9.16.6 Run-off

(1) General

The provision of adequate drainage for roads is extremely important for the maintenance of the roads and their traffic safety. The areas where attention must be directed can be categorized as follows:

- Surface water drainage: rainwater on the pavement surface, embankment slope and other surfaces within the limits of the ROW.
- Adjacent territory drainage: rainwater on the fields, grass land and inhabited areas outside the limits of the ROW, which will affect the roads.
- Water openings for rivers and water courses (Khlong) which the roads will have to cross.

(2) Run-Off Estimation Method

Estimates of discharge volume for each drainage system was made by using the rational formula.

The rational formula is expressed as follows:

$$Q = \frac{1}{3.6} \times C \times I \times A$$

where: Q = Run-off in cubic meters per second
C = Coefficient representing the ratio run-off to rainfall,
I = Intensity of rainfall, in millimeters per hour for the estimation time of concentration,
A = Drainage area in square kilometers.

(3) Run-Off Coefficient

In estimation the run-off coefficient, a variety of geological and ground conditions will be taken into consideration for each drainage area in view of the major differences that can exist between one area and another. The values thus determined are listed below.

Type of Drainage Area	Coefficient of Run-Off, "C"
Road surface (paved)	0.95
Embankment slope	0.35
Grass land	0.30
Paddy field	0.70
Cultivated field	0.20
Inhabited area	0.60

(4) Rainfall Intensity

Rainfall intensities are determined from the rainfall intensity-duration curve for each frequency of the occurrence of excessive rainfall prescribed in Subsection 9.4.4 Drainage Design Standard.

9.16.7 Hydraulic Design Principles and Study Results

(1) Roadway and Roadside Drainage

Rainwater which falls on the roadway flows laterally or obliquely from it, under the influence of the cross slope or superelevation on the carriageway and shoulders. When the roadway section lies on fill, an economical practice is to let the flow continue off the shoulder and down the side slope to the side drain or ditch. Little erosion results if the slopes are protected by sodding and if the water flows across the roadway and down to the slope as a uniform sheet. Dimensions, slopes and other characteristics of these ditches are determined by the flow to be accommodated.

The drainage systems which are applied to the elevated tollway are combination of inlets, downspouts, underground storm sewers with manholes and existing khlongs. The existing khlongs are utilized as the main drain facilities of the total system.

(2) Hydraulic Design of Culvert

The purpose of hydraulic design is to determine the type and size of culvert that will most economically accommodate the flow of the design discharge. In almost all cases, the primary control is the permissible level of the head water pool at the upstream side of the structure.

(3) Discharge Capacity

Manning's formula is used to calculate the mean velocity and discharge capacity of each waterflow in open channel or pipe or box culvert.

9.16.8 Flood Stage and At-Grade Expressway Grade Level

(1) General

The topography of the project area is very flat and the attitudes are ranging from 1 meter to 2 meters above mean sea level. Consequently, the predominant areas of the East and N-S corridors are subjected to periodic flooding.

Embankment is needed for at-grade expressway sections. The problems of the settlement and stability in constructing high embankment on the soft clay areas are deemed to be very serious. Thus, the study of the determination of the optimum grade level of the Expressway was made to avoid the rapid and severe deterioration of the Expressway due to the frequent inundation of the pavement structure.

(2) Design Flood Stage

The flood in the project area is characterized by the fluvial flood in combination with tidal effects. The probable flood stages – frequencies of the Chaophraya River between Pak Nam and Bang Sai area are presented in Fig. 9–24.

As a check on the actual flood situation at the embankment locations, the site investigations were carried out. The past flood marks were investigated and obtained data were confirmed with the residents at the site by interview. Table 9–25 shows the results of the site investigations.

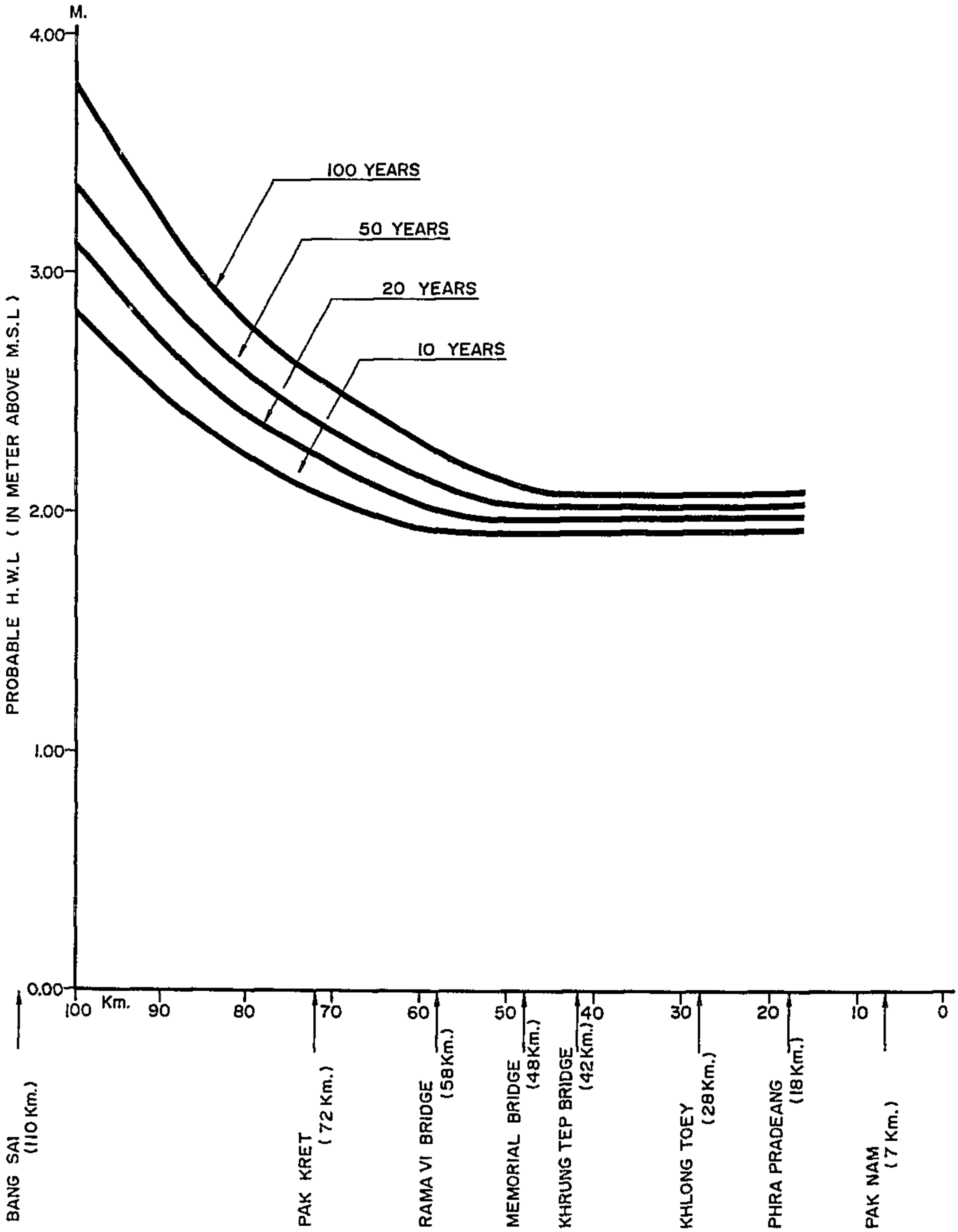


FIG. 9-24	PROBABLE FLOOD STAGES BETWEEN PAK NAM AND BANG SAI

THE SECOND STAGE EXPRESSWAY SYSTEM IN THE GREATER BANGKOK

TABLE 9–25 SURVEYED FLOOD STAGES AT EMBANKMENT SITES

Route	Station	Annual Flood Stage (above MSL)	Maximum Flood Stage (above MSL)
East Route	8 km + 000	1 3 ~ 1.5 m	1.5 ~ 1.8 m
	8 km + 800	1.4 m	1.7 ~ 1.9 m
N-S Route	2 km + 300	1.5 m	1.7 ~ 1.8 m
	2 km + 400	1.4 m	1.7 m

Based on the forthcoming study and survey results, and neglecting the effects of recent or future flood control measurements, the design flood stages as shown in Table 9–26 were proposed for the preliminary engineering design purposes.

TABLE 9–26 DESIGN FLOOD STAGES AT EMBAKMENT SITES

Route	Station	Design Flood Stage (above MSL)
East Route	8 km	+ 2.00 m
N-S Route	2 km	+ 1.90 m

(3) Proposed Finished Grade of the At-Grade Expressway

A minimum freeboard of 50 cm above the design flood stage was considered for the determination of the finished grade of the Expressway. The provision of the freeboard aims at prevention of the deterioration of pavement strengths by the infiltrated water.

Table 9–27 shows the suggested optimum initial finished grade of the Expressway.

TABLE 9–27 FINISHED GRADE OF AT-GRADE EXPRESSWAY

Route	Station	Design Flood Stage (above MSL)	Freeboard	Crossfall and Profile	Proposed Finished Grade (above MSL)
East Route	8 km	+ 2.00 m	0 50 m	0.5	+ 3.00 m
N-S Route	2 km	+ 1.90 m	0.50 m	0.5	+ 2.90 m

9.16.9 Drainage Study of the Victory Monument Undercrossing

(1) Run-Off Calculation

Estimated discharge at the pump station will be, based on the rational formula, as follows:

$$Q = \frac{1}{3.6} \times C \times I \times A$$

where: Q = Run-off in cubic meters per second;
C = Coefficient representing the ratio run-off to rainfall = 0.95;
I = Intensity of rainfall, in millimeters per hour for the estimation time of concentration = 101.5;
A = Drainage area in square kilometers = 0.023.

Therefore,

$$Q = \frac{1}{3.6} \times 0.95 \times 101.5 \times 0.023 = 0.62 \ m^3/sec.$$

$$= 37.0 \ m^3/min \text{ (25-year frequency at 1.0 hour concentration time)}$$

(2) Pump Units and Power Requirement

A sump pit will be provided at the low point of the undercrossing structure. The following centrifugal pump units will be required together with an emergency diesel engine generator set.

Number of pump unit	: 3 (including 1 – stand by pump unit)
Capacity of each pump unit	: 18.5 m^3/min
Total head	: 11 m
Power requirement	: 55 kw per each unit

(3) Sump Pit

The capacity of the sump pit is calculated to be about 90 m^3. A drywell shall be combined with the sump pit as shown in Fig. 9–25. A submerged sump unit (i.e. 80 mm bore and 5.9 kw) is also be installed for the maintenance purposes.

(4) Equipment List

The following equipment complete with the required piping with valves and fittings, controls and electrical/control wiring should be provided in the system:

- 3 units of main pumps (each pump unit with 400 mm bore, 18.5 m^3 per minute discharge capacity, 11.0 m total head and 55 kw motor drive unit);
- 1 unit of sump pump (80 mm bore, 0.6 m^3/min discharge capacity and 15.0 m total head including 5.7 kw motor drive unit);
- Operation panel;
- Electric power receiving panel;
- Transformer unit; and
- Emergency diesel engine generator unit.

