.	187098.
C-4 *	19729.	391.	6368.	35.	10040.	1801.	73055.	239188.
TOTAL *	125034.	20220.	27901.	116991.	112930.	74327.	75320.	1150213.

TABLE 5.2-6 CONT'D

*** PRIVATE -2000- ***

*	CBD-1	CBD-2	A-1	A-2	A-3	A-4	B-1	B-2
CBD-1	63055.	8574.	7872.	17501.	8297.	7039.	1727.	1984.
CBD-2	9649.	13686.	2165.	5162.	1868.	11316.	850.	1041.
A-1	18483.	4441.	34069.	11895.	4072.	3442.	2033.	1668.
A-2	25951.	7305.	6971.	77233.	10570.	5960.	1978.	2535.
A-3	16050.	3110.	3213.	12036.	58015.	2883.	1280.	1203.
A-4	10284.	14096.	2196.	5700.	2685.	48254.	1100.	1185.
B-1	13728.	5928.	5196.	9852.	5280.	5471.	46300.	3314.
B-2	16955.	7700.	4412.	13830.	4698.	6441.	2616.	54858.
B-3	16597.	6632.	4798.	12219.	6795.	5913.	1519.	2464.
B-4	10065.	5881.	2236.	5680.	4951.	5020.	768.	865.
B-5	11308.	10679.	2535.	6134.	3460.	14504.	901.	1205.
C-1	49724.	18829.	12947.	32430.	15927.	17943.	8127.	8580.
C-2	19384.	8013.	4435.	13323.	5647.	6959.	1734.	3757.
C-3	35965.	16827.	9521.	24615.	13816.	13898.	3024.	3880.
C-4	30955.	22338.	7021.	17080.	7606.	22483.	2449.	3123.
TOTAL	348153.	154039.	109587.	264690.	153687.	177566.	76406.	91662.

*	B-3	B-4	B-5	C-1	C-2	C-3	C-4	TOTAL
CBD-1	5648.	2295.	7906.	111.	201.	3610.	2196.	138016.
CBD-2	2671.	1409.	8991.	47.	93.	2171.	2005.	63124.
A-1	3828.	1238.	4619.	80.	117.	2350.	1269.	93604.
A-2	7008.	2263.	7139.	117.	207.	3782.	2027.	161046.
A-3	4412.	2098.	4583.	68.	113.	2471.	1032.	112567.
A-4	3205.	1879.	16348.	61.	108.	2498.	2715.	112354.
B-1	4199.	1462.	5682.	187.	156.	2292.	1473.	110520.
B-2	6225.	1522.	5686.	121.	321.	2487.	1578.	129450.
B-3	103997.	2136.	5598.	87.	137.	4598.	1632.	175122.
B-4	3369.	64040.	4570.	51.	66.	3037.	1681.	112280.
B-5	2882.	1589.	122141.	74.	87.	2575.	4536.	184610.
C-1	15378.	5858.	26317.	69152.	1100.	7708.	6211.	296231.
C-2	4664.	1483.	5911.	121.	74817.	2327.	1674.	154249.
C-3	18671.	6330.	16241.	157.	260.	120898.	5433.	289536.
C-4	7300.	3541.	38485.	166.	268.	5169.	218464.	386448.
TOTAL	193457.	99143.	280217.	70600.	78051.	167973.	253926.	2519157.

*** WORK -2000- ***

*	CBD-1	CBD-2	A-1	A-2	A-3	A-4	B-1	B-2
CBD-1	121756.	22299.	22469.	41840.	21238.	17493.	9624.	11726.
CBD-2	22116.	30687.	6576.	13473.	5450.	23353.	4697.	5984.
A-1	22143.	6529.	42355.	14761.	5881.	4915.	4917.	4452.
A-2	41680.	13537.	14949.	102939.	17606.	10833.	7700.	10196.
A-3	21099.	5468.	5949.	17598.	69164.	5149.	4218.	4156.
A-4	17443.	23479.	4994.	10856.	5157.	64939.	4245.	4927.
B-1	9177.	4537.	4009.	7382.	4052.	4061.	62716.	4678.
B-2	11197.	5789.	4347.	9806.	3990.	4710.	4706.	70010.
B-3	17331.	8081.	6417.	14080.	7994.	6940.	3906.	5847.
B-4	9339.	5760.	2815.	6151.	5209.	5078.	1816.	2049.
B-5	18992.	18983.	6016.	12123.	6944.	23366.	3998.	4724.
C-1	4405.	1920.	1597.	3227.	1641.	1750.	1740.	1577.
C-2	4369.	2062.	1369.	3257.	1515.	1707.	971.	1971.
C-3	18130.	10220.	6378.	13199.	7694.	8294.	3653.	4380.
C-4	11011.	9509.	3398.	7184.	3274.	8981.	2141.	2617.
TOTAL	350190.	168860.	134439.	277876.	166809.	191569.	121048.	139294.

*	B-3	B-4	B-5	C-1	C-2	C-3	C-4	TOTAL
CBD-1	17528.	9622.	18870.	5195.	4938.	19029.	11722.	355350.
CBD-2	8085.	5870.	10727.	2224.	2280.	10560.	9879.	169961.
A-1	6375.	2853.	5845.	1811.	1503.	6564.	3524.	134428.
A-2	14160.	6305.	11954.	3772.	3649.	13791.	7587.	280658.
A-3	[illegible]	5311.	6837.	1723.	1701.	8029.	3465.	168100.
A-4	6995.	5202.	23174.	2072.	1933.	8667.	9451.	193534.
B-1	3755.	1781.	3736.	1859.	1015.	3647.	2124.	119329.
B-2	5654.	2013.	4445.	1708.	2052.	4391.	2613.	137431.
B-3	114520.	4155.	6370.	1921.	1596.	11066.	3795.	214019.
B-4	4077.	69680.	4489.	995.	700.	5970.	2814.	126942.
B-5	6511.	4679.	156502.	2678.	1690.	9290.	13505.	290001.
C-1	1639.	887.	2190.	115965.	677.	1530.	1092.	141839.
C-2	1427.	645.	1437.	697.	97283.	1310.	871.	120891.
C-3	10663.	5870.	8737.	1665.	1383.	140894.	5348.	246508.
C-4	3619.	2789.	12644.	1220.	937.	5414.	267455.	342193.
TOTAL	213041.	127662.	285957.	145705.	123337.	250152.	345245.	3041184.

TABLE 5.2-6 CONT'D

*** RETURN TO HOME -2000- ***

	*	CBD-1	CBD-2	A-1	A-2	A-3	A-4	B-1	B-2
CBD-1	*	4791.	2238.	25744.	22531.	20960.	11926.	31184.	29420.
CBD-2	*	844.	2156.	5870.	6667.	3859.	13048.	9939.	12344.
A-1	*	820.	642.	37636.	6553.	4271.	2897.	14612.	7779.
A-2	*	2714.	1909.	20318.	53795.	15987.	9497.	34676.	26594.
A-3	*	1740.	702.	7221.	13471.	40684.	4541.	18999.	9452.
A-4	*	791.	2231.	5079.	5752.	3918.	33849.	10884.	11082.
B-1	*	208.	201.	3514.	2058.	1730.	1378.	83406.	4901.
B-2	*	349.	418.	3119.	3044.	1911.	2079.	10398.	63251.
B-3	*	732.	1061.	5760.	7738.	5589.	4810.	14820.	11474.
B-4	*	247.	255.	1685.	2155.	2084.	1951.	2463.	2439.
B-5	*	841.	1602.	6403.	6537.	5529.	16278.	10176.	9730.
C-1	*	19.	13.	191.	178.	147.	113.	525.	312.
C-2	*	167.	291.	751.	860.	491.	1168.	7242.	2168.
C-3	*	426.	513.	3566.	3872.	3192.	3205.	4821.	4569.
C-4	*	250.	374.	1983.	1965.	1447.	2947.	3022.	2980.
TOTAL	*	14939.	14608.	128840.	137176.	111799.	109687.	257167.	198495.

	*	B-3	B-4	B-5	C-1	C-2	C-3	C-4	TOTAL
CBD-1	*	28853.	22997.	20121.	107988.	40366.	86422.	92647.	548388.
CBD-2	*	10953.	9407.	12600.	38190.	16247.	32323.	47243.	221690.
A-1	*	8543.	5581.	5185.	29506.	9333.	25292.	24954.	183604.
A-2	*	22942.	18028.	17233.	80311.	28079.	82532.	83902.	498517.
A-3	*	13579.	16796.	10907.	41110.	12442.	49754.	36096.	277494.
A-4	*	10259.	10162.	23023.	39479.	14872.	30866.	58328.	260577.
B-1	*	3032.	1744.	1585.	20270.	4227.	7725.	7231.	143210.
B-2	*	5401.	2791.	3376.	22693.	9227.	12440.	13505.	154002.
B-3	*	104804.	11612.	8795.	35921.	9301.	59937.	34280.	316634.
B-4	*	3078.	68597.	2066.	11105.	3005.	10702.	7244.	119076.
B-5	*	9629.	8041.	90662.	53880.	12780.	32217.	83511.	347816.
C-1	*	254.	166.	179.	205033.	363.	554.	601.	208648.
C-2	*	749.	1509.	2230.	10964.	154317.	5114.	11032.	199053.
C-3	*	7550.	6589.	4586.	18115.	5492.	225410.	13818.	305724.
C-4	*	3237.	3539.	7502.	14291.	3953.	12571.	292326.	352387.
TOTAL	*	232863.	187559.	210250.	728856.	324004.	673859.	806718.	4136820.

*** TOTAL OF ALL TRIP PURPOSE -2000- ***

	*	CBD-1	CBD-2	A-1	A-2	A-3	A-4	B-1	B-2
CBD-1	*	203541.	35037.	59569.	94384.	56612.	38151.	43046.	44371.
CBD-2	*	36944.	49984.	15837.	30128.	12625.	52402.	15825.	20435.
A-1	*	59275.	15106.	143228.	47678.	18821.	13847.	24002.	15942.
A-2	*	88860.	27440.	47471.	274800.	55506.	29856.	45862.	41934.
A-3	*	53841.	11418.	18957.	53988.	194466.	14609.	25582.	15989.
A-4	*	37167.	50673.	14197.	30238.	14995.	172504.	17150.	18969.
B-1	*	43518.	16290.	24362.	46007.	25567.	17044.	256884.	20885.
B-2	*	44695.	20907.	15860.	42346.	15359.	18708.	20772.	228249.
B-3	*	52554.	22656.	22017.	47952.	28862.	23417.	22083.	23266.
B-4	*	35116.	17573.	10288.	26902.	25404.	18247.	6040.	7206.
B-5	*	46195.	40034.	18845.	39695.	25650.	72837.	16067.	18327.
C-1	*	117647.	42757.	30976.	81980.	40804.	40622.	23945.	24774.
C-2	*	47709.	20388.	11298.	32443.	13719.	17895.	12463.	13771.
C-3	*	110937.	47516.	35784.	101037.	61138.	43132.	16185.	21025.
C-4	*	106282.	63331.	29610.	90639.	38634.	73035.	12041.	18314.
TOTAL	*	1084281.	481110.	498307.	1040217.	628162.	646306.	557947.	533457.

