8.3 TOLL COLLECTION SYSTEM AND PLAN

8.3.1 Review on Toll System

1. Application of Toll System to Motorways

When looking from the financial point of view, the toll motorways are normally constructed with majority of their source of fund being loans which shall be in principle paid back with future toll revenues, while the non-toll motorways are mainly constructed by the national budget whose major financial resources are various types of taxes. Therefore, although development of the fixed social infrastructure facilities is usually implemented by the government budget, infrastructure development projects like motorways requiring huge amount of investment will place very heavy burden to the national account.

Taking above fact into account, it is reasonable to understand why the toll system is applied for construction of the motorways in many countries with the following reasons:

1) Construction of the motorways needs quite a huge amount of initial investment costs which can preferably be paid back with future toll revenues in a considerably long repayment period, by distributing the initial financial burden equally during the redemption period

2) The newly constructed motorways will provide the users with higher level of service such as shorter travel time on long distance trip with scheduled arrival time, lower vehicle operating cost, smoother and safer driving conditions in comparison to the driving on existing highways with inferior service level. These differences are considered as the benefits the motorway users receive, which are the major factors of determination of the toll rates.

3) Once the motorways are opened to traffic, they become every effective transport infrastructure to last a long time, so that the above-mentioned benefits can continue to prevail to not only every sector of the industry and society, but also to generations to come.

4) The source of funds required for capitalization of the initial investment cost for motorway construction can be long term loans from public and private financial institutions. This induces comparatively easy fund raising, and also fairly short period for motorway network development.

2. Types of Toll System

1) Introduction of Closed Toll System

In general, toll system can be classified into two types. One is the system applying distance-proportional toll rate in which toll rates are set in accordance with the distance and the types of vehicles traveling on the motorways. The other is the system adopting the flat toll rate in which the fixed toll fee is charged to the

same type of vehicle regardless of the distance traveled. This flat rate system is usually adopted for urban expressways.

Because of the reason that the proposed inter-city motorway network system consists of 14 routes connecting all the major regions and cities of the Kingdom with the total length of about 4,350 km, linking all the routes depending on the origin and destination of the vehicles, the applicable toll system shall be based on the toll according to the distance traveled (so-called "Closed System") with the terminal charge being added for each motorway user as a fee for usage of interchange facilities.

2) Introduction of Pool System

In principle, the calculation of redemption for the loan or fund required for the construction of the motorways is made separately for each route of motorways. The tolls are to be determined with consideration for the toll collection period, estimated traffic volume and other factors, and then calculated with an aim of ensuring that the costs can be covered by the amount of revenues received. The toll rate system which integrates two or more motorways in the redemption calculation is called the pool system.

When a certain section or a route of the motorway system, even though it is a tunnel or a long span bridge, fundamentally meets the tests of unity, substitution of the function of the road and fairness of burden on the user, the section or the route should be considered as an integral system justifying unified collection. However, in order to avoid future uncertainty in the decision of the toll rates of the sections which are to be completed earlier, it is appropriate to take one section or route consisting of such special structures into consideration with respect to pooled redemption for the time being, since construction plans for such sections or routes are fixed with a high degree of certainty. Regarding the other sections, it would be appropriate to take them into consideration of the pooled redemption, one by one, as each of the construction plan become certain. In compliance with the phased implementation plans of the motorways, the plans for other sections or routes would be made more concrete, all of these sections or routes shall be included in the consideration of redemption, and the pool system shall be adopted.

In other words, each section or route of the proposed motorways shall constitute a complete network system by linking each other, it is reasonable and adequate to maintain uniformity, consistency and equality of the toll system. At the same time, it would be better to avoid difference of toll rates within the same motorway system attributable to difference of implementation time schedule and expected traffic volume, and to execute scheduled installment of loan repayment regardless of the difference of construction costs due to inflation and higher cost of land acquisition.

8.3 2 Toll Collection System

1. Introduction

The study recommended the Closed System for toll collection of the proposed motorway network system. The Closed System in principle comprises that a toll ticket is issued at the entrance toll booth in an interchange and the toll fee is paid at the exit booth according to the distance traveled by classification of the type of vehicles with a rounded value for easy payment.

Among the "closed" toll collection systems, there are two representative systems. One is punch card system using punch card containing punched information such as vehicle type, name of entrance interchange and passage date which are read by machine and the toll is computed and collected. The other is the system utilizing magnetic card for the information similarly needed as the punch card system, but with much more reliable, efficient and economical compared to the former.

Review on various types of toll collection systems has come to the conclusion that the study would recommend the widely used magnetic card type collection system, in consideration of practicability and easiness of system control which is described in the following paragraph.

2. Proposed Toll Collection System

Toll collection system should permit accurate toll collection to be carried out without unnecessary disruption of traffic flow at the toll plaza gates. The toll equipment should operate 24 hours a day and therefore is constructed with highly durable parts, incorporating measures to prevent damages from dust and exhaust fumes. The equipment should also be durable to extremes of temperature and humidity, noise and other unfavorable conditions with adequate back-up facilities for emergency. Therefore upon determination of the proposed system, emphasis has been placed on the following principles:

- Availability of expeditious and efficient counting control by the line arrangement: Gate - Office - Operation Office - Administration Office.
- Operation simplicity, improved reliability and reduced maintenance expenses by computerization of the entire system.
- Possibility of strict, prompt and efficient site inspections.
- Protection of fraud and elimination of illegal traffic.
- Durability of equipment
- Maintainability of equipment

1) System Outline

This toll collection system is to be operated as a closed system using multiple sections of the motorways. The toll depends on the vehicle class and the distance traveled with the following procedures:

- The toll motorway user receives a transit ticket, and hands out the ticket at the

exit toll gate paying the toll automatically calculated by the system machines. The ticket is of a magnetic card with vehicle type and entrance gate number being encoded magnetically along with a hard printout.

- The entry system is semiautomatic. Vehicles are automatically preclassified by an automatic vehicle classification unit (AVC), and the operator at the toll gate also classifies manually the vehicle type and presses a vehicle classification key on the toll collector terminal (TCT). If the AVC and TCT classifications contradict one another, an instant warning and display are issued at the toll monitor console.

- When the vehicle classification button is processed at the toll collector terminal, a transit ticket is issued that is simultaneously magnetically encoded and printed out with entry information. The operator hands the transit card to the driver.

- The transit ticket is turned in and handed out by the driver at the exit toll gate, and the operator reads the ticket by the toll collector terminal.

- The toll fare is automatically computed and displayed both on the toll fare indicator (TFI) for the driver and on the TCT for the toll operator. The ticket is over-encoded and printed with exit transaction information.

- There are three cases of payment, namely, cash, voucher tickets and exemption.

- As the vehicle leaves the lane, it is further postclassified by the AVC, and it triggers an alarm in the event of a vehicle class discrepancy.

- It is recommended that vehicle classification shall depend on the number of vehicle's axles and the number of wheels on the axles, taking into consideration of the size of vehicle.

The recommendable typical vehicle classification applicable to toll collection system is described with indication of weight of toll rates in Table 8.3-1.

TABLE 8.3-1 VEHICLE CLASSIFICATION FOR TOLL RATES

Class	Definition	Rate Weight
1.	Passenger Car, Taxi, Pick-up, Micro-bus or Vehicles having 2 axles and 3 or 4 wheels	1.0-1.2
2.	Truck and Mini-bus of less than 8 tons or Vehicles having 2 axles and 5 or 6 wheels	1.2-1.5
3.	Heavy Truck and Bus of more than 8 tons Vehicles having 3 or more axles	1.5-2.0
4.	Extra Heavy Truck, Large Bus, Trailer or Vehicles having 4 or more axles	2.0-2.5

There would be different types of vehicle classification available in this system by adjusting the system configuration without requiring additional equipment cost.

2) System Configuration

A toll collection system overview is shown in Figure 8.3-1 and description on system configuration is filed in Appendix 8.3-1.