(5) Control Housing and Outfall Pipe

The control housing installed with various panels and transformers and emergency power units should be provided in the vicinity of the under-crossing keeping enough clearance above the maximum flood water surface.

The outfal pipe (500 mm ϕ stand pipe) should be connected with the planned concrete box culvert (i.e. relocation of existing storm drainage system) which is leading to the Khlong Sam Sen.

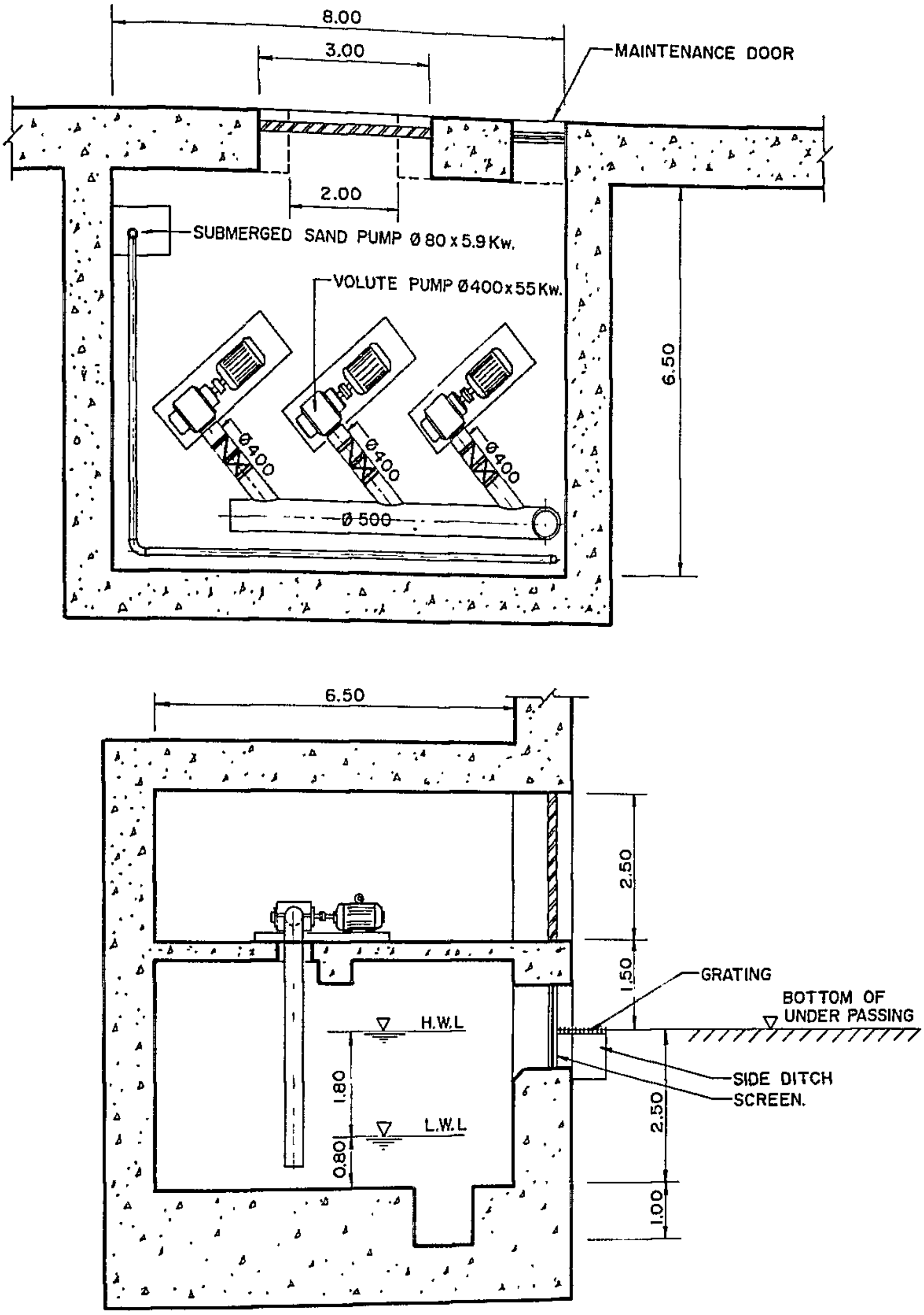


FIG. 9-25

OUTLINE PLAN OF PUMP STATION

THE SECOND STAGE EXPRESSWAY SYSTEM IN THE GREATER BANGKOK

9.17 Expressway Lighting and Other Electrical Systems

9.17.1 General

The objective of the provision of lighting facilities is to reduce the number of traffic accidents occurring during the hours of drakness. By providing lighting, it will also make the tollways more attractive to potential users.

9.17.2 Scope of Application

The provision of the lighting installations in this project covers the following locations and facilities:

- Throughways of the Expressway;
- Interchanges including ramps and through lanes and at-grade intersections;
- On-off ramps including toll plazas;
- Toll building interior lighting;
- Subsystems such as CCTV, signs, control systems, etc; and
- Emergency power units for the toll buildings and other facilities.

9.17.3 Design Standards of Expressway Lighting

The following design standards were considered in the Study:

- Informational guide for roadway lighting, American Association of State Highway and Transportation Officials (AASHTO); and
- Design standard for road lighting facilities, Ministry of Construction, Japan.

9.17.4 Design Illumination Intensities of the Expressway

The average intensities of illumination used in the design of the installations are as follows:

- 25 lux for the throughways;
- 25 lux for the interchanges and rampways; and
- 40 lux for the toll plazas.

These average intensities of illumination are provided by high pressure sodium lamps, each 250–400 watts.

Above features are determined based on the lighting standards already being implemented in the FES.

9.17.5 Design Features of the Expressway Lighting and Emergency Power Unit

(1) Selection of Luminaires

The types adopted are as follows:

ADOPTED TYPES OF LUMINAIRE

Location	Luminaire
Throughways	Cut-off Type
Rampways	– ditto –
Toll Plaza	Flood light or Cut-Off Type

(2) Light Source

The light sources, because of the long lighting time, the large area to be illuminated and the need to minimize maintenance require long life, high stability, high efficiency and a large capacity.

At present, three types of lamps are considered to be suitable.

– Fluorescent mercury vapor type;

– Low pressure sodium type; and

– High pressure sodium type.

The use of the high pressure sodium lamp for the light source is recommended for the following reasons:

– High efficiency;

– Long average life; and

– In keeping with existing installations.

(3) Ballasts

The ballasts for the high pressure sodium lamps are the lead peak type.

(4) Lighting Columns

The mounting position and heiht of luminaires are determined by the degree of road surface luminance required and the glare tolerated by drivers. In order to keep the level of glare low, the more powerful the light source, then the higher it must be generally from the road surface. The height and spacing of the columns are clearly interdependent. The type of lighting columns recommended is shown in Table 9–28.

TABLE 9–28 RECOMMENDED TYPE OF LIGHTING COLUMN

Location	Column Height (m)	Overhang (m)	Slope Angle (degree)	Standard Spacing (m)
Throughways	11	2.5	5	39
On/Off Ramps	9 ~ 10	2.0	5	–
Toll Plaza	14	–	–	–

(5) Toll Plaza Lighting

The maintained illumination level for the toll plazas is 40 lux as mentioned before. Flood lighting luminaires of 14 meter height with colour improved mercury vapor lamps will be used to light the toll plaza. This lamp has been selected instead of the high pressure sodium lamp because of its better colour rendering for the following reasons:

- The area is rather hazardous since drivers are required to maneuver the vehicles more carefully (i.e. change of lane, deceleration and acceleration for the transient stop at the booth, etc.);
- Easier identification of the vehicle classes by the toll collectors and staffers; and
- Easier identification of paper moneys.

(6) Toll Building Lighting and Emergency Power Supply

The toll building will be provided with fluorescent lighting with the similar illumination levels to the existing toll buildings.

The voltage of the system will be 220/380, 3 phase, 4 wire 50 hz. An emergency diesel generator set will be porovided for full power requirement for the toll plaza facilities including exterior lighting of the immediate toll booth area.

(7) Lighting Facilities for Traffic Signs

The guide sign boards are planned to light up based on road user visibility requirements. Light source for the guide sign boards lighting uses fluorescent lamps. The ballasts for fluorescent lamp are of correct lamp wattage type.

The lighting fixtures are installed to light up the sign boards. Lighting fixtures for the sign boards shall be firmly fixed on the mounting pole or gantry frame.

9.18 Traffic Control System

9.18.1 General

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.

Under these conditions, where the smooth traffic flow is interrupted, it is difficult to maintain the function of the expressway which would aim a high speed, high efficiency and greater user's benefit.

Thus, it is indispensable to provide the traffic control system for the maintaining of proper traffic conditions at all times aiming such goals as:

- Prevention of user's extra travelling time or distance;
- Maintenance of the safety and comfort or convenience; and
- Prevention of deterioration in traffic capacity of road network as a whole.

The first step of the provision of traffic control system is to provide the detecting system for the traffic surveillance, and then to establish the optimum system in order to cope with the varied situations.

In the broad terms, the problem of traffic control system normally involves organization, expressway patrol systems, traffic surveillance, enforcement of traffic regulations, and the provision of various traffic control devices, equipment and supporting facilities.

However, this study will mainly deal with the core systems which seem to require some improvement in the frameworks of the SES project.

The emergency telephone system and traffic control devices are discussed separately in other sections of this report.

9.18.2 Evaluation of Existing Traffic Control System

(1) Organization

In the organization of the ETA, the Safety Rescue and Traffic Control Section (SRTCS) is established under the control of the Operational Division. The SRTCS is responsible to the traffic management of the expressway in cooperation with the Police Department.

The traffic management, according to the ETA's regulation, consists of traffic surveillance, enforcement of traffic regulations and traffic control together with the management of accidents which also includes the rescue of disabled cars.

(2) Existing Traffic Control Facilities and Equipment

The existing traffic control center is located in the ETA's Expressway System Control Center in the Port Interchange Area.

The existing traffic control system has made the use of the following components:

- Closed circuit TV network (i.e. CCTV and monitoring TVs are set at interchanges, main toll plazas and the important points on the expressway) for surveillance of traffic;
- Emergency telephones installed on the roadside of the expressway at 1 kilometer interval;
- Variable traffic signs (i.e. matrix sign); and
- Traffic detectors installed at each toll plaza.

Information of traffic conditions of the expressway is collected by traffic detectors, CCTV, ETA traffic assistants, and ETA or police patrol units. The communication operator upon receipt of information will deliver instruction and other message from the traffic control center to the matrix sign, toll gates, police cars or motor cycles, fire engines, ambulances, ETA's patrol cars and the traffic assistants.

Fig. 9–26 shows the schematic diagram of the existing traffic control system.

