


THE KINGDOM OF THAILAND
BANGKOK METROPOLITAN ADMINISTRATION

TRAFFIC SAFETY PLAN FOR ROADS
IN THE KINGDOM OF THAILAND
(VICTORY MONUMENT)

FINAL REPORT
VOLUME I : MAIN REPORT

JANUARY 1984

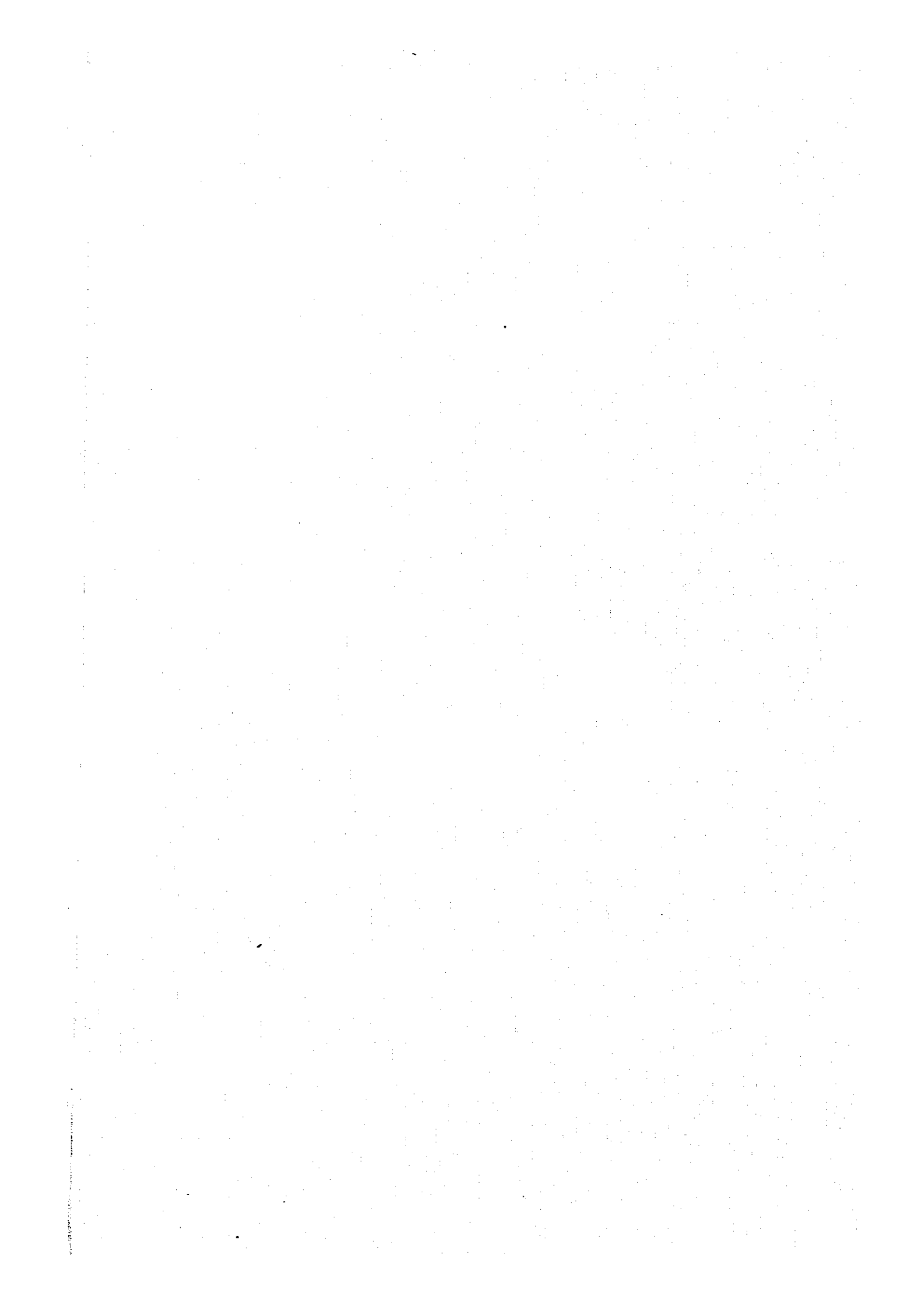
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JAPAN INTERNATIONAL COOPERATION AGENCY

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PREFACE

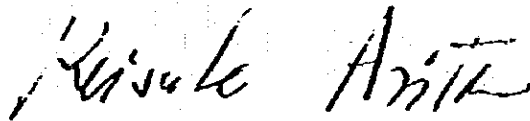
In response to the request of the Government of the Kingdom of Thailand, the Government of Japan decided to conduct a study on the Traffic Safety Plan For Roads (Victory Monument) and entrusted the study to the Japan International Cooperation Agency (JICA). The JICA sent to Thailand a study team headed by Mr. Yoshitomo Oguri from May to October, 1983.

The team exchanged views with the officials concerned of the Government of Thailand and conducted a survey in Thailand. After the team returned to Japan, further studies were made and the present report has been prepared.

I hope that this report will serve for the implementation of the plan and contribute to the promotion of friendly relations between our two countries.

I wish to express my deep appreciation to the officials concerned of the Government of the Kingdom of Thailand for their close cooperation extended to the team.

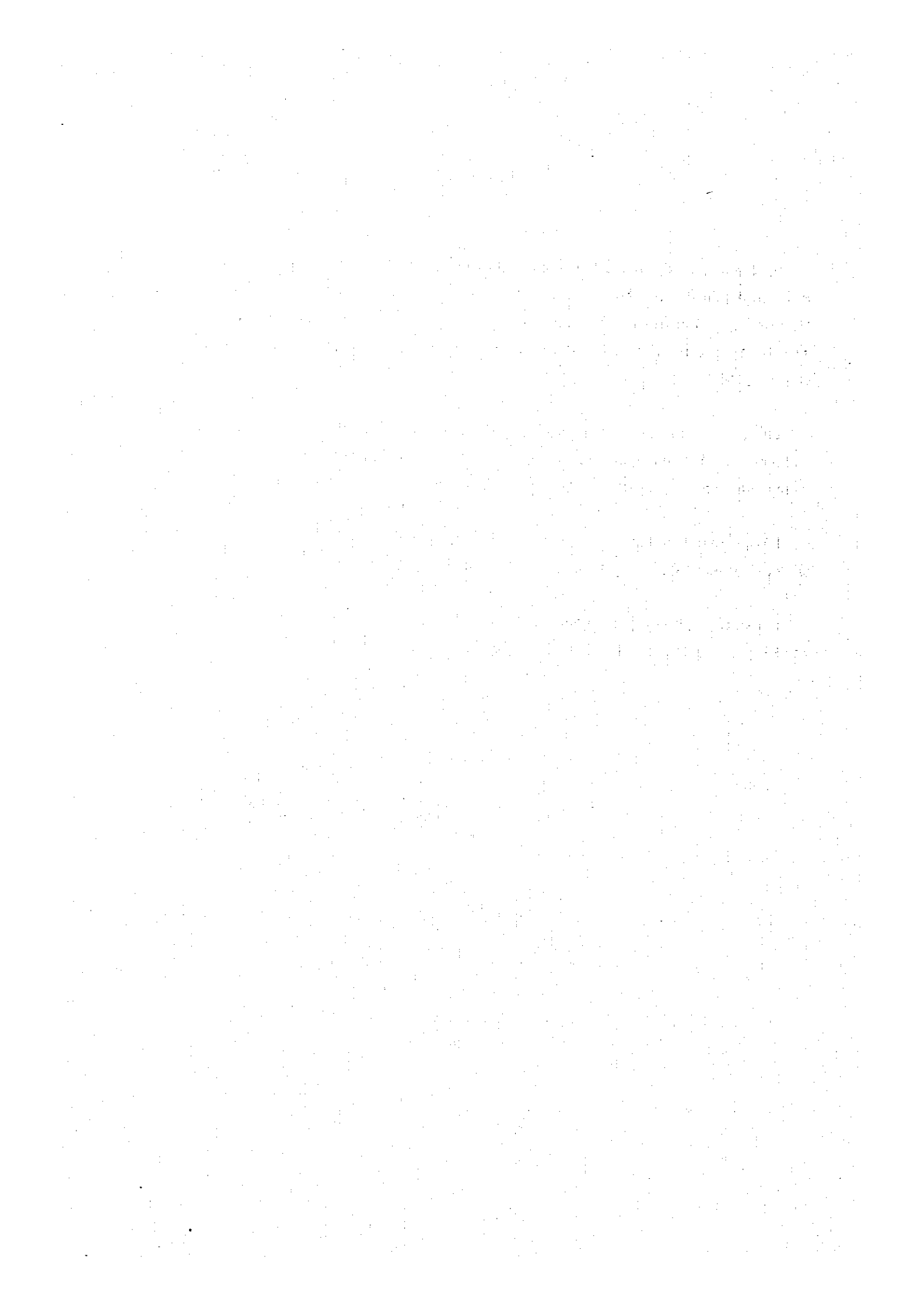
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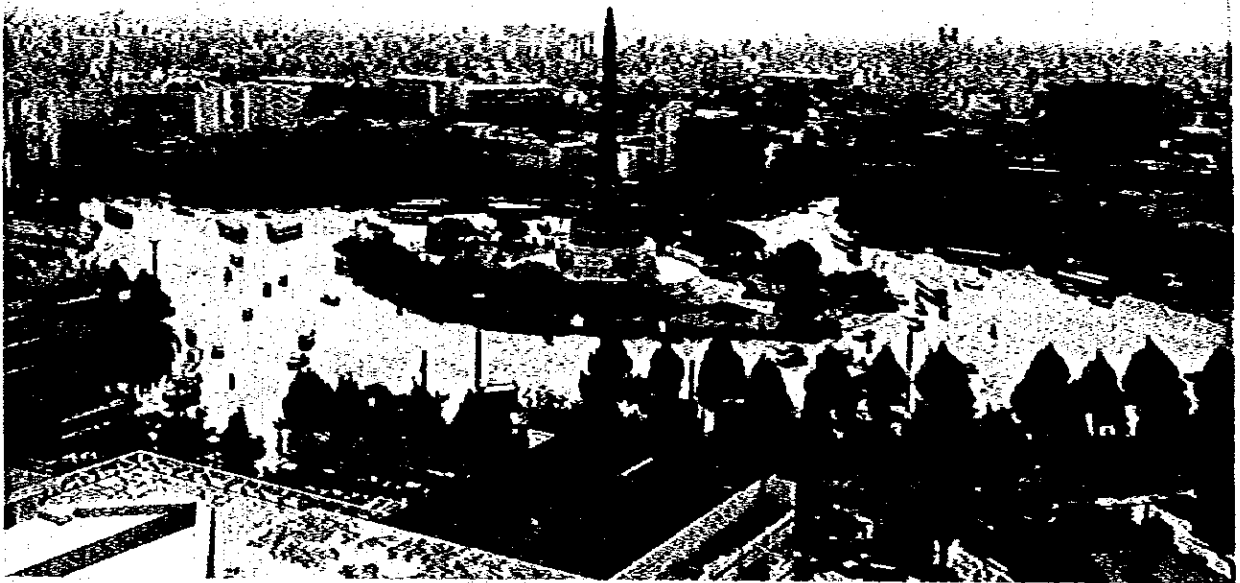