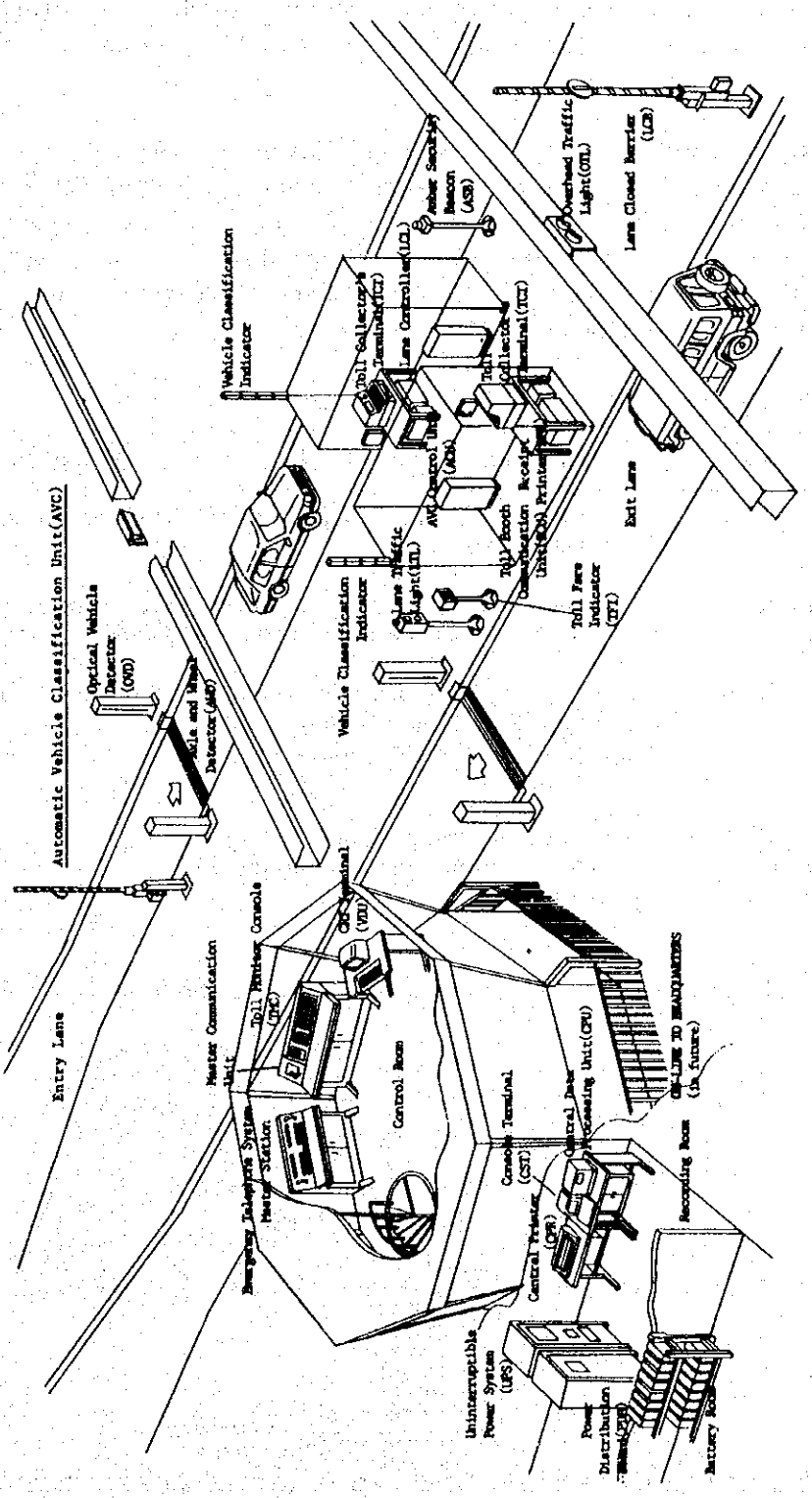


FIGURE 8.3-1 TOLL COLLECTION SYSTEM OVERVIEW

8.3.3 Toll Collection Management and Facility Plan

1. General Plan

A toll office is a building facility in which tolls for the motorways are collected. Toll houses are classified into two categories; one is roadway toll office or toll barrier where a toll office is located on a roadway and the other is a toll office located at the interchanges.

Usually each toll office has an average plotted area of 3,000 to 5,000 square meters, varying by scale and geographical conditions. Toll offices may be classified into 5 to 6 types by floor space and kind of toll gate, which are determined by traffic volume. The offices may also be differentiated in terms of whether they are located in hot or mild areas, and by the method of issuing toll cards. Outline of the facilities of the toll office is given in Table 8.3-2.

TABLE 8.3-2 OUTLINE OF TOLL OFFICE FACILITIES

Facilities	Description	Structure
Office Building	A building for the office tasks of toll collections	Reinforced concrete
Toll Gates	A facility where traffic cards are issued, and tolls are collected	P.C. structure of frame
Electric Power Room	A building to house power supply receiving and distributing equipment and non-utility equipment	Reinforced concrete
Supplementary Facilities	Include bicycle parking lot, flag poles, propane gas storehouse and incinerator	

A typical layout plan of the interchange toll office is shown in Figure 8.3-2.

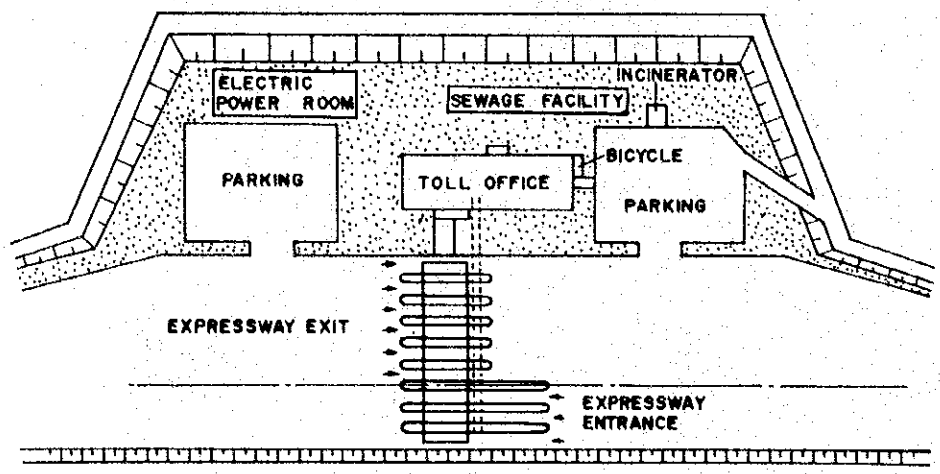


FIGURE 8.3-2 TYPICAL LAYOUT PLAN OF INTERCHANGE TOLL OFFICE

With regard to toll collection management, there would be three kinds of offices to be established as shown in Figure 8.3-3. Central or Division Toll Management Office will be responsible for overall management of toll collection including District Toll Operation Offices and Toll Plazas, auditing of financial reports submitted by these field offices, formulation of policies and strategies for toll collection and measures for revenue increase, etc. This division toll management office is normally attached to the division office for operations, and shall be organized with minimum number of key staff in order to minimize management cost.

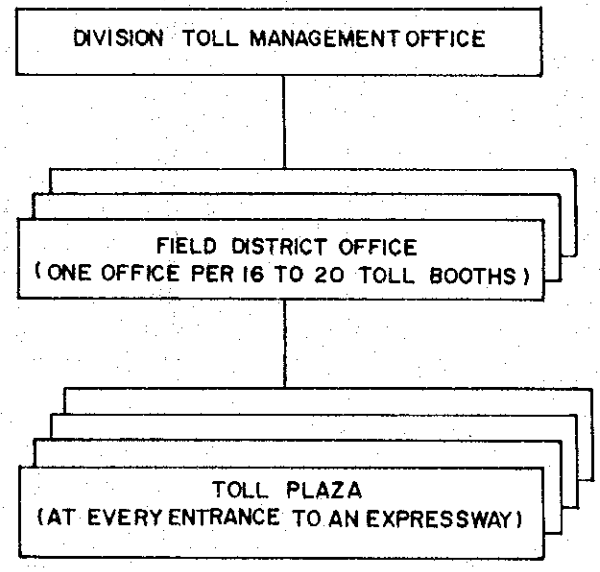


FIGURE 8.3-3 TOLL COLLECTION OFFICE MANAGEMENT SYSTEM

Field District Toll Office will be normally established for every 6 to 10 toll plazas and responsible for management of toll collection of Toll Plazas under its jurisdiction, bookkeeping, checking of tolls collected in comparison with vehicles entered to the motorways, safekeeping of tolls until such time as they are deposited in the bank, supply of materials to Toll Plazas and dispatching personnel to respective Toll Plaza. This office is normally attached to the district office for operations and run on a 24-hour basis.

Toll Plaza will be operated on a 24-hour basis by three shifts and responsible for toll collection at toll booths, issuing magnetic transit cards at the entrance gate and hand over receipts to motorway users, registering tolls collected and collection of traffic data, safekeeping of tolls until such time as they are transferred to the District Toll Office, and submitting data collected such as registered tolls and traffic data.

Staff requirement for each office is presented below in Appendix 8.3-2.

2. Proposed Toll Offices for Two Routes

Regarding the two routes of the motorway system, numbers of incoming and outgoing lanes and gates at the toll plazas of each interchange have been calculated based on average daily traffic volume in 2020 and peak hourly ratio as described in

section 6.7. According to the calculation, the numbers of booths required for each interchange are shown in Table 8.3-3.

TABLE 8.3-3 NUMBER OF BOOTH AT INTERCHANGE

Interchange	No of lanes incoming	outgoing	No of booth
Lampang - Doi Saket Route			
Lampang I/C	3	7	9
Mae Tha I/C	2	3	4
Lamphun I/C	3	5	7
Chiang Mai I/C	5	11	15
Doi Saket I/C	2	4	5
Ban Pong - Cha Am Route			
Ban Pong I/C	4	8	11
Photharam I/C	3	5	7
Ratchaburi I/C	4	8	11
Pak Tho I/C	3	6	8
Phetchaburi I/C	2	4	5
Tha Yang I/C	2	4	5
Cha Am I/C	3	6	8

8.4 MAINTENANCE PLAN

8.4.1 Objectives of Maintenance

The main objectives of maintenance operations in the motorway system are to maintain the motorways and their related facilities in the conditions as originally constructed or as later improved, so as to ensure smooth traffic flow, traffic safety and to provide traveling comfort to the motorway users.

Furthermore, the objectives shall be extended to maintain and promote the function of the motorways themselves and their associated facilities including traffic demand forecasts, and to maintain amicable relationship between the motorway administrator and the roadside communities complying with the social and environmental requirements.

8.4.2 Organization

1. Division Level

Since the head office organization and functions required for the motorway network system has been dealt with in the Section 8.1, organizational structure at division level of the whole network of the motorways at time of completion can be divided into 11 divisions as per the division office locations and their respective coverage of the respective motorways as shown in Table 8.4-1 and Appendix 8.4-1.

Each operational division office headed by a division director generally consists of 3 functional sections, namely; general affairs section in charge of personnel, contract and general affairs, operations section responsible for toll collection section and engineering section including engineers in various fields of specialities such as civil, electrical and mechanical engineering for maintenance operations.

In addition to above, each division office may, if necessary, accommodate traffic safety staffs and traffic control personnel as well as motorway police sub-station and other service companies. Standard staffing of the division office is shown in Appendix 8.4-2.

2. District Level

Under the supervision of the division office, there are about 5 to 12 district offices located at an interval of approximately 50 km on the motorway, whereas on the normal toll motorway there is in principle a single district office for each route.

For effective maintenance of the motorway, each district office is staffed by engineer in various fields and fitted with vehicle, tools and materials for miscellaneous operations. The number of district offices for the whole motorway network system is estimated to be approximately 90.

