GOVERNMENT OF THE KINGDOM OF THAILAND
MINISTRY OF INTERIOR
EXPRESSWAY AND RAPID TRANSIT AUTHORITY OF THAILAND

Feasibility Study on The Second Stage Expressway System in The Greater Bangkok

FINAL REPORT
VOLUME I : TEXT

NOVEMBER, 1983

JAPAN INTERNATIONAL COOPERATION AGENCY

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PREFACE

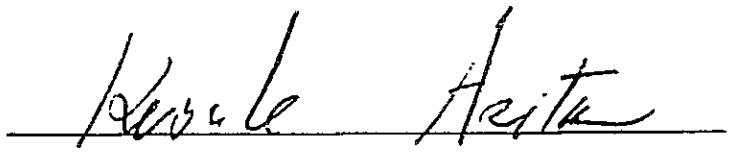
In response to the request of the Government of the Kingdom of Thailand, the Government of Japan decided to extend technical cooperation in conducting a feasibility study on the Second Stage Expressway System in the Greater Bangkok and entrusted the study to the Japan International Cooperation Agency (JICA). The JICA sent to Thailand a study team headed by Mr. Akira Shikichi which stayed in Bangkok from June 1982 to August 1983 and worked under the guidance of the Supervisory Committee chaired by Mr. Shigeomi Samukawa, Hanshin Expressway Public Corporation.

The team held discussions with the officials concerned of the Government of Thailand on the foregoing system and conducted a field survey in Thailand. Subsequently, further studies were made in Japan and the present report has been prepared.

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

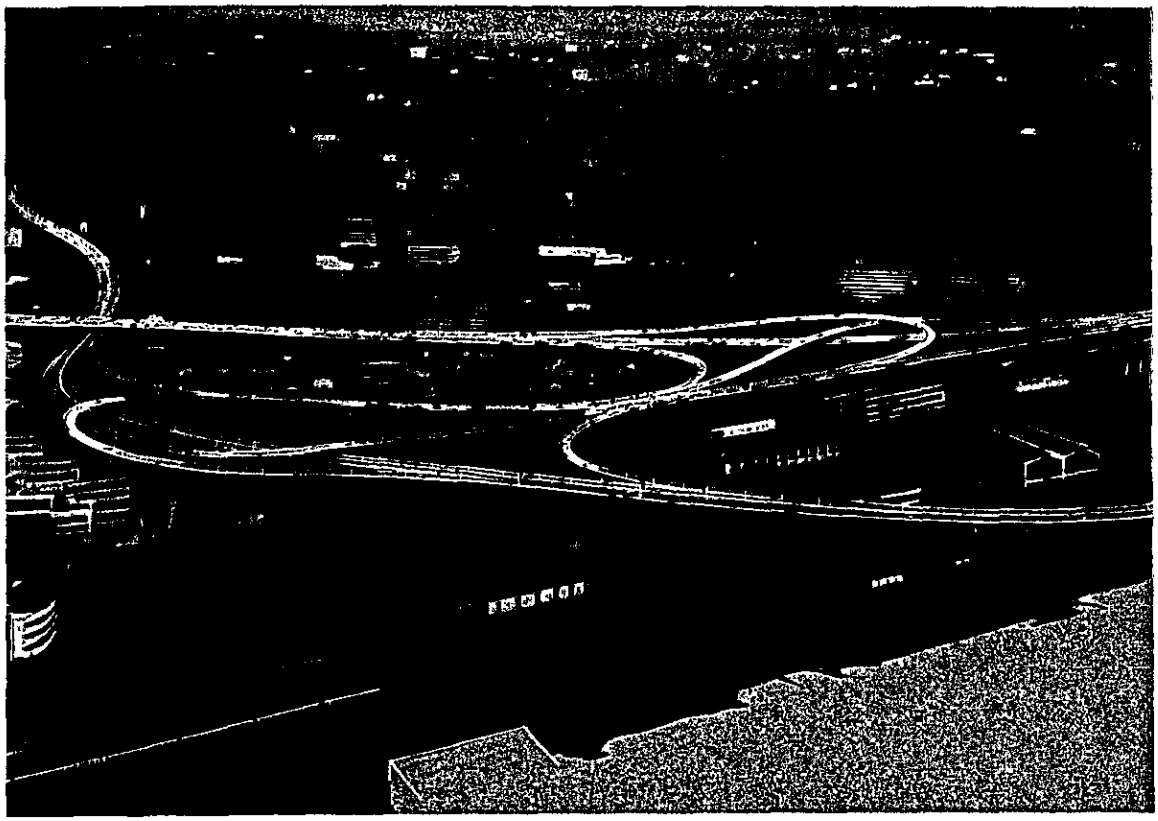
I wish to express my deep appreciation to the officials concerned of the Government of the Kingdom of Thailand for their close cooperation extended to the team.