	*	B-3	B-4	B-5	C-1	C-2	C-3	C-4	TOTAL
CBD-1	*	54519.	35334.	48520.	113320.	46579.	110041.	106979.	1090003.
CBD-2	*	24046.	17041.	42620.	40473.	19631.	45859.	59637.	483495.
A-1	*	21925.	10480.	18604.	31481.	11553.	36260.	30630.	498832.
A-2	*	49389.	27756.	39832.	84283.	32975.	102631.	94491.	1043086.
A-3	*	29180.	25249.	24985.	43155.	14641.	62101.	41208.	629369.
A-4	*	24174.	18341.	73474.	41654.	18338.	44159.	72201.	648234.
B-1	*	21707.	6008.	15306.	22614.	12474.	16222.	12094.	556982.
B-2	*	22997.	7209.	17125.	24639.	13392.	21368.	18775.	532409.
B-3	*	392682.	19251.	25090.	38018.	11410.	79974.	41222.	850454.
B-4	*	19019.	242001.	14633.	12205.	5094.	23954.	13580.	477262.
B-5	*	26202.	15292.	430891.	56695.	16934.	47022.	106360.	977046.
C-1	*	35032.	11841.	54968.	562115.	11231.	19235.	14482.	1112409.
C-2	*	10341.	4886.	15054.	11926.	442475.	11438.	15244.	681050.
C-3	*	79925.	23819.	44632.	20128.	11379.	660516.	31120.	1308273.
C-4	*	38748.	13153.	108289.	15899.	15302.	30920.	961099.	1615296.
TOTAL	*	849886.	477661.	974031.	1118605.	683408.	1311700.	1619122.	12504202.

TABLE 5.6-1 OD VOLUME OF VEHICLE TRIP IN 1977

O \ D	CBD_1	CBD_2	A_1	A_2	A_3	A_4	B_1	B_2	B_3	B_4	B_5
CBD_1	59528.	10141.	17739.	25536.	14621.	11399.	11370.	9451.	12214.	9047.	12922.
CBD_2	10054.	13380.	4448.	7436.	3129.	14287.	4735.	4306.	5219.	4590.	11541.
A_1	18981.	4768.	38130.	13614.	4962.	4189.	5795.	3616.	5350.	2673.	5187.
A_2	26551.	7769.	13825.	74496.	14218.	8734.	11281.	9243.	11495.	7263.	10166.
A_3	15443.	3233.	5231.	14672.	50274.	4215.	5649.	3405.	6650.	5964.	5972.
A_4	10973.	14714.	4002.	7816.	3900.	50961.	4673.	3959.	5516.	4912.	20712.
B_1	12240.	5650.	5688.	10085.	4970.	5179.	48820.	4457.	4314.	1602.	4962.
B_2	10451.	4981.	3762.	9586.	3357.	4483.	4637	46806.	4963.	1713.	4260.
B_3	12832.	5586.	5644.	11630.	6622.	6115.	5106.	5120.	84690.	4630.	6137.
B_4	8490.	5165.	2435.	5786.	4998.	4945.	1483.	1509.	3549.	56564.	4179.
B_5	11659.	11379.	4712.	8337.	5014.	19402.	4526.	3896.	5234.	4059.	116535.
C_1	14269.	5515.	3488.	9430.	4247.	5094.	2060.	2558.	4264.	1585.	7780.
C_2	6399.	2759.	1792.	4751.	1910.	2767.	2086.	2278.	1641.	1112.	2586.
C_3	17959.	8892.	5743.	13886.	7632.	7983.	2842.	3160.	10750.	4845.	9017.
C_4	12955.	5910.	3476.	8421.	3575.	11030.	1960.	2325.	4137.	2549.	18393.
P_1	2325.	2460.	3708.	1356.	1286.	1376.	1264.	883.	881.	982.	1104.
P_2	104.	17.	494.	256.	258.	276.	344.	294.	203.	223.	245.
E_1	1684.	713.	894.	1704.	998.	1119.	931.	800.	1282.	817.	1622.
E_2	2427.	1030.	1286.	2459.	1440.	1613.	1345.	1151.	1853.	1178.	2339.
E_3	1981.	840.	1056.	2008.	1176.	1319.	1090.	940.	1511.	962.	1909.
TOTAL	257305.	118902.	127553.	233265.	138587.	166486.	121997.	110157.	175716.	117270.	247568.

O \ D	C_1	C_2	C_3	C_4	P_1	P_2	E_1	E_2	E_3	TOTAL
CBD_1	11643.	5324.	17552.	14901.	2308.	104.	1690.	2439.	1989.	251918.
CBD_2	4385.	2251.	7779.	8878.	2459.	17.	715.	1034.	845.	111488.
A_1	3015.	1378.	5926.	4128.	3728.	494.	894.	1290.	1053.	129171.
A_2	8482.	3960.	16034.	12815.	1362.	256.	1709.	2467.	2012.	244138.
A_3	3907.	1647.	8991.	5266.	1289.	258.	1000.	1441.	1176.	145683.
A_4	4308.	2068.	7646.	11019.	1372.	276.	1119.	1618.	1320.	162884.
B_1	1812.	1037.	2888.	2038.	1262.	344.	927.	1341.	1088.	120704.
B_2	2245.	1599.	3389.	2828.	884.	294.	792.	1147.	938.	113115.
B_3	4040.	1445.	12448.	6294.	884.	203.	1284.	1854.	1512.	184076.
B_4	1362.	632.	4513.	2557.	978.	223.	816.	1176.	961.	112321.
B_5	6577.	1985.	8441.	16834.	1098.	245.	1626.	2347.	1915.	235821.
C_1	86709.	662.	2158.	2092.	360.	89.	1232.	1775.	1449.	156816.
C_2	1131.	68344.	1903.	3121.	134.	38.	804.	1158.	946.	107660.
C_3	1948.	1059.	106710.	4917.	967.	255.	1654.	2385.	1947.	214551.
C_4	1939.	1282.	4547.	187348.	778.	203.	2095.	3022.	2464.	282409.
P_1	354.	130.	968.	793.	4188.	25.	288.	132.	197.	24700.
P_2	89.	38.	255.	203.	25.	0.	44.	8.	22.	3398.
E_1	1238.	806.	1657.	2098.	289.	44.	0.	180.	122.	18998.
E_2	1786.	1162.	2392.	3025.	133.	8.	180.	0.	158.	26965.
E_3	1456.	948.	1952.	2469.	197.	22.	122.	158.	0.	22116.
TOTAL	148426.	97757.	218149.	293624.	24695.	3398.	18991.	26972.	22114.	2668932.

TABLE 5.6-2 OD VOLUME OF VEHICLE TRIP IN 1979

O \ D	CBD_1	CBD_2	A_1	A_2	A_3	A_4	B_1	B_2	B_3	B_4	B_5
CBD_1	62387.	10627.	18590.	26763.	15323.	11947.	11807.	9905.	12801.	9482.	13543.
CBD_2	10537.	14022.	4665.	7792.	3280.	14975.	4919.	4512.	5470.	4811.	12097.
A_1	19892.	4994.	39963.	14264.	5200.	4394.	6010.	3791.	5607.	2802.	5436.
A_2	27826.	8142.	14490.	78074.	14901.	9154.	11730.	9687.	12047.	7612.	10653.
A_3	16184.	3388.	5482.	15378.	52689.	4418.	5866.	3568.	6969.	6250.	6259.
A_4	11502.	15419.	4199.	8191.	4088.	53412.	4859.	4149.	5780.	5147.	21707.
B_1	12705.	5870.	5897.	10484.	5159.	5376.	50727.	4644.	4487.	1665.	5161.
B_2	10950.	5221.	3947.	10046.	3518.	4694.	4831.	49053.	5202.	1795.	4463.
B_3	13447.	5855.	5916.	12189.	6940.	6410.	5315.	5366.	88757.	4852.	6431.
B_4	8897.	5413.	2553.	6064.	5238.	5183.	1541.	1581.	3719.	59281.	4379.
B_5	12220.	11925.	4940.	8737.	5255.	20333.	4705.	4082.	5486.	4254.	122132.
C_1	14952.	5777.	3652.	9886.	4452.	5338.	2144.	2684.	4470.	1662.	8153.
C_2	6706.	2890.	1879.	4979.	2001.	2898.	2176.	2389.	1719.	1165.	2712.
C_3	18822.	9319.	6021.	14550.	7998.	8366.	2959.	3311.	11265.	5078.	9451.
C_4	13579.	10386.	3641.	8827.	3747.	11559.	2036.	2437.	4336.	2670.	19276.
P_1	2532.	2669.	4040.	1476.	1390.	1487.	1364.	951.	953.	1062.	1195.
P_2	113.	19.	538.	281.	281.	300.	374.	316.	222.	243.	267.
E_1	1764.	747.	939.	1788.	1046.	1172.	966.	838.	1345.	856.	1700.
E_2	2545.	1078.	1349.	2579.	1510.	1691.	1395.	1208.	1942.	1235.	2451.
E_3	2076.	879.	1107.	2103.	1232.	1380.	1136.	987.	1583.	1008.	2001.
TOTAL	269636.	124640.	133808.	244451.	145248.	174487.	126860.	115459.	184160.	122930.	259467.

O \ D	C_1	C_2	C_3	C_4	P_1	P_2	E_1	E_2	E_3	TOTAL
CBD_1	12201.	5578.	18395.	15618.	2512.	113.	1770.	2556.	2085.	264003.
CBD_2	4597.	2359.	8151.	9303.	2667.	19.	750.	1083.	884.	116893.
A_1	3161.	1443.	6213.	4327.	4066.	538.	939.	1352.	1104.	135496.
A_2	8890.	4151.	16804.	13431.	1482.	281.	1793.	2586.	2109.	255843.
A_3	4096.	1725.	9423.	5520.	1394.	281.	1048.	1511.	1233.	152682.
A_4	4515.	2166.	8015.	11548.	1483.	300.	1174.	1696.	1382.	170732.
B_1	1885.	1086.	3002.	2119.	1360.	374.	964.	1387.	1134.	125486.
B_2	2354.	1675.	3552.	2966.	953.	316.	833.	1204.	983.	118556.
B_3	4236.	1514.	13045.	6596.	958.	222.	1347.	1943.	1585.	192924.
B_4	1427.	662.	4729.	2680.	1058.	243.	855.	1234.	1008.	117745.
B_5	6890.	2080.	8846.	17642.	1189.	267.	1704.	2459.	2007.	247153.
C_1	90878.	697.	2263.	2192.	390.	96.	1293.	1861.	1517.	164357.
C_2	1185.	71627.	1993.	3272.	145.	42.	842.	1216.	992.	112828.
C_3	2044.	1108.	111836.	5152.	1049.	278.	1733.	2500.	2039.	224879.
C_4	2032.	1343.	4766.	196347.	845.	222.	2196.	3167.	2584.	295996.
P_1	383.	141.	1051.	862.	4516.	27.	313.	147.	213.	26772.
P_2	96.	42.	278.	222.	27.	0.	48.	8.	24.	3699.
E_1	1299.	846.	1737.	2199.	313.	48.	0.	189.	127.	19919.
E_2	1872.	1218.	2507.	3170.	148.	8.	189.	0.	165.	28260.
E_3	1526.	994.	2045.	2588.	215.	24.	127.	165.	0.	23176.
TOTAL	155567.	102455.	228651.	307754.	26770.	3699.	19918.	28264.	23175.	2797399.