Keisuke Arita

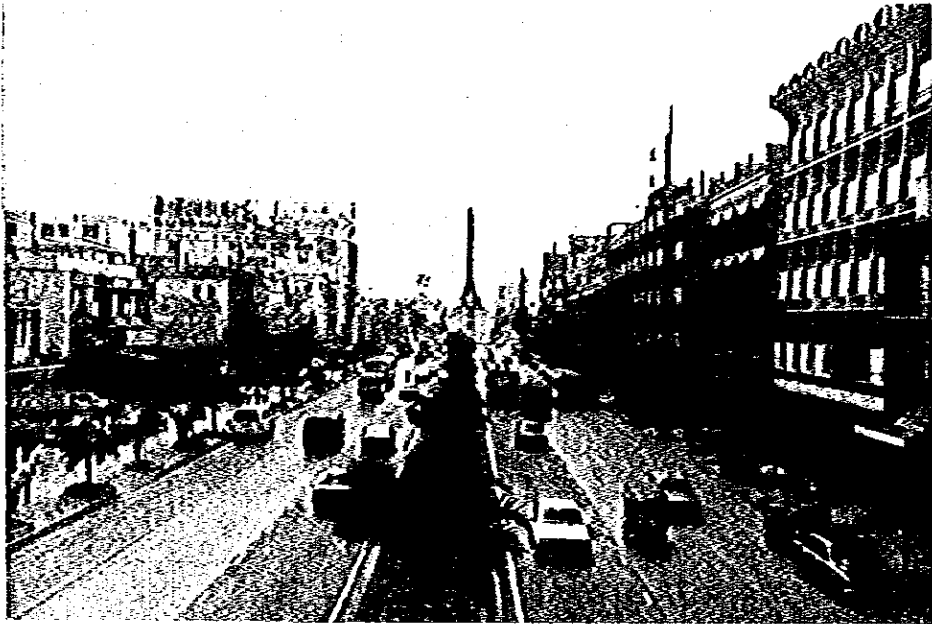
President

Japan International Cooperation Agency

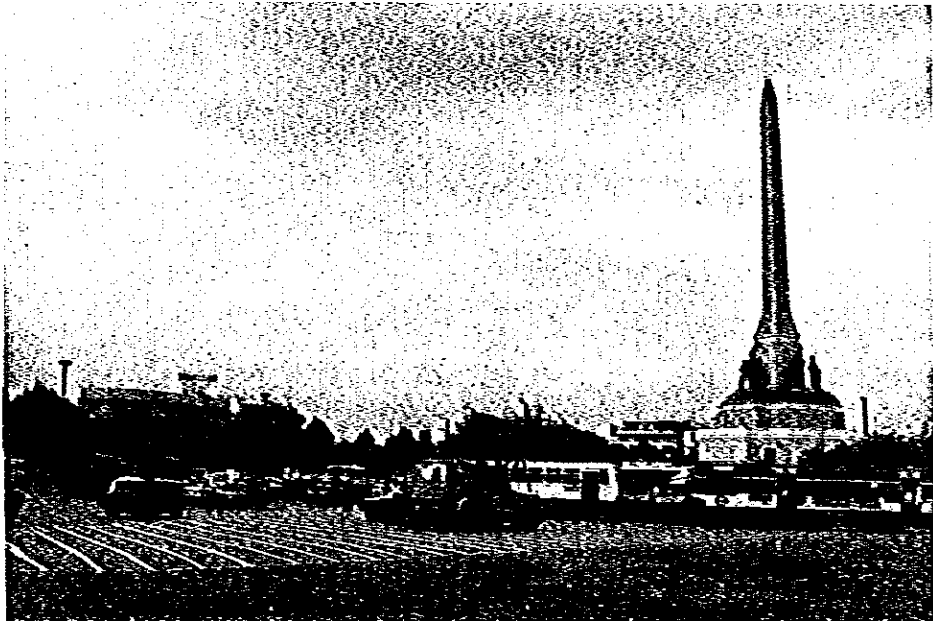




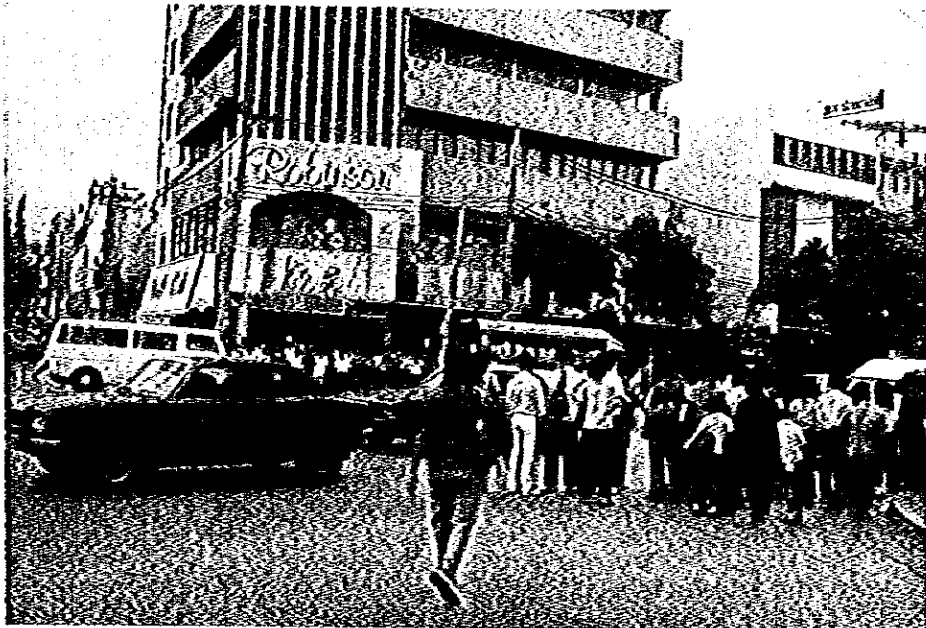
VICTORY MONUMENT



VICTORY MONUMENT
(View from Phahonyothin Road)



VICTORY MONUMENT ROUNDABOUT



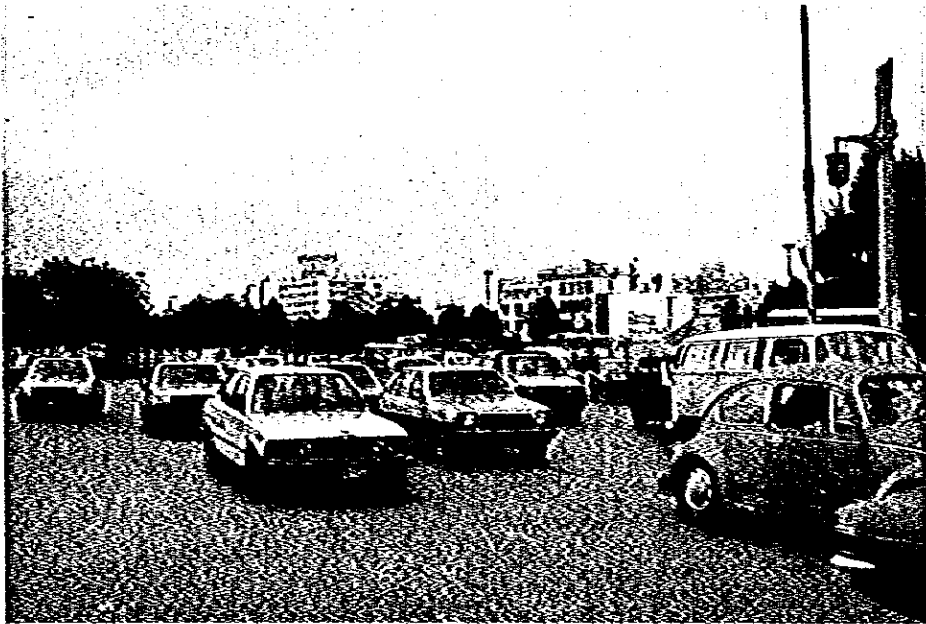
WAITING PEDESTRIANS
(on Ratvithi (w) Road)



CROSSING PEDESTRIANS
(on Phayathai Road)