November 1983

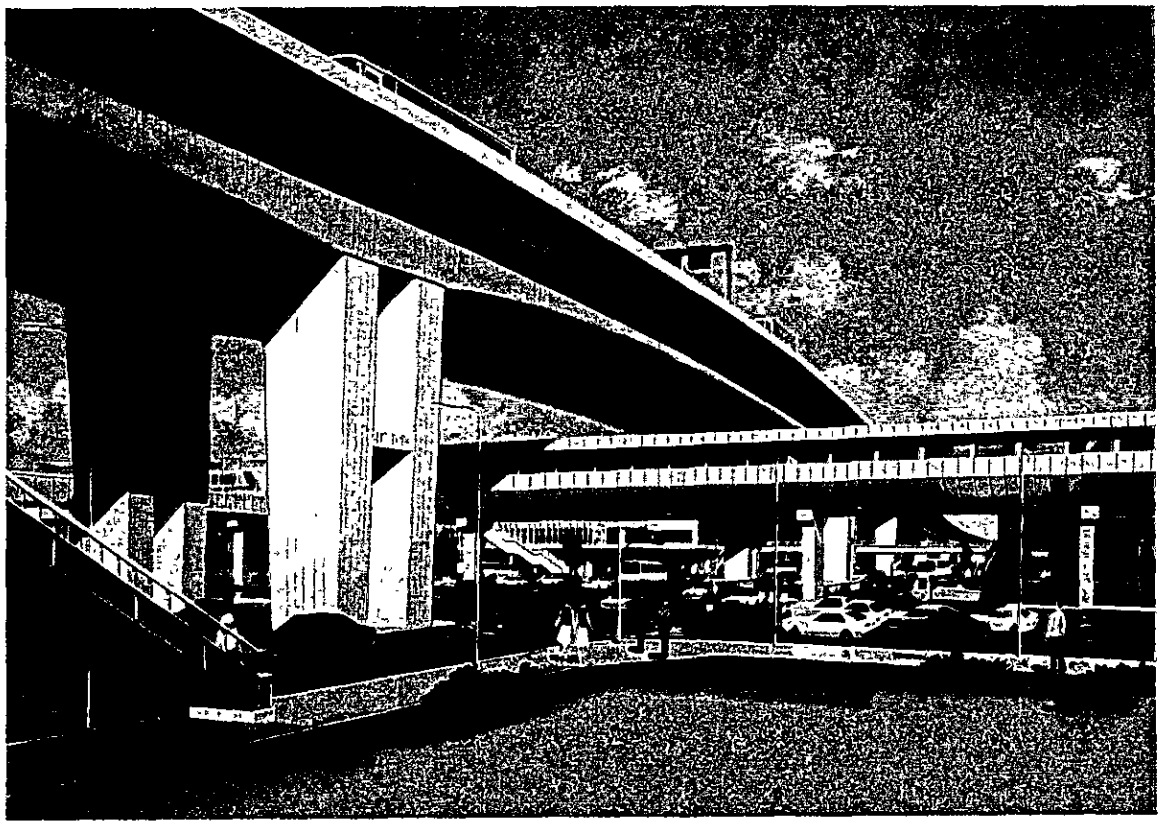


Keisuke Arita
President
Japan International Cooperation Agency

PERSPECTIVES OF THE SECOND STAGE EXPRESSWAY SYSTEM

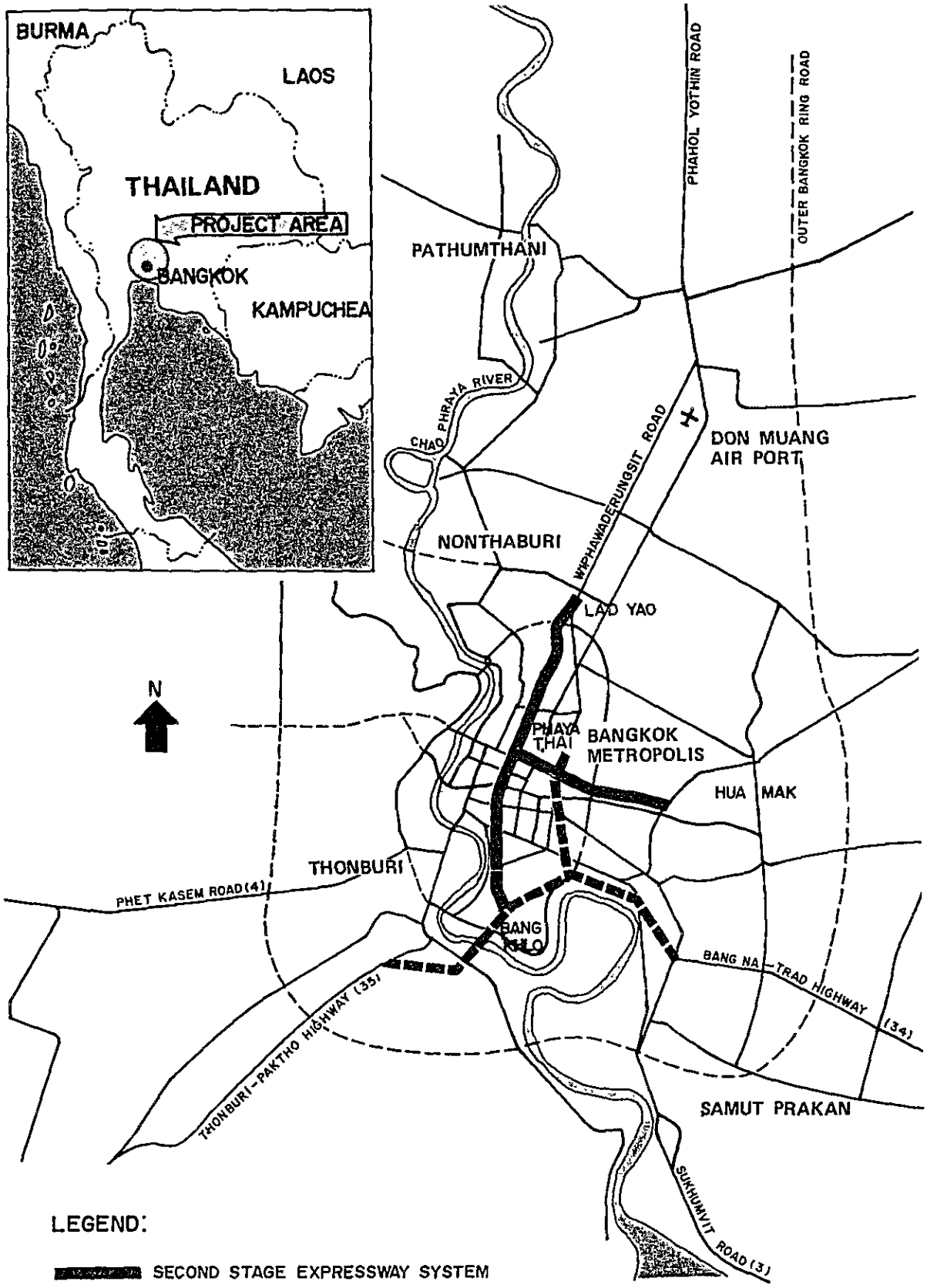


MAKKASAN INTERCHANGE

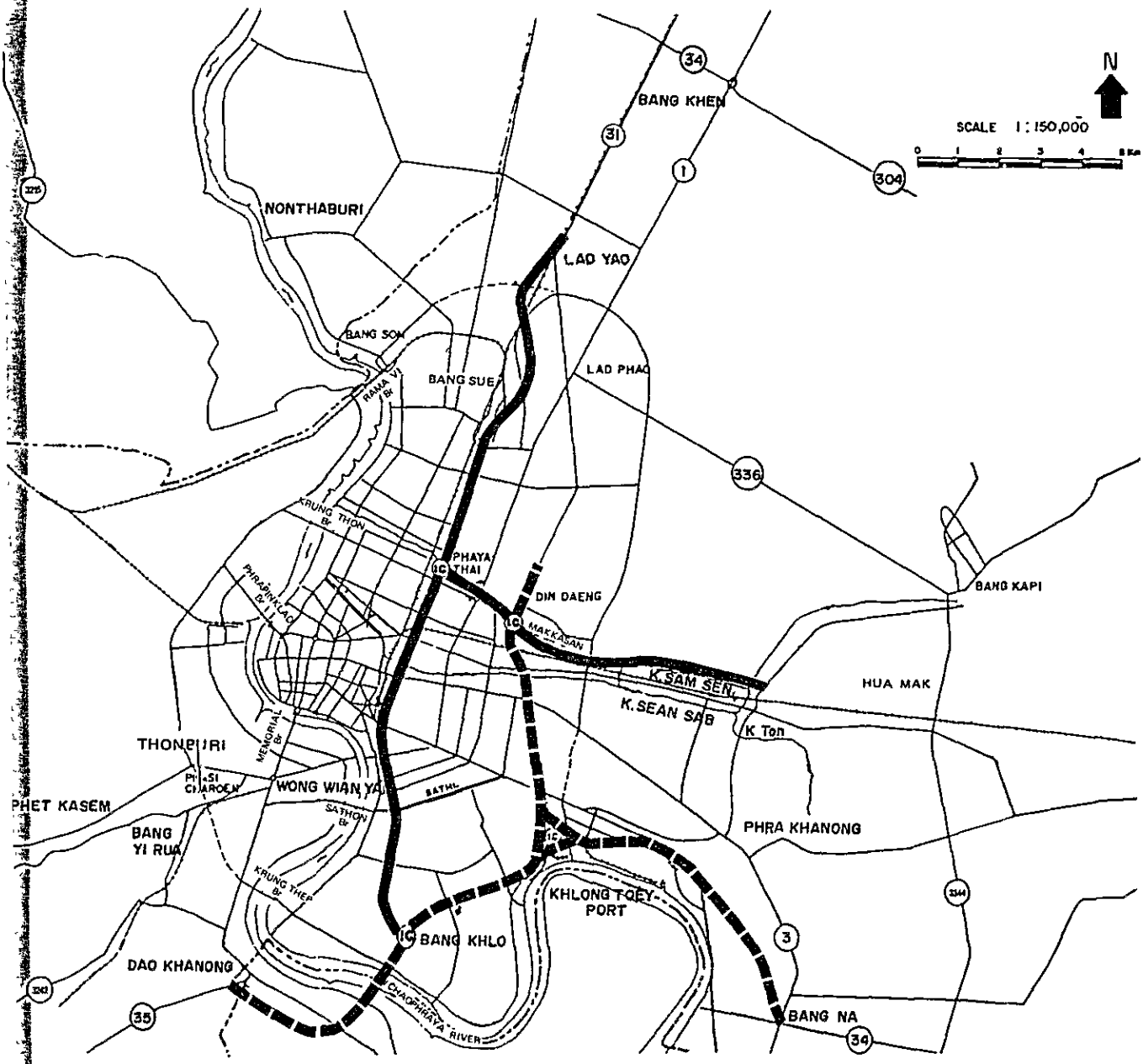


FLYOVER – RAMA IV ROAD

PROJECT LOCATION MAP



MAP OF PROJECT AREA

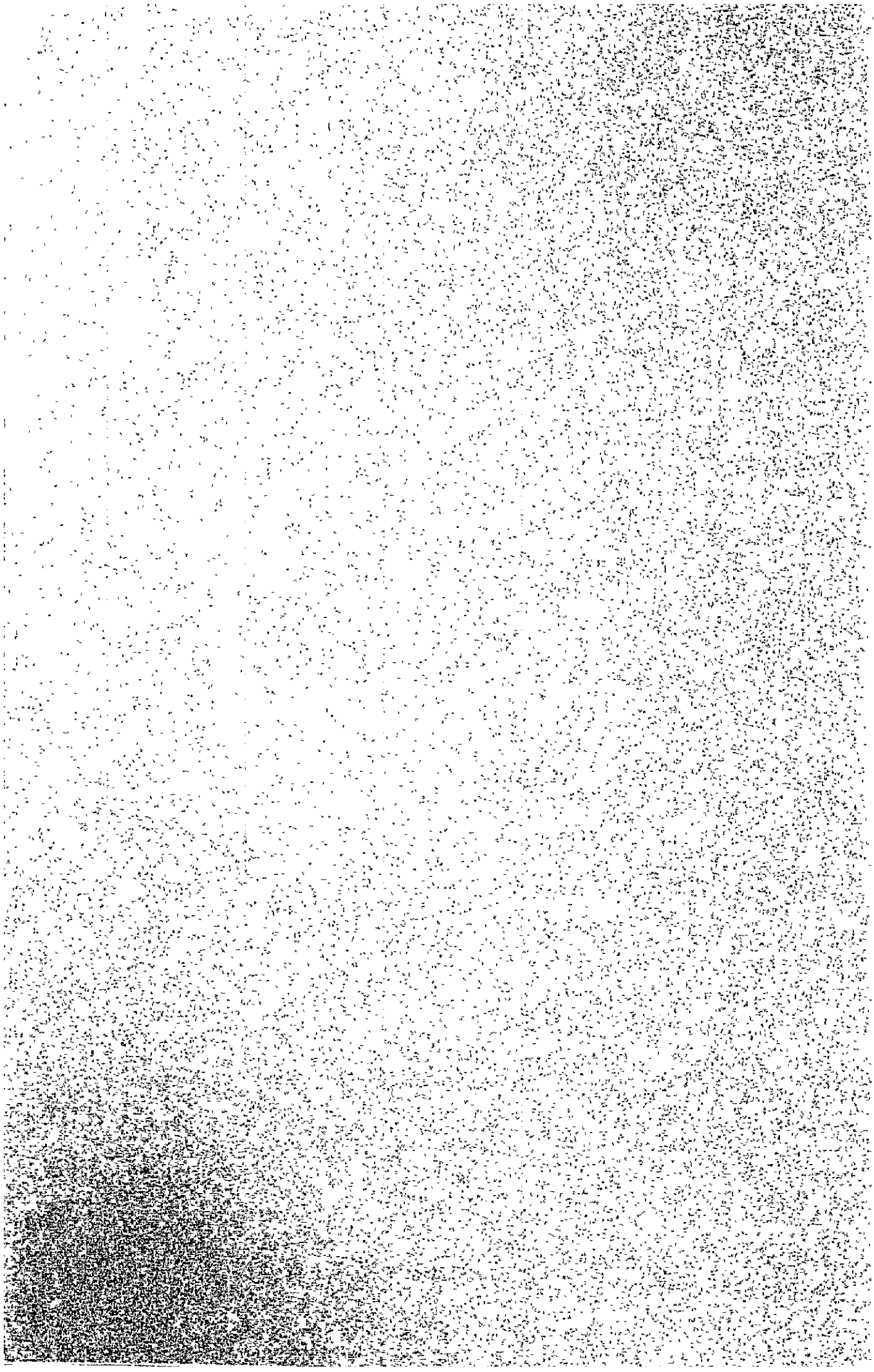


LEGEND :

SECOND STAGE EXPRESSWAY SYSTEM

FIRST STAGE EXPRESSWAY SYSTEM

SUMMARY AND RECOMMENDATIONS



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1. PROJECT BACKGROUND

The Greater Bangkok Area has been and will continue to be, the main focus of human activities in the Kingdom, generating social and economic benefits that have important multiplier effects over the rest of the country. The population increase in Bangkok leads to a continuing expansion of the urban area and an intensified land use in the built-up area.

The rapid urban expansion in the Greater Bangkok Area has entailed inevitably various urban problems and these have become increasingly serious especially in the central business district and its fringe areas. Inadequacy of basic infrastructures, inappropriate land use, housing shortage and the great need to improve the transportation network are the main problems.

The necessity to strengthen the road network in the Greater Bangkok Area by providing an expressway network is primarily due to the recent increase in vehicle traffic demand accompanying the development of the area. The First Stage Expressway System was thus planned to link the major highways from the north, the south and the east to relieve the traffic congestion in Bangkok. The Din Daeng-Port and Bang Na-Port sections were opened to traffic in October 1981 and January 1983, respectively. Under such circumstances, it is urgent to develop the Second Stage Expressway System since the road traffic demand in the area is foreseen to be extremely large.

TRAFFIC CONGESTION IN SUKHUMVIT ROAD

2. STUDY

2.1 Study Objectives

The overall objective of the Study is to determine the technical, economic and financial feasibility of, and to prepare an optimum program for, the construction of the Second Stage Expressway System.

2.2 Phasing

The Study Area covers the Greater Bangkok Area (Bangkok, Nonthaburi and Samut Prakan). The Study has been divided into Phase I and Phase II to meet the requirement of the work and time schedule. In general, this comprises as follows:

(1) Phase I Study

Phase I Study essentially consists of the traffic forecast and the screening of the Second Stage Expressway components, and comprises the following works:

- Collection and Analysis of Data;
- Traffic Study;
- Expressway Network Planning and Inception Traffic Assignment;
- Inception Engineering Studies for the Established Second Stage Expressway Network;
- Provisional Cost Estimates;
- Provisional Economic Evaluation; and
- Identification of the High Priority Routes.

(2) Phase II Study

The routes, namely the North-South Route (hereinafter called the "N-S Route") and the East Route were selected for the feasibility study as a result of Phase I Study.

Briefly, the Phase II Study comprises the following tasks:

- Collection and Analysis of Additional Data;
- Traffic Surveys and Studies;
- Traffic Assignment;
- Finalization of the Route Locations;
- Preliminary Engineering Design;
- Cost Estimates;
- Economic Evaluation;
- Financial Study;
- Foreseeable Economic and Social Impact Studies; and
- Formulation of Implementation Program.

3. FINDINGS AND RECOMMENDATIONS

In the road network of the Greater Bangkok Area, the expressway network forms the backbone, and the Second Stage Expressway System is an integral part of this expressway network. The aims of the Second Stage Expressway System Project (the Project) are:

- Meet the needs of the ever-growing vehicle traffic in the Greater Bangkok Area and facilitate improved traffic flows for the enhancement of urban activities;
- Form a nucleus of a road network for the Greater Bangkok Area together with the existing major roads, and provide connections to the First Stage Expressway System so as to allow a smooth flow of vehicle traffic into and away from the city centers; and
- Manage the expressway network as a tollway system, an efficient way of road system development, which will levy a toll from users who obtain benefits from the utilization of the expressway.

3.1 Route Components of the Project

As a result of the studies executed in the two phases, N-S Route and East Route were selected (Table 1).

TABLE 1 ROUTES COMPRISED IN THE SECOND STAGE EXPRESSWAY SYSTEM

Designation	Length of Route
North-South Route	19.2 km approx.
East Route	8.7 km approx.
Total Length	27.9 km approx.

3.2 Optimum Routes

Among the several alternative route locations for each of the components, the proposed routes were chosen to be subjected to further detailed study and eventually led to four alternative expressway development plans.

3.3 Evaluation of the Expressway Development Alternatives

Evaluation of above mentioned four alternative expressway development plans (Fig. 1) reveals that the most viable development plan is the Alternative R-1. This alternative calls for the construction of the easternmost expressway segment of the East Route to be postponed.