TABLE 5.6-3 OD VOLUME OF VEHICLE TRIP IN 1981

O \ D	CBD_1	CBD_2	A_1	A_2	A_3	A_4	B_1	B_2	B_3	B_4	B_5
CBD_1	65224.	11113.	19437.	27978.	16020.	12489.	12240.	10355.	13384.	9913.	14159.
CBD_2	11015.	14660.	4875.	8147.	3428.	15656.	5097.	4719.	5718.	5030.	12646.
A_1	20794.	5225.	41779.	14911.	5437.	4595.	6235.	3961.	5862.	2928.	5682.
A_2	29091.	8512.	15146.	81625.	15579.	9568.	12184.	10129.	12595.	7958.	11137.
A_3	16920.	3542.	5731.	16077.	55084.	4618.	6079.	3730.	7286.	6534.	6543.
A_4	12023.	16120.	4389.	8564.	4274.	55839.	5033.	4340.	6042.	5381.	22694.
B_1	13162.	6080.	6111.	10877.	5347.	5570.	52628.	4829.	4656.	1728.	5356.
B_2	11451.	5457.	4120.	10502.	3679.	4908.	5024.	51284.	5441.	1877.	4667.
B_3	14060.	6122.	6183.	12743.	7255.	6697.	5517.	5607.	92792.	5073.	6724.
B_4	9302.	5659.	2667.	6339.	5476.	5419.	1599.	1653.	3887.	61976.	4578.
B_5	12775.	12467.	5163.	9134.	5494.	21258.	4884.	4269.	5735.	4447.	127684.
C_1	15631.	6043.	3818.	10336.	4654.	5578.	2239.	2806.	4671.	1736.	8524.
C_2	7011.	3022.	1964.	5206.	2093.	3033.	2264.	2497.	1799.	1219.	2834.
C_3	19678.	9742.	6293.	15212.	8362.	8746.	3067	3464.	11778.	5308.	9880.
C_4	14194.	10857.	3807.	9227.	3917.	12085.	2116.	2549.	4532.	2792.	20153.
P_1	2667.	2780.	4275.	1552.	1450.	1550.	1428.	996.	998.	1104.	1249.
P_2	123.	20.	592.	306.	308.	329.	408.	348.	244.	266.	292.
E_1	1845.	782.	977.	1867.	1094.	1226.	1000	876.	1407.	895.	1778.
E_2	2659.	1128.	1407.	2694.	1578.	1766.	1446.	1260.	2030.	1292.	2563.
E_3	2171.	920.	1157.	2199.	1289.	1443.	1179.	1029.	1655.	1054.	2092.
TOTAL	281796.	130251.	139891.	255496.	151818.	182373.	131667.	120701.	192512.	128511.	271235.

O \ D	C_1	C_2	C_3	C_4	P_1	P_2	E_1	E_2	E_3	TOTAL
CBD_1	12757.	5833.	19230.	16328.	2644.	123.	1851.	2672.	2180.	275930.
CBD_2	4805.	2465.	8524.	9726.	2778.	20.	786.	1134.	925.	122154.
A_1	3300.	1510.	6495.	4522.	4301.	592.	977.	1409.	1154.	141669.
A_2	9296.	4337.	17568.	14040.	1559.	306.	1873.	2703.	2205.	267411.
A_3	4283.	1804.	9852.	5771.	1454.	308.	1096.	1579.	1290.	159581.
A_4	4721.	2266.	8377.	12073.	1548.	329.	1227.	1772.	1445.	178457.
B_1	1965.	1128.	3113.	2198.	1428.	408.	996.	1439.	1177.	130196.
B_2	2460.	1752.	3713.	3100.	998.	348.	868.	1256.	1025.	123930.
B_3	4428.	1583.	13638.	6895.	1003.	244.	1409.	2032.	1657.	201662.
B_4	1493.	693.	4944.	2801.	1099.	266.	894.	1290.	1053.	123[illegible]38.
B_5	7205.	2174.	9248.	18444.	1242.	292.	1782.	2571.	2098.	258366.
C_1	95006.	728.	2362.	2291.	414.	105.	1351.	1945.	1588.	171826.
C_2	1237.	74883.	2084.	3420.	155.	46.	880.	1270.	1038.	117955.
C_3	2137.	1159.	116921.	5386.	1098.	304	1811.	2614.	2133.	235093.
C_4	2124.	1405.	4982.	205274.	834.	243	2295.	3311.	2700.	309447.
P_1	404.	151.	1100.	902.	4678.	31.	324.	154.	223.	28016.
P_2	105.	46.	304.	243.	31.	0.	54.	8.	26.	4053.
E_1	1357.	884.	1815.	2299.	324.	54	0.	198.	134.	20812.
E_2	1957.	1274.	2620.	3315.	155.	8.	198.	0.	173.	29523.
E_3	1595.	1040.	2137.	2706.	223.	26.	134.	173.	0.	24222.
TOTAL	162635.	107115.	239027.	321734.	28016.	4053	20806.	29530.	24224.	2923391.

TABLE 5.6-4 OD VOLUME OF VEHICLE TRIP IN 1987 (CASE 2)

O \ D	CBD_1	CBD_2	A_1	A_2	A_3	A_4	B_1	B_2	B_3	B_4	B_5
CBD_1	73754.	12564.	21978.	31638.	18115.	14124.	13531.	11710.	15132.	11209.	16010.
CBD_2	12456.	16577.	5513.	9212.	3877.	17702.	5637.	5335.	6467.	5687.	14300.
A_1	23516.	5906.	47243.	16864.	6147.	5194.	6891.	4482.	6627.	3312.	6426.
A_2	32896.	5625.	17128.	92299.	17616.	10820.	13530.	11451.	14241.	8999.	12594.
A_3	19133.	4005.	6481.	18179.	62288.	5222.	6727.	4218.	8239.	7389.	7399.
A_4	13596.	18228.	4963.	9683.	4832.	63140.	5575.	4906.	6833.	6085.	25661.
B_1	14549.	6723.	6750.	12059.	5907.	6166.	58324.	5384.	5166.	1917.	5944.
B_2	12947.	6171.	4663.	11876.	4160.	5552.	5602.	57991.	6150.	2122.	5277.
B_3	15899.	6922.	6992.	14409.	8204.	7576.	6132.	6344.	104927.	5737.	7604.
B_4	10519.	6399.	3016.	7168.	6192.	6127.	1776.	1869.	4396.	70081.	5177.
B_5	14446.	14098.	5838.	10329.	6212.	24038.	5421.	4827.	6485.	5029.	144382.
C_1	17677.	6831.	4320.	11687.	5263.	6311.	2491.	3172.	5283.	1964.	9639.
C_2	7928.	3417.	2221.	5886.	2366.	3427.	2530.	2824.	2033.	1378.	3205.
C_3	22251.	11017.	7116.	17202.	9455.	9889.	3403.	3916.	13318.	6003.	11172.
C_4	16051.	12278.	4305.	10434.	4429.	13665.	2349.	2881.	5126.	3157.	22788.
P_1	2851.	2814.	4639.	1646.	1491.	1582.	1467.	1018.	1038.	1126.	1287.
P_2	154.	25.	734.	381.	383.	409.	516.	431.	303.	332.	364.
E_1	2085.	884.	1108.	2112.	1237.	1387.	1102.	990.	1590.	1012.	2010.
E_2	3007.	1275.	1595.	3047.	1785.	1998.	1594.	1426.	2295.	1460.	2898.
E_3	2454.	1040.	1306.	2487.	1457.	1632.	1296.	1165.	1872.	1192.	2366.
TOTAL	318169.	146799.	157909.	288598.	171416.	205961.	145894.	136340.	217521.	145191.	306503.

O \ D	C_1	C_2	C_3	C_4	P_1	P_2	E_1	E_2	E_3	TOTAL
CBD_1	14425.	6595.	21746.	18463.	2823.	154.	2093.	3021.	2465.	311550.
CBD_2	5434.	2789.	9637.	10997.	2812.	25.	888.	1281.	1045.	137671.
A_1	3735.	1706.	7344.	5114.	4675.	734.	1108.	1598.	1303.	159925.
A_2	10507.	4906.	19866.	15876.	1656.	381.	2118.	3056.	2493.	302058.
A_3	4842.	2040.	11140.	6525.	1496.	383.	1239.	1786.	1458.	180189.
A_4	5338.	2561.	9473.	13653.	1580.	409.	1388.	2004.	1634.	201542.
B_1	2189.	1261.	3451.	2439.	1466.	516.	1098.	1586.	1294.	144189.
B_2	2783.	1980.	4199.	3505.	1022.	431.	982.	1422.	1161.	139996.
B_3	5006.	1790.	15422.	7798.	1045.	303.	1593.	2297.	1874.	227874.
B_4	1688.	783.	5591.	3168.	1120.	332.	1011.	1458.	1191.	13[illegible]062.
B_5	8146.	2459.	10458.	20856.	1278.	364.	2015.	2907.	2373.	291961.
C_1	107432.	823.	2673.	2591.	437.	129.	1528.	2200.	1796.	194247.
C_2	1400.	84675.	2356.	3867.	161.	56.	996.	1436.	1174.	133336.
C_3	2416.	1311.	132210.	6091.	1142.	378.	2048.	2555.	2412.	265705.
C_4	2403.	1588.	5634.	232117.	913.	302.	2595.	3744.	3054.	349813.
P_1	426.	156.	1145.	935.	4678.	38.	329.	169.	231.	29066.
P_2	129.	56.	378.	302.	38.	0.	66.	10.	32.	5043.
E_1	1535.	1000.	2053.	2599.	329.	66.	0.	224.	151.	23474.
E_2	2213.	1440.	2963.	3748.	170.	10.	224.	0.	195.	33343.
E_3	1805.	1176.	2418.	3060.	231.	32.	151.	195.	0.	27335.
TOTAL	183852.	121095.	270157.	363704.	29072.	5043.	23470.	33349.	27336.	3297379.