BUS USERS



TRAFFIC FLOW

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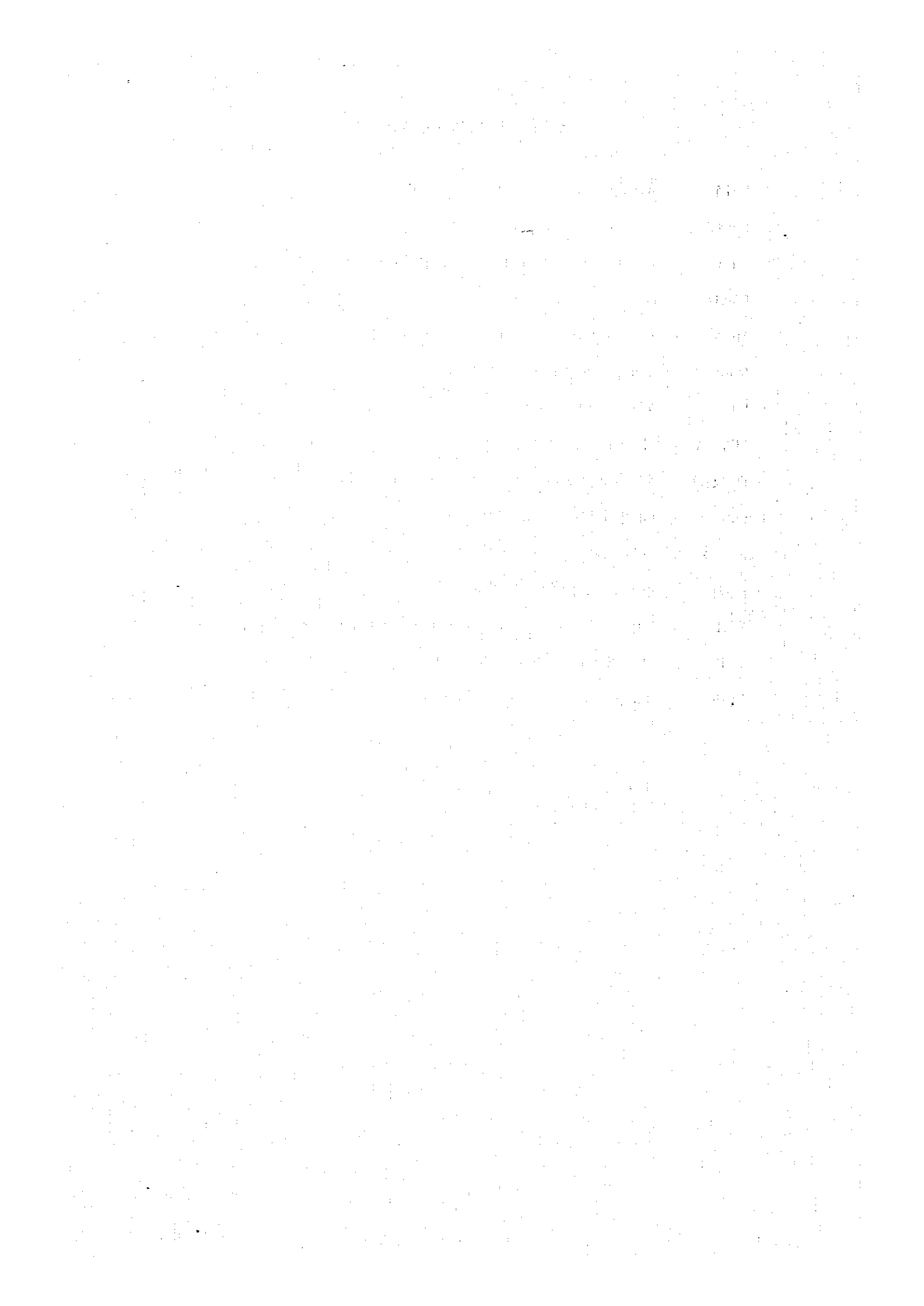
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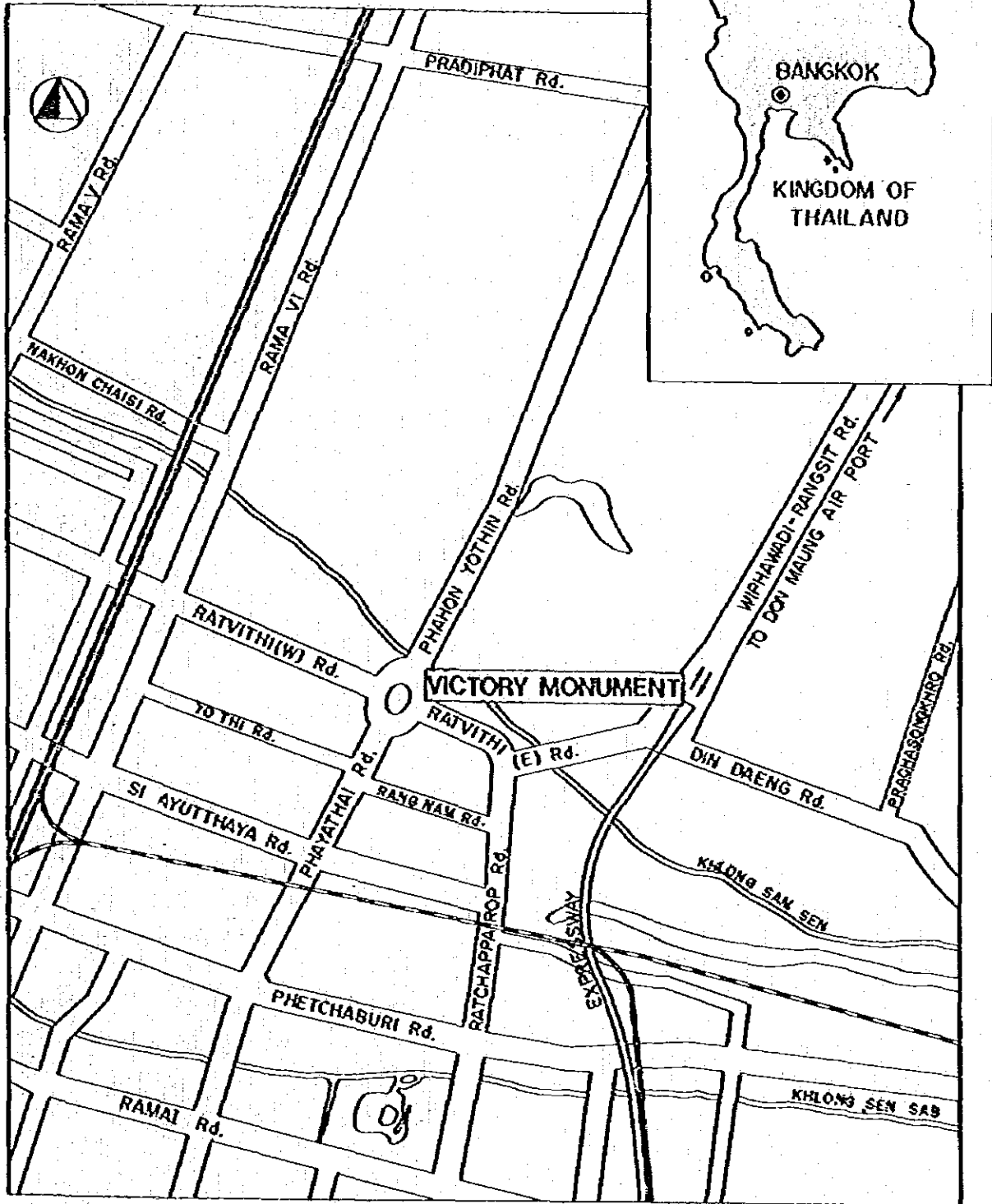
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LIST OF ABBREVIATIONS

BMA	Bangkok Metropolitan Administration
BMTA	Bangkok Mass Transit Authority
ETA	Expressway and Rapid Transit Authority of Thailand
IBRD	International Bank for Economic Cooperation (World Bank)
JICA	Japan International Cooperation Agency
MEA	Metropolitan Electricity Authority
MOI	Ministry of Interior
MWWA	Metropolitan Water Works Authority
OCMRT	Office of the Committee for the Management of Road Traffic, MOI
OPP	Office of Policy and Planning, MOI
Pol. D	Police Department, MOI
PWD	Department of Public Works, MOI
SCH	Supreme Command Headquarters, Ministry of Defence
TCP	Department of Town and Country Planning, MOI
TOT	Telephone Organization of Thailand



STUDY AREA



SUMMARY

The Victory Monument is one of the most historic landmarks in the metropolitan city, Bangkok and constitutes a roundabout (rotary intersection) where four arterial streets converge, i.e., Ratvithi (W), Phayathai, Phahonyothin and Ratvithi (E) street.

The total daily traffic volume at junctions of the four streets is about 170,000 of which approximately 19,000 are buses, inclusive of mini-bus and private bus. The roundabout, besides its function of intersection, plays a role of bus terminal and all buses entering the roundabout make stop at one of four quadrants of the elliptic roundabout. There are about 150,000 pedestrians daily and most of them are bus users who transfer bus at the roundabout bus stops.

The roundabout is congested, on top of the aforementioned heavy traffic and pedestrians, due to irregular traffic movements on the untidy spacious roadway and conflicts between motor vehicle traffic and pedestrians who cross streets to transfer bus.

The main aim of this study is to propose alternatives for grade-separated pedestrian crossing facility which will eliminate the present conflict between street crossing pedestrians and vehicles.

Prior to preparing alternatives, a traffic counting survey was carried out in June 1983. The survey includes counting number of pedestrians and their movement. The pedestrian volumes during peak hour at the junctions of Phahonyothin, Ratvithi (E), Ratvithi (W) and Phayathai street are 7,223, 6,309, 3,207 and 2,484, respectively.

According to the survey, 97% of pedestrians who cross the streets at the junctions are bus users. And about 20% of bus users cross two streets to transfer bus, while the remainder (80%) crosses only one street.

To determine effective width of footpath, a forecast of pedestrian's number in the future has been made utilizing readily available data. The pedestrian's increase rate between 1983 and 2000 has been estimated at 1.38 which will increase the pedestrians at the Phahonyothin street to about 10,000 persons per hour in year 2000.

Taking into account the present walking velocity and density on the sidewalks, the effective width of 4.5 meters has been considered reasonable for the expected pedestrians in the future. In case of Alternative 3 (tunnel), an additional space (1.0 m. wide) to accommodate necessary accessories has been provided, bringing the total width of tunnel to 5.5 m.

In preparing alternatives, particular attention and cares to the following important aspects have been given;

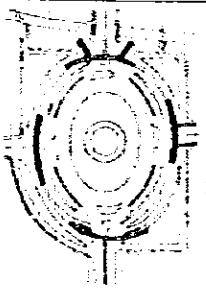
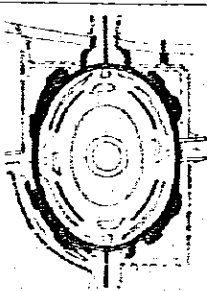
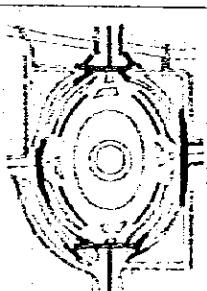
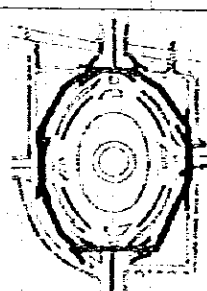
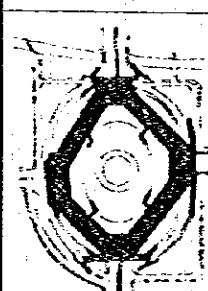
- 1) conformity to the road improvement scheme which has been planned and expected to be implemented, to ensure orderly traffic movements on the roundabout;
- 2) convenience of pedestrians;
- 3) preservation of the dignity of the Victory Monument and its view; and
- 4) preservation of the existing trees planted around the roundabout.

A number of public utilities laid under and around the roadway of the roundabout also, to a certain extent, have influence on the planning of alternatives.

In all, five alternatives to the level of prefeasibility study have been prepared. There are two alternatives in type of overpass bridge and three alternatives in type of underpass tunnel. They are;

- 1) separate overpass (Alternative 1);
- 2) continuous overpass (Alternative 2);
- 3) separate underpass (Alternative 3);
- 4) continuous underpass (Alternative 4); and
- 5) underpass with commercial space (Alternative 5).