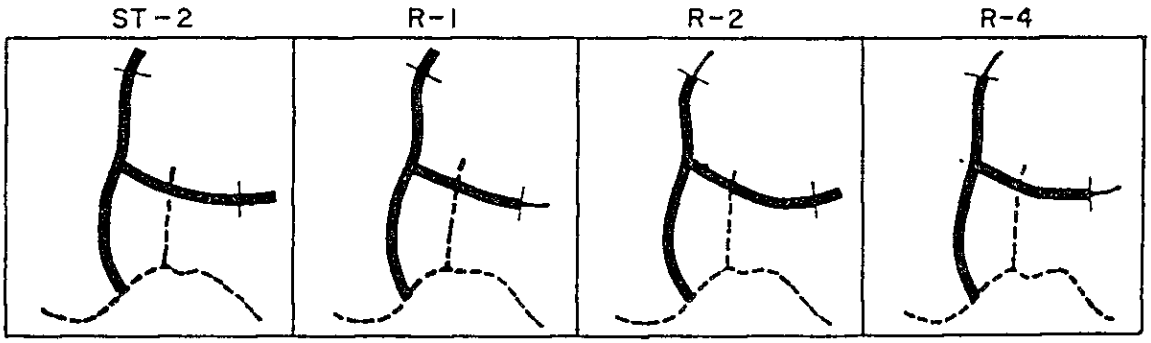


FIG. 1 THE SES ALTERNATIVES

3.4 Future Traffic Volume on the Expressway

(1) Traffic volume in the expressway network of both the First and Second stage Expressway Systems was forecast as 594 thousand trips per day in 2000. This indicates that the present trips in the First Stage Expressway System will jump 7.4 times, and 13% of all of the trips estimated in the Greater Bangkok Area will use the expressway network.

(2) The average traffic volume per kilometer in 2000 is estimated as 108,000 vehicles per day. By comparing this with the designed traffic capacity of the expressways, the average congestion rate is calculated to be 60%. An average trip length on the expressways is estimated as 12 km.

(3) Upon completion of the project, traffic volume on the First Stage Expressway System will increase by 20%. Also the traffic volume on the ordinary roads within the central urbanized area will decrease by about 14% with the completion of the Second Stage Expressway System.

(4) It is foreseen that the expressway network will be mainly used by passenger cars rather than by trucks and buses (Table 2).

TABLE 2 VEHICLE COMPOSITION IN YEAR 2000

Vehicle Type	Expressway Systems	GBA Road Network
Passenger Car	82.1%	75.8%
Bus	1.5%	1.4%
Light Truck	10.4%	12.9%
Heavy Truck	6.0%	9.9%
Total	100.0%	100.0%

(5) The estimated traffic volumes on the expressway network in the year 2000 is shown in Fig. 2.

(6) The result of overall traffic forecast shows that even after the completion of the Second Stage Expressway System there will still remain a traffic problem in the Greater Bangkok Area. Therefore, efforts at strengthening the ordinary road network by appropriate agencies should be continued to avoid the traffic problems which are foreseen in very near future.

3.5 Estimated Project Costs and Implementation Schedule

(1) The total project costs in 1983 prices and current prices of the Second Stage Expressway System are:

1) ฿16,790 million (in 1983 prices) ; and

2) ฿26,200 million (1983 prices plus 6% p.a. eacalation allowance).

(2) Following shows the sumamry of estimated project costs (Table 3) in 1983 prices:

TABLE 3 ESTIMATED PROJECT COST

Cost in million Baht

Designation	Foreign Currency Portion	Local Currency Portion	Total
Construction Cost	5,750 (51 6%)	5,380 (48.4%)	11,130 (100%)
Land Acquisition and Compensation Cost	–	3,480	3,480
Contingencies and Others	870 (39.9%)	1,310 (60.1%)	2,180 (100%)
TOTAL	6,620 (39.4%)	10,170 (60 6%)	16,790 (100%)

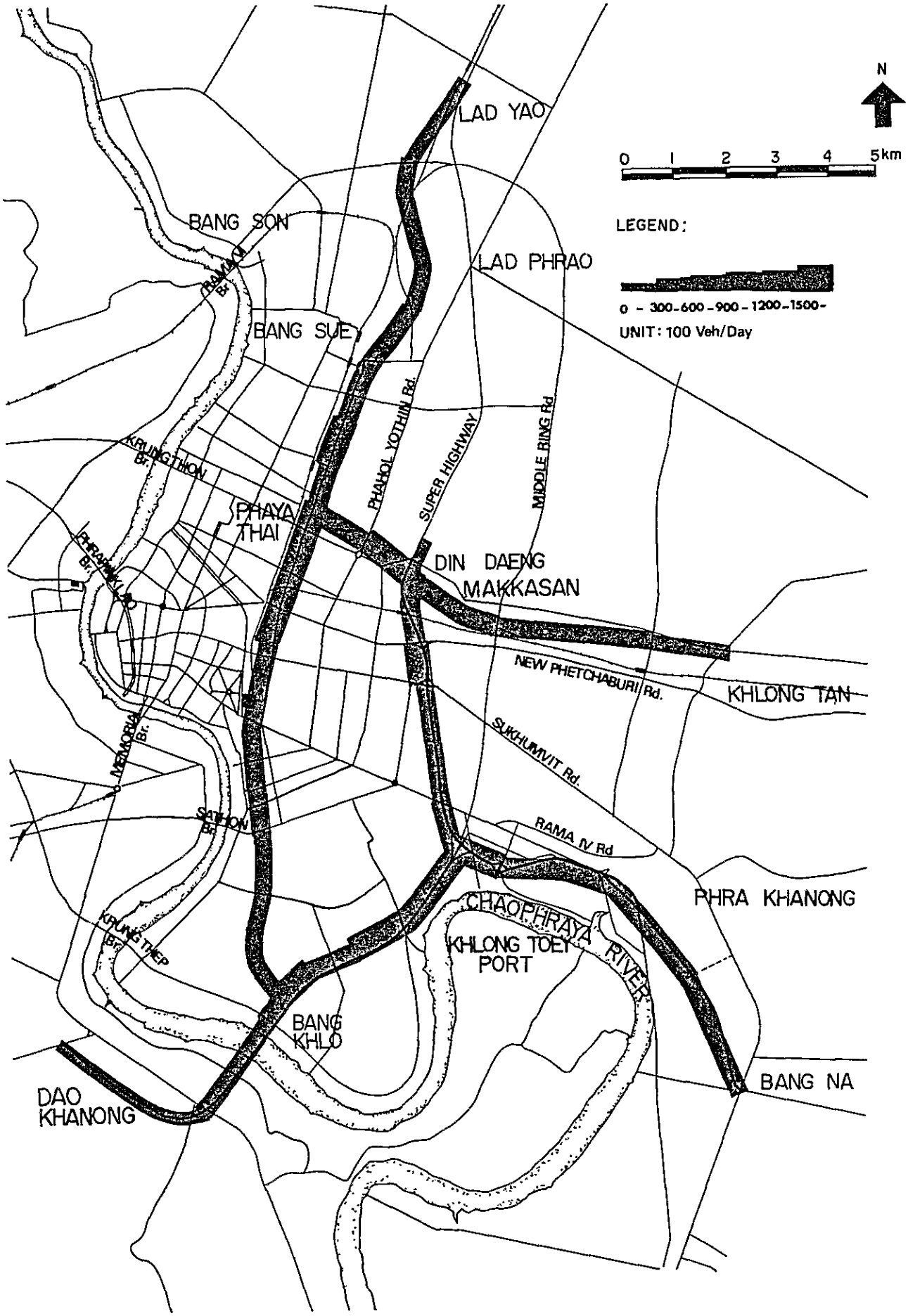


FIG. 2 ESTIMATED TRAFFIC VOLUMES, IN THE YEAR 2000

(3) The implementation of the Project requires an extremely large investment. For this reason, and to obtain maximum economic and fianncial benefit a staged construction approach is recommended as shown in the following figure (Fig. 3).