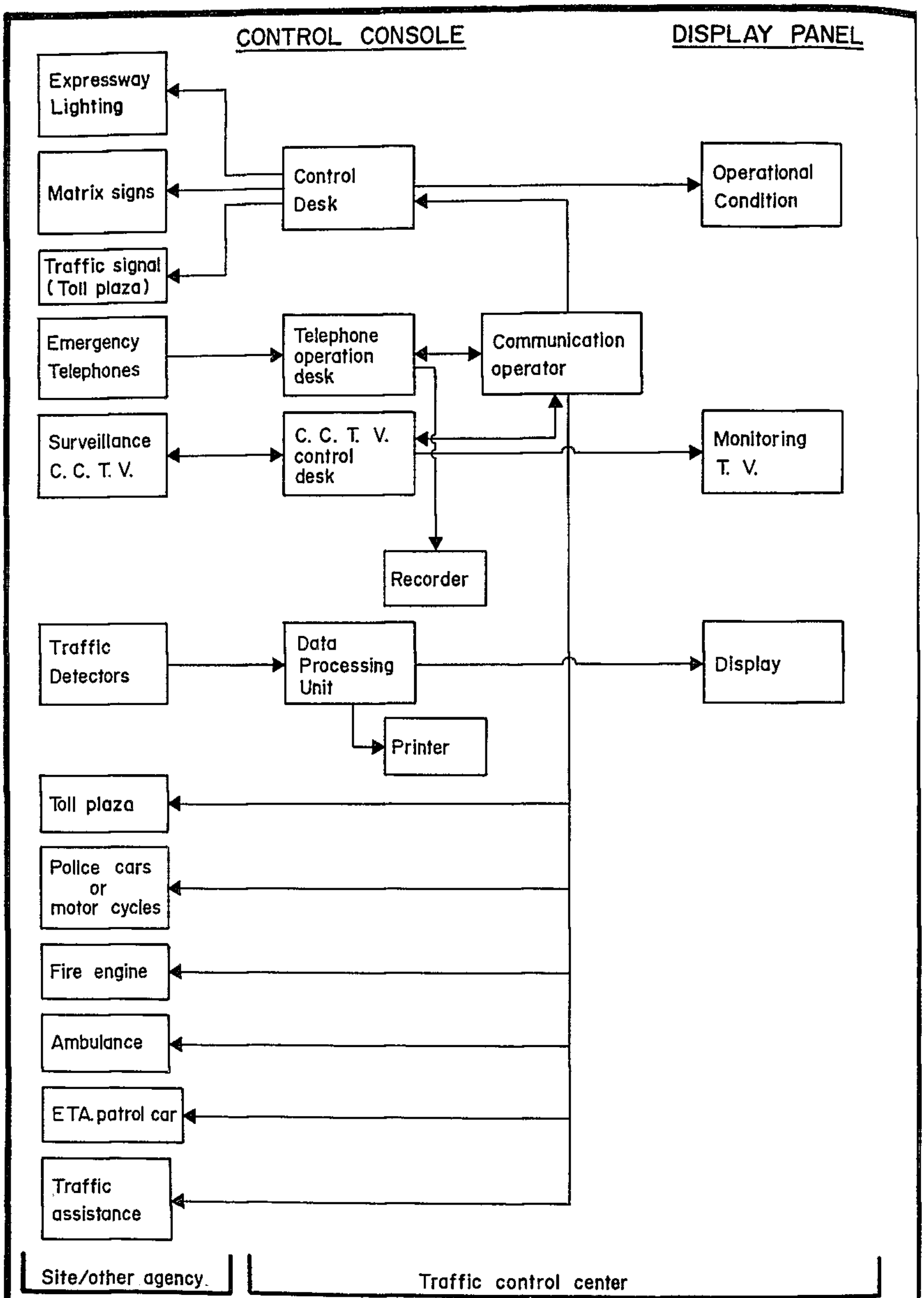


FIG. 9-26

SCHEMATIC DIAGRAM OF EXISTING TRAFFIC CONTROL SYSTEM

THE SECOND STAGE EXPRESSWAY SYSTEM IN THE GREATER BANGKOK

9.18.3 Recommendations

(1) CCTV System

CCTVs are installed for the purpose of rapid detection of the changes in traffic situations. The information are transmitted to the monitoring TVs set in the traffic control center so that critical spots can be viewed on TV screens by calling them from the TV operating desk.

The concept of existing CCTV system in the FES can be kept unchanged and be applied to the SES. The expansion work in the SES project would comprise also the strengthenning of the present system in the FES providing additional CCTVs. Thus, the new surveillance system comprising the FES and SES would provide the uniform, up-graded and effective network.

The recommended locations of the CCTVs are as shown on Fig. 9–27. The supporting system in the traffic control center should be expanded accordingly.

(2) Traffic Detecting System

Presently, loop type traffic detectors are installed at each on-ramp. The traffic volume by type of vehicle are detected and the data are sent to local processing unit which is set in toll plaza administration office. The information is further transmitted to the traffic control center to totalize the traffic volumes.

The existing traffic detecting system is utilized mainly for the checking of the collected toll fares. However, as the traffic volume in the expressway increases the necessity of other functions would be required to the system. Such functions would include:

- Analysis of trafic flows on the expressway;
- Forecast of the possible traffic congestion (i.e. location and congestion level); and
- Control of traffic signals and variable type information indicators (i.e. matrix signs).

It is recommended that the loop type traffic detectors should be provided on the through traffic lanes in addition to the detectors to be provided at each on-ramp. The proposed locations of the detectors are shown on Fig. 9–28.

The traffic flow directed towards areas of congestion should be controlled by the new type of matrix signs (refer to subsection 9.21.4) before on-ramps thus encouraging drivers to voluntarily keep away from congested points when necessary.

(3) Summary of the Recommended Functions of Upgraded Traffic Control System

Recommended functions of traffic control system after the upgrading are shown in Fig. 9–29 and Table 9–29.

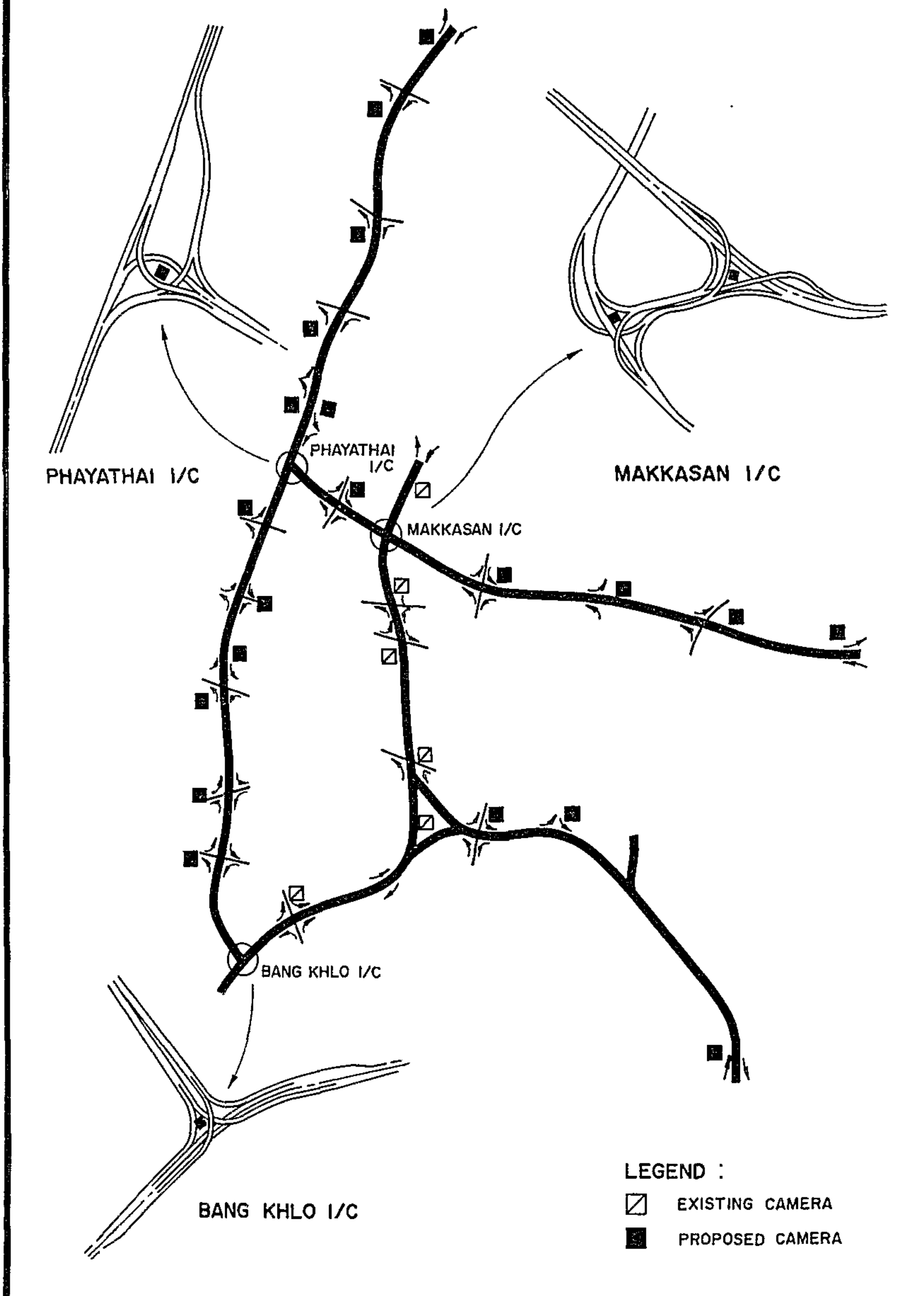
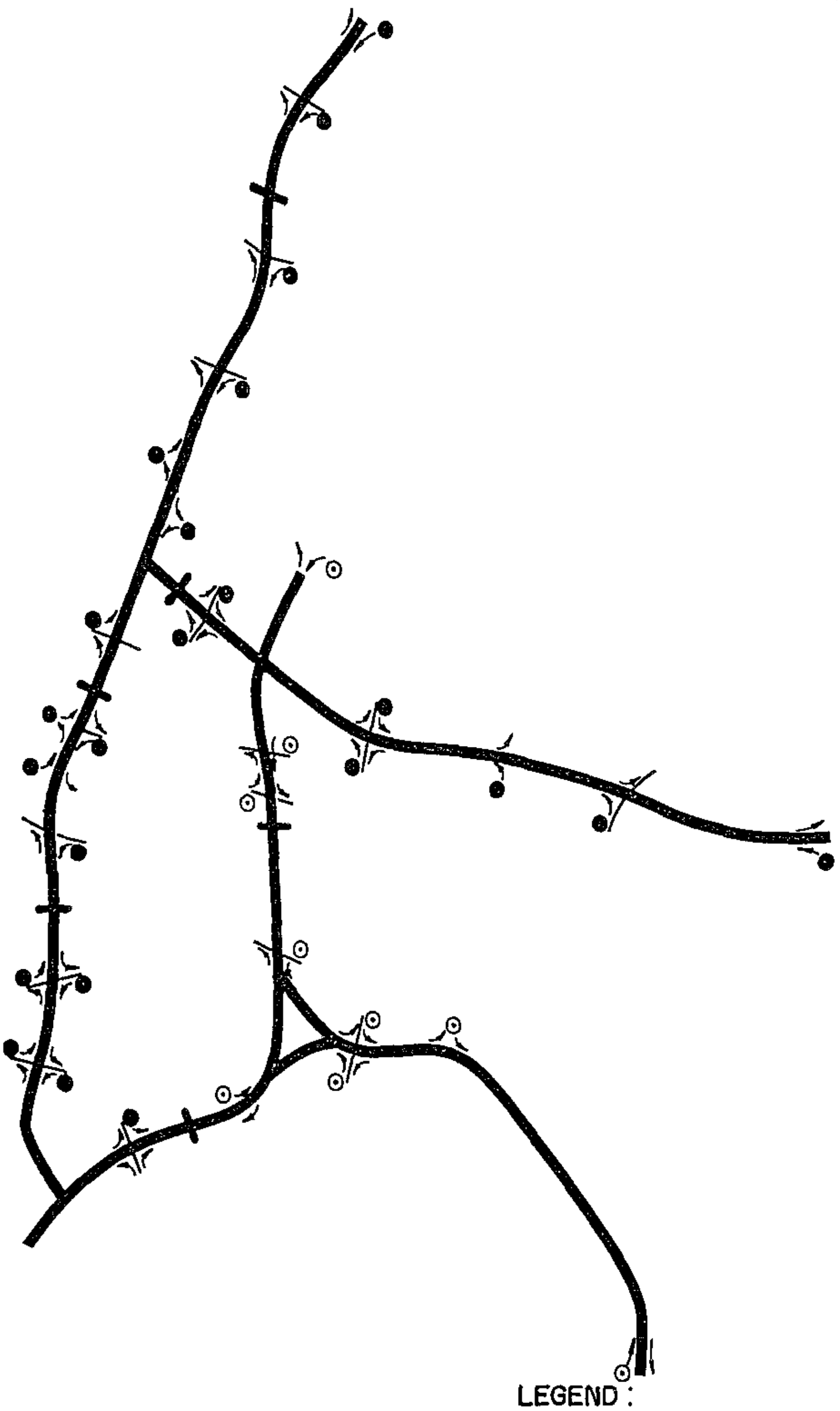