TABLE 5.6-5 OD VOLUME OF VEHICLE TRIP IN 1987 (CASE 4)

O \ D	CBD_1	CBD_2	A_1	A_2	A_3	A_4	B_1	B_2	B_3	B_4	B_5
CBD_1	67647.	12626.	19146.	28566.	14662.	11449.	10494.	8341.	11591.	8939.	12674.
CBD_2	12503.	15982.	4322.	7585.	3194.	14566.	4435.	3829.	4677.	4291.	11628.
A_1	20551.	4654.	38804.	13977.	5067.	4003.	5490.	3658.	4974.	2541.	4887.
A_2	29552.	7933.	14039.	78318.	15441.	8624.	10606.	8830.	11167.	7065.	9808.
A_3	15541.	3318.	5294.	15924.	52383.	4406.	5143.	3325.	6502.	5983.	5935.
A_4	11142.	15075.	3804.	7797.	4142.	57694.	4146.	3497.	5171.	4795.	20626.
B_1	11449.	5335.	5463.	9684.	4625.	4683.	49208.	4270.	4159.	1552.	4410.
B_2	9360.	4492.	3787.	9276.	3308.	3973.	4395.	51789.	5159.	1789.	4154.
B_3	12329.	5074.	5209.	11368.	6494.	5724.	4851.	5318.	91319.	4656.	6018.
B_4	8547.	4877.	2356.	5760.	5155.	4873.	1443.	1609.	3681.	59289.	4258.
B_5	11677.	11643.	4446.	8208.	5064.	19442.	3946.	3787.	5171.	4117.	124928.
C_1	12751.	4923.	3282.	8748.	3896.	4554.	1747.	4069.	4109.	1550.	7079.
C_2	5122.	2186.	1558.	4022.	1661.	2161.	1674.	2144.	1562.	1006.	2198.
C_3	16877.	7868.	5189.	12583.	7551.	7453.	2696.	3327.	12655.	4915.	9138.
C_4	11575.	9127.	3152.	7630.	3469.	10103.	1806.	2258.	4017.	2580.	18020.
P_1	2851.	2814.	4639.	1646.	1491.	1582.	1467.	1018.	1038.	1126.	1287.
P_2	154.	25.	734.	381.	383.	409.	516.	431.	303.	332.	364.
E_1	1606.	682.	854.	1628.	954.	1070.	852.	762.	1227.	781.	1550.
E_2	2421.	1027.	1284.	2455.	1437.	1609.	1282.	1148.	1847.	1176.	2334.
E_3	1913.	810.	1016.	1938.	1136.	1272.	1016.	906.	1459.	929.	1844.
TOTAL	265568.	124471.	128378.	237494.	141513.	169650.	117213.	114316.	181788.	119412.	253140.

O \ D	C_1	C_2	C_3	C_4	P_1	P_2	E_1	E_2	E_3	TOTAL
CBD_1	10074.	4079.	16098.	12891.	2823.	154.	1615.	2431.	1922.	258222.
CBD_2	3781.	1724.	6723.	8017.	2812.	25.	686.	1031.	815.	116626.
A_1	2814.	1182.	5241.	3666.	4675.	734.	852.	1283.	1014.	130067.
A_2	7717.	3271.	14130.	11199.	1656.	381.	1632.	2460.	1941.	245770.
A_3	3488.	1392.	8669.	4931.	1496.	383.	956.	1438.	1137.	147644.
A_4	3726.	1578.	7005.	9920.	1580.	409.	1072.	1613.	1275.	166067.
B_1	1484.	725.	2746.	1895.	1466.	516.	846.	1280.	1010.	116806.
B_2	3809.	1495.	3525.	2702.	1022.	431.	762.	1144.	904.	117276.
B_3	3863.	1375.	14131.	5978.	1045.	303.	1227.	1848.	1461.	189591.
B_4	1327.	570.	4626.	2590.	1120.	332.	780.	1175.	928.	115296.
B_5	5803.	1622.	8559.	16409.	1278.	364.	1554.	2340.	1850.	242208.
C_1	91479.	656.	2087.	1990.	437.	129.	1175.	1774.	1402.	157837.
C_2	1080.	75816.	1761.	2579.	161.	56.	768.	1158.	914.	109587.
C_3	1858.	976.	112605.	5000.	1142.	378.	1580.	2379.	1880.	218050.
C_4	1797.	997.	4638.	201250.	913.	302	2001.	3014.	2381.	291030.
P_1	426.	156.	1145.	935.	4678.	38.	329.	169.	231.	29066.
P_2	129.	56.	378.	302.	38.	0.	66.	10.	32.	5043.
E_1	1181.	772.	1584.	2004.	329.	66.	0.	193.	131.	18226.
E_2	1781.	1160.	2385.	3019.	170.	10.	193.	0.	168.	26906.
E_3	1407.	916.	1885.	2385.	231.	32.	131.	168.	0.	21394.
TOTAL	149024.	100518.	219921.	299662.	29072.	5043.	18225.	26908.	21396.	2722712.

TABLE 5.6-6 OD VOLUME OF VEHICLE TRIP IN 2000

O \ D	CBD_1	CBD_2	A_1	A_2	A_3	A_4	B_1	B_2	B_3	B_4	B_5
CBD_1	86496.	17828.	20211.	32732.	17096.	12469.	9785.	9545.	13324.	8807.	13915.
CBD_2	17832.	29342.	5183.	9609.	3817.	16483.	4089	4499.	5347.	4367.	13135.
A_1	21212.	5390.	39982.	13743.	5213.	3794.	5827.	4204.	5178.	2440.	4422.
A_2	33298.	9904.	13769.	86764.	16871.	8579.	10125	9997.	12546.	6750.	9783.
A_3	17751.	3907.	5354.	17134.	61273.	4714.	5179.	3995.	7481.	6257.	6205.
A_4	12311.	16862.	3667.	7963.	4568.	61118.	3703.	3619.	5496.	4733.	15964.
B_1	9809.	4571.	5305.	8210.	4226.	3865.	66998.	5801.	4054.	1645.	3327.
B_2	10625.	5197.	4323.	10459.	3980.	4004.	6303	66528.	6446.	2080.	4274.
B_3	14302.	5777.	5413.	12795.	7536.	5940.	5134.	6647.	118799.	5959.	6396.
B_4	8615.	4793.	2269.	5746.	5555.	4801.	1598.	1911.	5137.	67092.	4214.
B_5	13103.	13163.	4078.	8402.	5325.	19027.	3155.	3979.	5535.	4120.	143868.
C_1	20893.	8198.	5672.	14329.	6886.	7116.	5017.	7587.	6848.	2766.	9803.
C_2	7990.	3416.	2371.	6246.	2753.	2664.	2611.	3271.	2503.	1096.	2758.
C_3	20971.	9694.	6306.	16128.	9348.	9036.	3982.	5035.	15755.	6613.	11100.
C_4	17144.	13915.	4089.	10011.	5006.	14219.	2464.	3269.	5473.	3521.	26084.
P_1	2819.	2847.	4579.	1607.	1482.	1567.	1451.	1024.	1031.	1112.	1275.
P_2	154.	25.	734.	381.	383.	409.	516.	431.	303.	332.	364.
E_1	1675.	743.	772.	1605.	970.	998.	864.	824.	1312.	737.	1504.
E_2	3026.	1343.	1388.	2903.	1753.	1804.	1560.	1490.	2371.	1333.	2718.
E_3	1986.	881.	912.	1906.	1150.	1184.	1022.	978.	1556.	875.	1784.
TOTAL	322012.	157796.	136377.	268713.	165191.	183791.	141383.	144634.	226495.	132635.	286893.

O \ D	C_1	C_2	C_3	C_4	P_1	P_2	E_1	E_2	E_3	TOTAL
CBD_1	16538.	6345.	19683.	18090.	2809.	154.	1683.	3042.	1997.	312549.
CBD_2	6234.	2615.	8414.	11617.	2847.	25.	747.	1348.	887.	148437.
A_1	5017.	1981.	6440.	4811.	4619.	734	772.	1392.	917.	138088.
A_2	13469.	5138.	18307.	14717.	1620.	381.	1610.	2910.	1911.	278449.
A_3	6540.	2411.	10947.	7108.	1488.	383	972.	1757.	1153.	172009.
A_4	5762.	2152.	8539.	13683.	1567.	409.	1001.	1808.	1188.	180113.
B_1	4020.	1482.	3891.	2452.	1436.	516	862.	1552.	1018.	135040.
B_2	7084.	2561.	5318.	3896.	1028.	431	822.	1486.	974.	147859.
B_3	6853.	2275.	18128.	8163.	1042.	303.	1313.	2373.	1558.	236706.
B_4	2338.	845.	6387.	3492.	1106.	332	737.	1332.	874.	129174.
B_5	7979.	2269.	10374.	23090.	1266.	364.	1508.	2727.	1790.	275122.
C_1	149756.	1274.	4224.	3122.	511.	129.	1720.	3105.	2038.	260994.
C_2	2514.	124759.	2616.	2605.	190.	56.	1052.	1902.	1248.	174621.
C_3	3673.	1819.	191080.	9128.	1169.	378.	2020.	3651.	2397.	329283.
C_4	2796.	1293.	9013.	290166.	946.	302	2494.	4507.	2959.	419671.
P_1	498.	181.	1182.	988.	4678.	38.	322.	163.	224.	29068.
P_2	129.	56.	378.	302.	38.	0	66.	10.	32.	5043.
E_1	1728.	1054.	2025.	2500.	324.	66.	0.	221.	88.	20010.
E_2	3121.	1906.	3660.	4518.	163.	10.	221.	0.	314.	35602.
E_3	2048.	1252.	2403.	2966.	226.	32.	88.	314.	0.	23563.
TOTAL	248097.	163668.	333009.	427414.	29073.	5043.	20010.	35600.	23567.	3451401.

TABLE 7.2-1 DIRECT CONSTRUCTION COST (BRIDGE)