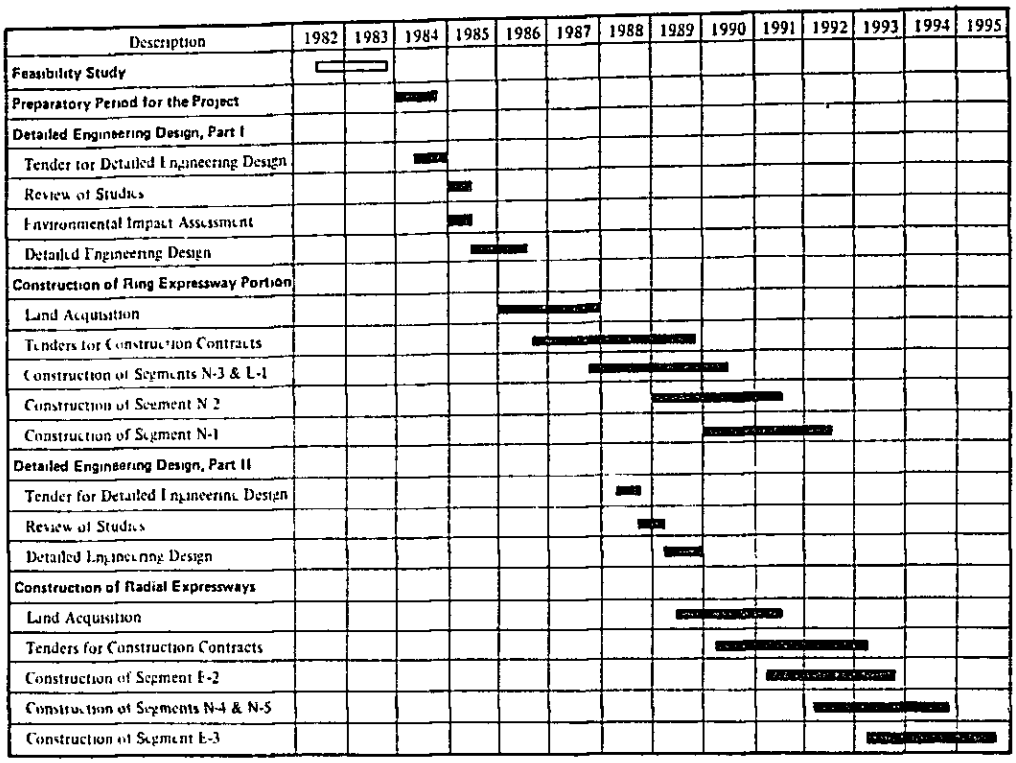


FIG. 3 RECOMMENDED IMPLEMENTATION SCHEDULE OF THE SECOND STAGE EXPRESSWAY SYSTEM PROJECT

3.6 Economic Indicators

The economic indicators for the Expressway development alternatives are shown as follows (Table 4):

TABLE 4 ECONOMIC ANALYSIS

Development Alternative	Present Worth of Benefit at i = 12% (in ฿ million)	B/C Ratio at i = 12%	IRR (%)
1) R-1	6,094.2	1.65	17.0
2) ST-2	5,889 0	1 60	16.7
3) R-2	5,015.7	1.52	16.1
4) R-4	4,757.0	1.51	16.0

It is found that the R-1 alternative indicates the highest return while the differences of the return among these plans are quite small. The R-1 is recommended as the SES development plan (Fig. 4).

3.7 Financial Aspects

The cost-revenue relationship was studied under the same basic conditions of the economic analysis together with the recommended toll fare levels (Table 7). Following are the results of the financial analysis of the Alternative R-1 :

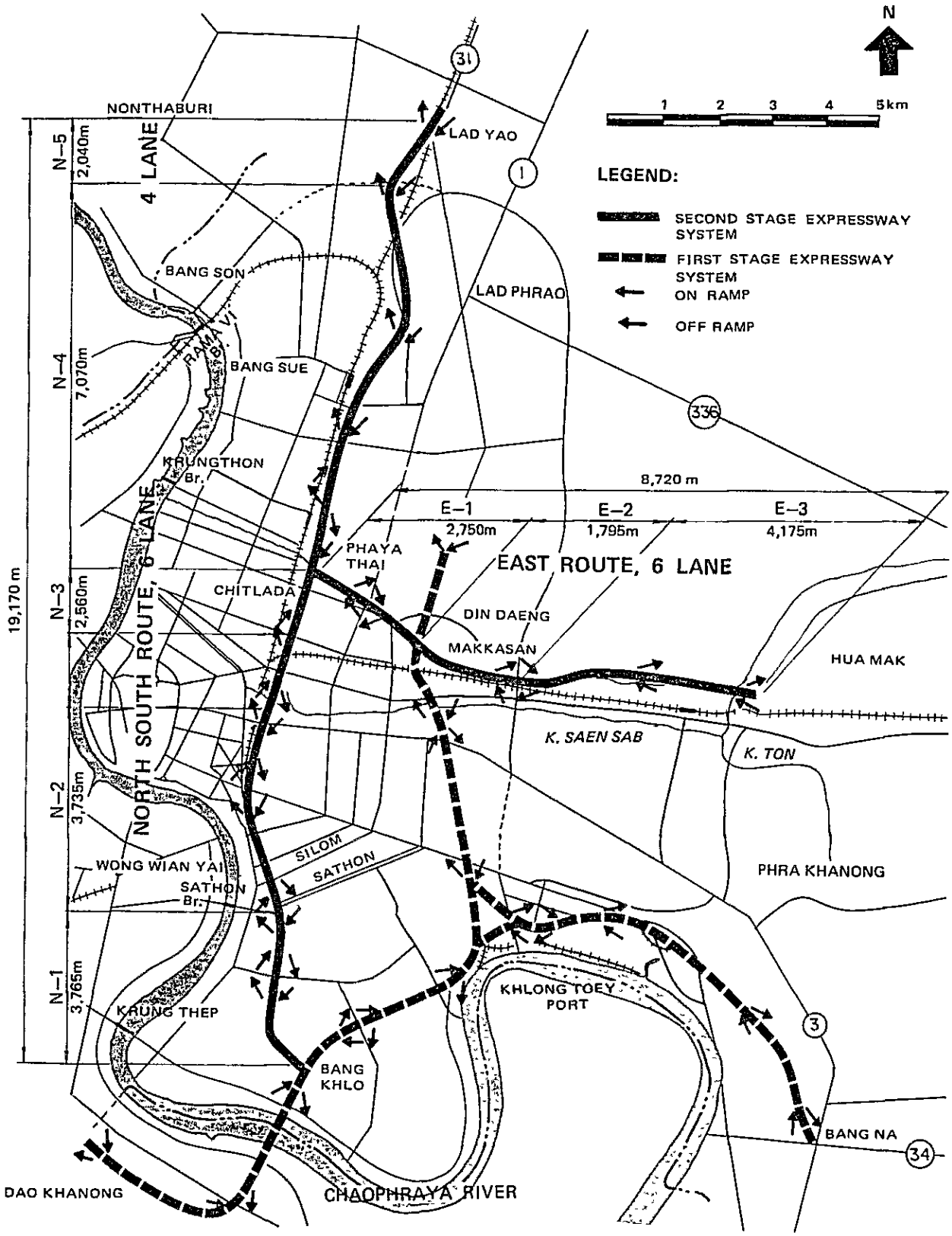


FIG. 4 EXPRESSWAY ROUTES AND CONSTRUCTION SEGMENTS

Present Worth of Surplus at i = 12%	Financial Revenue/Cost Ratio at i = 12%	Financial IRR
฿ 0.2 million	1.0	12.0%

Alternative options of the funding schedule are studied as shown below (Table 5). An overall interest charge should be kept at a low level in order to yield surplus under the constraint of the financial return of 12%.

It is recommended that the option (a) or another combination of funds which minimizes the overall interest burden to the debt should be sought. It is forecast that all loans can be paid back by year 2006 if all the estimated cash flow surplus is allocated for the refunding.

TABLE 5 ALTERNATIVE FUNDING SCHEDULE

Finance	Option (a)		Option (b)		Option (c)	
	Percent	Interest	Percent	Interest	Percent	Interest
Government Investment	20 [1]	–	–	–	20	–
Loan A (grace period 10 years) [4]	40 [2]	i = 3%	40	i = 3%	40	i = 8%
Loan B (grace period 5 years) [4]	40 [3]	i = 12%	60	i = 12%	40	i = 15%
Repayable all loans by	2006		2012		non-payable	

Notes: 1. Equivalent to the percentage of right-of-way acquisition cost.
2. Equivalent to the percentage of foreign currency component.
3. Equivalent to the percentage of local currency component.
4. After the grace period, the repayment over twenty years for Loan A and ten years for Loan B.