The actual organization of the district offices would be of great variety, depending on the structural designs of the motorway, traffic characteristics and functional

importance of the offices. The basic standard requirement of the staffing, maintenance facilities and equipment of a typical district office is presented in Appendices 8.4-2 and 8.4-3.

TABLE 8.4-1 LOCATION AND COVERAGE OF DIVISIONS

Location	Coverage		
1. Chiang Mai	TM 1	257.6 km	Lampang-Chiang Rai
2. Phitsanulok	TM 1	323.5 km	Nakhon Sawan-Lampang
3. Khon Kaen	TM 2	340.5 km	Nakhon Ratchasima-Nong Khai
4. Surin	TM21	300.1 km	Nakhon Ratchasima-Ubon Ratchathani
5. Chon Buri	TM 3	291.9 km	OBRM-Chanthaburi
	TM35	239.1 km	Chon Buri-Nakhon Ratchasima
Total		531.0 km	
6. Saraburi	TM34	211.7 km	OBRM-Aranyaprathet
	TM36	120.3 km	Saraburi-Chachoengsao
Total		332.0 km	
7. Bangkok	TM 1	175.5 km	OBRM-Nakhon Sawan
	TM 2	195.0 km	OBRM-Nakhon Ratchasima
	TM31	167.5 km	Outer Bangkok Ring Motorway
	TM36	70.5 km	Saraburi-Lopburi
Total		608.5 km	
8. Ratchaburi	TM32	100.0 km	OBRM-Kanchanaburi
	TM33	62.0 km	OBRM-Suphan Buri
	TM36	175.0 km	Pak Tho J/C-Lopburi
Total		337.0 km	
9. Petchaburi	TM 4	422.5 km	OBRM-Chumphon
10. Surat Thani	TM 4	284.7 km	Chumphon-Thung Song
	TM41	190.7 km	Kurabi-Khanom
	TM42	136.0 km	Phra Saeng-Phuket
Total		611.4 km	
11. Songkhla	TM 4	216.4 km	Thung Song-Malaysian Border
	TM 4	28.0 km	Hat Yai-Songkhla
	TM43	36.9 km	Ron Phibun-Nakhon Si Thammarat
Total		281.3 km	
Grand Total		4,345.4 km	

3. Proposed Organizations for Two Routes

With regard to the two routes of the motorway system, locations of the division offices and district offices are proposed with coverage length of each office as the following. The organization structure of each office may be formed up based on the standard described above.

1) Lampang-Doi Saket Route:

With the total length of 98.7 km in 4-lane route including mountainous and rolling terrains with two tunnels, 4 long bridges and 24 long viaducts, it is recommended to have one divisional office in Chiang Mai with 2 district offices in Chiang Mai covering 56.2 km with 3 interchanges at Doi Saket, Chiang Mai and Lamphun, and in Hang Chat covering 42.0 km with 2 interchanges at Lampang

and Mae Tha.

When this route is extended to connect Chiang Rai in the future, Chiang Mai Division Office is supposed to cover the route length of 257.6 km with additional district offices to be supervised by this division office.

2) Ban Pong-Cha Am Route:

This route extends with the length of 133.7 km in 6-lane from Ban Pong to Cha Am which has 5 long bridges and 8 long viaducts. The division office is to be located in Petchaburi with 3 district offices at Ratchaburi covering 42 km with 1 junction at Ban Pong and 2 interchanges at Ban Pong and Ratchaburi, at Pak Tho covering 49.2 km with 2 interchanges at Pak Tho and Petchaburi, and Tha Yang covering 42.0 km with 2 interchanges at Tha Yang and Cha Am.

When the routes such as TM 4, TM 32 and TM 36 are either newly constructed or extended to formulate the complete motorway network system, supervision of the motorway section from Ban Pong to Pak Tho junction on TM 36 is to be transferred to the division office to be set at Ratchaburi, and Petchaburi Division Office will supervise with the length of 422.5 km from OBRM to Chumphon with additional district offices.

The supervision coverage diagrams of the 2 routes are illustrated in Figure 8.4-1.

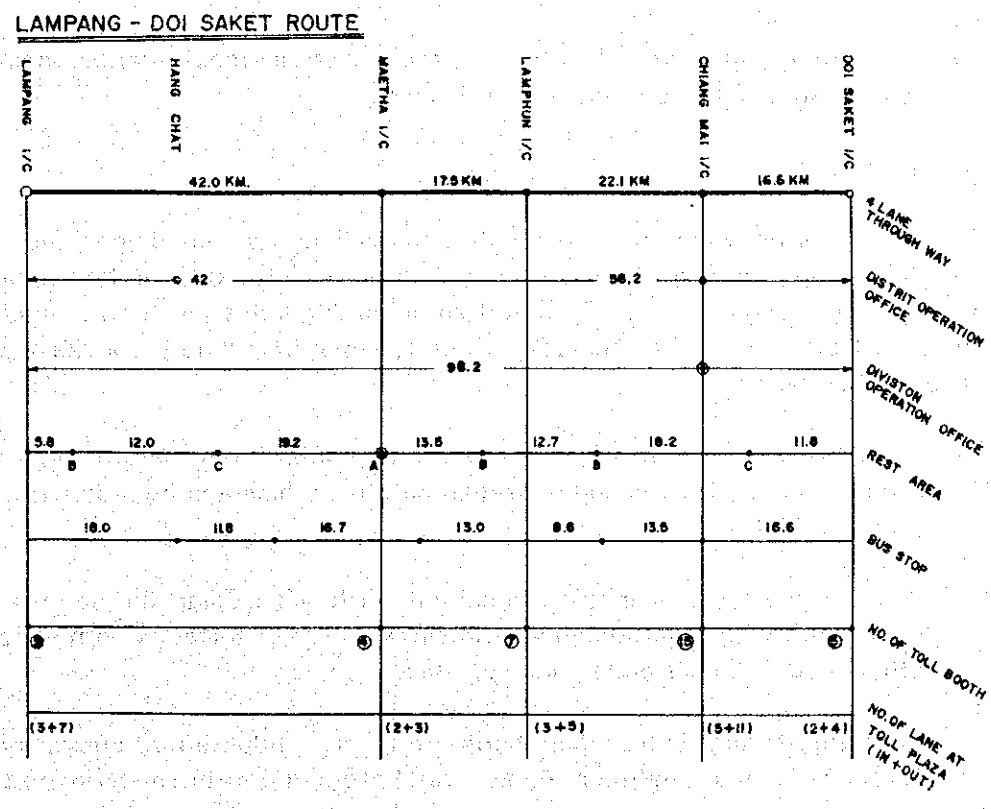


FIGURE 8.4-1a SUPERVISION COVERAGE DIAGRAM OF TWO ROUTES

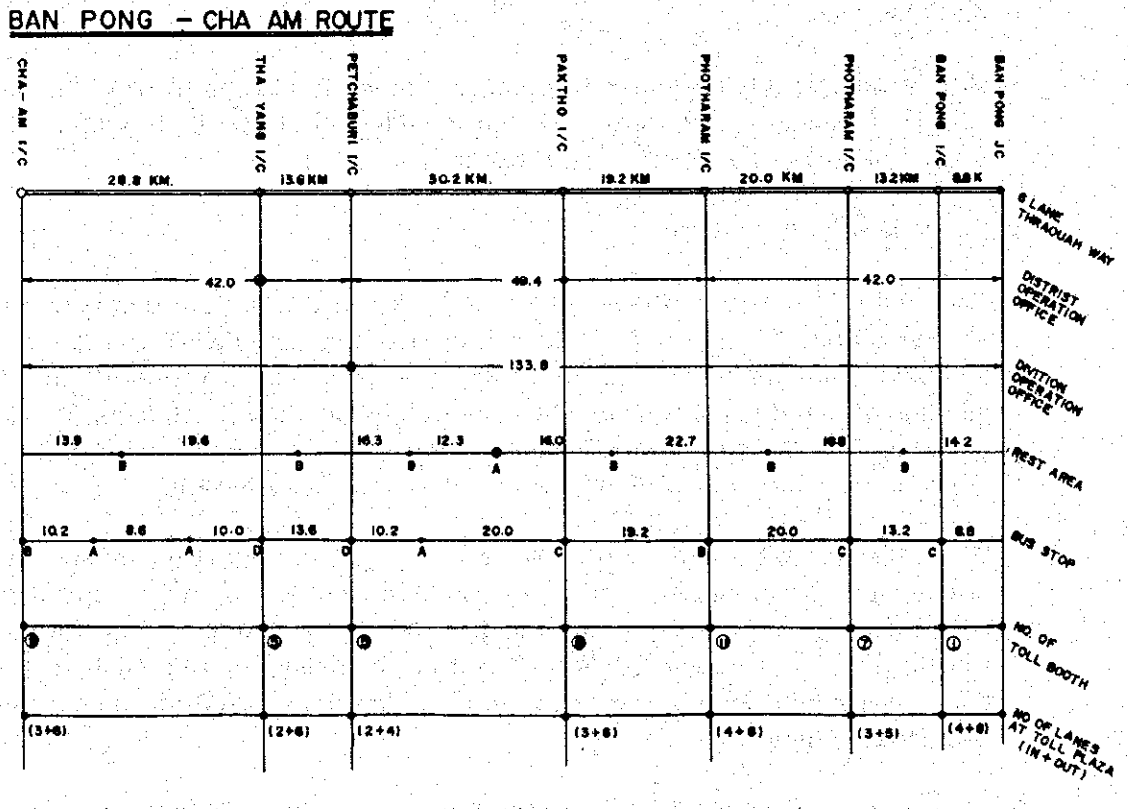


FIGURE 8.4-1b SUPERVISION COVERAGE DIAGRAM OF TWO ROUTES

8.4.3 Maintenance Method and Procedures

In order to accomplish the objectives of the motorway maintenance, maintenance works as introduced below shall be carried out.