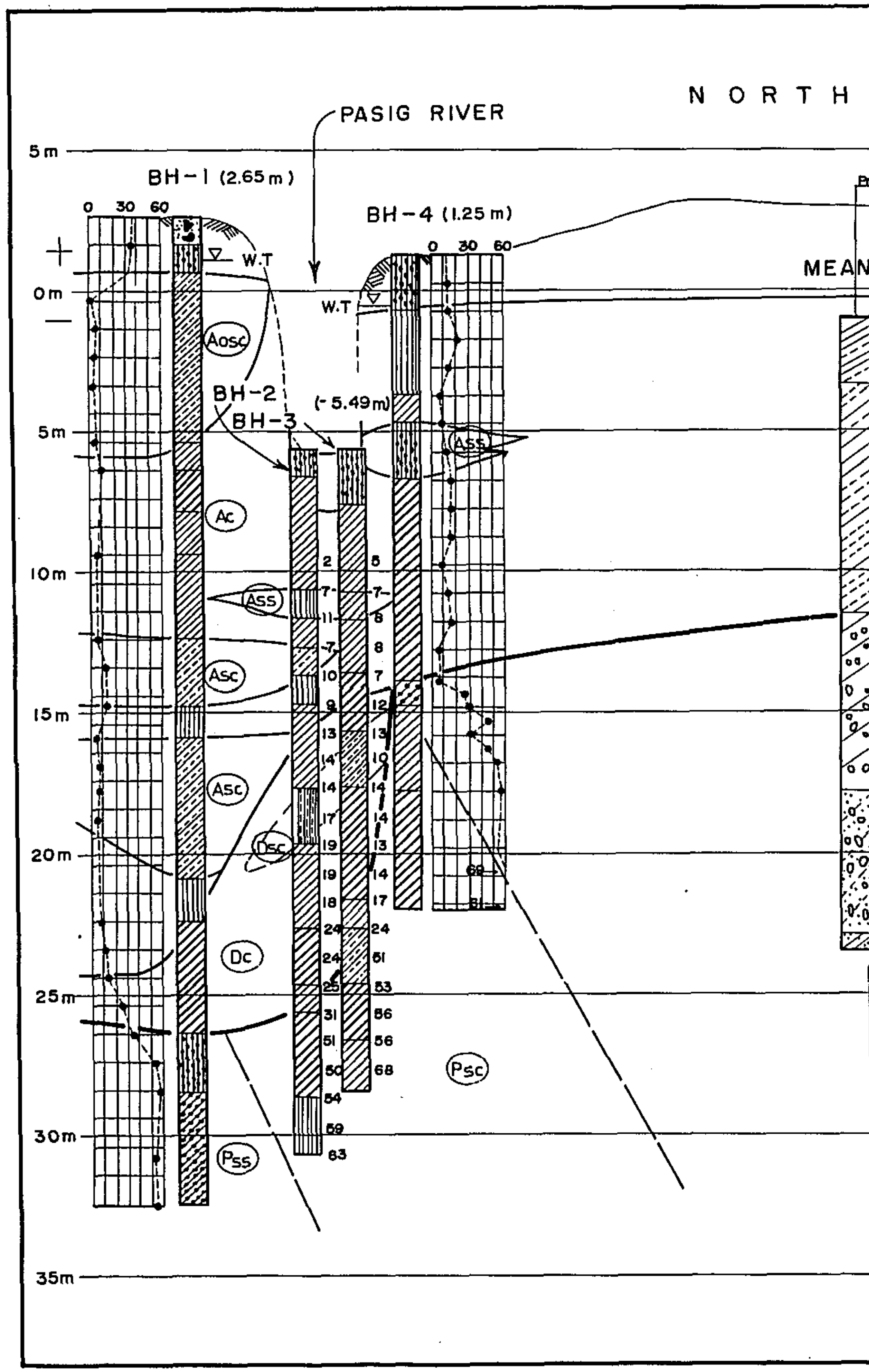
Route	Section	Financial Cost	Local Component		Foreign Component	Economical Component
			Tax	Other		
R-10	Roxas Br. ~ Zaragosa St.	x 10^3	x 10^3	x 10^3	x10^3	x10^3
	Zaragosa St. ~ Don Bosco					
	Don Bosco ~ C_2	9,947	1,418	4,073	4,456	8,529
	C_2 ~ C_3	17,792	2,536	7,312	7,944	15,256
	C_3 ~ C_4					
	Overpassing Br. of C_1	5,906	1,105	2,143	2,658	4,801
	Overpassing Br. of C_2	8,568	1,603	3,110	3,855	6,965
	Overpassing Br. of C_3	5,906	1,105	2,143	2,658	4,801
C-4	R_8 ~ R_9					
	R_9 ~ R_{10}	16,596	2,452	6,746	7,398	14,144
	Depressed section under the Bonifacio monument					
C-3	R_9 ~ R_{10}	23,482	3,320	9,686	10,476	20,162
C-2	Gov Forbes ~ R_9					
	R_9 ~ R_{10}	10,880	1,535	4,502	4,843	9,345
C-1	Beginning point ~ R_{10}					
	R_{10} ~ Harbor road					
Harbor Road	2nd St. ~ Zaragosa St.	38,286	4,942	16,017	17,327	33,344
Intersection of R_{10} and C_4						
Total		137,363	20,016	55,732	61,615	117,347

Prices at 1974

TABLE 7.2-2 DIRECT CONSTRUCTION COST (ROAD)

Route	Section	Acquisition of Right of Way	Financial Cost	Local Component		Foreign Component	Economical Component
				Tax	Other		
R-10	Roxas Br. ~ Zaragosa St.	x 10^3 1,971	x 10^3 4,740	x 10^3 641	x 10^3 1,706	x 10^3 2,393	4,099
	Zaragosa St. ~ Don Basco	32,535	7,061	978	2,627	3,456	6,083
	Don Basco ~ C_2	8,706	3,637	496	1,297	1,844	3,141
	C_2 ~ C_3	1,548	21,020	2,771	7,398	10,851	18,249
	C_3 ~ C_4	6,099	10,506	1,325	3,555	5,626	9,181
	Overpassing Br. of C_1	–	3,314	450	1,166	1,698	2,864
	Overpassing Br. of C_2	–	4,303	578	1,494	2,231	3,725
	Overpassing Br. of C_3	–	5,152	691	1,752	2,709	4,461
C-4	R_8 ~ R_9	–	6,626	895	2,449	3,282	5,731
	R_9 ~ R_{10}	110,367	21,108	2,745	7,783	10,580	18,363
	Depressed section under the Bonifacio monument	–	31,814	7,678	5,796	18,340	24,136
C-3	R_9 ~ R_{10}	44,361	21,279	2,815	7,496	10,968	18,464
C-2	Gov Forbes ~ R_9	6,415	9,976	1,421	3,436	5,119	8,555
	R_9 ~ R_{10}	22,298	17,166	2,418	5,931	8,817	14,748
C-1	Beginning point ~ R_{10}	7,968	5,236	777	1,742	2,717	4,459
	R_{10} ~ Harbor road	8,400	3,029	456	1,017	1,556	2,573
Harbor Road	2nd St. ~ Zaragosa St.	14,700	6,544	900	2,398	3,246	5,644
Intersection of R_{10} and C_4		15,418	10,448	1,301	3,361	5,786	9,147
Total		280,786	192,959	29,336	62,404	101,219	163,623

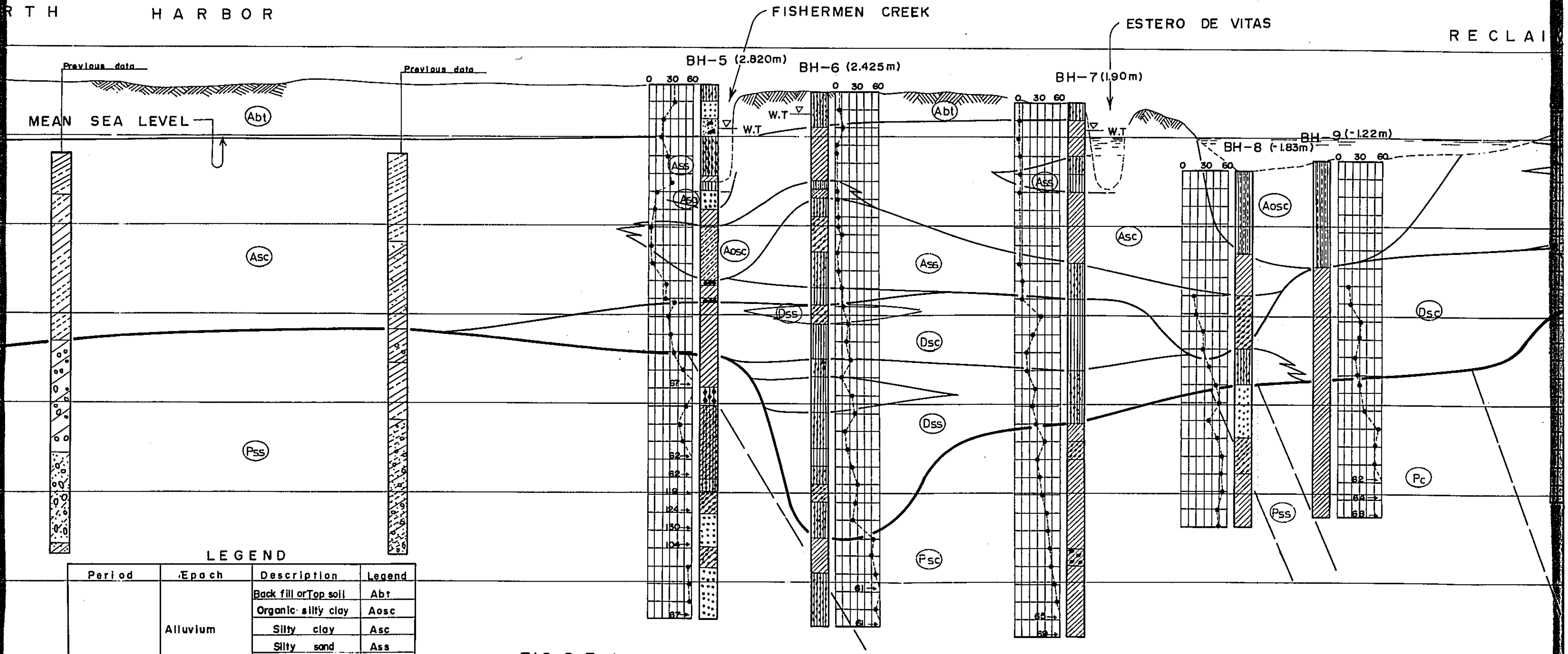
Prices at 1974



LEGEND

Period	Epoch	Description	Legend
Quaternary	Alluvium	Back fill or Top soil	Abt
		Organic silty clay	Aosc
		Silty clay	Asc
		Silty sand	Ass
		Sand & gravel	Asg
	Diluvium	Silty clay	Dsc
		Silty sand	Dss
		Sand & gravel	Dsg
Tertiary	Pliocene	Silty clay	Psc
		Silty sand	Pss
		Sand & gravel	Psg