FIG. 9-27 PROPOSED LAYOUT PLAN OF C.C.T.V CAMERA

THE SECOND STAGE EXPRESSWAY SYSTEM IN THE GREATER BANGKOK



LEGEND :

- ● PROPOSED LOCATION OF TRAFFIC DETECTOR
- ⊙ EXISTING TRAFFIC DETECTOR AT ON-RAMP
- ▬ PROPOSED LOCATION OF TRAFFIC DETECTOR ON THROUGH TRAFFIC LANES

FIG.9-28	PROPOSED LAYOUT PLAN OF THE TRAFFIC DETECTOR

THE SECOND STAGE EXPRESSWAY SYSTEM IN THE GREATER BANGKOK

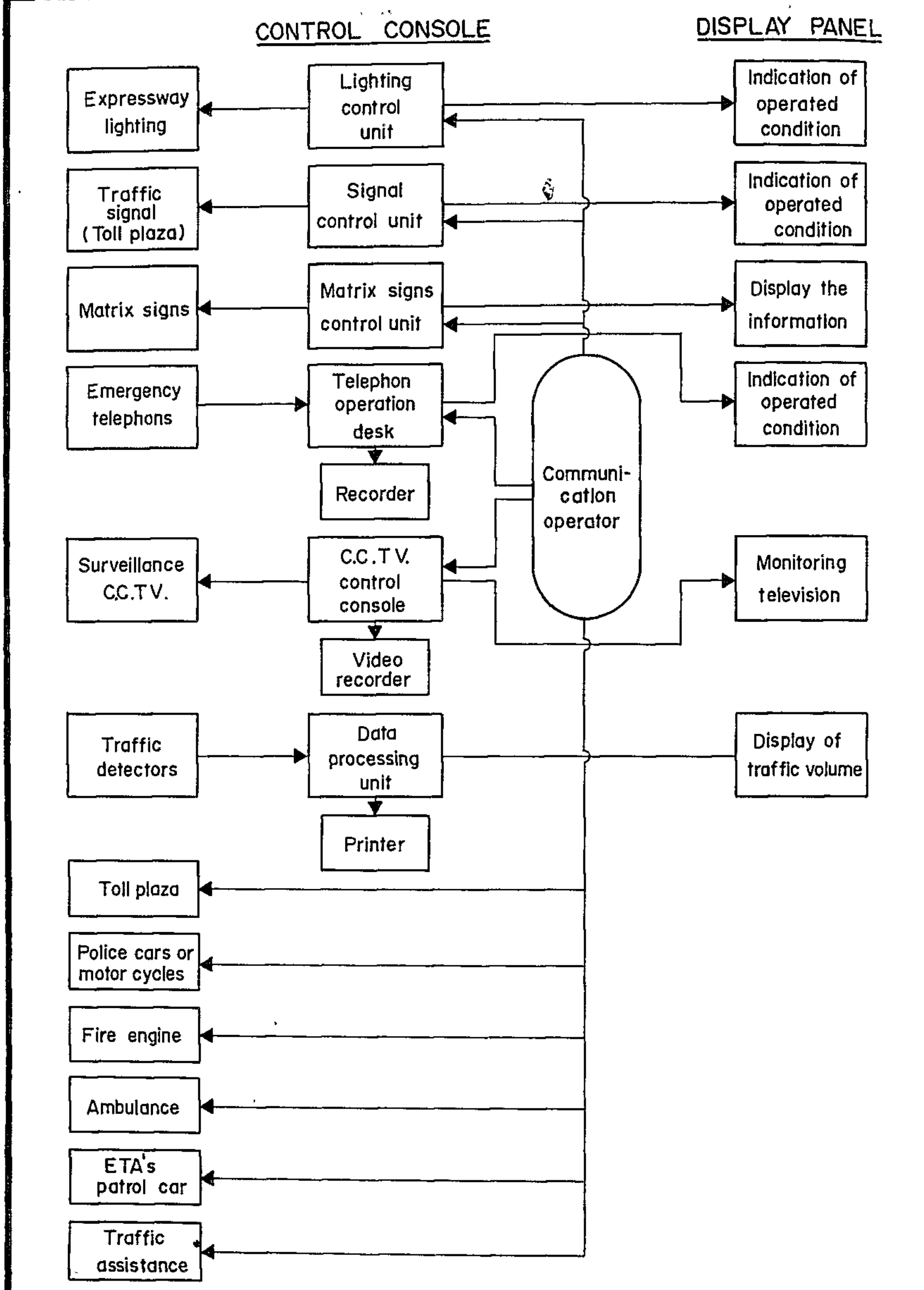


FIG. 9–29 SCHEMATIC DIAGRAM OF RECOMMENDED TRAFFIC CONTROL SYSTEM

THE SECOND STAGE EXPRESSWAY SYSTEM IN THE GREATER BANGKOK

TABLE 9–29 OUTLINE OF THE RECOMMENDED TRAFFIC CONTROL OPERATION

Facilities	Local Operation	Operation at Traffic Control Center		
		Control Console	Data Processing Unit	Display Panel
Expressway lighting	Controlled mainly at site automatically by the timer or photo cell	Subsidiary control	–	On/Off indicator lamps
Traffic signals at toll gate	Subsidiary control	Control mainly by the Operator	–	Indicate operated phase
Matrix signs	Subsidiary control	Control mainly by the Operator	–	Indicate displayed information by letters on the panel
Emergency telephones	–	Communication with the Operator and record the correspondence automatically	–	Indicate operating mode by flickered lamp
Surveillance CCTVs	Subsidiary control with the local control unit installed at the toll building	Control mainly by the control unit and record the selected video with the time information	–	Monitor the TV screeens
Traffic detectors	Install at each on-ramp and specified point on throughway	–	Process the data utilizing softwares automatically	Display forecasted traffic volumes digitally

9.19 Emergency Telephone System

9.19.1 General

Whenver car-accidents or breakdowns occur in the Expressway, the emergency telephones installed on the roadside of the Expressway are used by the users to obtain assitance and warn the tollway control center.

9.19.2 Evaluation of Existing Emergency Telephone System

Presently, terminal telphones are installed on the roadside of the expressway at 1 kilometer interval. Each terminal telephone is directly connected with the operation console desk in the expressway system control center by the private telephone line.

The operation console desk is further linked with adjacent police station by the private telephone line. This desk is also linked by radio communication with patrol cars for the emergency services.

9.19.3 Recommendations

The scope and design features of the emergency telephone system of the SES should conform to the current system since no inherent disadvantages or inconveniences to the existing system are to be found.

9.20 Toll Collection System

9.20.1 General

The study purpose is to outline the comprehensive toll collection system which should cover the FES and SES. For this purpose a study of the necessary constructions and furnishing equipment required for the system have been made after the evaluation of the existing system.

9.20.2 Evaluation of Existing Toll Collection System

(1) Organization

There are 10 toll plazas for the FES (Din Daeng-Port-Bang Na Expressway).
The operation of toll collection is divided into four levels of responsibility as follows:

1st Level (Toll Collecting)

Toll collecting has been carried out by collectors. Collectors are responsible for the cash they collect and are accountable for it.

2nd Level (Supervision of the Toll Collecting Operations, and Running of the Plazas)

- Supervisor is responsible for the constant supervision of all booths through the control board and visual observation in the barrier type toll plaza; and
- Chief Collector is responsible for the handling of collected toll, in most cases handing over the money to the bank, and the management of the plaza staff.

3rd Level (Management of Toll Plazas)

Management of toll plazas is carried out by a Plaza Chief who is in charge of a main toll plaza or several on-ramp type toll plazas.

The function of a Plaza Chief is to plan and decide the followings based on the traffic data:

- The number of lanes to be opened on different days and different times of day; and
- The number of staff needed to maintain these lanes.

4th Level (Administering of the Toll Collection Section)

The operation of the above mentioned activities is controlled under the responsibility of a chief of Toll Collection Section. He is in charge of the administrering of the Toll Collection Section.

(2) Existing Toll Collection System

There are 10 toll plazas in the FES. The schematic diagram of the existing toll collection system is as shown on Fig. 9–30.

Presently, the ETA adopts the flat rate system. This system is considered to be appropriate because the average travel distance is comparatively short and it reduces the service time at the toll booths.

The vehicle classification and corresponding current toll fares are as listed in Table 9–30.