1. Inspection

In order to correctly determine, estimate and evaluate road conditions and utilization patterns, inspections of the motorway shall be performed for either inputs to the needs for any repairs or to maintain them in such conditions that no hindrance to ordinary traffic will occur. There are three types of inspections for these purposes as described below:

- Daily Inspection: Patrols are carried out regularly once a day in principle to inspect road conditions and utilization patterns which can be recognized visually from a vehicle.

- Periodic Inspection: Periodic inspections on foot including the nearest possible approach to all structures including signs and road surfaces with exception of offices are to be performed once or twice a year.

- Extra Inspection: Extra inspections are to be conducted whenever needed in such cases as during the rainy season, before and after the monsoon season,

during and after the concentrated heavy rains and upon request.

The findings obtained from these inspections shall be recorded in a proper form as the inspection record, which can be categorized for instance as "in need of emergency repair", "heavily damaged and need detailed investigation for large scale repair", "slightly damaged and repair needed in due course", "no detectable abnormality", etc, so that routine maintenance, repair and rehabilitation plans can be formulated.

2. Road Cleaning

Road cleaning comprises removing dirt and trash from the surface of the motorway and various facilities to maintain the surface clean and deprive of traffic obstruction. The cleaning is essential to keep the designed level of service of the motorway, and the types of cleaning with descriptions as below.

- Road Surface Cleaning: Machine cleaning by sweeper and/or sprinkler with manual pick up of large objects.

- Incidental Facility Cleaning: Manual cleaning of the road surface, parking lots and green areas at interchanges and in rest areas.

- Roadside Facility Cleaning: Manual cleaning of public lavatories

- Road Fixture Cleaning: Machine cleaning by jet cleaner and/or sprinkler or manual cleaning of guard rails, signs, drain pipes, drainage ditches, expansion joints, tunnel sidewalls and lighting fixtures.

The frequency of cleaning is to be determined according to the road conditions, roadside conditions and quantity and kind of trashes.

3. Vegetation Control

Vegetation for the motorway aims at providing its users with mental refreshment and creating scenic beauty through landscaping and environmental conservation by means of erosion protection and provision of windbreaks.

Vegetation control comprises cultivation of new growth, preservation of full-grown vegetation and renewal of old and withering vegetation, in order that grass, plants and trees can play their intended roles. It is to be mentioned that the trees, plants and grass cultivated for slope protection or for environmental measures can sometimes become obstacles to both the supervision of the roads and the living environment of roadside inhabitants by obscuring the road signs and delineators, or by causing slope fires from discarded cigarette butts.

4. Repairs

There are many types of repairs required for the motorways, which can be summarized and categorized as follows:

1) Pavement Repairs

2) Repairing of Bridges and Viaducts

Damage to the expansion joints and shoes of bridges and viaducts constitutes the most frequent trouble, which require overall repair needing limited time of traffic control. (Careful consideration shall be taken into account of minimizing the use of expansion joints and selection of the type of shoe.)

As for the steel bridges and viaducts, lack of proper daily maintenance will significantly shorten the life of the bridges. Corrosion of the steel is one of the main causes of aging, and once corrosion begins wear and tear of the bridge components accelerate. Therefore, during construction and during maintenance rust prevention by painting shall be applied with the following criteria.

- Deterioration Degree I
Rust, cracks and peeling are present on the surface of paint and the effectiveness of the paint cover has been entirely lost.

- Deterioration Degree II
Point rust is plentiful and cracks, rust and peeling are present in some degree but part of cover remains undamaged.

- Deterioration Degree III
Although there is almost no rust on the surface of paint cover, gloss decrease and chalking are significant and the top coat has vanished in places.

3) Repairing of Tunnels

4) Minor Repairs

Typical minor repairs required for the motorway can be described as follows:

- Pavement repairs such as pot-hole fitting, crack sealing, patching of local damage and adjustment of height differences in adjoining parts of structures.

- Minor repairs of the traffic control equipment, including repair and repainting of guard rails, repair and renewal of signs and repainting of road markings.

- Minor repairs of earthworks, including repair of slopes and slope structures, removal of fallen rock and earth and supplemental drainage structures.

Generally, periodic maintenance works, improvement and disaster prevention/restoration works can be performed on a contract basis by regular retaining sub-contractors on a certain leg of the motorway or on tender depending upon the scale of the required works.

8.4.3 Maintenance Work Plan

As discussed in the preceding section, maintenance of the motorways involves road inspection, cleaning, planting, minor repairs as daily work for preserving road functions and periodic maintenance works such as painting and reinforcing bridges, improving pavements and slopes together with such measures as disaster prevention. The maintenance works also include in the future improvement works for enhancing road functions such as adding interchanges, expanding rest facilities and upgrading information facilities, etc. in response to economic and social needs.

For the purpose of performing these tasks efficiently and systematically, it is important to formulate the maintenance work plan for the motorways because many of the works are carried out on road shoulders or by restricting driving on at least single lane by application of traffic regulations disseminating maintenance work information in advance through road information apparatus or signs.

The maintenance work plan can be drawn out with the frequency of activities required for the plan as shown in Appendix 8.4-4 below, because normally they are performed on a regular time cycle depending on the type of work items.

With regard to the improvement and upgrading works, their detailed plans shall be worked out based on the master plan drawn out at the head office of the motorway network system, together with the construction plan of the new routes and others.

It would be recommendable for the head office of the motorway system administrator to work out and prepare a maintenance manual, by which the regular maintenance works and periodical repair works including large scale rehabilitation shall be conducted with optimum efficiency and minimum cost.

8.5 TRAFFIC CONTROL PLAN

8.5.1 Organization and Function of Traffic Control Office

1. Functions of Traffic Control

The basic functions of traffic control of the motorways are to ensure smooth traffic flow and safety and to provide the users with traveling comfort. These functions illustrated in Figure 8.5-1 are divided into the several components and tasks, such as Traffic Control, Traffic Surveillance and Traffic Regulation & Enforcement.

It is to be mentioned that on motorways traveling speed is high and the access on entry and exit is fully controlled, which require the motorway administrator to supply information on road and traffic conditions including traffic congestion and disturbance, as well as weather. It is also indispensable to give roadside aid to car accidents and breakdowns for assuring safe and pleasant driving. At the same time, there is a social demand for a service level suited to the toll motorways, and therefore traffic control is one of the most important works requiring urgency and immediate response of all operation works.

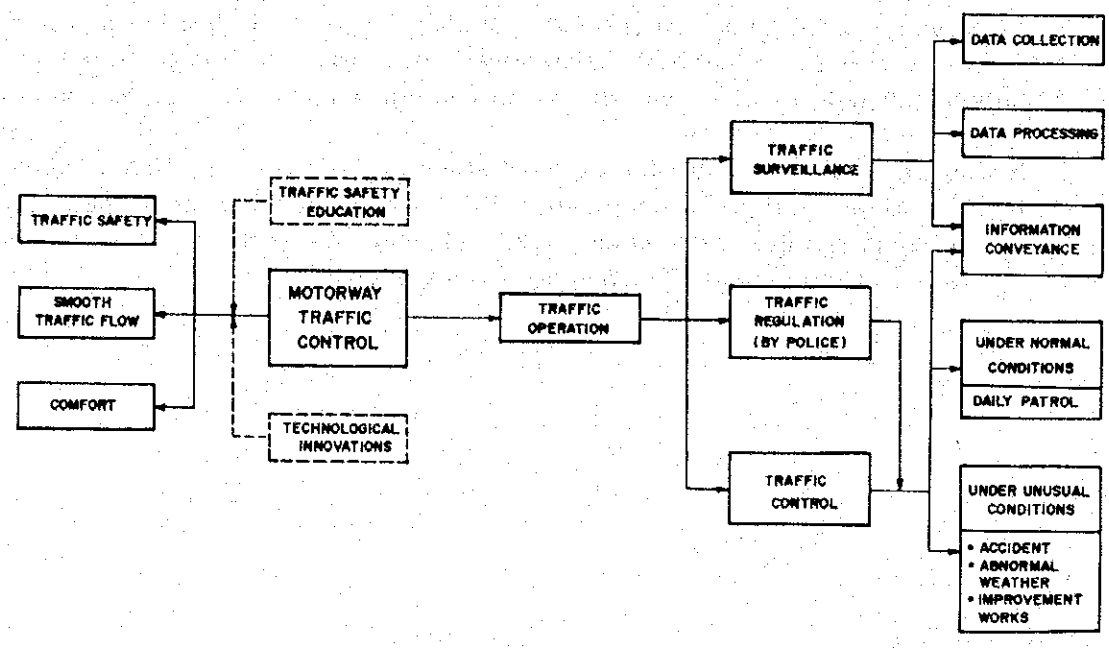


FIGURE 8.5-1 FUNCTION OF TRAFFIC CONTROL ON MOTORWAY

1) Traffic Control

The traffic control includes the general traffic control on the motorways under the normal conditions as carried out by the motorway or police patrol units, as well as those emergency measures taken for the purpose of controlling traffic under unusual conditions. The unusual conditions may include traffic accident, adverse weather (torrential rain, heavy thunderstorm concentrated at fairly small area, strong wind, fog, etc.) and such conditions may be generated from improvement works to the motorways as widening of carriageway, construction of

additional ramp, pavement repairs, etc.

The traffic control also includes dissemination of information on road, traffic, and weather conditions along with traffic accident gathered at the traffic control centers, sub-centers at the district offices or at the toll plazas. The information is to the concerned offices and sections of the motorway system, to the motorway police patrol units, fire brigades, hospitals and other coordinating organizations of the motorways, and to the drivers of the vehicles on them through such media as wireless, highway radio, changeable message signs and broadcasting, etc.