Their schematic configurations and structural features are as follows;

Alternative	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Item					
Type of Structure	P.C. Hollow Slab	P.C. Hollow Slab and R.C. Slab	R.C. Box Culvert	R.C. Box Culvert	R.C. Box Culvert
Height of Stairway	6.0 m	6.0 m	4.1 m	4.1 m	4.75 m
Total length	255 m	630 m	290 m	650 m	850 m

These alternatives have been extensively reviewed by the concerned parties, assessing various aspects inclusive of construction cost, maintenance cost, construction method, amenity and convenience of pedestrians and aesthetic impact. Out of the five alternatives, two alternatives, i.e., "continuous overpass" and "separate underpass", have been selected

for preliminary engineering design.

The preliminary design for the selected two alternatives, i.e., Alternative 2 and Alternative 3, was carried out, according to the geometrical and structural conditions which are quoted, in principle, from the prevailing design standards in Thailand.

As to Alternative 2, the continuous and circular bridge with a pedestrian deck in each quadrant of the roundabout has been designed in a manner to reduce possible visual intrusion upon the Victory Monument's sight from the approaching streets and enhance the inside view of the roundabout. This led to adoption of the slender prestressed concrete hollow slab, while the pedestrian decks are of reinforced concrete slab.

As to Alternative 3, besides structural design, due cares have been given to planning of ventilation and lighting system inside the tunnels to ensure comfort and security of pedestrians. The stairways' roofs which are only visible structures on the ground have been designed in a manner so that they might fit in with the view of the Victory Monument.

Under this study, the traditional approach to evaluation of alternatives is not applicable, because the expected pedestrian crossing facility is required to satisfy various aspects which are not measurable quantitatively but subjective matters, while the traditional evaluation method mostly relies on economic analysis putting all benefits and costs in common monetary units.

Since the traditional cost-benefit evaluation method is not directly applicable, this report follows the concept of the cost-effectiveness technique which works on the basic premise that better decisions will arise if clearer and more relevant information is supplied to the decision maker.

Presented in this report for evaluation of the two alternatives are data and information as to engineering features, qualitative assessment on amenity and beauty, and economic benefit. The evaluation on the two alternatives and selection of a final alternative should be made through a thorough examination on the findings of this study as well as social requirements.

For both alternatives, the estimated construction cost, construction period and structural type with length and width are shown in the following table.

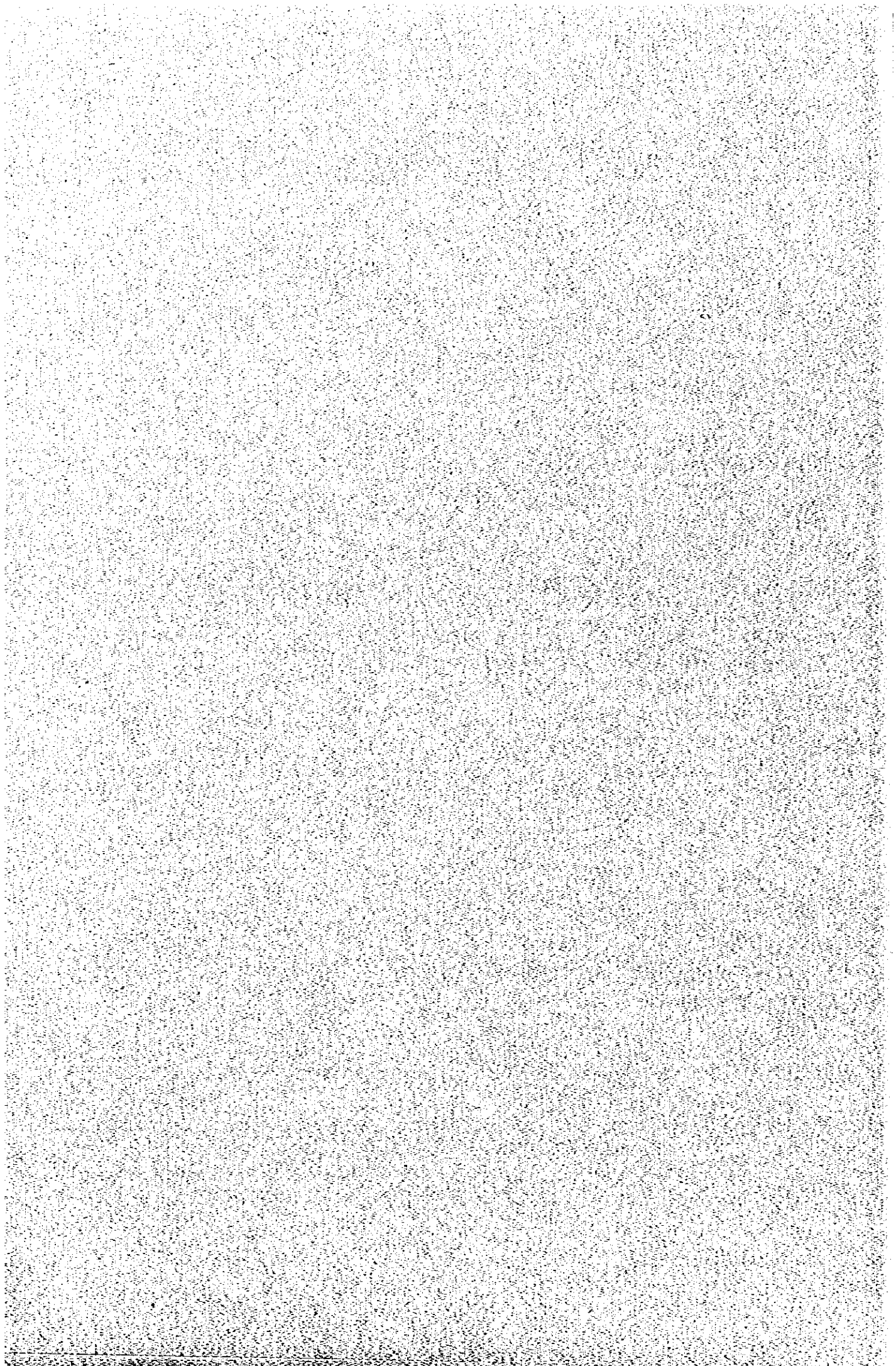
	Alternative 2 (Continuous overpass)	Alternative 3 (Separate underpass)
Type of Structure	P.C. Hollow slab for bridge over streets R.C. Slab for pedestrian decks	R.C. Box culverts
Footpath Width	4.5 m	5.5 m inclusive of accessory room (1.0 m)
Length of Structure ¹⁾	615 m	226 m
Construction Cost ²⁾	79.3 million Baht	140.4 million Baht
Construction Period	14 months	18 months

1) Exclusive of stairways

2) Inclusive of consulting service fee

The final report consists of two volumes; Volume I (Main Report) and Volume II (Drawings).

CHAPTER 1
INTRODUCTION



CHAPTER 1 INTRODUCTION

A. Background

1. The Victory Monument, being located in the central part of the metropolitan city, Bangkok and national historic spot, constitutes a roundabout (rotary intersection) in the shape of ellipse where four arterial streets converge. The roundabout is crowded with a heavy traffic and pedestrians all the day. In view of the envisaged high increasing rate of the pedestrian and traffic in the area, the traffic problem as well as pedestrians' safety would be more serious in the future. The Royal Thai Government has given the highest priority to facilitate a development of traffic plans at the Victory Monument Roundabout.

2. To ensure orderly vehicle traffic flow and safety on the roundabout, applying channelization, traffic island and improvement of the traffic signal system, the Ministry of Interior (MOI) together with the Bangkok Metropolitan Administration (BMA) is about to implement a road improvement project with assistance from the World Bank (IBRD).

3. Meanwhile BMA also has been undertaking a safety plan program for pedestrians at the roundabout. However, as the program entails engineering complexity requiring high technics, the Royal Thai Government requested the Government of Japan for technical assistance to carry out a feasibility study on a pedestrian safety plan at the Victory Monument roundabout.

4. The feasibility study on a pedestrian safety plan (hereinafter referred to as the Study) is one of the two components of the project "Traffic Safety Plan for Roads in the Kingdom of Thailand" for which the Japanese government has extended a technical assistance.

5. Japan International Cooperation Agency (JICA), the official agency responsible for implementation of technical cooperation programs by the Government of Japan, has set up a study team (hereinafter referred to as the Team) for consulting services to the Study.

B. Objectives

6. The roundabout of the Victory Monument where four arterial roads converge is in the shape of ellipse with major axis of about 300 m in the direction of North and South, and about 200 m of minor axis. According to the traffic count, there are approximately 150,000 pedestrians, while about 170,000 vehicles pass through the roundabout daily. The roundabout, besides its function of interchange, plays a role of bus-terminal where some 19,000 buses inclusive of mini-buses and private buses arrive and depart daily.

7. Most of the pedestrians are bus passengers who get off bus at one corner of the roundabout and walk down to another corner crossing one or two streets to transfer bus. This movement of pedestrians' crossing makes a conflict with vehicle traffic on the streets, leading to one of the major causes of traffic jam and deteriorated safety at the roundabout.

8. Another major cause of the deteriorated traffic situation is irregular traffic movements on the untidy spacious roadways at the roundabout. For this problem, as aforementioned, BMA and MOI are about to implement a traffic channelization project of which detailed designs were prepared by MOI and BMA with technical and financial assistance from IBRD.

9. The scope of the Study is, therefore, limited to the solution of traffic conflict between pedestrians and vehicles with provision of grade-separated pedestrians' crossing facility and the objectives of the Study have been defined as follows;

- 1) to propose and evaluate alternatives for pedestrian crossing facility at the roundabout; and
- 2) to perform technology transfer to BMA counterpart personnel in the course of the study.

C. Study Flow and Schedule

10. The Victory Monument is one of the most historic landmarks and located in the busiest place in the Metropolitan Bangkok. All planning and designing of improvement and/or construction works to be executed around the monument are required particular considerations, besides engineering aspects, to the effect that they could be acceptable by majority of the public. As such, it was speculated that for pedestrian crossing facility at the roundabout, a number of alternatives ranging from simple structure to comprehensive one could be possible.

11. Taking into account the aforementioned feature, the study flow for the Study was intensively discussed between BMA staff and the Team. The major activities as agreed upon include the followings;

- 1) to collect existing relevant data;
- 2) to conduct field survey, inclusive of traffic count and topography survey if necessary;
- 3) to prepare alternatives;
- 4) to screen the above alternatives; and
- 5) to conduct preliminary design to the level of feasibility study.

As may be noticed, the screening procedure contrasts with other feasibility studies. This arrangement has been made to enable BMA to make a best choice among as many alternatives as possible and to ensure an effective study. The flow chart of the study is shown in Appendix 1.