TABLE 9–30 CLASS OF VEHICLE AND TOLL RATE

Class	Vehicle	Toll Rate
1	Private car and taxi (4 wheels)	10
2	Pick up and mini bus (4 wheels)	10
3	Truck (more than 4 wheels)	20
4	Large vehicle such as trailer	20
5	Unused	–
6	Truck (more than 4 wheels)	20
7	Bus (more than 4 wheels)	20
8	Bus (more than 4 wheels)	20
9	Exempt vehicle (with pass)	–
10	Exempt vehicle (without pass)	

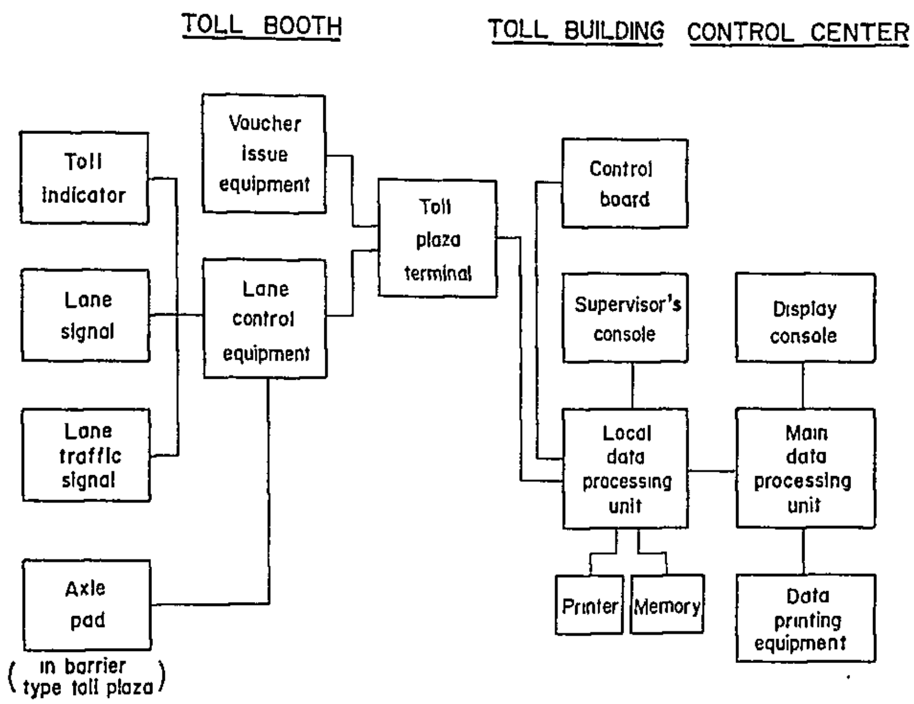


FIG. 9–30 FLOW DIAGRAM OF TOLL COLLECTION SYSTEM

Existing toll collection services are commended in 1981 for the Din Daeng-Port Section and in 1982 for the Bang Na-Port Section. The up-to-date equipment such as data processing units and micro computers are provided. It is observed to be no major functional problem in the current mechanism of the system.

9.20.3 Toll Collection Facilities in the SES

The location of the toll gates has been determined and is as shown in Fig. 9–7.

The pavement construction and lighting for the toll plazas are also included in the general tollway cost estimates for this study and the typical general arrangement of the toll plazas is shown in the DRAWING.

(1) Scope of Toll Plaza Works

Each toll plaza consists of the work items shown below;

- Toll gate structure including pillars and roof structure;
- Refuge islands;
- Toll booths;
- Toll building structures; and
- Equipment installation in each booth and toll building.

(2) Design Features of Toll Plaza

Taking account of the future toll structure (i.e. flat tariff system) and the performance of the present system, the similar types of existing facilities would be provided in the SES project.

a) Roof Structure

A roof structure to cover the toll booths and collection area is needed for protection from the weather. The roof and the supporting pillars for the roof structure will be made of permanent construction materials.

b) Refuge Island

The refuge island is needed to provide a foundation for the toll booth and protection from approaching vehicles. Drawpit and air ducts are installed to provide the air condition system for each toll booth.

c) Toll Booth

The toll booth is used as a space for toll collection. The booth structure is prefabricated unit.

d) Toll Building

The toll building is provided mainly for the supervision of the toll collecting operations and consist of the following floor plans:

- Control room with supporting office spaces (i.e. manager, secretary and recording);
- Security and lobby;
- Counting security;
- Security van;
- Service and cafeteria;

- Locker rooms; and
- Emergency generator room

e) Equipment and Devices in the Toll Plaza

The following equipment and devices will be provided in the toll plaza:

- Signal system for traffic lane control in the toll plaza area;
- Toll collection devices such as voucher issue equipment, fare display and vehicle detector, all provided in the toll booth;
- Vehicle weighing devices in the barrier type toll gate;
- Local data processing unit in the toll building;
- Interphone system;

9.20.4 Recommendations

The scope and design features of the toll collection facilities in the SES should follow the present system which is provided for FES.

No functional modification to the existing toll collection system which involves the toll booth, toll building and expressway control center (i.e. toll collection main office) will be recommended.

Schematic diagram of the recommended data processing system which covers the FES and SES is presented in Fig. 9–31 together with the explanation of the function of each toll collection facility.

9.21 Traffic Signs

9.21.1 General

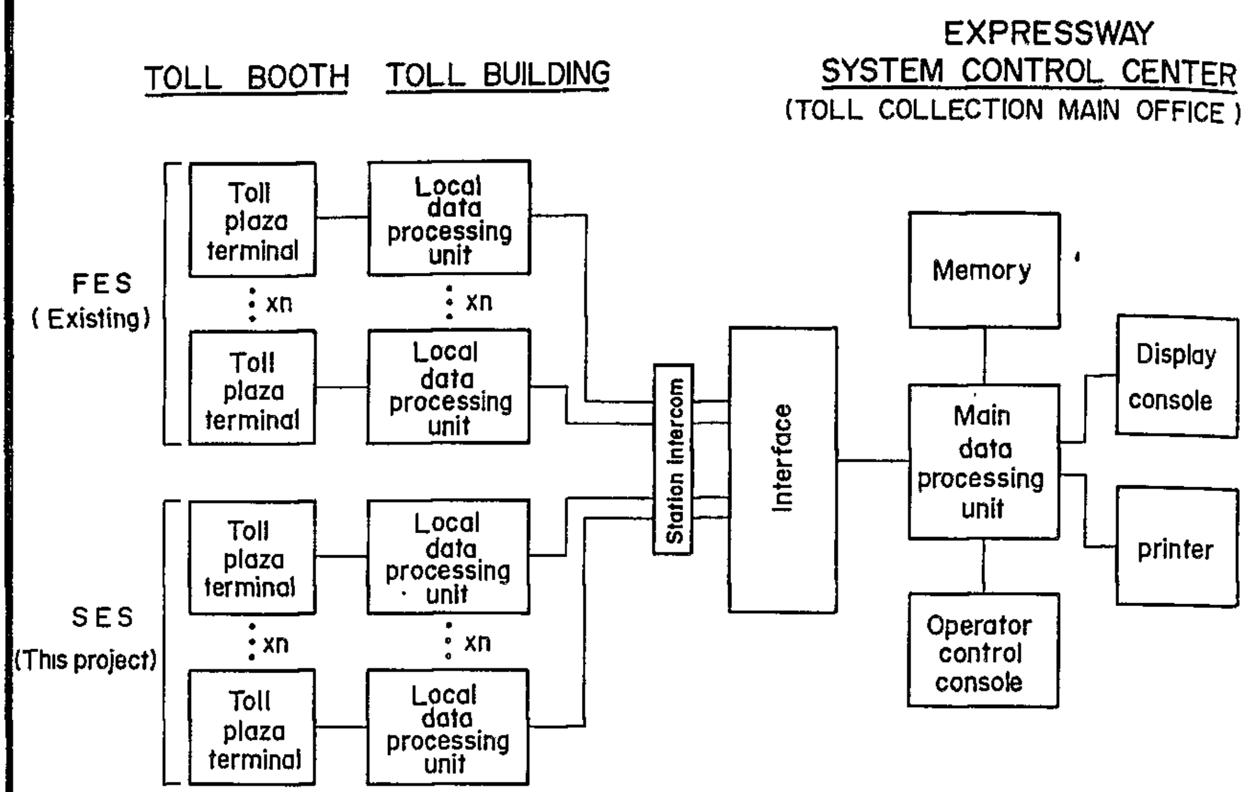
Effective signing of the expressway is essntial to ensure traffic safety and user's convenience, taking into account those factors controlling the effectiveness of signs which include legibility (ease in reading the message), target value (factors which draw attention to the sign, such as size and contrast with background), and the priority value (location in relation to other signs).

9.21.2 Evaluation of Existing Traffic Sign System

The existing system mainly consists of the guide signs and variable traffic signs (i.e. matrix signs).

(1) Guide Signs

Guide signs convey information to assist drivers, such as destinations and distances, services facilities, and route confirmation information. These signs are playing a very important role in informing drivers in advance of the correct traffic lane for making an exit or entry at interchanges and of the location of toll plazas. Overhead signs are provided at certain locations. Lighting facilities are provided for those guide signs.



FUNCTION OF TOLL BOOTH	FUNCTION OF TOLL BUILDING	FUNCTION OF EXPRESSWAY CONTROL CENTER
– TOLL COLLECTION AND ISSUANCE OF VOUCHER ; – REGISTRATION AND CALCULATION OF THE TOLLS ; – VEHICLE COUNTING BY THE LOOP DETECTOR ; AND – REGISTRATION OF THE NUMBER AND TYPE OF VEHICLE .	– REAL TIME AUDIT BY THE TOLL PROCESSOR ; – HANDLING, STORAGE AND TRANSFER OF COLLECTED TOLL ; – SURVEILLANCE OF TOLL COLLECTION OPERATIONS ; AND – COMMUNICATIONS TO TOLL BOOTHS, EMERGENCY AND POLICE PATROLS AND TO THE EXPRESS WAY CONTROL CENTER	– TOTALIZE AND CHECK THE TOLL AMOUNT COLLECTED AT EACH TOLL PLAZA ; – TOTALIZE THE NUMBER AND TYPE OF VEHICLE REGISTERED AT EACH TOLL PLAZA ; AND – CHECKING OF MISREGISTRATION AND DISCREPANCIES ;

FIG. 9-31 SCHEMATIC DIAGRAM OF RECOMMENDED TOLL DATA PROCESSING SYSTEM

THE SECOND STAGE EXPRESSWAY SYSTEM IN THE GREATER BANGKOK

(2) Matrix Signs

The matrix signs are installed in the FES, 14 sets at the important locations between Din Daeng and Bang Na. Displaying patterns are 3 for speed limitations, 6 for lane closure and 1 for stop.

9.21.3 Types of Variable Message Signs

The variable message sign display and inform the motorists of the road traffic conditions and abnormal conditions such as traffic accidents, repair works and traffic congestions for traffic control purposes.

The types of variable message sign are normally as follows:

a) Matrix Type Indicator

The display on the indicator is made up by letters or symbols formed by lamps installed in the indicator.

b) Screen Type Indicator

The display on the indicator is by means of black printed letters on a white rolled screen. Variable information is transmitted to the motorists by rolling up the screen. Fluorescent lamps installed behind the screen aid the night time use of the indicator.

c) Through Light Type Indicator

The display on the indicator is by means of printed letters on black rolled screen with white letters. Variable messages are sent to the motorists by rolling up the screen. Information is displayed on the indicator at night by incandescent lamps installed behind the screen.

The matrix type variable message sign is preferable for the following reasons:

- Sufficient legibility;
- Excellent for arousing the motorists attention;
- More number of display patterns;
- Quick change of displayed message; and
- Higher reliability and easier maintenance.

9.21.4 Recommendations

Effective signing of urban expressway is of vital importance for the proper operation of the expressway and street network, particularly at on/off-ramps and expressways in the vicinity of interchanges.