2) Traffic Surveillance

Traffic surveillance aims at collecting information on those as described in the preceding paragraph such as road and traffic conditions with the equipment like vehicle detectors, closed circuit television cameras, helicopters, emergency telephones and other means through cooperative motorists, mobile telephones, patrol vehicles, etc. Some of these equipment can produce quantitative data, while others will provide incidental and different level of information. Traffic information collected through these means is to be processed and interpreted by traffic engineers and then, passed on to the patrol and other units of the motorway system and to the traffic police for traffic control, along with to those organizations as above-mentioned.

3) Traffic Regulation and Enforcement

Traffic regulation and enforcement is generally in the jurisdiction of the police in most countries and regulate and enforce the traffic on the motorways with various control measures as stipulated by the governing traffic laws and regulations such as maximum speed limit control, temporary closure of a lane or even a section of the motorways during an emergency.

2. Organization

In order to accomplish the objectives or functions of traffic control of the motorways, an organization with a three-tier hierarchical setup, consisting of a headquarters, divisional offices and district offices with their respective roles and responsibilities as well as coordination among themselves and concerned outside organizations is indispensable.

The main tasks involved in traffic control can be divided into four items, namely planning and programming, traffic engineering, traffic operation, and coordination with related agencies and public relations.

1) Head Office

The head office is responsible for planning, development and formulation of standards, in particular of those on traffic engineering. In addition, as described in Section 8.1, it is entrusted to stipulate policy and strategy of the development and improvement of the motorway system, long and medium terms construction

and operation plans including financial plans for new constructions or improvement works, and the plans for the works to be contracted to private companies.

2) Division Office

At the divisional offices, in addition to the activities for maintenance and toll collection operations, the offices are responsible for traffic engineering studies for enhancing the efficiency and quality of traffic operations and control along with the management of the traffic control centers.

3) District Office

The district offices are mainly devoting themselves to carry out the field activities of traffic control and operations such as patrolling, inspections and accident investigations. Also, they are coordinating with the traffic police stationed in their offices for execution of law enforcement by the policy units.

The main tasks and responsibilities of traffic control system for each of the three management offices are shown in Table 8.5-1, and their detailed activities are illustrated in Appendix 8.5-1.

TABLE 8.5-1 MAIN TASKS OF TRAFFIC CONTROL SYSTEM

Main Tasks	Head Office	Division Office	Dist.Office
1. Planning and Programming	Planning	Basic Design	
2. Traffic Engineering	Development, Standard, & Planning	Survey & Data Processing	
3. Traffic Control	Policy & Planning	Management	Execution
4. Maintenance	Planning & Consultation	Supervision	Execution
5. Coordination & Public Relations	National Level	Division Level	Dist. Level

3. Traffic Control Center

Normally, traffic control work is performed in the traffic control center. The center belongs to the division office and is usually located in the same division administrative building. The center is working in close coordination with the traffic operation squads on duty in each district office and motorway traffic police units, fire brigade, rescue organs, automobile federation or association of the country, public or private wrecker operator and other organs related to the motorways.

1) Tasks and Functions

The traffic control center shall be equipped with various central equipment for gathering information on traffic and road conditions, conveyance of such information to drivers, traffic management during any non-recurrent incidents. During an incident, the traffic control center shall be the nucleus where information is re-

ceived from site, while instructions are given in return of what to do, being the most important base where requests for ambulance, fire engine, local police and other organs or facilities are conveyed by exclusive telephone lines.

The proposed tasks and responsibilities of the traffic control center are listed below.

- Communication with patrol cars on duty
- Reception of emergency telephone calls
- Communication with other organizations for help or cooperation
- Operation of graphic panel or CRT displays
- Operation of roadside traffic control equipment
- Provision of road and traffic information to road users
- Surveillance of traffic situations and compilation of traffic and incident data
- Monitoring of progress of accident disposal or other activities
- Direction of execution squadrons

2) Information Flow at the Center

The traffic information center is headed by a chief of the center who is responsible to report to the division director and staffed by appropriate number of control officers and staffs depending upon the motorway distance coverage and kind of equipment to be installed.

The flow of information at the center in terms of personnel interaction is shown in Figure 8.5-2 and the outline of traffic control and management system is shown in Appendix 8.5-2.

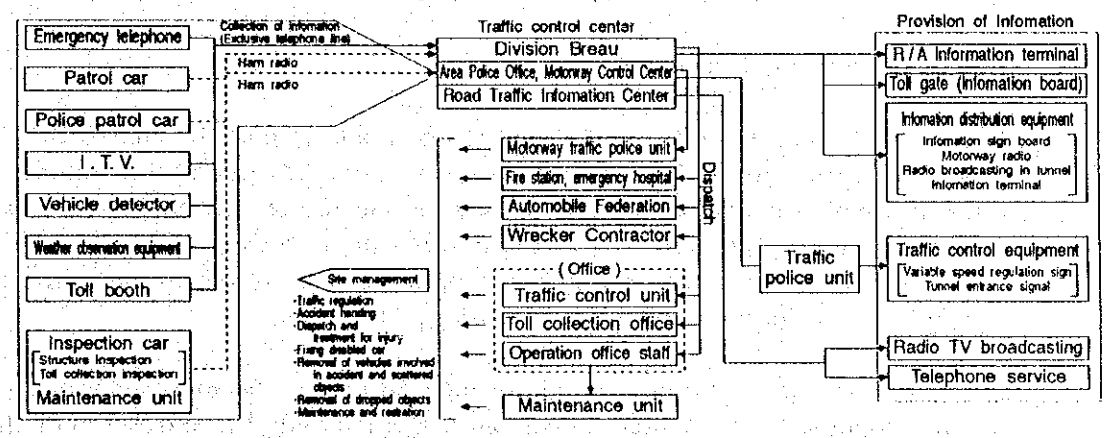


FIGURE 8.5-2 MOTORWAY TRAFFIC CONTROL TREE

8.5.2 Traffic Control System

For the purpose of efficiently manage the motorways in an organized manner, a traffic control system shall be established. The system has four major functions, namely, information collection, information processing and decision making, information dissemination and execution and enforcement of the decision. Appendix 8.5-3 depicts the concept of the system.

1. Information Collection

Traffic data and incident information are either automatically gathered through vehicle detectors, weather observatory equipment and other devices, or manually reported through emergency telephone, or radio communication system provided to patrol cars. CCTV system is also an essential tool for traffic surveillance as it furnishes system operator with image of traffic situation.

2. Information Processing and Decision-Making

Traffic control center is a kernel of the traffic control system. All information is gathered to the center where traffic management activities such as incident detection, assistance to drivers, detour implementation, special enforcement, etc. are activated through monitoring the traffic situation. According to the information and situation, decision-making as to how to recover the abnormal situation to the normal conditions of the motorway including rescue of the casualties and disposal of the damaged vehicles or road facilities.

3. Information Dissemination

Roadside information dissemination devices such as changeable message sign, motorway radio, etc. are controlled from the traffic control center so that road and traffic conditions are conveyed to road users and adverse effects by incident and congestion will be mitigated to a minimum.

Information shall also be provided through video terminal at rest areas and through telephone service, in which inquiry is answered either by operator or pre-recorded message. These facilities are capable of providing more specific information.

4. Execution and Enforcement

In case of an incident on the motorway, countermeasure must be immediately taken. There are variety of traffic control measures such as speed limit reduction in a adverse weather condition, closure of shoulder, closure of one lane, and closure of a section of motorways, etc. The traffic control must be executed in a coordinated manner by both the motorway administrator and police, for which the traffic control center is a core for overseeing such activities.

In addition to the traffic control center located at the division office, it is recommended to install a sub-center at each district office to gather and distribute data for road side equipment, to monitor certain information for prompt execution of countermeasures against incident and to back up the functions of the control center to some extent, in case of communication interruption between the center and sub-center.

Traffic control center comprises a control room where staffs are stationed and control desks, terminals and display panel are located, a machine room where computer, peripherals and other equipment are installed, a power room where an uninterruptible power supply system is placed, and other spaces such as office,

workshop, storage room, etc.

Sub-center shall comprise a control room where monitoring or control desk is installed and a terminal station where computer, peripherals and data transmission system art located.

Roadside equipment are installed at various locations along the motorway and they are controlled either by district office or by control center. Communication network is also to be established among the offices and between offices and roadside equipment. Figure 8.5-3 illustrates the location of roadside equipment and how these equipment are connected and operated.