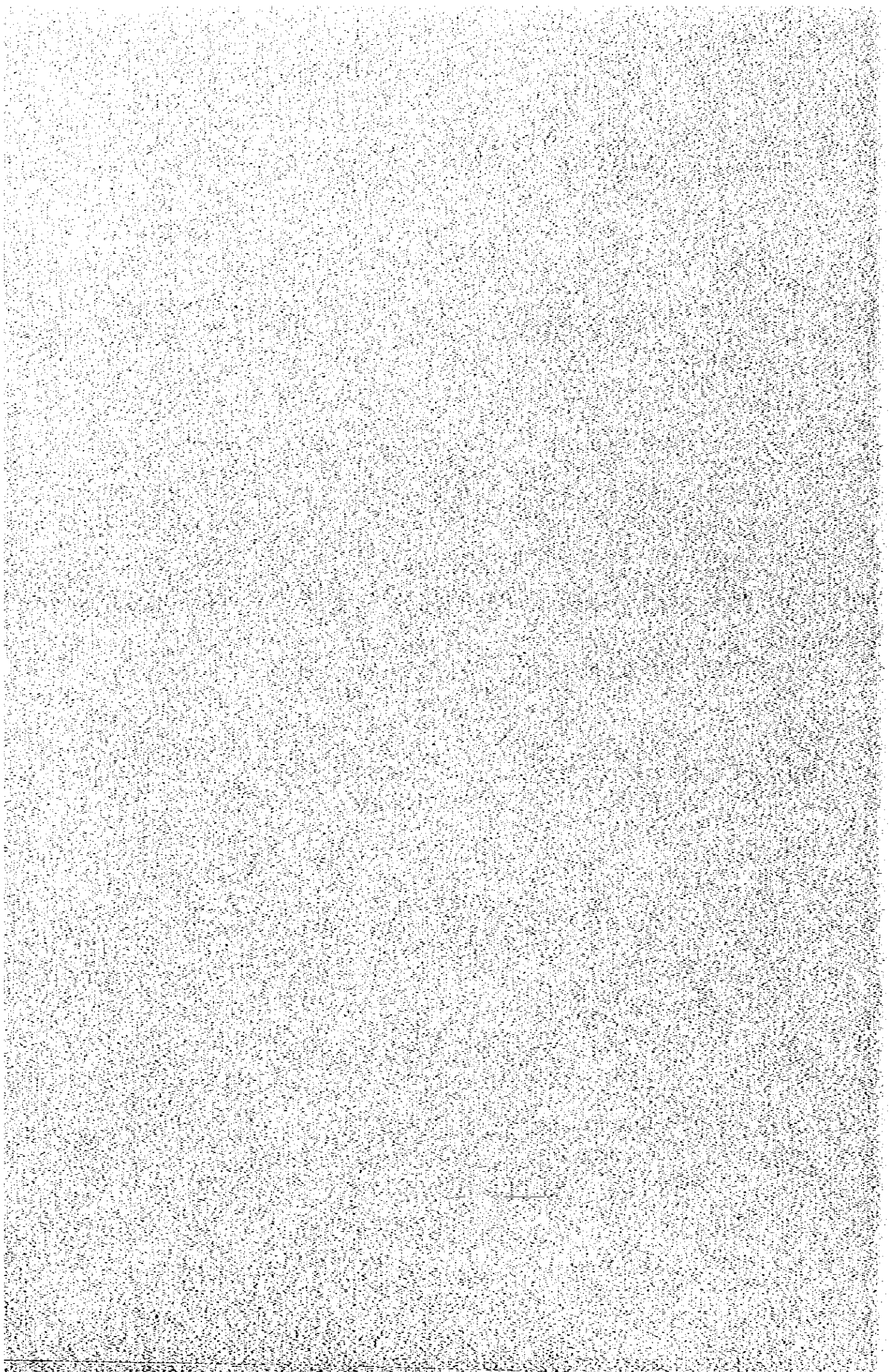
12. The Study has been commenced in late May 1983 with the time frame of eight months. The detailed work schedule is shown in Appendix 2 and respective reports were submitted at the times as indicated in the work schedule.

D. Organization

13. The agencies directly concerned with the Study are BMA and JICA. The Study has been, however, carried out by the Team under the guidance of the Supervisory Committee organized by JICA. The schematic organization chart during implementation of the Study is shown in Appendix 3. The Team has performed its study in collaboration with BMA through its counterpart personnel.

CHAPTER 2

FEATURES OF STUDY AREA



CHAPTER 2 FEATURES OF STUDY AREA

A General

14. The Study area is, as aforementioned, limited to the roundabout of the Victory Monument and its immediate vicinity (See Figure-1).

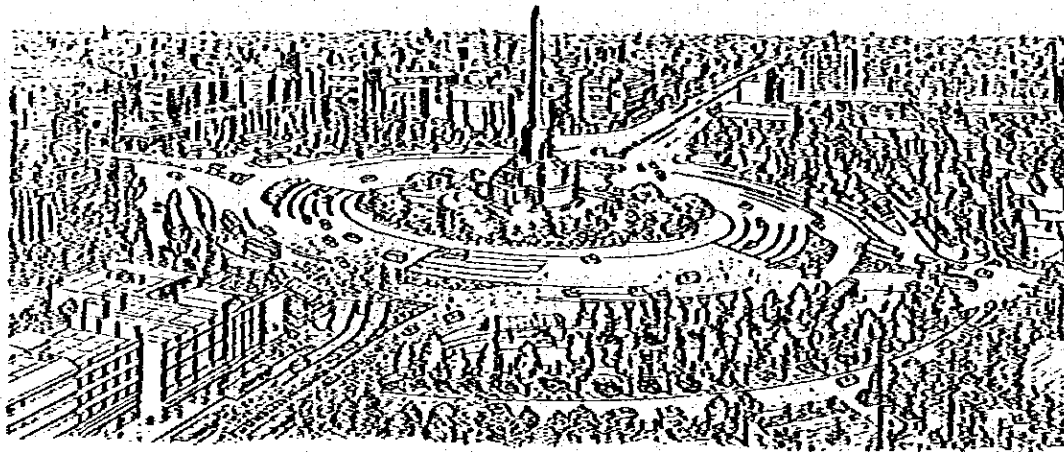
15. The Victory Monument was built originally in honour and commemoration of the virtue of the 59 Indo-China war veterans who sacrificed their lives for the freedom and prestige of Thailand over the Franco-Thai territorial conflict of Indo-Chinese contingency in January 1941. The monument is now considered to honour the Thai veterans of all modern wars – World War II, Korea and Vietnam. The monument is a fifty meter high obelisk surrounded by five statues symbolizing the army, navy, air-force, police and civilian. The monument was completed on June 25, 1942.

16. Except for some public institutes like hospital and school, the area adjacent to the Victory Monument is, at present, dominated by commercial stores combined with residences. The Victory Monument, however, apart from its surrounding areas constitutes a historic and symbolic spot with dignity in the mid town. This requires that any proposals for pedestrian crossing facilities should be planned and designed in a way that they could fit in with the monument.

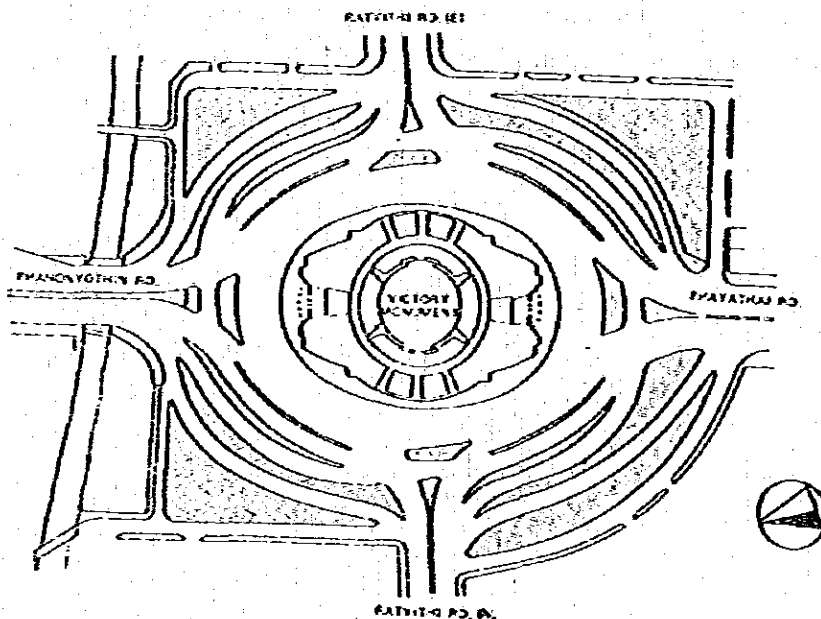
17. Other features in the area which would have the direct influence on the preparation of alternative plans for the pedestrian crossing facilities are described in the following paragraphs. They are mainly environmental issues, public utilities laid under the roundabout and the road improvement project to be implemented by MOI and BMA.



Location



Panoramic View



Proposed Channelization Plan

Figure-1 Victory Monument Roundabout

B. Environment

18. The roundabout at the Victory Monument is a part of rectangular square about 300 m long in the direction of North-South and about 200 m at right angle (See Figure-1). The remaining part of the square is an open space with trees and lawn. Some of the trees are as high as 10 m and 40 years old. The trees contribute to enhance urban aesthetics and provide shelters for pedestrians and are all worth being preserved.

19. The trees, however, were planted in accordance with the present layout of the roundabout, some of them will incidentally stand in the way of new plans for pedestrian crossing facility. Realizing the importance of the trees, due care to minimize the number of trees subject to removal has been given in the course of preparation of alternative plans.

C. Underground Utilities

20. Since the roundabout is located in the central part of Bangkok, a number of public utilities run through in all directions under the roadway. In the underground, found are main pipes of drainage, water supply, high tension electric cables and telephone cables. They are placed at depth of 1.2 m to 2.4 m beneath the road surface.

21. The existence of utilities has a large effect on planning of pedestrian crossing facility, particularly in case of underground structures. The utilities, if they shall be kept where they are, govern the configuration and depth of new underground structures to be built.

22. After consultation with BMA, it has been decided to remove utilities if found necessary and warranted to secure pedestrians' convenience.

D. Road Improvement Project

23. The roundabout where four arterial streets, Ratvithi (W) Phayathai, Phahonyothin and Ratvithi (E) ¹⁾ road converge, accommodates about 8 lanes in one direction, although there are no clear lane-markings. The traffic volume counts for about 170,000 per day of which about 19,000 vehicles are buses, with composition of about 60% of BMTA ²⁾ buses and about 40% of minibuses.

24. All buses entering into the roundabout approach to sidewalks across traffic lanes and make stops for passengers. The free and irregular movements of buses intercept other through-traffic, leading to traffic hazards and congestion.