3.8 Recommendations

(1) The Second Stage Expressway System is planned to form an inner ring expressway in the central urbanized area together with the First Stage Expressway System and to provide two trunk radial routes in the core area of the Greater Bangkok Area extending north and east. Thus, the development of the Second Stage Expressway System will not only strengthen the road network in the Greater Bangkok Area, but also greatly increase the use of the First Stage Expressway System.

(2) The implementation of the construction of the Second Stage Expressway System should be effected at the earliest possible date, before land acquisition and compensations become more difficult due to the extraordinarily rapid development of the urban area, especially within the ring formed by the expressways.

(3) Delay of implementation would entail increasingly difficult traffic management during construction due to increased traffic congestion in the existing road network and would result in increased construction time and cost.

(4) The construction of the Second Stage Expressway System requires a large investment. For this reason a staged construction program is recommended, commencing detailed

engineering design early in 1985 and completing the construction of the last priority segment in 1995.

(5) The priority for construction of the different segments of the Second Stage Expressway System should be as follows, from the viewpoints of land acquisition and compensation as well as by traffic demand (Table 6 and Fig. 3).

TABLE 6 CONSTRUCTION SEGMENT AND PRIORITY

Construction Priority	Construction Segment	Route
1	N–3 and E–1	N–S and East Routes
2	N–2	N–S Route
3	N–1	N–S Route
4	E–2	East Route
5	N–4 and N–5	N–S Route
6	E–3	East Route

(6) The adoption of a flat tariff system is recommended for the expressway network which comprises the First and Second Stage Expressway Systems. The recommended toll fare levels are shown in Table 7.

TABLE 7 RECOMMENDED TOLL FARE LEVELS

Fare at 1983 Prices

Applicable Expressway	Year	Toll Fare in Baht	
		Small Vehicle	Large Vehicle
First Stage Expressway System, 1st and 2nd Legs	1982–1987	10	20
Entire First Stage Expressway System and Second Stage Expressway System Segments Opened by Stage	1988–1995	15	25
Entire First and Second Stage Expressway Systems	After 1996	20	30

4. NECESSITY AND EFFECT OF THE PROJECT

4.1 Necessity of the Project

(1) To serve and maintain Greater Bangkok as a well functioned capital city, the development of the Second Stage Expressway System is urgently needed (Fig. 5). The result of the Study shows the following socio-economic growth by the year 2000 in the Greater Bangkok Area (Fig. 6).

- The estimated total urbanized area in 2000 is about 1.5 times that of 1982.
- Although the growth rate has been forecast to taper off somewhat in the future, the population is expected to continue to grow to 8.7 million by 2000; and

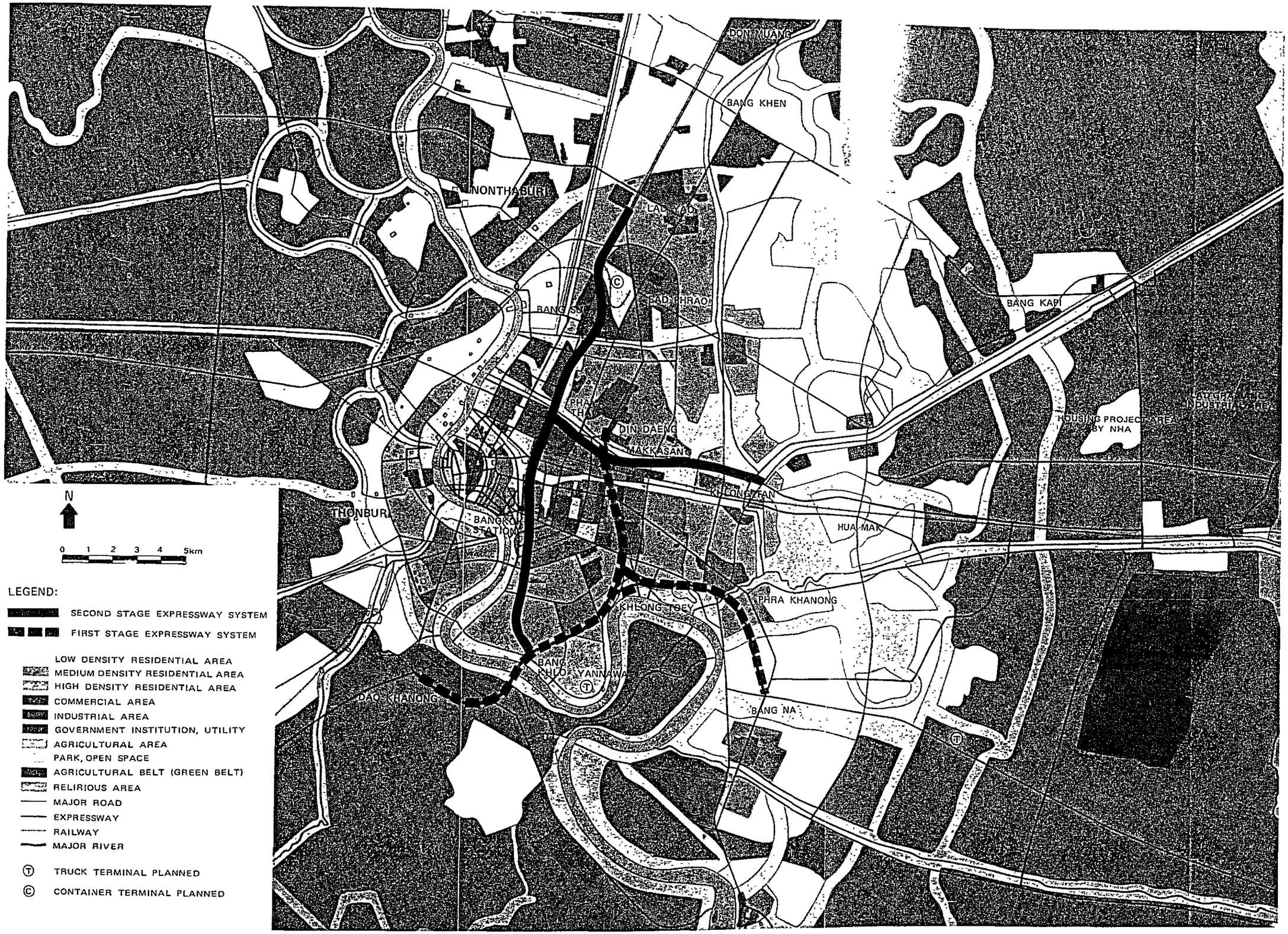


FIG. 5 FUTURE LAND USE AND EXPRESSWAY SYSTEMS

- The economy of the Greater Bangkok Area is characterized by the dominance of the tertiary sector. The gross product will expand from 133 billion Baht of 1982 to 280 billion Baht in 2000 in terms of 1972 prices.