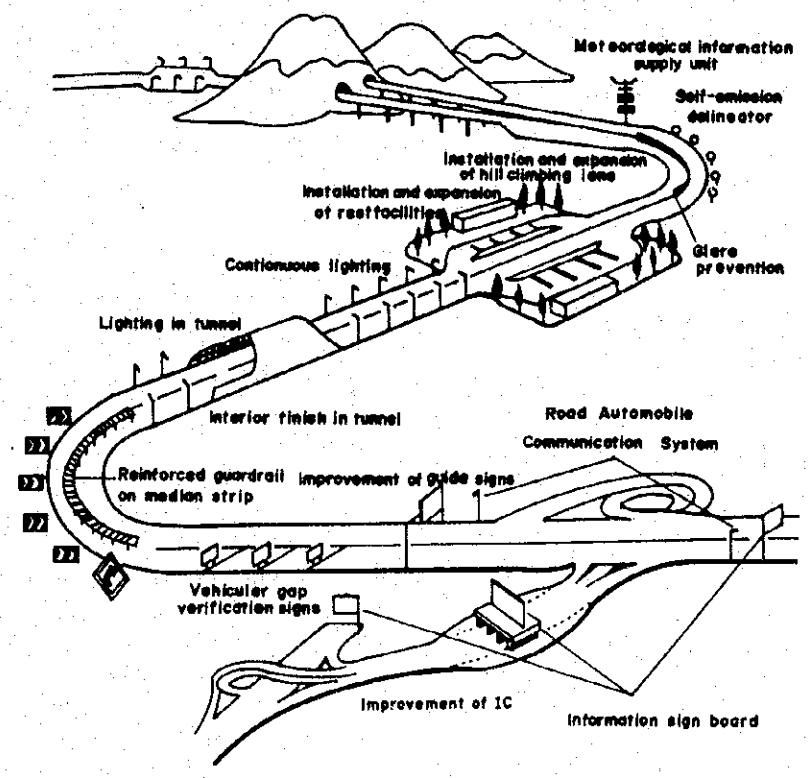
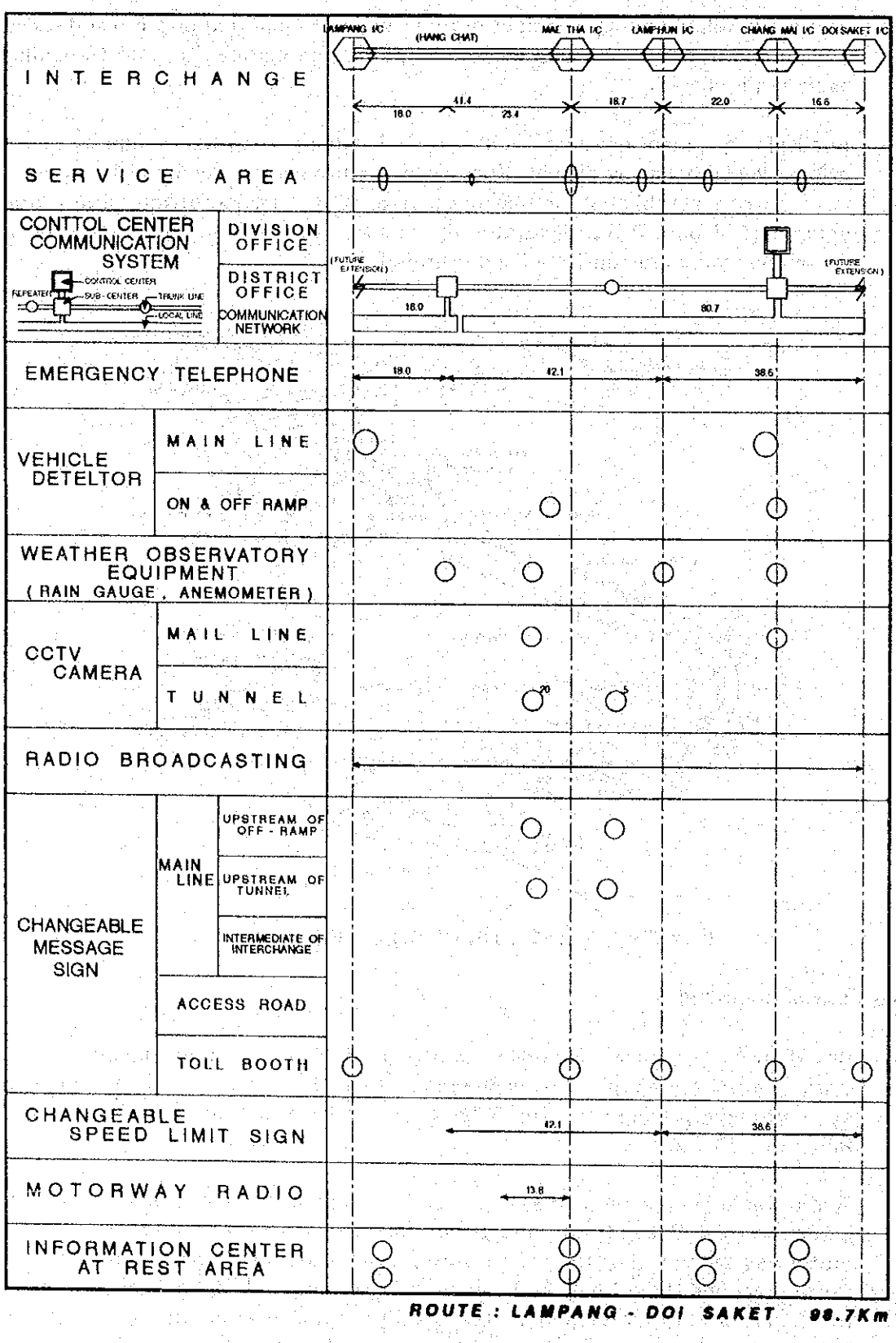


FIGURE 8.5-3 LOCATION OF ROADSIDE EQUIPMENT

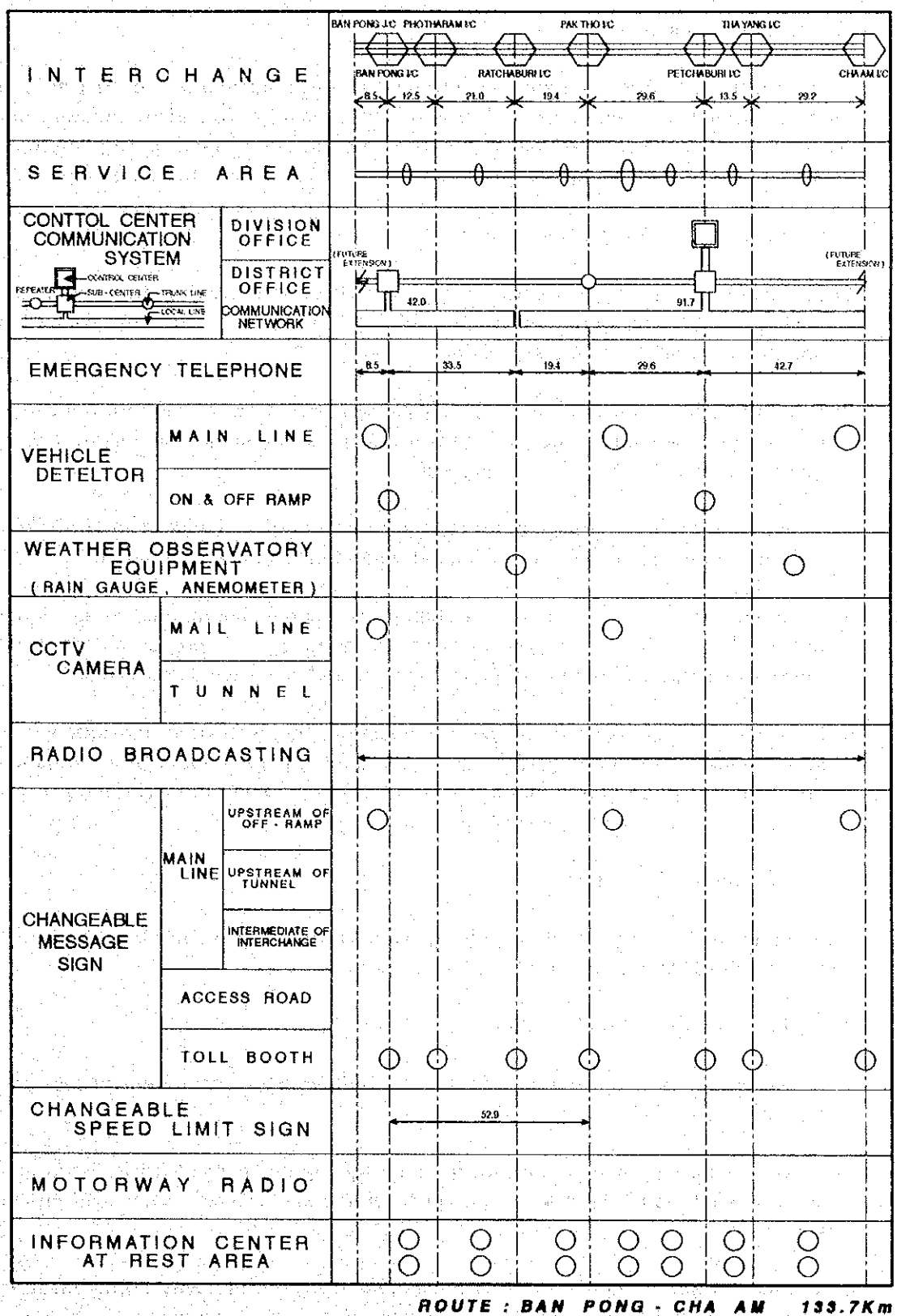
8.5.3 Traffic Control Plan

Based on the preceding discussions on the traffic control and management system, traffic control system plan has been prepared for the two sections of the motorway system, namely, Lampang - Doi Saket Route of 98.7 km and Ban Pong - Cha Am Route of 133.7 km.

Two traffic control centers shall be set up at Chiang Mai to cover 98.7 km length of Lampang - Doi Saket Route and at Petchaburi to cover 133.7 km length of the motorway system. For the former route, two sub-centers are to be installed at Chiang Mai and Hang Chat, each covering 56.2 km and 42.0 km respectively. Also for the latter route, three sub-centers shall be installed at Photharam, Paktho and Tha Yang, each covering 42.0 km, 49.4 km and 42.0 km Various types of roadside equipment and devices are to be installed as shown in the diagram in Figure 8.5-4.



FEASIBILITY STUDY ON THE INTER-CITY TOLL MOTORWAY PROJECTS	FIGURE 8.5-4a DIAGRAM OF TRAFFIC CONTROL SYSTEM



FEASIBILITY STUDY ON THE INTER-CITY TOLL MOTORWAY PROJECTS	FIGURE 8.5-4b DIAGRAM OF TRAFFIC CONTROL SYSTEM

8.6 TRAFFIC SAFETY MEASURES

8.6.1 Measures to Accidents

There are three factors to induce occurrence of traffic accidents, i.e. 1) traffic and road conditions, 2) road users and 3) vehicles. Measures to traffic accident comprises preventive measures against occurrence of accident itself and countermeasures to minimize the casualties of road users, by application of the following:

1. Improvement of Driving Conditions:

1) Provisions for night accidents; by installation of effective lighting equipment, such as continuous lighting, divisional lighting, flicker delineator, anti-glare screen and internally illuminated traffic sign.