25. BMA has been planning a road improvement project to ensure orderly and smooth traffic flow on the roundabout. The concept of the improvement is to introduce traffic channelization system for buses, providing with adequate traffic islands on the roadway of the roundabout. Detailed layout of the traffic islands are shown in Figure-1 (See Drawing No. G-2 in Volume II).

26. This road improvement program is expected to be implemented in the near future. The alternative plans for the Study, therefore, have been in principle developed in consistency with the channelization plan to the extent possible.

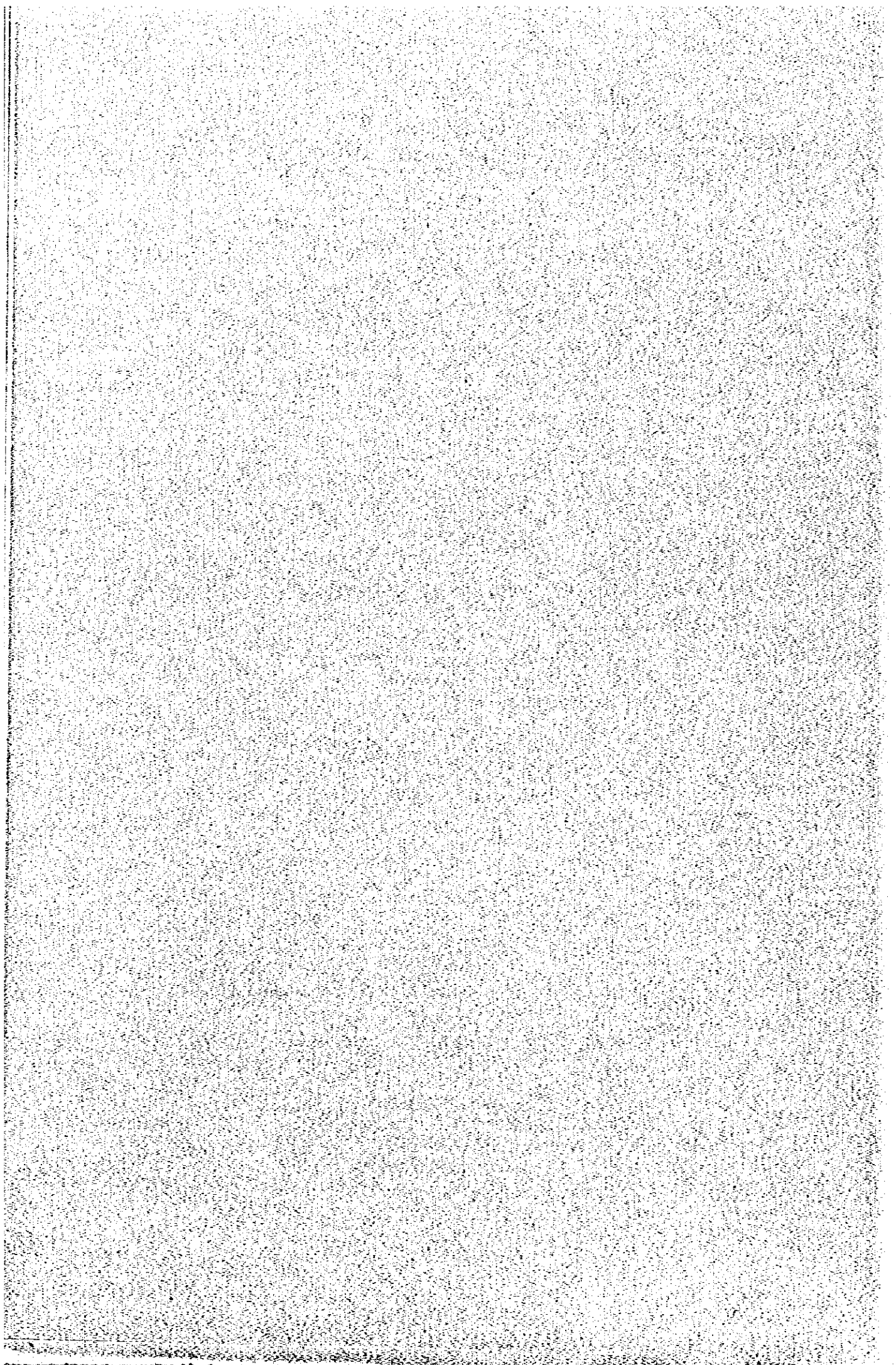
27. Besides the road improvement project, a study on drainage improvement scheme has been under way by BMA. The study area covers the Victory Monument where main drainage pipes run through and drainage pumps are installed. In the future, coordination between two studies may be required.

1) Phayathai ;	26.2 m. wide 8 lanes
Phahonyothin ;	24.0 m. wide 6 lanes
Ratvithi (W) ;	20.5 m. wide 6 lanes
(west extension of Ratvithi)	
Ratvithi (E) ;	20.5 m. wide 6 lanes
(east extension of Ratvithi)	

2) BMTA : Bangkok Mass Transit Authority

CHAPTER 3

TRAFFIC



CHAPTER 3 TRAFFIC

28. To determine scope and size of pedestrian crossing facility, a survey on pedestrians and traffic volume at four junctions, where the four streets converge at the roundabout, was carried out by the Team in June 1983.

29. The survey on pedestrians include counting the number of pedestrians and their movements on the roundabout through personal interviews at sites. The vehicle traffic survey was conducted for eight classified types of vehicles.

A. Pedestrian

30. The number of pedestrians varies remarkably with junctions. Appendix 4 shows the numbers of pedestrians who cross streets at the junctions with hourly fluctuations. The Phahonyothin junction is the largest with 47,488 persons for 12 hours from 7 am. to 7 pm. while the Phayathai junction being the least with 21,667 persons.

31. In general practice, facilities for pedestrians are planned and designed on the basis of hourly number of pedestrians. At the roundabout, a peak of rush hours in the evening appears between 5 pm. and 6 pm. (with exception of 6 pm. – 7 pm. at the Ratvithi (E) junction).

32. Table-1 and Appendix 5 show the pedestrian volume during peak rush hour at each of the four junctions at the roundabout.

Table-1 Pedestrian Volume at Peak Hour

Junction (Street)	Pedestrian Volume
Phahonyothin	7,223 (Persons)
Ratvithi (E)	6,309
Ratvithi (W)	3,207
Phayathai	2,484

33. Table-2 presents the movements of pedestrians during rush hours between 5 pm. and 7 pm. The total number of pedestrians at the four junctions for the two hours counts for 29,800 persons, of which 6,619 persons crossed two streets (figure in bracket in column of "two-crossing" in Table-2 must be divided by two to gain real number of persons because they are counted twice at two junctions). On an average, 22% of pedestrians crossed two

streets in their movement, while the remainder (78%) crossed only one street. A schematic pedestrians' flow pattern is shown in Appendix 6.

34. These figures in Table-2 are informative in planning pedestrian facility, i.e., if four pedestrian crossing facilities are constructed independently at each junction of the roundabout, about one-fifths (20%) of pedestrians who cross two streets, are forced to climb up and down stairways of facilities twice. In other words, if a pedestrian facility connecting the four junctions with a continuous structure is built around the roundabout, approximately one-fifths (20%) of the pedestrians could be relieved from toil of additional climbing up and down, as compared to the case of separately built pedestrians' crossing facilities.

Table-2 Pedestrian Movement

(5 pm. - 7 pm.)

Junction (Street)	One-crossing	Two-crossing	Total
Phahonyothin	9,545 (81%)	2,249 [4,498] (19%)	11,794 [14,043] (100%)
Ratvithi (E)	8,305 (82%)	1,858 [3,716] (18%)	10,163 [12,021] (100%)
Phayathai	1,851 (64%)	1,061 [2,120] (36%)	2,911 [3,972] (100%)
Ratvithi (W)	3,430 (71%)	1,452 [2,904] (29%)	4,882 [6,383] (100%)
Total	23,181 (78%)	6,619 [13,238] (22%)	29,800 [36,419] (100%)

Note: [] shows the double counted figure at each junction.

35. Table-3 shows transportation means of pedestrians at the roundabout. Of 29,800 pedestrians, 20,953 persons (70%) transfer bus at the roundabout while 776 persons (3%) use no bus at all. The remaining 8,071 persons (27%) only either get off or get on bus.

Table-3 Pedestrian Type by Transportation Means

(Time 5 pm. - 7 pm.)

Pedestrian Type	Pedestrian Volume
Bus - Bus	20,953 (70%)
Bus - No bus	8,071 (27%)
No bus - No bus	776 (3%)
Total	29,800 (100%)

36. According to the survey, the average walking velocity at peak hour is 70 m/min. on the sidewalks of the Victory Monument and 73 m/min. at off peak hour. This velocity is a little bit slower than those of New York and Tokyo with average of 80 m/min.

37. Pedestrian density in term of square meter per one pedestrian was also observed during the pedestrians' survey. The average density at peak hour is around 5 m²/person with the smallest of 2 m²/p., while at off peak hour being 8 m²/p.

38. The relations between pedestrians' volume density and walking velocity are shown in Appendix 7. As observed, walking velocity, within a range of 2 m²/p. to 10 m²/p. of density, remains more or less unchanged. These findings will be used for determination of width of expected pedestrians' crossing facility at the Victory Monument.

B. Vehicle Traffic

39. Traffic survey of vehicles at peak hours has been carried out at the Victory Monument roundabout on June 15, 1983. The counting took place at the four junctions. As the objective of vehicle counting is mainly to gain traffic volume during the hours when the number of street crossing pedestrians is highest, counting was made between the hours 6 am. -- 9 am., 11 am. -- 1 pm. and 4 pm. -- 7 pm.

40. Although the traffic survey was carried out by counting the number of eight types of vehicles, the results of the survey are assorted into five major groups of types.

They are

- 1) Private passenger car;
- 2) Taxi, Samlor and Silor;
- 3) BMTA bus, Mini bus, and Other bus;
- 4) Truck and Pick-up; and
- 5) Motorcycle.

41. The vehicle traffic volume at peak hours in the morning and afternoon which appear at 8 am. -- 9 am. and 4 pm. -- 5 pm. respectively, is shown in Appendix 8. The composition of vehicle types during peak hours is presented in Appendix 9. The passenger car is the highest of all vehicles followed by taxi and samlor, and motorcycle. The proportion of buses to the total traffic is about 12%.

42. Most bus transportation service in Bangkok is maintained by BMTA. But there are some bus services operated by authorized private companies. The number of total bus trips at the Victory Monument is at approximately 19,000 daily and they make stop at one of the four quadrants at the Victory Monument. The private buses wait at the bus stops in the quadrants for passengers to their full capacity or so, and therefore they sometimes occupy limited bus stop spaces for a long time reducing road traffic capacity.