FIG 2



LEGEND

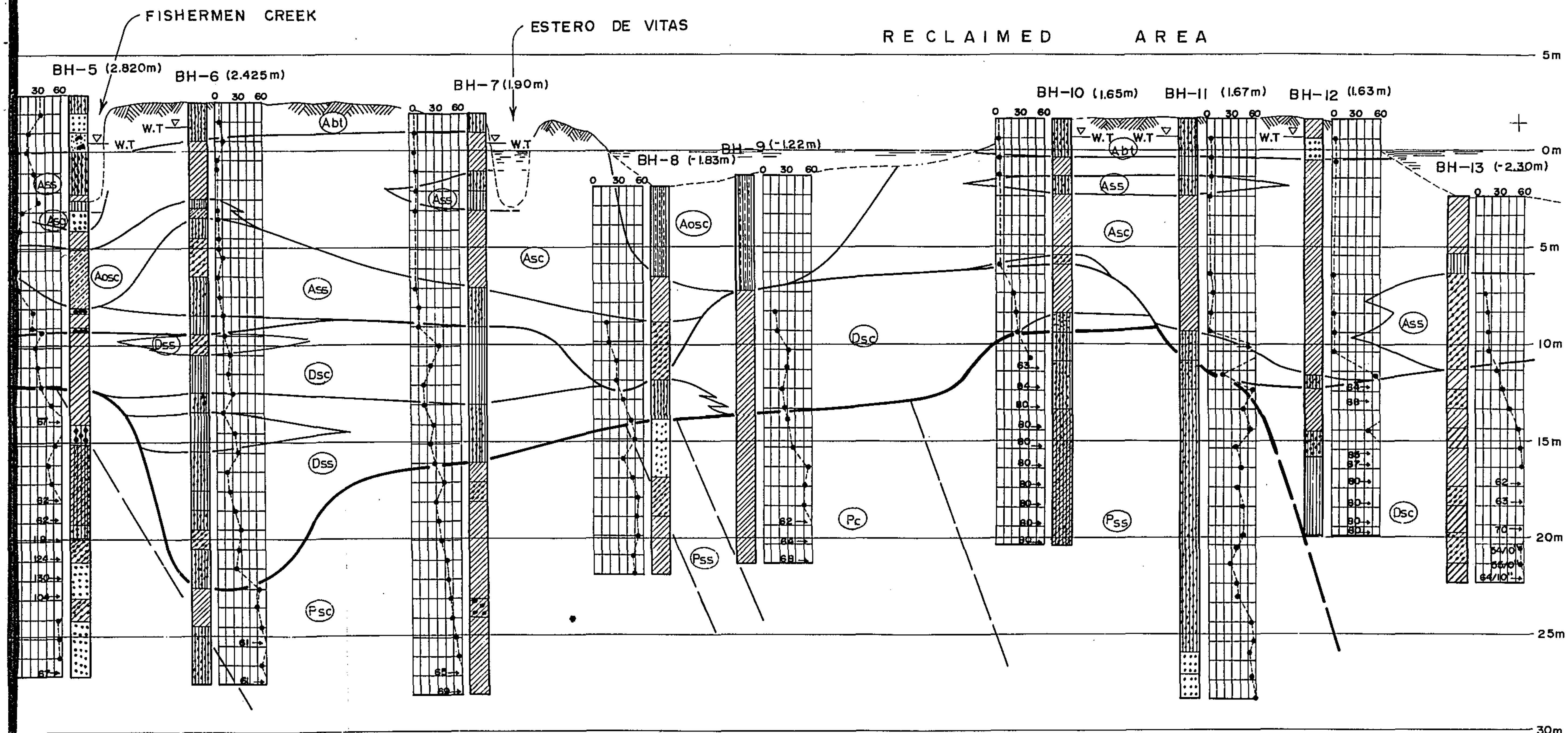
Period	Epoch	Description	Legend
Quaternary	Alluvium	Back fill or Top soil	Abt
		Organic silty clay	Aosc
		Silty clay	Asc
		Silty sand	Ass
		Sand & gravel	Asg
	Diluvium	Silty clay	Dsc
		Silty sand	Dss
		Sand & gravel	Dsg
Tertiary	Pliocene	Silty clay	Psc
		Silty sand	Pss
		Sand & gravel	Psg