Signs must be designed primarily for drivers who are not familiar with the route or the variable traffic condition so that they will tend to react promptly, naturally and safely to the design conditions and traffic situation encountered.

When the expressway network will have the addition of the SES, it is expected that the 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 certain on-ramp(s).

However, being simpler system, it is foreseen that the FES type system would have shortcomings at such problems of the lack of the message capacity in the conveyance of traffic regulation and information, as well as of the additional locations of signs.

In order to strengthen the existing signing system, the introduction of the high capacity type overhead matrix indicators is recommended.

The recommended types and locations of traffic signs in the vicinity of on/off-ramps are as shown in Fig. 9–32. The control of matrix indicators are to be done at the traffic control center through the remote control system.

Table 9–31 shows the characteristics and locations of the recommended signs.

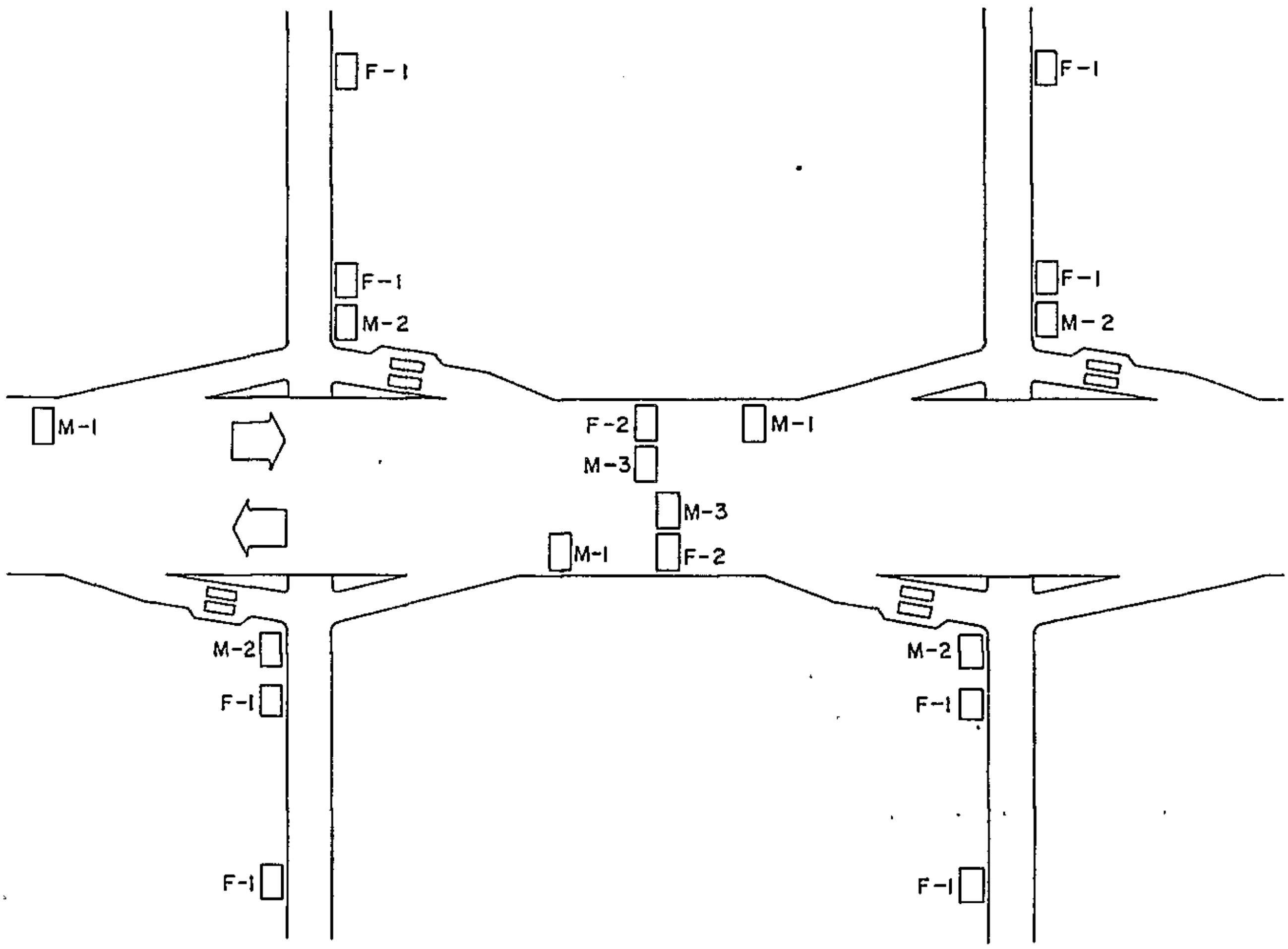


FIG. 9–32 TYPICAL LAYOUT OF SIGNS IN THE VICINITY OF ON/OFF-RAMP

TABLE 9–31 RECOMMENDED SIGN SYSTEM

Classification	Type	Installed Locations	Conveyed Information	Support Design
Guide Signs	*F-1	On the street, near on-ramps	Expressway or on-ramp ahead	Overhead or overhang, portal or pole type
	*F-2	On the Expressway, near exit terminals (interchanges and off-ramps)	Destinations of expressway and connected roads	Overhead, portal type
Matrix Signs	M-1	On the Expressway, before off-ramps	Traffic condition of connected roads	Overhang, pole type
	M-2	On the street, before on-ramps	Abnormal traffic or other conditions of expressway	Overhead, portal type
	M-3	On the Expressway, near exit terminals (interchanges and off-ramps)	Abnormal traffic or other conditions of expressway and connected roads	Overhead, portal type
	*M-4	On the Expressway, at interchanges, on/off-ramps, sharp curves, etc.	Speed limitation, lane(s) closure and stop	Pole mounting

Note: *denotes the existing sign system.

Chapter 10
ENVIRONMENTAL IMPACT STUDY

CHAPTER 10 ENVIRONMENTAL IMPACT STUDY

10.1 General

Environmental impacts were evaluated mainly for two types of environments; namely, physical and socio-economic. In addition to the favorable impacts on transportation and the basic human living environment mentioned hereinafter, adverse impacts and proposals for their mitigation were examined. The following components were adopted as the basis for this study.

a) Project Expressway

- North-South Route; and
- East Route.

b) Affected Areas

- Greater Bangkok Area; and
- Corridors of the Project Expressway

c) Time Period for Consideration of Environmental Impact

- During the period of construction; and
- After construction.

10.2 Study Purpose

The purpose of this study is to ensure that the planning of the development of the Second Stage Expressway System (SES) has given careful consideration to environmental effects, so that the plan will, to the extent practicable, minimize all adverse effects, and also achieve beneficial effects or enhance environmental values, especially for the purpose of offsetting any unavoidable adverse effects. To meet this end the preliminary qualitative analysis of the foreseeable effects of the Project Expressway on the above environmental indicators was carried out.

10.3 Basic Premises of the Study

(1) Environmental Quality Standards and Research Data

Prior to the preliminary qualitative analysis, the Study Team looked into the existing environmental quality standards and past research data.

However, it was found that these standards and research data are still in the adjustment or development stage and do not treat the matters at length.

Under such circumstances, the data from Japanese practices are frequently made use of for the preliminary qualitative analysis on the particular environmental effect such as air quality, noise and vibration.

(2) Limitation of the Preliminary Qualitative Analysis

The preliminary qualitative analyses are limited to the case study only. The case studies were aimed at the identification of problems which should be assessed by full scale studies to be conducted in the framework of the preparation of the EIA.

The full scale EIA would involve numerous variables which require thorough and lengthy studies and this was considered to be beyond the control of the Scope of Works. The Team is aware that the real environmental qualitative analysis must be carried out based on the Government's predetermined policy on environmental assessment as well as the detailed research data which are to be utilized for the various calculations. Therefore, the conclusions which are derived from the case studies would still have the natures of tentative.

The Team is leaving room for the discussion of the future explorations in the establishment of more complete assessment policies. It is therefore, hoped that the appropriate agencies pick up and continue with this endeavor.

10.4 Project Description and Environmental Background

Descriptions of the expressway development project study of alternative routes, land use, socio-economic features, transportation facilities, etc. have been discussed and are analysed in the respective sections and Appendix mentioned below:

Description	Chapter	Section/Sub-section
Project background	1	1.1
Study objectives and scope of work	1	1.2 & 1.3
Execution of the Study	1	1.4.3
Expressway network Study	6	6.3
Objective routes	8	8.2
Salient features of the objective routes	8	8.4
Selection of the optimum alternative route	8	8.5–8.7
Design standard of the project roads and bridges	9	9.4
Typical cross-section of the Expressway	9	9.4.2
Preliminary design of interchanges	9	9.7
Study of viaduct and other structures	9	9.13
Engineering geology and soils and materials study	9	9.15
Meteorology and hydrology	9	9.16
Land use	3	3.1
Population and employment	3	3.2 & 3.3
Socio-economic development in the past and in the future	2	2.2 & 2.3
Transportation facilities, road network	4	4.2
Transportation facilities, water and railway	2	2.3.1
Water supply	2	2.3.1
Institutions and historical features considered	8	8.3 & 8.5

10.5 Favorable Environmental Impacts

"Without Project" alternative would involve the use of existing road networks which are clearly inadequate at present and for the future development of the Greater Bangkok Area (GBA), and, would result in serious traffic congestion throughout the GBA. The Study of the economic evaluation revealed that the benefits of the development of the Expressway would far outweigh the costs to be incurred for the project. The aspects producing a large magnitude of favorable effects are discussed in the following paragraphs.

(1) Increase of Transprot Mobility and Accessibility

The Second Stage Expressway System, together with the FES, will greatly enhance and strengthen the function of the road network system in the GBA.

As seen on Fig. 11–1 in Section 11–3 the Expressway (i.e. N–S Route and East Route) is planned to form an inner ring in the central urbanized area and to provide two radial routes in the core area of GBA extending north and east.

Thus, the development of the SES will improve the traffic condition in the GBA, especially in its core area. Accordingly, the transport mobility and accessibility of the GBA will be greatly improved and bring about a striking reduction of traffic cost.

(2) Realization of Land Use Potential

Land use potential in the GBA will be greatly enhanced. In land use allocation, inefficient concentrations can be decentralized and inefficient dispersions can be integrated. Changes in land use will be realized and land values will be increased.

(3) Increase of Land Value

The improvement in accessbility will reasonably induce enhancement in land use potentiality and cause an increase in development demand due to favorable location, conditions, and thus to general environmental betterment increase in land value.

(4) Better Community Composition

Existing community overcrowding will be reduced by the provision of the Expressway. The growth of new communities will be promoted by investors and inhabitants in the GBA and the establishment of better communities will improve the comfort of the area.

(5) Other Environmental Impacts

Project investment will produce the multiplier effect for the regional economy and the improvement of accessibility between development centers would enhance employment opportunities.

10.6 Summary of Adverse Effects and their Mitigation

The Study of probable environmental impacts by the Project Expressway together with the existing environmental situations are studied in the framework of the case study.