43. The traffic flow at the Victory Monument is far from desirable one in particular during rush hours which appear around 8:00 to 9:00 am. and 4:00 to 5:00 pm. The deteriorated traffic conditions are not peculiar at the Victory Monument roundabout but seen on the most arterial roads in Bangkok, mainly because of undercapacity of roads. However, at the Victory Monument roundabout, the conflict between vehicle traffic and crossing pedestrians contribute to make traffic congestion worse.

44. A scheme, therefore, to segregate crossing pedestrian from vehicle traffic is expected to contribute to alleviation of traffic condition at the Victory Monument.

C. Forecast of Pedestrian

45. To determine a width of passage of crossing pedestrians' facility, a forecast of pedestrian has been made based on available data such as present volume of pedestrians, future bus passengers and population prepared by concerned authorities in Thailand. Target year of the forecast has been set for year 2000.

46. The flow chart of forecasting of future pedestrian crossing volume is shown in Figure 2 and the procedure of forecast of pedestrian crossing volume is summarized as follows;

- 1) The pedestrians at the Victory Monument will be classified into three groups in terms of their transportation means (See Table-3) i.e., those who come and leave the Monument by bus (Type-1), those who use no bus at all (Type-2), and those who use bus only one way either coming or leaving (Type-3). The forecast of the pedestrians at the Victory Monument has been made for above three groups separately.
- 2) For the Type-1 pedestrians, by its transportation nature, the growth rate in the forecast of bus passenger prepared by Expressway and Rapid Transit Authority (ETA)¹⁾ has been applied.
- 3) For the Type-2 pedestrians who are expected to increase in proportion to population growth, the population increasing rate in the forecast made by Department of Town and Country Planning (TCP)²⁾, has been applied.
- 4) For Type-3, an average growth rate of Type-1 and Type-2 has been adopted.

47. The TCP's forecast of population estimated its growth rate at approximately 1.8 percent per annum from 1980 to 2000 in the Greater Bangkok. The study area of TCP covers Bangkok Metropolis, Nonthaburi and Samutprakan, and have nearly 3,100 square kilometer in the area. The application of the study's result to bus passengers at the Victory Monument, in consideration of bus operating area by BMTA where the average length of bus operation routes is at approximately 20 km, could be warranted.

48. The growth rate of forecasted future bus passengers by the Second Stage Expressway System of ETA is used in this Study. The growth rate of bus passengers is about 2.0 percent annually from 1983 to 2000. This estimated growth rate is in conformity with that of the road improvement project. The average increase rate for all pedestrians at the Victory Monument roundabout has been estimated at 1.38 between 1983 and 2000 based on the above two studies.³⁾

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- 1) "Feasibility Study on the Second Stage Expressway System in the Greater Bangkok": Expressway and Rapid Transit Authority of Thailand (ETA).
 - 2) Draft Plan issued in 1982: Department of Town and Country Planning (TCP), Ministry of Interior.
 - 3) The estimation is based on the assumption that the present bus route system will be kept unchanged in the future.

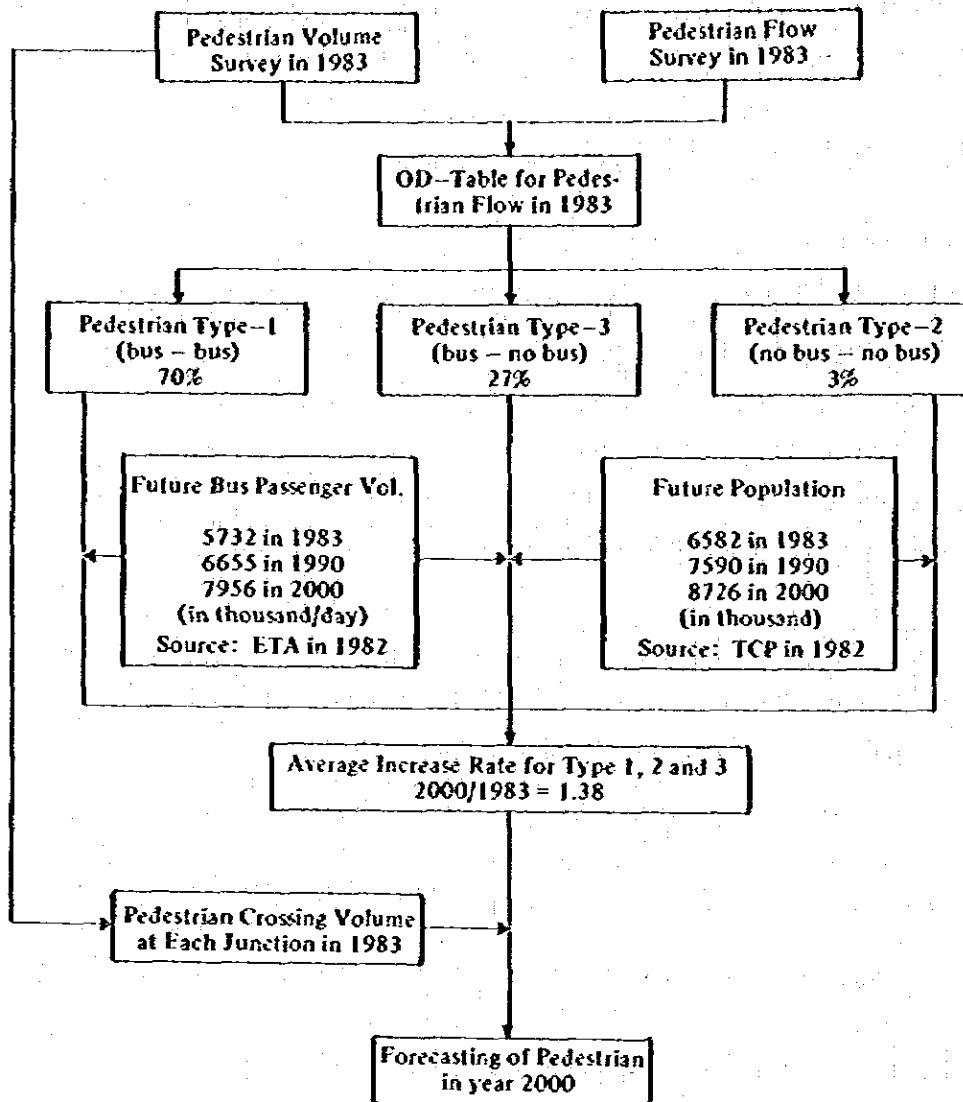


Figure-2 Flow Chart of Forecast of Pedestrian

D. Forecast of Vehicle Traffic

49. For planning and designing pedestrian's crossing facilities, a future traffic volume of vehicles is not a determinant. In this report, therefore, an approximate estimation on future traffic volume has been made mainly for the purpose of economic evaluation of alternatives to be proposed hereinafter.

50. The present daily traffic volume at the monument has been obtained from the traffic counting at the site which covers for 8 hours and the results of the traffic survey which had been carried out on the four streets nearby the Victory Monument covering a whole day by the Office of the Committee for the Management of Road Traffic (OCMRT) in 1980. Table-4 shows the present traffic volumes at the roundabout.

Table-4 Present Daily Traffic Volumes
(Exclusive of Motorcycle)

Type of vehicle	Road			
	Ratvithi (W)	Phayathai	Phahonyothin	Ratvithi (E)
Passenger Car & Taxi	33,800	61,600	57,900	50,900
Mini Bus	1,900	4,900	1,500	6,100
Heavy Bus	4,400	5,700	8,500	6,000
Pick-Up	2,200	1,700	4,200	3,900
Heavy Truck	900	1,400	900	2,000
Total	43,200	75,300	73,000	68,900

Unit: Vehicle/day

Note: The figures have been estimated from the traffic counting for 8 hours in 1983 by the Team and the traffic survey for a whole day in 1980 by OCMRT.

51. The traffic growth rate developed in the study on the Second Stage Expressway System in the Greater Bangkok has been utilized in this report. This growth rate could be applicable to this study because the some section of second stage expressway is located in the vicinity of the Victory Monument. Table-5 presents the traffic growth rate forecast in the above mentioned study.

Table-5 Annual Traffic Growth Rate

Type of vehicle	Year	1980/1983	2000/1990
Passenger Car		5.2 (%)	3.6 (%)
Bus		5.9	3.4
Truck		4.0	3.0

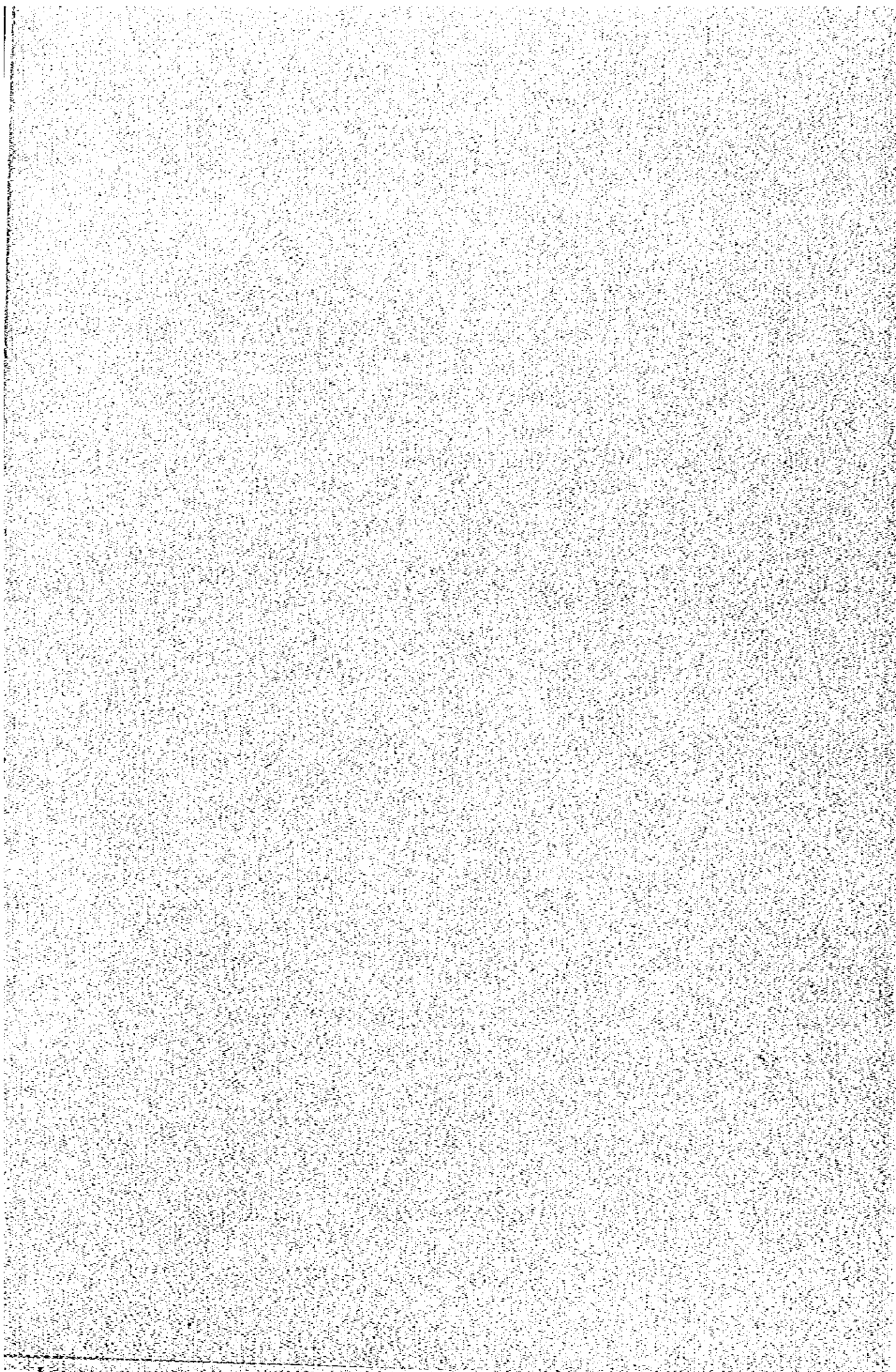
Source: The feasibility study on the Second Stage Expressway of ETA