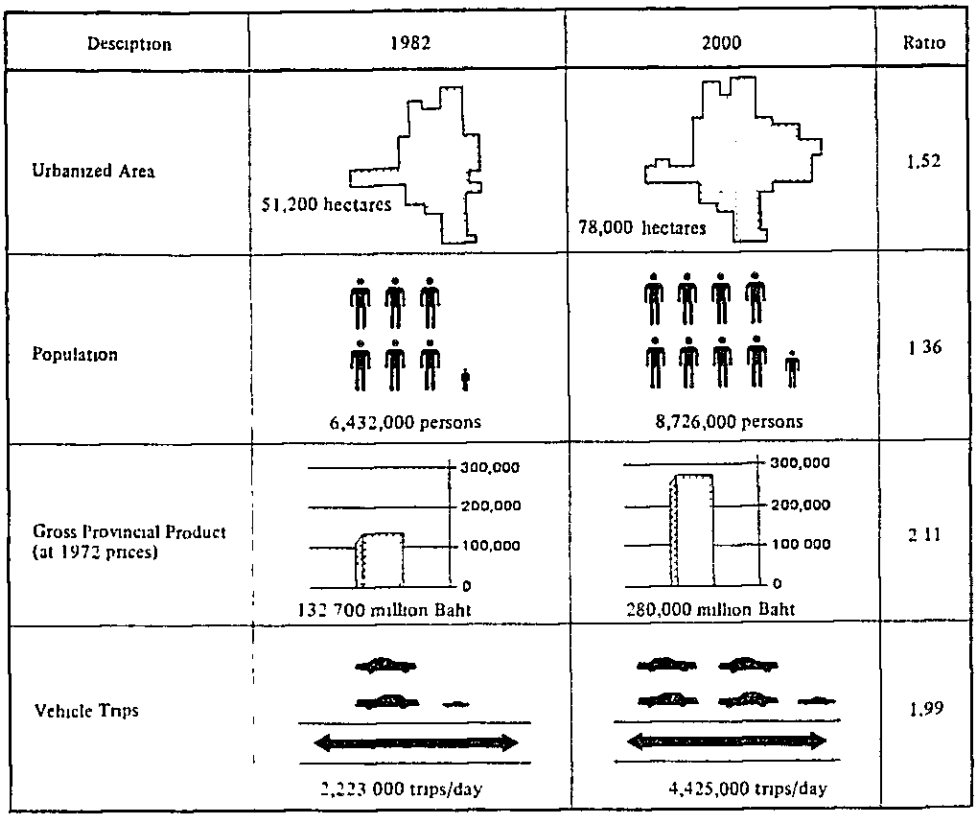


FIG. 6 CHANGES OF SOCIO-ECONOMIC AND TRAFFIC SITUATION IN THE GREATER BANGKOK AREA

(2) Planned as an integral part of the expressway network in the Greater Bangkok, the Second Stage Expressway System is expected to play the following important roles:

- Maintenance of urban activities by avoiding serious traffic congestions;
- Breaking a deadlock in road development which is facing a great right-of-way difficulty; and
- Supplement any to the function of the First Stage Expressway System and the Mass Transit System.

a) It is foreseen that a continued increase in the vehicular traffic demand will deteriorate further the traffic congestion on the roads which has already reached an intolerable level. Present and future traffic demand in the Greater Bangkok Area is summarized in the following table (Table 8).

TABLE 8 DAILY TRAFFIC DEMAND IN GREATER BANGKOK AREA

Items	1982	2000	2000/1982
Person trips ('000)	8,555	13,260	1.55
Vehicle trips ('000)	2,223	4,425	1.99

b) In parallel with the development of the First Stage Expressway System, the Government is promoting the strengthening of other road networks in the Greater Bangkok Area. However, a difficulty in right-of-way acquisition is a roadblock in the at-grade road network strengthening/development programme in urbanized areas.

c) The First Stage Expressway System is planned to link the major highways from the north, the south and the east to relieve the traffic congestion in Bangkok, with a total length of 27 km. However, this expressway system serves only a few corridors without giving access to other important parts of the Greater Bangkok Area. Under the increasing traffic demand in the area, the expansion of the expressway network within the framework of the Second Stage Expressway System is an urgent necessity.

4.2 Effect of the Project

(1) The development of the Second Stage Expressway System will improve the traffic condition in the Greater Bangkok Area, especially in its central urbanized area. Accordingly, the transport mobility and accessibility in the Greater Bangkok Area will be greatly improved.

(2) Since the Greater Bangkok Area is a population concentrated city, transportation services have a great impact on urban well-being, as well as on the national economic growth. The result of the Study revealed that the reduction of traffic costs would reach to approximately 14 million Baht a day by the year of 2000 (Table 9 and Fig. 7).

TABLE 9 OVERALL TRAFFIC COST

Cost in million Baht per day in 1983 prices

Items	1982 [1]	2000		
		With FES	With FES & SES	Ratio (3)/(2)
	(1)	(2)	(3)	(4)
Vehicle running cost	60.74	154.87	152 66	0.98
Passengers' time cost	12.30	68.05	56.33	0.83
Total vehicle operating cost	73.04	222.90	208.99	0.94

Notes: 1 Traffic cost in 1982 was simulated on the road network assuming that the Port-Bang Na section was already opened.

- FES : First Stage Expressway System
- SES : Second Stage Expressway System

(3) The Second Stage Expressway System will provide a vital portion of the expressway network in the Metropolis and distribute traffic around the area, preventing serious traffic congestion which would otherwise occur in certain radial and circumferential roads. There will be a reduction of 20% in vehicle-hours and an increase of 24% in average travelling speed if the Second Stage Expressway System is developed (Table 10 and Fig. 7).

TABLE 10 AVERAGE TRAFFIC SPEED AND AVERAGE EXPRESSWAY TRIPS

Items	1982 [1]	2000		
		With FES	With FES & SES	Ratio (3)/(2)
	(1)	(2)	(3)	(4)
Average traffic speed in GBA (km/hr)	38.3	22 4	27.7	1.24
Vehicle hours ('000 Hr/day) in GBA	571	2286	1871	0.80
Average expressway trips per day ('000)	76	269	594	2 20

Notes 1 Traffic demand in 1982 was simulated on the road network assuming that the Port-Bang Na section was already opened

- GBA Greater Bangkok Area
- FES . First Stage Expressway System
- SES Second Stage Expressway System

(4) Land use in the Greater Bangkok Area will be improved by the development of the Second Stage Expressway System, as inefficient concentrations can be decentralized and inefficient dispersions can be intergrated. Existing community overcrowding will be reduced by the growth of new communities promoted by investors and inhabitants in the Greater Bangkok Area and the establishment of better communities will enhance the comfort of the area.

Items	1982	2000		Ratio
	(1)	(2) with FES	(3) with FES & SES	(3)/(2)
Overall Traffic Cost (in 1983 prices)	Assuming Bang Na Section opened 73.0 million Baht per day	222.9 million Baht per day	209.0 million Baht per day	0.94
Average Traffic Speed	1 hr 38.3 km/hr	1 hr 22.4 km/hr	1 hr 27.7 km/hr	1.24
Average Express-way Trips	76,000 trips/day	269,000 trips/day	594,000 trips/day	2.21

FIG. 7 EFFECT OF THE PROJECT

5. GENERAL FEATURES OF THE SECOND STAGE EXPRESSWAY SYSTEM

5.1 Main Features

(1) The Second Stage Expressway System consists of the following two routes:

a) The North-South Route runs in a northerly direction for a route length of 19.2 km from the planned Dao Khanong-Port Section of the First Stage Expressway System to the national road No. 31; and

b) The East Route of 8.7 km length runs easterly from the connecting point with the North-South Route to Phra Khanong-Bang Kapi road.

(2) Both of these routes are inter-related and are indispensable to the expressway network in the Greater Bangkok Area. A part of the North-South Route and the initial stretch of the East Route are intended to compose an integral part of the ring expressway which together with the Din Daeng-Port-Bang Khlo section of the First Stage Expressway System will serve the central urbanized area of Bangkok.

The Expressway is planned to be 6 lanes except for a stretch between the Middle Ring Road and the terminus of the North-South Route where 4 lanes are planned (Fig. 8).

5.2 Supporting Facilities

(1) Toll Collection Facilities

The First and Second Stage Expressway Systems will be operated adopting the flat tariff and on-ramp toll collection system. The locations of the on and off ramps have been determined as shown in Fig. 4.

Toll gate structures, refuge islands, toll booths, toll buildings and equipment installation in each booth and toll buildings are included in the cost.