FIG 2 3-1

R-10 SOIL PROFILE

R-10 FEASIBILITY STUDY

SCALE
HORIZONTAL = 1:10,000
VERTICAL 1:200



R-10 SOIL PROFILE

R-10 FEASIBILITY STUDY

SCALE
HORIZONTAL = 1:10,000
VERTICAL 1:200

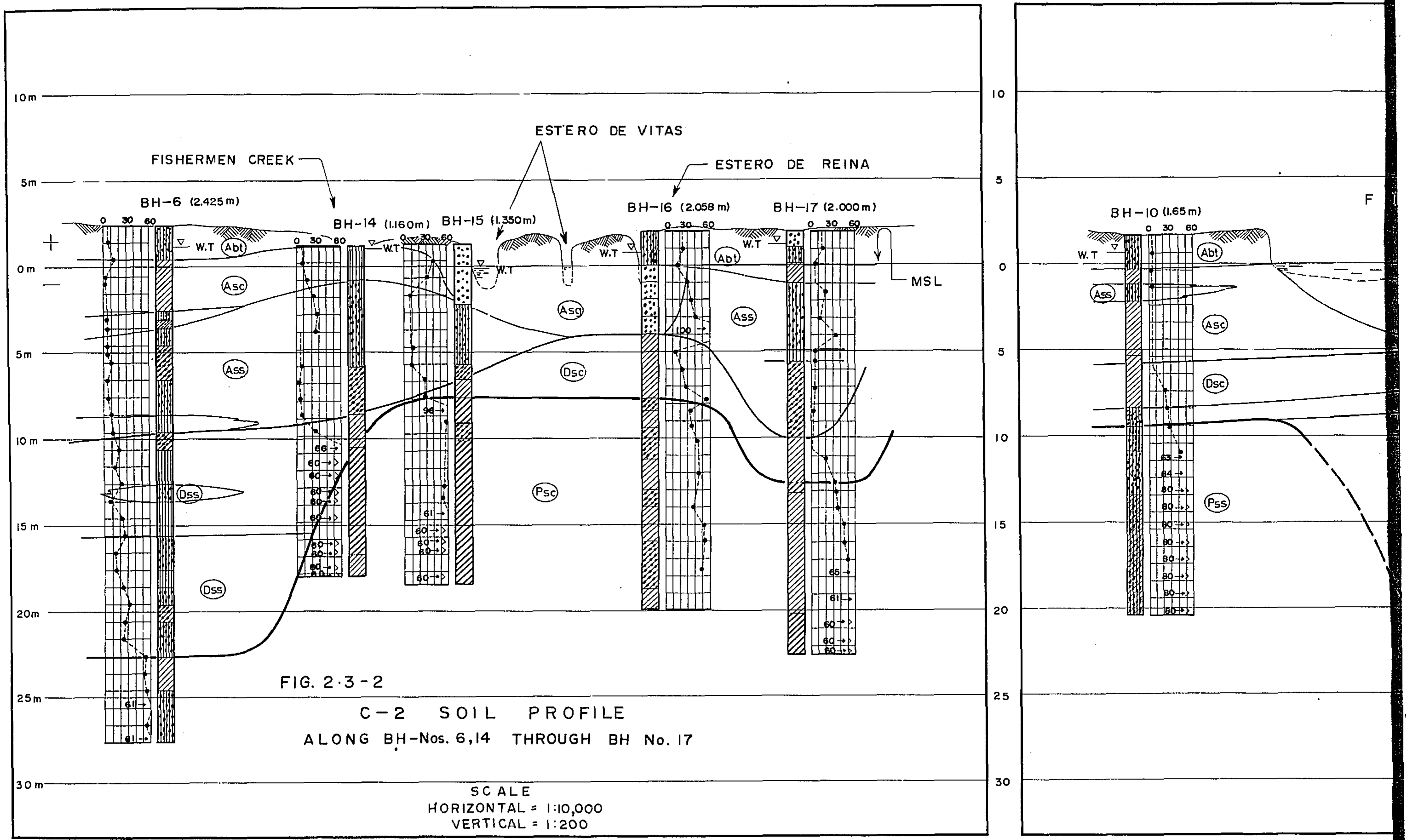


FIG. 2·3-2

C-2 SOIL PROFILE

ALONG BH-Nos. 6,14 THROUGH BH No. 17

SCALE
HORIZONTAL = 1:10,000
VERTICAL = 1:200

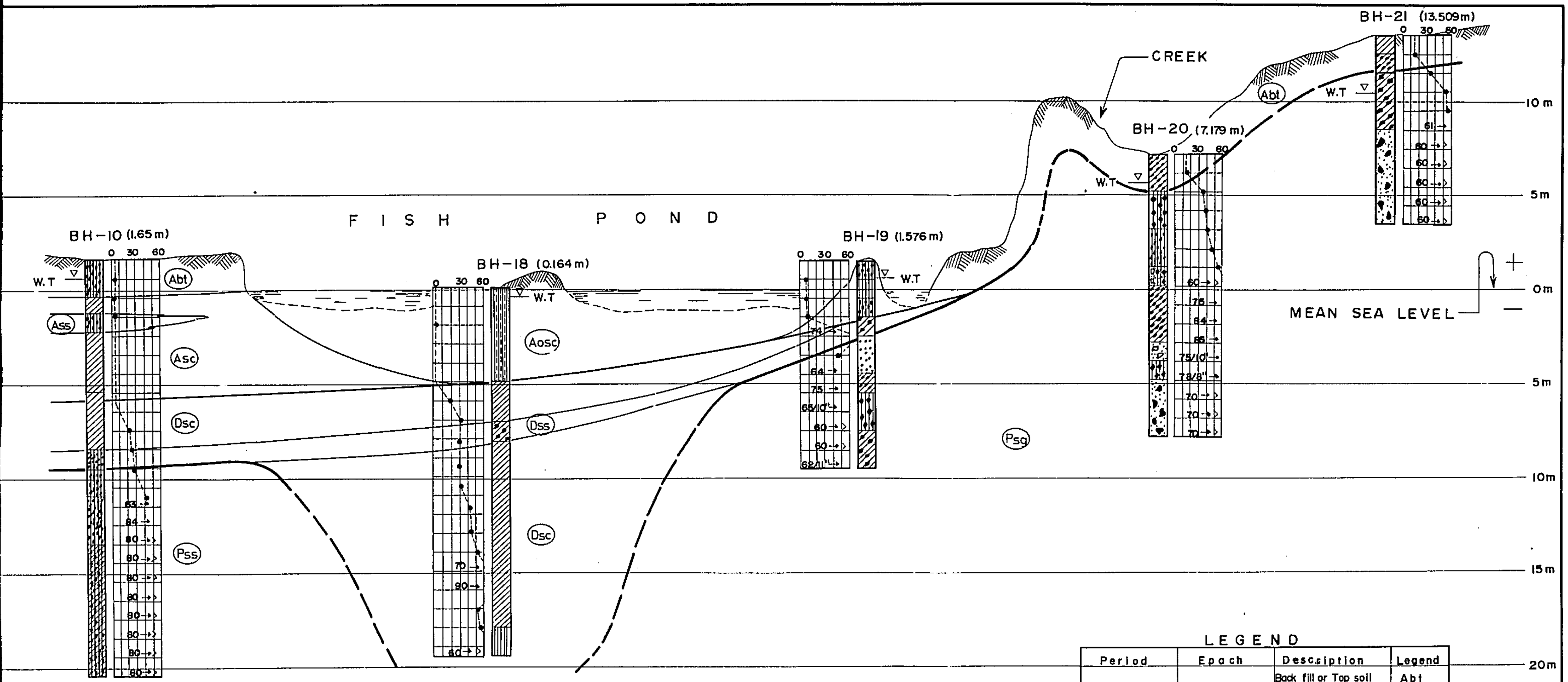


FIG. 2·3-3

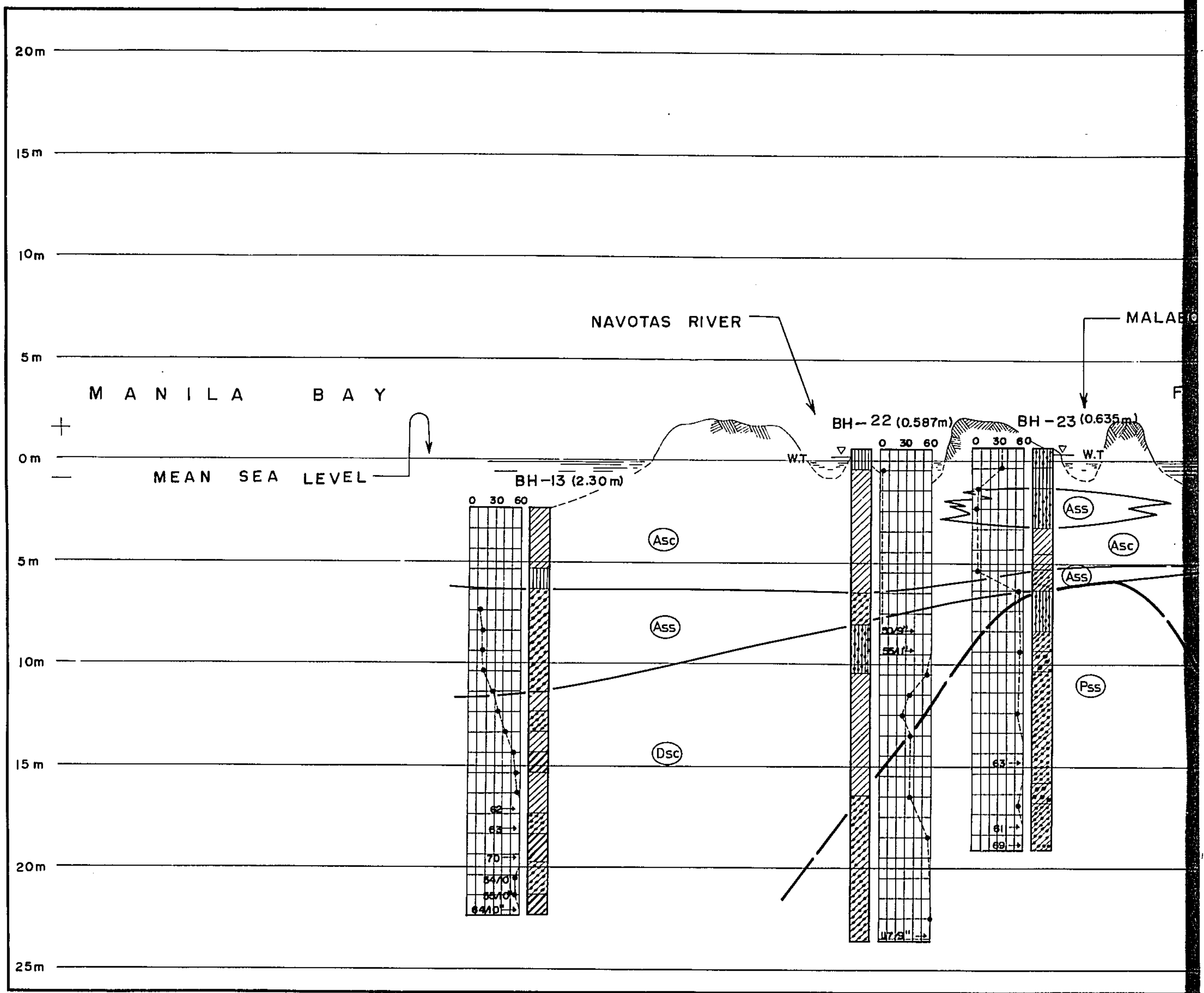
C-3 SOIL PROFILE

ALONG BH-Nos. 10, 18 THROUGH BH No. 21

LEGEND

Period	Epoch	Description	Legend
Quaternary	Alluvium	Back fill or Top soil	Abt
		Organic silty clay	Aosc
		Silty clay	Asc
		Silty sand	Ass
		Sand & gravel	Asg
	Diluvium	Silty clay	Dsc
		Silty sand	Dss
		Sand & gravel	Dsg
Tertiary	Pliocene	Silty clay	Psc
		Silty sand	Pss
		Sand & gravel	Psg

SCALE
HORIZONTAL = 1:10,000
VERTICAL = 1:200



20m
15m
10m
5m
0m
5m
10m
15m
20m
25m
MANILA BAY
MEAN SEA LEVEL
NAVOTAS RIVER
MALAB
BH-13 (2.30m)
BH-22 (0.587m)
BH-23 (0.635m)
W.T
0 30 60
Asc
Ass
Dsc
Pss

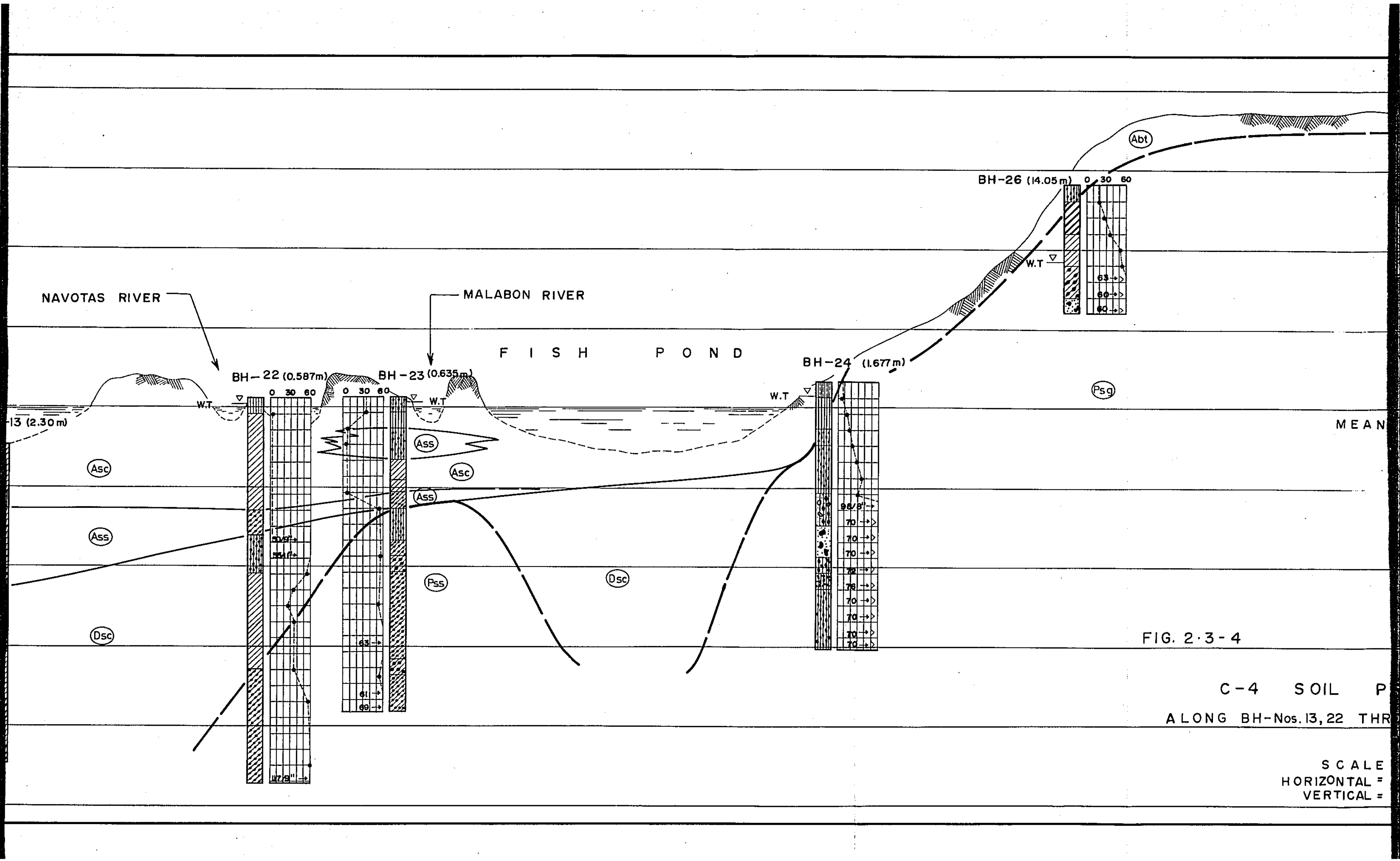
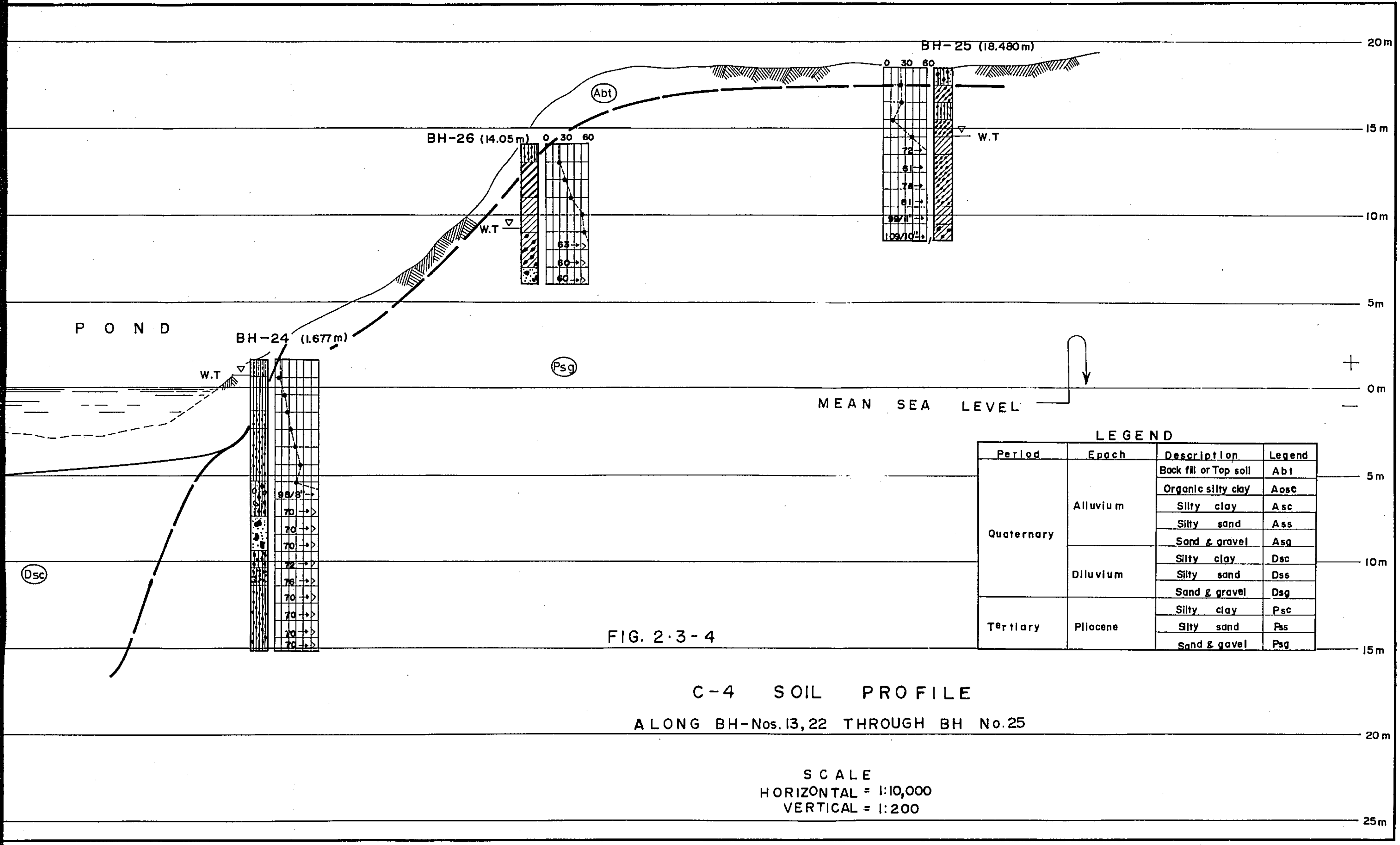