2) Provisions for accidents on motorways with sharp curves; by installation of useful traffic signs, such as warning traffic sign, interchange guide sign, rest area guide sign and car spacing warning sign.

3) Provisions for in-tunnel accidents; by improvement of vision in the tunnel, through installation of in-tunnel illumination and in-tunnel interior board.

4) Provisions for accidents in sudden change of weather conditions; by application of remedial measures in the event of rainfall or mist, by improvement of surface water drainage, weather information collector and cross wind provisions.

5) Provisions for accidents from traffic congestion; by installation and extension of interchanges, uphill carriageway, etc., in particular, improvement of interchanges, provision of speed change lane and additional climbing lane, widening of road shoulder and emergency parking bay, etc.

2. Enhancement of Safety:

Provisions for fatal accidents resulting from breaking into the median strip; by improvement of reinforcement of median strip guard fences.

3. Optimization of Driving Environment:

1) Provisions for fatal accidents from driver's fatigue; by improvement of rest areas and their facilities.

2) Provisions for safe and smooth traffic flow; by improvement of traffic information system, such as road traffic information service and vehicle spacing information system.

In addition to above measures, it is necessary for the motorway administrator in close cooperation and coordination with related agencies and institutions such as traffic police, fire brigade, emergency hospital, public school, etc. to encourage promotion of the following operations.

4. Promotion and Establishment of Traffic Order:

1) Education of driving and traffic rules;
2) Enforcement of effective traffic guidance and control;

5. Improvement of Emergency Rescue System:

6. Improvement of Emergency Medical Service System:

7. Establishment and Improvement of Traffic Accident Analysis System:

8. Improvement of vehicle maintenance system;

8.6.2 Traffic Safety Facilities

Traffic safety facilities have been developed from the stand point of traffic engineering as well as psychological and physiological ability of ordinary drivers, in order to secure smooth and safe road traffic and effective traffic operation of the motorways. The major safety facilities are presented as follows:

1. Road Lighting Facilities:

Road lighting provides drivers with necessary visual information and also helps ease the tension associated with being at the wheel. It contributes to reducing traffic accidents at night while preventing crimes at rest areas and offering driving pleasure through enhancing the nocturnal scenic beauty along motorways. Road lighting includes continuous lighting provided along the carriageways and local lighting installed at interchanges and rest areas.

1) Continuous lighting; Continuous lighting is provided over specially designated section of an motorway with a minimal thoroughfare traffic density of 50,000 vehicles a day.

2) Local lighting; Local lighting is used at interchanges, junctions, toll-gate plazas, rest areas, parking lots and bus stops. Lighting facilities for interchanges, junctions, rest areas and parking lots are installed at diverging and merging points and ramps.

2. Tunnel Safety Facilities:

Tunnels are very liable to induce a secondary disaster once an accident occurs in them because they have limited width and space. Also, light transmittance in tunnels is apt to drop due to car exhaust causing a traffic snarl. In order to solve these problems tunnels are equipped with a variety of safety facilities and devices.

1) Ventilation facilities; The ventilation of tunnels aims at prevention of air contamination in these tunnels caused by the exhaust gas from passing vehicles. The facilities are installed in a tunnel unable to improve the inside environment to a standard level, either by natural wind produced by weather conditions or traffic

wind generated by the vehicles passing through the tunnel. The ventilation system of a tunnel is carefully studied and determined at the very initial stage of designing the tunnel as to which system being adopted, which is one of the very important factors for determination of the excavation cross section of the tunnel and affects the project as a whole.

There are many types of ventilation system for tunnels, such as transverse system, semi-transverse system, longitudinal system including Saccardo type, vertical shaft type, centralized exhaust type and electrostatic precipitator type.

2) Tunnel lighting facilities; Lighting facilities in tunnels provide a very effective means of improving driving safety and preventing traffic accidents in tunnels. Power failure for lighting and other facilities in tunnels can be very dangerous for drivers traveling through tunnels. An emergency lighting system from the secondary electric power supply facilities shall be provided to preclude a potential hazard for those tunnels longer than 200 m.

3. Meteorological Information Facilities:

The meteorological information facilities are used to gather the weather information necessary to prepare for bad weather and sudden change of climate conditions, and to advise these to the drivers.

The facilities include many kinds of equipment installed along the motorways. The meteorological data to be gathered are atmospheric temperature, road surface temperature, amount of rain, wind direction and velocity. The observation instruments to measure these factors are handled as one unit. Instruments measuring visibility of atmosphere are used also, depending on the local weather conditions and motorway administration status.

The main instruments are thermometer for temperature, precipitation gauge or detector for rain, CCTV and transmissometer for fog, wind direction and velocity indicator for wind and so on.

4. Measuring Instruments:

In order to maintain the integrity of the motorways and to prevent traffic hazards, height, axle weight and overall weight of the vehicles are to be checked.

1) Vehicle height checking device; Vehicle height checkers are to be installed at the entrance ramp of every start/end barrier of all interchanges to enforce the traffic regulations on all vehicles.

2) Axle weight scale; Axle weight scales are to be installed in front of toll gates at interchanges.

3) Vehicle weight scale; In general, vehicle weight scales are used to re-check the weight of vehicles measured by the axle weight scale, and to check the gross weight which are to be installed at entrance and end of barriers and interchanges

where large truck traffic is heavy.

5. Road Drainage:

Rain water often submerges portions of the ground lower than their surroundings. To prevent this, motorways are so designed that rain water may be drained along natural grades. Where no natural grade is available due to geographical restrictions, pumps are to be installed to drain rain water.

8.6.3 Traffic Safety and Safe Driving

In order to stimulate awareness of the importance of traffic safety and safe driving by the road users, especially those drivers on long-distance inter-city motorways to be newly introduced to the Kingdom, it is strongly recommended to prepare and conduct traffic safety campaign and guidance for introduction, development and improvement of traffic safety and safe driving.

1. Traffic Safety Campaign:

For traffic safety campaign, the following activities are proposed:

- Public relations activities of the motorways administrator;
- Publicity of "Motorways" to road users;
- Preparation of motorways maps;
- Traffic safety campaign on motorway driving;

2. Guidance to Safe Driving:

For improvement of safe driving on motorways, preparation, distribution and dissemination of the following are recommended:

- Guide book on safe driving on motorways;
- Introduction of safety guidance on motorways;
- Holding of traffic safety symposium;
- Other related activities by the motorway administrator;

CHAPTER 9

COST ESTIMATES

CHAPTER 9

COST ESTIMATES

9.1 GENERAL

9.1.1 Procedure for Cost Estimates

The project cost was estimated on the basis of the preliminary design and construction planning.

The base unit cost of labor, materials and construction equipment were estimated using the data collected in the Master Plan Study, and reexamined and updated with the information presented by DOH.
The unit cost of each work item basis was calculated using base unit cost. Then finally the unit cost was settled with two components of foreign currency portion and local currency portion.

The other hand, construction contract packages were assumed in connection with construction planning. Mass hauling of Lampang - Doi Saket Route was studied because the projected route is mountainous terrain. Then construction quantities were summarized on the basis of each package.

Finally the construction cost was calculated using above unit cost and quantites. Then the project cost was summarized including maintenance and operation costs, land acquisition cost and engineering cost.

9.1.2 Components of the Project Cost

The basic component of the project cost include:

- Construction cost
- Physical Contingency
- Maintenance and Operation costs
- Land Acquisition cost
- Engineering and Supervision costs

9.1.3 Conditions of Project Cost Estimate

The cost estimate was executed in accordance with the following basic assumptions and conditions:

1) The project cost is based on the prices in the month of November, 1994.

2) The exchange rate of currency is:

US$1.0 = 98.18 Yen = 25.01 Baht (1.0 Baht = 3.93 Yen)
As of the end of November, 1994

3) The unit price is divided into foreign currency portion and local currency portion. The foreign and local component consists of the following items:

a) Foreign currency component;

- Imported equipment, materials and supplies,
- Imported materials in the local market, and
- Wages of expatriate personnel.

b) Local currency component;

- Domestic materials and supplies,
- Wages of local personnel, and
- Tax.

4) Land acquisition cost is calculated on the basis of unit cost presented by Land Acquisition Division of DOH.

5) Contingency of project is assumed at 10 % of the total of construction cost.

6) The cost of engineering service is assumed at 6% for Lampang - Doi Saket Route, and 4% for Bang Pong - Cha Am Route, of the construction cost.

9.1.4 Availability of Local Materials

Thailand has already experienced constructions of expressway and possesses almost sufficient technology for it. Except some construction equipment and special facilities such as of tunnel, Thailand is able to product most of materials for construction of expressway.

Regarding to earth work, according to the previous NATURAL CONDITION SURVEY report, submitted in February 1994, availability of local materials is as follows;

1) For Lampang - Doi Saket Route, four(4) promised borrow areas are exist along the projected route and materials from excavation section is also available, and

2) For Bang Pong - Cha Am Route, five(5) promised borrow areas are exist along the projected route.

9.2 UNIT COST ANALYSIS

9.2.1 Components of Unit Cost of Work Items

The unit cost of work items itself were devided three parts, as foreign currency, local currency and tax. According to cost estimate system in Thailand, base cost of the unit cost is multiplied by factor F, according to construction cost and time, separately roadwork and structural work, as shown in Table 9.2-1.

TABLE 9.2-1 MULTIPLE FACTOR

	Overhead (%)	Contingency (%)	Interest (%)	Profit (%)	Sum.	VAT (7%)	Factor F
Roadwork (Case of > 500 M Baht > 24 Months)	2.0148	6.00	2.40	6.50	1.1691	0.0818	1.2510
Structural work (Case of > 200 M Baht > 21 Months)	1.5778	5.00	5.33	8.33	1.2024	0.0842	1.2866

9.2.2 Labor Costs

Based on the data collected, the unit labor cost was set up as shown in Table 9.2-2.