52. The traffic volume of vehicles in 1987 when the pedestrian crossing facility is assumed to be completed, has been estimated by type of vehicles, multiplying the present number of traffic volumes by the above growth rates. The growth rates of Mini bus and Heavy bus, and Pick-up and Heavy truck are assumed to be same as those of Bus and Truck in Table-5, respectively. Table-6 shows the estimated traffic volume in 1987. The future traffic volumes after 1987 can be obtained applying the above growth rates.

Table-6 Traffic Volume in 1987
(Exclusive of Motorcycle)

Type of vehicle	Road			
	Ratvithi (W)	Phayathai	Phahonyothin	Ratvithi (E)
Passenger Car & Taxi	40,900	74,700	70,100	62,100
Mini Bus	2,500	5,800	1,900	7,800
Heavy Bus	5,700	7,200	10,700	7,600
Pick-Up	2,500	2,000	4,900	4,600
Heavy Truck	1,100	1,600	1,100	2,400
Total	52,700	91,300	88,700	84,500

CHAPTER 4
DESIGN CONDITIONS



CHAPTER 4 DESIGN CONDITIONS

A. Width of Footpath

53. The width of footpath for pedestrian can be theoretically calculated by the following formula,

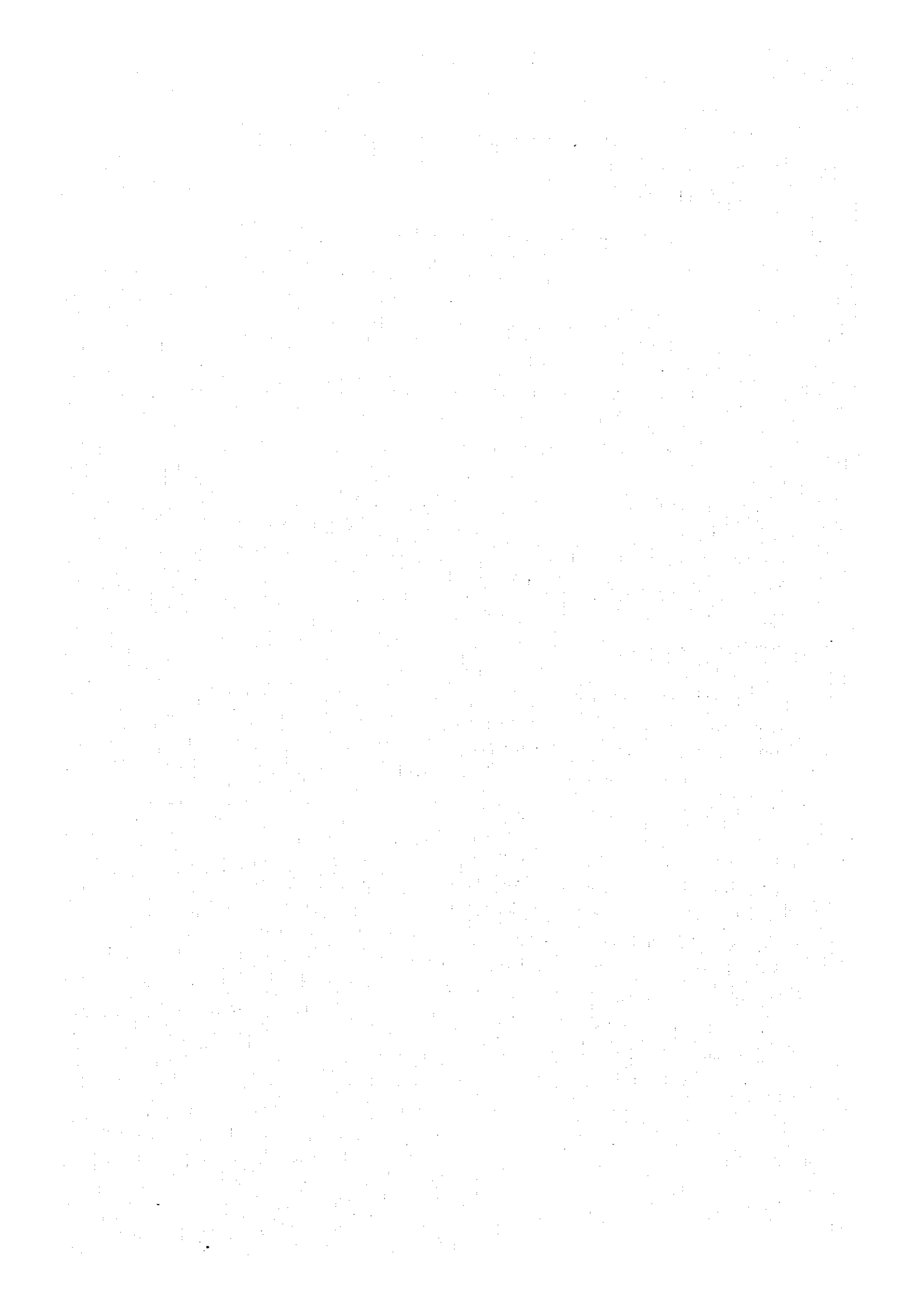
$$W = \frac{Q}{V} \cdot D \quad \text{or} \quad Q = W \cdot \frac{V}{D}$$

where W ; Effective width of footpath (m)
 Q ; Pedestrian volume (person/minute)
 V ; Walking velocity (m/minute)
 D ; Space for one pedestrian (Density, m^2 /person)

54. A walking velocity (V) is proportional to density (D). The relation between V and D has been developed with data which were obtained from the survey at the Victory Monument roundabout (See Appendix 7). Based on the findings on the relation between V and D , a diagram of Q and W with index of D has been developed and is shown in Figure of Appendix 10. From this figure, the width of footpath can be decided, when pedestrian volume Q and density D are given.

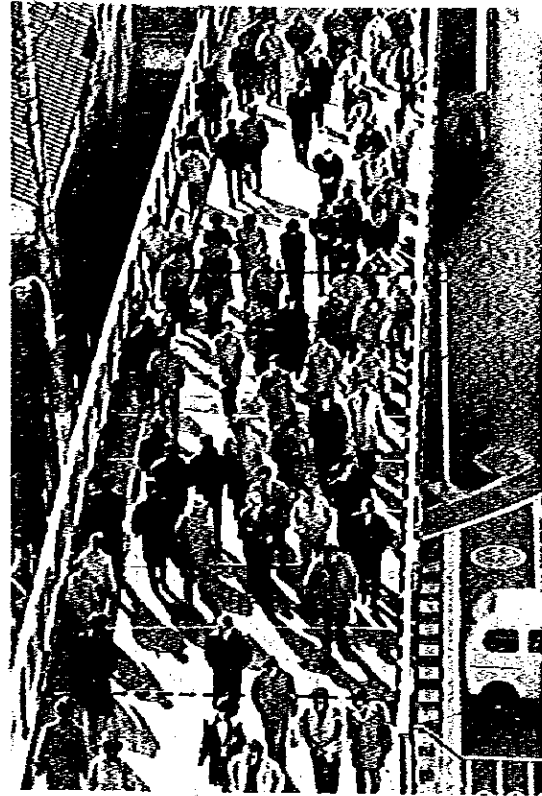
55. The pedestrian volume at the roundabout varies widely with junctions (or streets). In general practice, a facility shall be designed for the highest volume of pedestrian. Since the difference between the highest and second highest pedestrian volumes is relatively small, the Team has selected the average pedestrian volume of Phahonyothin and Ratvithi (E) streets for planning.

56. For a density of $2 m^2$ /person and pedestrian volume of 8,500 to 10,000 persons per hour, width becomes about 4.5 m by the diagram in Appendix 10. The present density at the roundabout varies with a range of $2 m^2$ /p. to $10 m^2$ /p. Meanwhile, as observed from Appendix 7, the density (D) of $2 m^2$ /p. seems to warrant the average walking velocity which is being enjoyed by pedestrians at the roundabout. Based upon the above findings, the design density has been determined at $2 m^2$ /p. The effective width of 4.5 m appears to be sufficient for expected future pedestrian volume and reasonable from the view point of amenity (See the pictures on the next page).





Picture-A



Picture-B



Picture-C

The average pedestrian densities in the pictures are as follows.

- Picture-A about 5.5 m²/p
- Picture-B about 2.0 m²/p
- Picture-C about 1.0 m²/p

PEDESTRIAN DENSITY

B. Geometric and Structural Design Conditions

57. The geometric and structural design conditions which have been developed by BMA and the Study Team are shown in Appendix 11 and 12, respectively. The structural design conditions are mainly quoted from those of BMA.

C. Other Design Conditions

58. For the design of the underpass tunnel of the Alternative 3, the design criteria for lighting and ventilation have been determined as follows.

Lighting

59. To enhance pedestrian's comfort as well as security in a tunnel, the provision of lighting should be considered. For the Study, the minimum light intensity value has been set at 50 lux. ¹⁾

Ventilation

60. For the pedestrian's short tunnel, in general, no ventilation system is required. However, taking into account the relatively high humidity in the study area and with a view to enhance pedestrian's comfort, BMA and the Team agreed to plan ventilation equipment. The standard in the Safety Ordinance on Building of Tokyo Metropolis has been quoted. According to the ordinance, 30 m³ of air per 1 m² of floor shall be ventilated every hour.

1) This is quoted from the Japanese technical standard for pedestrian tunnel.