(2) Expressway Lighting and Other Electrical System

Scope of application in the Project covers the following locations and facilities:

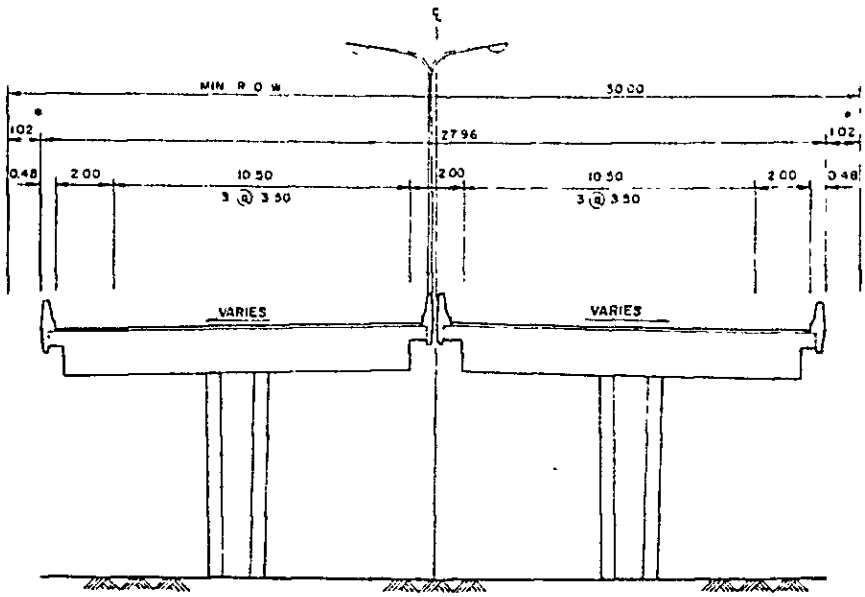
- Throughways of the Expressway;
- Interchanges including rampways, and through lanes and at-grade intersections;
- On-off ramps including toll plazas;
- Toll building interior lighting;
- Subsystems such as closed circuit TV system, signs, control system, etc.; and
- Emergency power units for the toll buildings and other facilities (i.e. pump station for the undercrossing structure).

(3) Traffic Control System and Traffic Signs

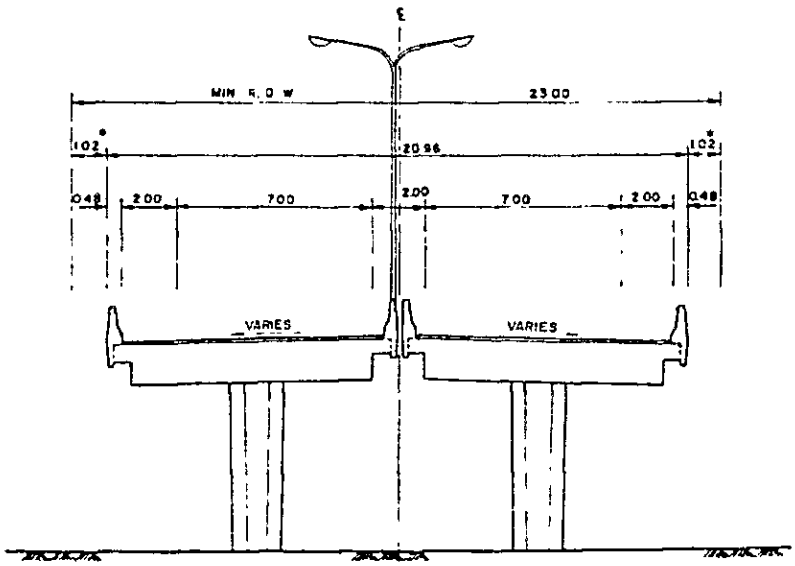
The following systems are provided for the Expressway·

- Closed circuit TV network for the surveillance of traffic;
- Emergency telephones installed on the roadside of the Expressway at 1 kilometer interval;

6–LANE ELEVATED EXPRESSWAY



4–LANE ELEVATED EXPRESSWAY



NOTE: The figures with asterisk show absolute minimum values. They shall be substituted by 5 meters of desirable minimum values to provide set back distance where the viaducts are planned within the row of the existing or planned streets.

FIG. 8 TYPICAL CROSS SECTIONS OF THE EXPRESSWAY

– Variable traffic signs (i.e. matrix sign) and guide signs (refer to discussions presented below); and

– Traffic detectors installed at each toll plaza and on the through traffic lanes.

When a traffic jam occurs in the expressway the result is more serious compared with the case of the arterial street, since the expressway system is not able to cater readily for detour or route change for the vehicles which are already driven thereon.

By the time the expressway network has the addition of the SES, it is expected that traffic demands would be considerably jumped up. Thus, it would become urgent to prevent the deterioration of the service level of the expressway. In case of the expressway system, the countermeasures for the above are provided frequently by means of strict traffic regulations such as booth control and the closure of critical on-ramp(s).

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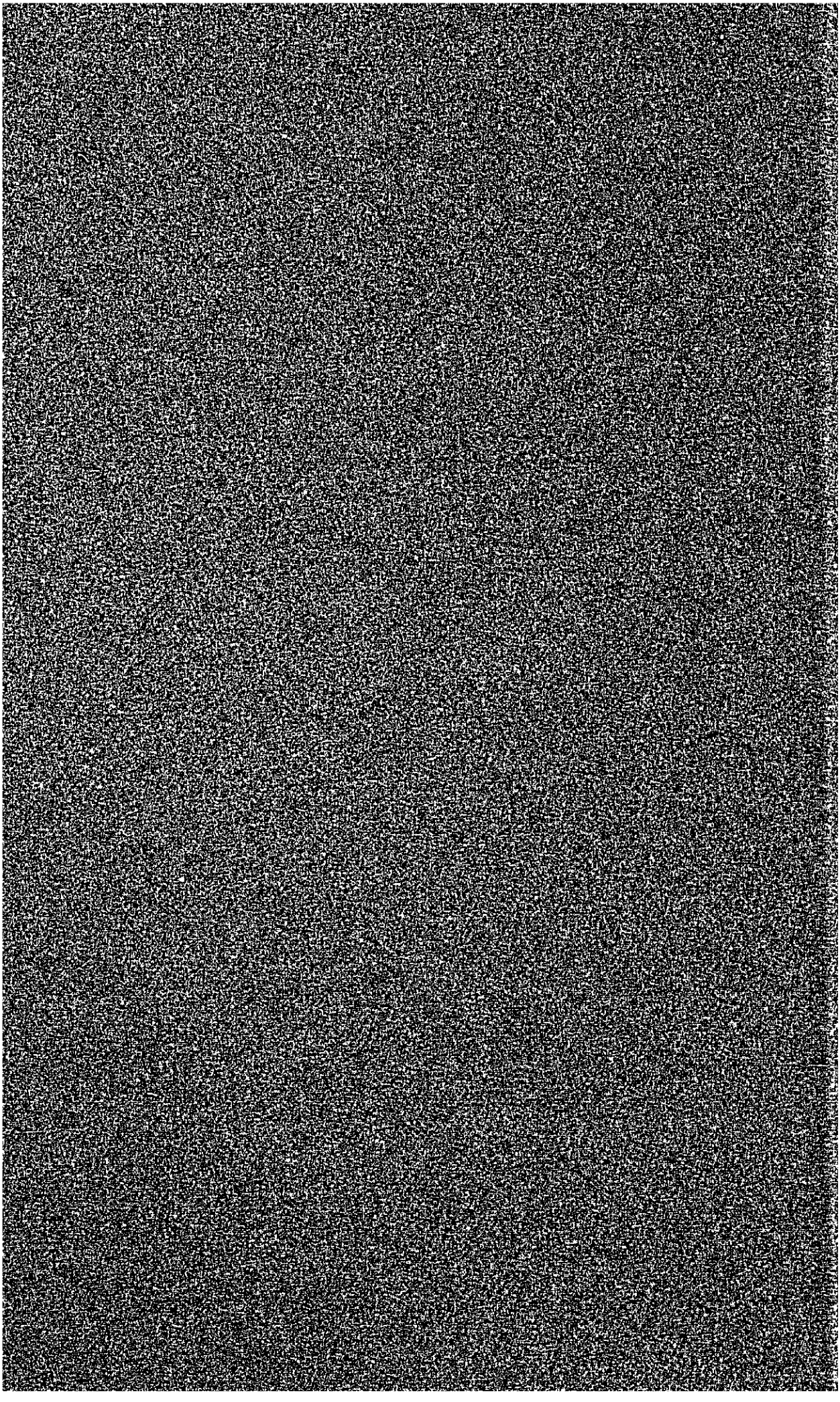

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