Possible adverse environmental effects and their mitigation are summarized as follows:

(1) Temporary Pollution

Temporary pollution such as dust, noise, vibration and water pollution as well as traffic problems during construction can be foreseen. This nuisance and inconvenience during construction should be significantly reduced by introduction of strict construction management and adoption of proper construction equipment and methods.

The Khlong waters are likely to get muddy if countermeasures are not provided during construction of bridge foundations, although the duration of time involved is limited. The water can be kept as clean as possible by adopting steel piling and other suitable construction procedures.

(2) Traffic Flows During the Construction

Increased congestion during construction compared with the before-construction stage is anticipated due to the yearly increase in traffic volume and the operation of constructional equipment.

To mitigate this condition, the traffic management during construction for each construction segment or section would be studied including also the instruction to contractors, basically to keep the same number of lanes as the existing condition and to maintain required minimum vertical clearance under the temporary support for the construction of the superstructure.

If necessary, other positive action may be taken to manage the traffic diversion using the existing street network with improvement to some roads.

(3) Inhabitants Displacement

The displaced families will be sufficiently compensated and/or resettled to proper areas.

(4) Viaduct Along Existing Khlong

The alignment of N–S Route passes over the existing Khlong at the north of Bang Sue Railway Station for about 1.0 km. In order to avoid the changes of water quality and ecosystem of the Khlong countermeasure should be provided so as to permit free air movement (i.e. oxidation) and enough sun light intake (i.e. photosynthesis/fauna).

(5) Flood Control

If the low cost incentive construction applying at-grade system would be adopted for the development of the Expressway, serious flood problems would be foreseen in the upstream area. To avoid these problems and adverse effects, the Expressway would be planned by the viaduct system.

(6) Preservation of the Environment of the Victory Monument

The East Route crosses the Phahol Yothin Road in the proximity of the Victory Monument. Since the Monument is believed to be the one of the national important historical features, the harmony with the existing environment must be studied extensively in the detailed engineering design.

The undercrossing structure should be considered at this location in order to reduce the visual impact to the monument.

(7) Noise Control

Traffic noise may be an objectionable feature of a highway in the urban environment, particularly in residential areas. Where an expressway is constructed on viaduct, solid parapets are more effective than open railings in shielding adjacent development from traffic noise. Where there are adjacent facilities which are particularly sensitive to traffic noises, the parapets should be high enough to block the line of sight between the vehicles and the sensitive facilities.

Special sound shields may be justified at certain locations, particularly along ground level or elevated expressways through noise sensitive areas to minimize the effect of noise.

(8) Wat Don Cemetery Area

The N-S Route passes through the Wat Don Cemetery near the Station 4 km, and about 200 tombs will be disturbed. Careful negotiations concerning the compensation of these tombs are necessary during the detailed right-of-way study and the detailed engineering design stages.

10.7 Conclusions

(1) Air Quality

In order to improve the air quality, it is necessary to consider the comprehensive measures including regulations for the manufacture and maintenance of vehicles. On the other hand, it is essential to promote air quality survey and its analysis as well as establishment of a method of forecasting.

(2) Noise

Automobile noise is mainly emitted from engines, air intakes and exhaust pipes, cooling fans, drive trains, tires and so on. Actually, however, various factors, such as traffic volume, type of automobile vehicles, speed, structure of roads, etc. are completely integrated to create automobile noise problems at roadsides, aside from the noise created by automobiles themselves.

Accordingly, in order to minimize these problems effectively, it is necessary that measures such as regulation of noise emitted from vehicles themselves, the improvement of automobile structure, the improvement of operating conditions of vehicles, and improvement of road structure should be introduced in addition to other measures at roadsides.

(3) Vibration

Problems of traffic vibration in the areas along the roads are caused by the combination of various factors, such as, vehicle weight, running conditions and road conditions (evenness of road surface, pavement structure, roadbed conditions, etc.)

It is essential to promote various fundamental surveys and the preparation of research data as well as the establishment of forecast method.

(4) Supplemental Paper on Pre-Environmental Impact Study

The Supplemental Paper on pre-environmental impact study which summarized the result of case study is handed over to ETA and the office of National Environment Board. In the execution of further environmental impact assessment, this supplemental paper must be used as a base line study guidance.

Chapter 11
ESTIMATED CONSTRUCTION AND MAINTENANCE COST

CHAPTER 11 ESTIMATED CONSTRUCTION AND MAINTENANCE COSTS

11.1 General

Based on the preliminary design of the Expressway (i.e. N–S and East Routes), construction cost of each segment was estimated and converted to economic cost for the economic evaluation. Similarly, costs of land acquisition and compensation and road maintenance were estimated.

The estimation was conducted in accordance with the following criteria:

1) The estimates are made on the assumption that all construction works will be contracted to general contractors by international tender.

2) The unit costs were computed under the economic conditions prevailing in June, 1983.

3) The cost was estimated for all alternatives and was classified into foreign currency (indicated in Baht) and local currency (indicated in Baht) portions.

   Foreign currency and local currency components of each unit price were computed based on the following classification of basic cost elements.

   The foreign currency component consists of the costs of:

   - Imported equipment, materials and supplies;
   - Domestic materials of which the country is a net importer;
   - Wages of expatriate personnel; and
   - Overhead and profit of foreign firms.

   The local currency component includes the cost of:

   - Domestic materials and supplies of which the country is a net exporter;
   - Wages of local personnel;
   - Overhead and profit of local firms; and
   - Taxes.

4) The unit cost of each work item is obtained by accumulating the labour cost, equipment cost, material cost, etc. for the item, and the result is checked against recent actual figures for construction works in Bangkok.

5) Land acquisition and compensation costs are estimated based on the unit cost data obtained from BMA and ETA.

6) For all unit costs a constant allowance of 30% for overhead and profit was added to the direct unit prices.

7) Contingency allowance was made of 10% of the total of construction cost, land acquisition and compensation cost.

8) The detailed engineering design and supervision fees etc. were assumed to be 6.5% of the construction cost, and the breakdowns are as follows:

   - Detailed Engineering Design : 2.5%
   - Supervision and others : 4.0%

11.2 Unit Cost by Work Items

The unit cost by work items is calculated from the material cost, labour cost, equipment cost, etc. analyzing the data on the construction cost of recent similar natures of projects such as the First Stage Expressway System in Bangkok, and the Nonthaburi and Pathumthani Bridges Construction Project as well as taking into consideration the local conditions in Bangkok. The resulting unit costs by items are as listed in Appendix Table 11–1.

Detailed unit price analysis was carried out for the selected work items to maintain the required accuracy of the cost estimates as well as to determine the components of foreign currency, local currency and tax.

Appendix Table 11–3 shows the summary of the breakdown of these components by each type of work.

11.3 Land Acquisition and Compensation

Unit prices for land acquisition are obtained from BMA and for the building compensation are from ETA.

The breakdown of these costs by section and by route is given in Table 11–1 (see Fig. 11–1 for the construction segments).

TABLE 11–1 LAND ACQUISITION AND COMPENSATION COSTS

(million Baht)

Segment	Expressway Section	Land Acquisition Cost	Compensation Cost
N-1	STA. 0+770 - STA. 4+535	123.55	162.60
N-2	STA. 4+535 - STA. 8+270	943.76	480.00
N-3	STA. 8+270 - STA. 10+830	95.74	61.92
N-4	STA. 10+830 - STA. 17+900	162.21	89.45
N-5	STA. 17+900 - STA. 19+940	5.18	3.00
	SUB-TOTAL	1,330.44	796.97
E-1	STA. 0+780 - STA. 3+530	524.80	470.99
E-2	STA. 3+530 - STA. 5+325	74.04	41.31
E-3	STA. 5+325 - STA. 9+500	194.61	50.00
E-4	STA. 9+500 - STA. 14+340	15.54	26.10
	SUB-TOTAL	808.99	588.40
	TOTAL	2,139.43	1,385.37

11.4 Cosntruction Cost

The construction cost estimates for the feasibility study have been based on the quantities calculated in the preliminary design and on the unit costs for each work item.

The N–S Route was divided into five (5) segments and the East Route into four (4), to meet the stage construction program which is as described in Chapter 14 "Implementation Plan". The summary of the calculation for each segment is presented in Tables 11–2 thru 11–5.

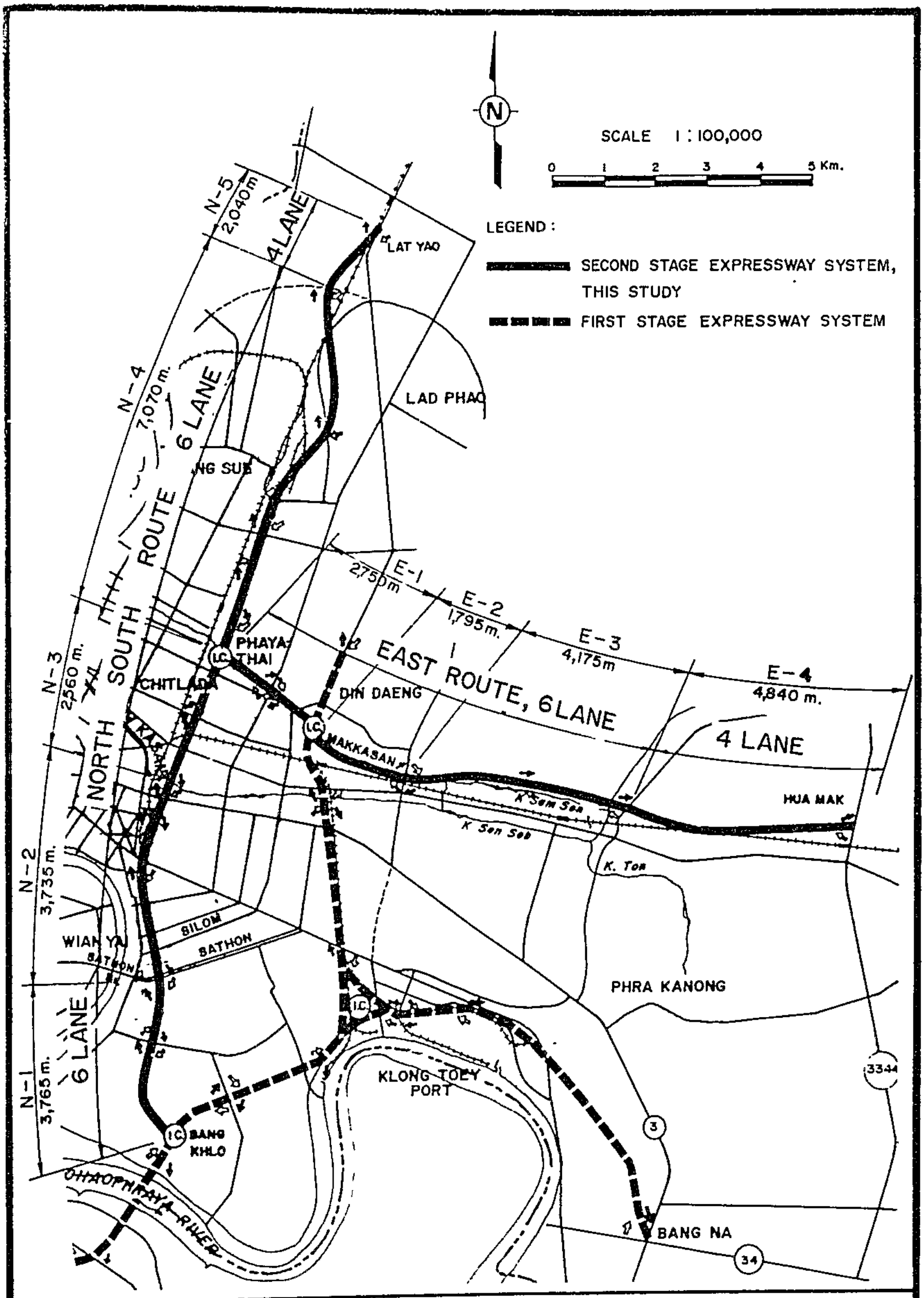


FIG. 11-1

CONSTRUCTION SEGMENTS FOR THE STUDY

THE SECOND STAGE EXPRESSWAY SYSTEM IN THE GREATER BANGKOK

11.5 Maintenance Cost

Maintenance has been difined as "the preserving and keeping of each type of roadway, roadside, structure, and facility as nearly as possible in its original condition as constructed or as subsequently improved, and the operation of road facilities and services to provide satisfactory and safe transprotation".