FIG. 2·3·4

C-4 SOIL P

ALONG BH-Nos. 13, 22 THR

SCALE
HORIZONTAL =
VERTICAL =



LEGEND

Period	Epoch	Description	Legend
Quaternary	Alluvium	Back fil or Top soil	Abt
		Organic silty clay	Aosc
		Silty clay	Asc
		Silty sand	Ass
		Sand & gravel	Asg
	Diluvium	Silty clay	Dsc
		Silty sand	Dss
		Sand & gravel	Dsg
Tertiary	Pliocene	Silty clay	Psc
		Silty sand	Pss
		Sand & gravel	Psg

FIG. 2·3-4

C-4 SOIL PROFILE

ALONG BH-Nos. 13, 22 THROUGH BH No. 25

SCALE
HORIZONTAL = 1:10,000
VERTICAL = 1:200

FIG. 3.2-1 ROADSIDE INTERVIEW QUESTIONAIRE

OD-1	Roadside Interview Questionnaire										Metro–Manila Transport Study (R-10 Road Project)	
Sta. No.	Direction	Date of Interview	Time	1	6:00 ~ 6:59	5	10:00 ~ 10:59	9	14:00 ~ 14:59	13	18:00 ~ 18:59	Book No. Sheet No.	Signature
				2	7:00 ~ 7:59	6	11:00 ~ 11:59	10	15:00 ~ 15:59	14	19:00 ~ 19:59		Interviewer
				3	8:00 ~ 8:59	7	12:00 ~ 12:59	11	16:00 ~ 16:59	15	20:00 ~ 20:59	of	
				4	9:00 ~ 9:59	8	13:00 ~ 13:59	12	17:00 ~ 17:59	16	21:00 ~ 22:00		Supervisor

1 — Type of Vehicles

1	Car
2	Taxi
3	Jeepney
4	Van, pick-up
5	Bus
6	Light truck
7	Heavy truck

2 — Origin

3 — Destination

4 — Facility of Origin and Destination Tripend

1	Residental facilities
2	Working facilities
3	Public institutional facilities
4	Educational and cultural facilities
5	Medical supply disposal facilities
6	Hotel, amusement, restaurant
7	Industrial facilities
8	Transportation facilities
9	Warehouse facilities
10	Sports, recreational center, parks, greens
11	Agricultural & fishery facility

5 — Commodity Types

1	Unprocessed cereals	8	Forestry products
2	Other unprocessed agricultural foodstuffs	9	Mining products
3	Unprocessed agricultural cash crop	10	Mineral oil products
4	Processed agricultural cash crop	11	Building and construction materials
5	Processed cereal product	12	Manufactured producers goods
6	Manufactured foodstuffs	13	Miscellaneous
7	Other manufactured consumer goods		

6 — Weight in Tons

7

1	Commuting to work
2	Going to school
3	Shopping
4	Social recreation
5	Private business
6	Work
7	To home from work
8	To home from school
9	To home from shopping
10	To home from social recreation
11	To home from private business
12	Boat passenger

8 — No. of Passengers (Including Driver)

1	2	4	3	4	5	6	7	8

FIG. 3.2-2 DPH LOADOMETER FIELD SHEET

1. STATION NO. ______ DIRECTION ______			
2. DATE ______ HOUR ______			4
3. VEHICLE LICENCE NO. ______			
4. VEHICLE TYPE	7 LIGHT TRUCK 11 8 HEAVY TRUCK 11 9 TRUCK 12 10 TRUCK–TRAILER 11–11 11 TRUCK–TRAILER 11–12 12 TRUCK–TRAILER 12–11 13 TRUCK–TRAILER 12–12 14 SEMI–TRAILER 111 15 SEMI–TRAILER 112 16 SEMI–TRAILER 121 17 SEMI–TRAILER 122		8
5. ORIGIN OF TRIP	STREET/BARRIO: ______ CITY/MUNICIPALITY: ______ PROVINCE: ______		10
	STREET/BARRIO: ______ CITY/MUNICIPALITY: ______ PROVINCE: ______		14
7. TYPE OF VEHICLE BODY ______			18
8. COMMODITY TYPE	1st TYPE ______		19
	2nd TYPE ______		21
	3rd TYPE ______		23
9. TOTAL COMMODITY WEIGHT ______ kgs			25
10. LICENCED CAPACITY	LOAD CAPACITY	MOTOR VEHICLE ______ kgs	30
		TRAILER ______ kgs	35
	GROSS VEHICLE WEIGHT	MOTOR VEHICLE kgs	40
		TRAILER kgs	45
11. HALF AXLE WEIGHT	MOTOR VEHICLE	1st AXLE ______ pound	50
		2nd AXLE ______ pound	54
		3rd AXLE ______ pound	59
	TRAILER	1st AXLE ______ pound	64
		2nd AXLE ______ pound	69
		3rd AXLE ______ pound	74
12. LOADOMETER ADJUSTMENT FACTOR ______			

FIG. 3.2-3 FERRY PASSENGERS INTERVIEW QUESTIONNAIRE

Signature of Interviwer		Signature of Supervisor	
Date		Time (To be recorded by supervisor)	(1) 4 ~ 6 a.m. (7) 4 ~ 6 p.m. (2) 6 ~ 8 a.m. (8) 6 ~ 8 p.m. (3) 8 ~ 10 a.m. (9) 8 ~ 10 p.m. (4) 10 ~ 12 a.m. (10) 10 ~ 12 p.m. (5) 12 ~ 1 p.m. (11) 12 ~ a.m. (6) 2 ~ 4 p.m.
Direction	1. Arrival to Manita 2. Departure from Manila		
Name of Boat		The Total Number of Passengers in This Boat (To be recorded by supervisor)	

0 In what province/city/municipality do you live?________________

1 1-1 What province are you going to?________________

1-2 What city or municipality are you going to?________________
(for arrival passenger)

1-3 What house No. and street are you going to?________________
(for arrival passenger)

1-4 What sort of building are you going to?________________
(for arrival passenger)

2 2-1 What province did you come from?________________

2-2 What city did you come from?________________
(for departure passenger)

2-3 What house No. and street did you come from?________________
(for departure passenger)

2-4 What sort of building did you come from?________________
(for departure passenger)

3 What is the main purpose of your trip?

(1) Visiting friends, relatives, etc.
(2) Making Recreation, Leisure, Sightseeing, etc.
(3) Shopping, making personal business
(4) Returning from visiting friends, relatives, etc.
(5) Returning from making recreation, leisure, sightseeing, etc.
(6) Returning from shopping, making personal business
(7) Works (business)
(8) Immigrant from province

4 4-1 How many companions do you have? (Including yourself) ________________ Persons

4-2 How are they related to you?

(1) Family (including relatives)
(2) Friends
(3) Officemates, customers, clients, etc.

5 What mode of transportation did you take before getting on this boat?

(1) Jeepney (2) Bus (3) Private car (4) Taxi (5) Bus or Jeepney (for arriving passenger)
(6) Pick-Up, Van (7) Truck (8) Tricycle (9) Calesa or animal-drawn vehicle
(10) Bicycle, Motorcycle, Walking

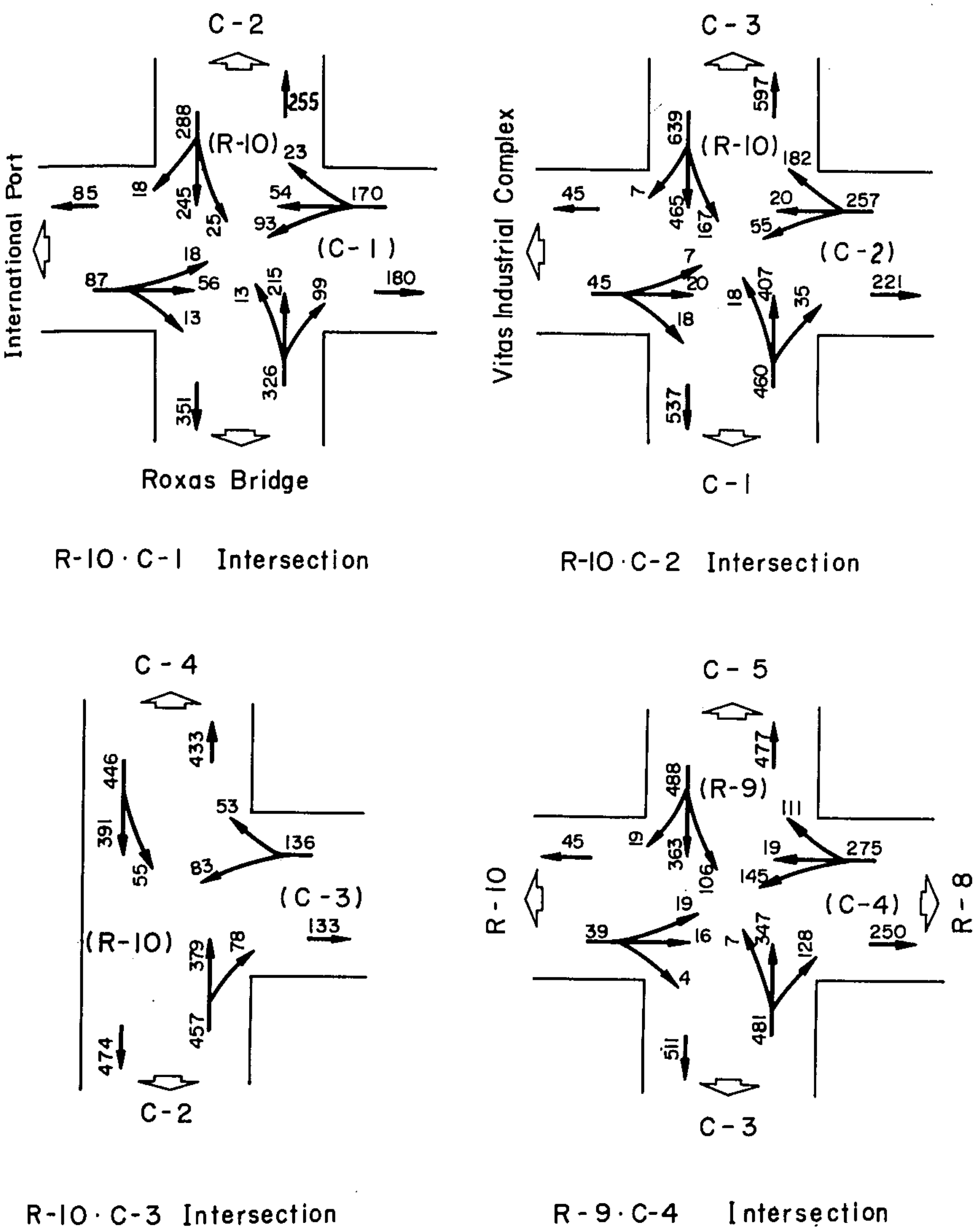


FIG. 5.7-1 INTERSECTION TRAFFIC VOLUME (2000)

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