The maintenance costs and the operation costs for the Expressway were considered separately. The road maintenance costs comprised the cost of yearly maintenance of road and structures and the cost for periodical resurfacing of the pavement.

The Expressway is mainly to be of concrete construction and should be relatively maintenance-free. Routine maintenance is therefore confined to the costs of electricity for lighting, cleaning and minor repairs.

Yearly Maintenance Cost	Maintenance	Electricity Cost	(1)
		Cleaning Cost	(2)
	Repairs	Repair Cost	(3)
	Others		(4)

(1) Electricity Cost

This includes the cost of electricity for lighting and other facilities and services.

(2) Cleaning Cost

This includes the cost of cleaning the road surface, drainage facilities, guadrails, regulatory signs and other services.

(3) Repair Cost

This includes the cost of road surface repairs, overlays, painting of bridges and guardrails etc. inspection of structures, expansion joint repairs and inspection and repair of electric and traffic control facilities.

(4) Others

This was taken as 10% of the total of items (1) to (3).

After consultation with the ETA estimates were made for the cost of the above maintenance which is summarized below:

Yearly Maintenance Cost, Per km of the Expressway

Item	Cost (Baht)
Electricity Cost	395,480
Cleaning Cost	82,810
Repair Cost	211,330
Others	68,960
Total	758,580

Notes: 1) The length of ramps is converted into the equivalent length of 6 lanes of throughway.
2) Maintenance costs of undercrossing section is included.
3) Maintenance costs of arterial streets and overbridge are excluded from the total amount.

TABLE 11-2 SUMMARY OF PROJECT COSTS IN 1983 PRICES

N-S Route (1) STA. 0+770 - STA. 10+830 (million Baht)

		ECONOMIC COST			TAX	TOTAL
		F/C	L/C	TOTAL		
STA. 0+770 - STA. 4+535 SEGMENT N-1	Construction	667.47	456.23	1,123.70	157.03	1,280.73
	Land Acquisition	-	123.55	123.55	-	123.55
	Compensation	-	162.60	162.60	-	162.60
	Sub-Total	667.47	742.38	1,409.85	157.03	1,566.88
	Contingencies	66.75	74.24	140.99	15.70	156.69
	Engineering	34.13	39.96	74.09	9.16	83.25
	TOTAL	768.35	856.58	1,624.93	181.89	1,806.82
STA. 4+535 - STA. 8+270 SEGMENT N-2	Construction	820.83	556.24	1,377.07	193.15	1,570.22
	Land Acquisition	-	943.76	943.76	-	943.76
	Compensation	-	480.00	480.00	-	480.00
	Sub-Total	820.83	1,980.00	2,800.83	193.15	2,993.98
	Contingencies	82.08	198.00	280.08	19.32	299.40
	Engineering	41.84	48.99	90.83	11.23	102.06
	TOTAL	944.75	2,226.99	3,171.74	223.70	3,395.44
STA. 8+270 - STA. 10+830 SEGMENT N-3	Construction	610.05	463.23	1,073.28	146.63	1,219.91
	Land Acquisition	-	95.74	95.74	-	95.74
	Compensation	-	61.92	61.92	-	61.92
	Sub-Total	610.05	620.89	1,230.94	146.63	1,377.57
	Contingencies	61.01	62.09	123.10	14.66	137.76
	Engineering	32.51	38.06	70.57	8.72	79.29
	TOTAL	703.57	721.04	1,424.61	170.01	1,594.62

TABLE 11-3 SUMMARY OF PROJECT COSTS IN 1983 PRICES

N-S Route (2) STA. 10+830 - STA. 19+940 (million Baht)

		ECONOMIC COST			TAX	TOTAL
		F/C	L/C	TOTAL		
STA. 10+830 - STA. 17+900 SEGMENT N-4	Construction	1,442.88	1,001.93	2,444.81	339.03	2,783.84
	Land Acquisition	-	162.21	162.21	-	162.21
	Compensation	-	89.45	89.45	-	89.45
	Sub-Total	1,442.88	1,253.59	2,696.47	339.03	3,035.50
	Contingencies	144.29	125.36	269.65	33.90	303.55
	Engineering	74.19	86.86	161.05	19.90	180.95
	TOTAL	1,661.36	1,465.81	3,127.17	392.83	3,520.00
STA. 17+900 - STA. 19+940 SEGMENT N-5	Construction	218.29	156.03	374.32	51.78	426.10
	Land Acquisition	-	5.18	5.18	-	5.18
	Compensation	-	3.00	3.00	-	3.00
	Sub-Total	218.29	164.21	382.50	51.78	434.28
	Contingencies	21.83	16.42	38.25	5.18	43.43
	Engineering	11.36	13.30	24.66	3.04	27.70
	TOTAL	251.48	193.93	445.41	60.00	505.41
TOTAL OF SEGMENT N-1 - N-5	Construction	3,759.52	2,633.66	6,393.18	887.62	7,280.80
	Land Acquisition	-	1,330.44	1,330.44	-	1,330.44
	Compensation	-	796.97	796.97	-	796.97
	Sub-Total	3,759.52	4,761.07	8,520.59	887.62	9,408.21
	Contingencies	375.95	476.11	852.06	88.77	940.83
	Engineering	194.03	227.17	421.20	52.05	473.25
	TOTAL	4,329.50	5,464.35	9,793.8	1,028.4	10,822.29

TABLE 11-4 SUMMARY OF PROJECT COSTS IN 1983 PRICES

EAST ROUTE (1) STA. 0+780 - STA. 9+500 (million Baht)

		ECONOMIC COST			TAX	TOTAL
		F/C	L/C	TOTAL		
STA. 0+780 - STA. 3+530 SEGMENT E-1	Construction	857.94	620.82	1,478.76	202.71	1,681.47
	Land Acquisition	-	524.80	524.80	-	524.80
	Compensation	-	470.99	470.99	-	470.99
	Sub-Total	857.94	1,616.61	2,474.55	202.71	2,677.26
	Contingencies	85.79	161.67	247.46	20.27	267.73
	Engineering	44.81	52.47	97.28	12.02	109.30
	TOTAL	988.54	1,830.75	2,819.29	235.00	3,054.29
STA. 3+530 - STA. 5+325 SEGMENT E-2	Construction	374.14	254.90	629.04	87.53	716.57
	Land Acquisition	-	74.04	74.04	-	74.04
	Compensation	-	41.31	41.31	-	41.31
	Sub-Total	374.14	370.25	744.39	87.53	831.92
	Contingencies	37.41	37.03	74.44	8.75	83.19
	Engineering	19.10	22.36	41.46	5.12	46.58
	TOTAL	430.65	429.64	860.29	101.40	961.69
STA. 5+325 - STA. 9+500 SEGMENT E-3	Construction	757.72	516.23	1,273.95	179.19	1,453.14
	Land Acquisition	-	194.61	194.61	-	194.61
	Compensation	-	50.00	50.00	-	50.00
	Sub-Total	757.72	760.84	1,518.56	179.19	1,697.75
	Contingencies	75.77	76.08	151.85	17.92	169.77
	Engineering	35.75	41.85	77.60	9.59	87.19
	TOTAL	869.24	878.77	1,748.01	206.70	1,954.71

TABLE 11-5 SUMMARY OF PROJECT COSTS IN 1983 PRICES

EAST ROUTE (2) STA. 9+500 - STA. 14+340 (million Baht)

		ECONOMIC COST			TAX	TOTAL
		F/C	L/C	TOTAL		
STA. 9+500 - STA. 14+340 SEGMENT E-4	Construction	419.93	310.56	730.49	100.03	830.52
	Land Acquisition	-	15.54	15.54	-	15.54
	Compensation	-	26.10	26.10	-	26.10
	Sub-Total	419.93	352.20	772.13	100.03	872.16
	Contingencies	41.99	35.22	77.21	10.00	87.21
	Engineering	22.13	25.91	48.04	5.94	53.98
	TOTAL	484.05	413.33	897.38	115.97	1,013.35
TOTAL OF SEGMENT E-1 - E-2	Construction	2,409.73	1,702.51	4,112.24	569.46	4,681.70
	Land Acquisition	-	808.99	808.99	-	808.99
	Compensation	-	588.40	588.40	-	588.40
	Sub-Total	2,409.73	3,099.90	5,509.63	569.46	6,079.09
	Contingencies	240.97	309.99	550.96	56.94	607.90
	Engineering	121.79	142.59	264.38	32.67	297.05
	TOTAL	2,772.48	3,552.49	6,324.97	659.07	6,984.04
GROUND TOTAL OF ALL ROUTES (N-S, EAST)	Construction	6,169.25	4,336.17	10,505.42	1,457.08	11,962.50
	Land Acquisition	-	2,139.43	2,139.43	-	2,139.43
	Compensation	-	1,385.37	1,385.37	-	1,385.37
	Sub-Total	6,169.25	7,860.97	14,030.22	1,457.08	15,487.30
	Contingencies	616.92	786.10	1,403.02	145.71	1,548.73
	Engineering	315.82	369.76	685.58	84.72	770.30
	TOTAL	7,101.99	9,016.83	16,118.82	1,687.51	17,806.33

Periodical maintenance to the road surface has been assumed to comprise a bituminous overlay every 7 years with repainting of the steel railing, guardrails and other road furnitures at the same time. The estimates for periodical maintenance are summarized below:

Periodical Maintenance Cost, per km of the Expressway

Item	Cost (Baht)
Repair	
– Overlay	8,396,800
– Painting	839,680
Others	839,680
Total	10,076,160

The result of the calculations for each route are summarized as shown below. This indicates that the annual maintenance cost excluding periodical maintenance cost per year amounts to approximately 0.2% of the total construction cost.

Designation	Expressway Length	Maintenance Cost
N–S Route	19.17 km	14.54×10^6 Baht
East Route	13.56 km	10.29×10^6 Baht
TOTAL	32.73 km	24.83×10^6 Baht