TABLE 9.2-2 LABOR COST

Item	Unit Price (Baht) per day	per hour
Foreman	300	37.5
Operator	500	62.5
Driver	250	31.0
Labor	180	22.5

9.2.3 Costs of Construction Materials

The cost of major materials for construction was derived after discussions with DOH. A list of the cost of major materials is presented Appendix 9.2-1, including their currency portion.

9.2.4 Costs of Construction Equipment

Breakdown of major construction equipment owing and operation cost is presented in Appendix 9.2-2. On the basis of this table, the currency potion was assumed as shown in Table 9.2-3.

TABLE 9.2-3 CURRENCY PORTION OF CONSTRUCTION EQUIPMENT (ASSUMED)

Cost Item	Item	F/C	L/C	Remarks
Operation Cost	Oprerator	0%	100%	
	Fuel	0%	100%	
	Lube	0%	100%	
	Inv. Cost	100%	0%	
	Mtn. Cost	70%	30%	(F/C:L/C=7:3)
	Other Parts	100%	0%	
Depreciation Cost		100%	0%	

9.2.5 Unit Cost of Work Items

The unit cost of each work item was calculated on the basis of labor cost, material cost and operation cost of equipment including contractor's overhead and profit that described at 9.2.1. As described at 9.1.4, there are borrow area along the projected routes, average hauling distance was assumed twenty(20) km. The calculation was also made taking into consideration the currency portion.

The unit cost of each work item is shown in Table 9.2-4 for roadworks and Table 9.2-5 for bridge works. Results of detailed calculation are presented in Appendices 9.2-3, 9.2-4 and 9.2-5.

TABLE 9.2-5 UNIT COST OF BRIDGE WORKS AND ITS CURRENCY PORTION

No.	Item	Type	Unit	Unit Cost(Baht)					Remarks	
				F/C	%	L/C	%	Total		
1	Super-structure	RC A	sqm	3,600	42.0%	5,000	58.0%	8,600	RC slab	
2		PC B-1	sqm	4,000	54.0%	3,400	46.0%	7,400	l <=25m	
3		PC B-2	sqm	4,600	55.0%	3,700	45.0%	8,300	25< l <30	
4		PC B-3	sqm	5,900	57.0%	4,400	43.0%	10,300	30<= l <=35	
5		PC B-4	sqm	9,700	60.0%	6,500	40.0%	16,200	35< l <=50	
6		MC	sqm	58,800	88.0%	8,300	12.0%	67,100	50< l <100	
7	Sub-structure	A-1	each	293,100	36.0%	526,700	64.0%	819,800	Abutment	L-D Route
8		A-2	each	102,900	37.0%	178,600	63.0%	281,500	Pier	L-D Route
9		A-3	each	322,300	36.0%	573,300	64.0%	895,600	Abutment	B-C Route
10		A-4	each	122,500	37.0%	212,200	63.0%	334,700	Pier	B-C Route
11		B-1	each	240,600	37.0%	403,100	63.0%	643,700	l <=25m	
12		B-2	each	517,900	37.0%	868,900	63.0%	1,386,800	30<= l <40	
13		B-3	each	838,500	37.0%	1,408,300	63.0%	2,246,800	40<= l <=50	
14		C	each	417,200	37.0%	699,200	63.0%	1,116,400	L-D Route	
15		D-1	each	518,200	37.0%	867,800	63.0%	1,386,000	L-D Route	
16		D-2	each	830,600	37.0%	1,392,000	63.0%	2,222,600	B-C Route	
17		E	each	653,700	37.0%	1,098,600	63.0%	1,752,300	B-C Route	
18		F-1	each	2,860,600	40.0%	4,289,700	60.0%	7,150,300	35<= H <=45	
19		F-2	each	1,672,900	40.0%	2,521,800	60.0%	4,194,700	25<= H <=35	
20	Foundation	C-1	each	616,800	80.0%	154,200	20.0%	771,000	dia.1.0, lm=120m	(F/C:L/C=7:3)
21		C-2	each	707,200	80.0%	176,800	20.0%	884,000	dia.1.2, lm=120m	(F/C:L/C=7:3)
22		C-3	each	718,400	80.0%	179,600	20.0%	898,000	dia.1.5, lm=90m	(F/C:L/C=7:3)
23		D	each	1,038,800	70.0%	445,200	30.0%	1,484,000	V=539.154cum	(F/C:L/C=7:3)
24		E	each	662,200	70.0%	283,800	30.0%	946,000	dia.3.0, lm=16m	(F/C:L/C=7:3)

TABLE 9.2-4 UNIT COST OF BRIDGE WORKS AND ITS CURRENCY PORTION

Work Items	Discription Class	Unit	Unit Cost(Baht) F/C	%	L/C	%	Total	Remarks
1.Preparation Works								
(1)Clearing	catchpoint	sqm	1.04	52.0%	0.96	48.0%	2.00	
(2)Grubbing (Rolling & Mt. Area)	t=1.0 m	sqm	2.40	60.0%	1.60	40.0%	4.00	
2.Foundation Improvement Works								
(1)Cement Stabilization	t=2.0 m	sqm	132.00	33.0%	268.00	67.0%	400	Mixing and compaction only
(2)Bearing Unit Piles		sqm	800	40.0%	1,200	60.0%	2,000	
3.Roadway Excavation								
(1)Common		cum	66.00	66.0%	34.00	34.0%	100	Hauling 20 km
(2)Soft Rock		cum	99.00	66.0%	51.00	34.0%	150	Hauling 20 km
(3)Hard Rock		cum	123.50	65.0%	66.50	35.0%	190	Hauling 20 km
(4)Unsuitable Material(Grubbing)		cum	39.60	66.0%	20.40	34.0%	60	Hauling 10 km
4.Embankment								
(1)Common		cum	8.55	57.0%	6.45	43.0%	15.00	Irm Excv., compaction only
(2)Borrow Material		cum	121.50	45.0%	148.50	55.0%	270	Hauling 20 km
(3)Removal of Surplus soil		cum	39.60	66.0%	20.40	34.0%	60	Bank Volume, Hauling 10 km
5.Pavement								
(1)Concrete Pavement	t=25 cm	sqm	288.10	43.0%	381.90	57.0%	670	Included Joints
(2)Concrete Pavement	t=30 cm	sqm	327.60	42.0%	452.40	58.0%	780	Included Joints
(3)Asphalt Concrete Wearing	t=5 cm	sqm	101.50	70.0%	43.50	30.0%	145	Included Prime Coat
(4)Soil Aggregate Subbase Course		cum	170.00	50.0%	170.00	50.0%	340	Hauling 20 km
(5)Crushed Rock Base Course		cum	226.80	42.0%	313.20	58.0%	540	Hauling 20 km
6.Plantation								
(1)Buffer Zone		sqm	12.00	24.0%	38.00	76.0%	50	
(2)Median/Gardening		sqm	20.00	25.0%	60.00	75.0%	80	
(3)Grassing		sqm	4.60	23.0%	15.40	77.0%	20	
7.Slope Protection Works								
(1)Seeding		sqm	2.20	22.0%	7.80	78.0%	10	
(2)Sodding		sqm	4.20	21.0%	15.80	79.0%	20	
(3)Protection Frame with Sack		sqm	720	72.0%	280	28.0%	1,000	
8.Bridge Works								
(1)Viaduct(L-D Route)				74.0%		26.0%	special	
(2)Viaduct(B-C Route)				55.0%		45.0%	special	
(3)Bridges(6 Lanes)				42.0%		58.0%	special	
(4)Bridges(4 Lanes)				42.0%		58.0%	special	
(5)Bridges(Rampway 2 Lanes)				42.0%		58.0%	special	
(6)Bridges(Rampway 1 Lanes)				42.0%		58.0%	special	
(7)Over Bridge(L-D Route)	l =120m	each	6,345,000	46.0%	7,406,000	54.0%	13,751,000	
(8)Over Bridge(B-C Route)	l =170m	each	8,455,000	47.0%	9,571,000	53.0%	18,026,000	
(9)Over Bridge(cut section)	l =50m	each	3,083,000	46.0%	3,603,000	54.0%	6,686,000	
(10)Canal Bridge	l =35m	each	2,185,000	51.0%	2,101,000	49.0%	4,286,000	
9.Tunnel Works				72.0%		28.0%	special	
10.Miscellaneous Works								
(1)Re-located Road		m	3,600	60.0%	2,400	40.0%	6,000	(F/C:L/C=6:4)
(2)Re-located Water Way		m	3,300	60.0%	2,200	40.0%	5,500	(F/C:L/C=6:4)
(3)Construction Road for Tunnel		m	2,580	60.0%	1,720	40.0%	4,300	(F/C:L/C=6:4)
11.Retaining Wall Works				30.0%		70.0%		(0.6% of SUBTOTAL(a))
(1)T-type Retaining Wall	H=8.0m	m	22,300	37.2%	37,700	62.8%	60,000	
(2)Leaning Retaining Wall	H=8.0m	m	9,200	32.0%	19,900	68.0%	29,100	
(3)Gravity Retaining Wall	H=3.0m	m	2,400	30.0%	5,600	70.0%	8,000	
(4)Concrete Block Mesonry	H=5.0m	m	2,700	35.0%	5,000	65.0%	7,700	
12.Culvert Works				25.0%		75.0%		(0.5% of SUBTOTAL(a))
(1)Box Culvert								
	2.0x1.5	m	5,800	34.0%	11,100	66.0%	16,900	Included Head wall
	3.0x1.2	m	6,700	34.0%	12,900	66.0%	19,600	Included Head wall
	3.0x1.5	m	7,000	34.0%	13,800	66.0%	20,800	Included Head wall
	3.5x1.5	m	7,900	34.0%	15,100	66.0%	23,000	Included Head wall
	3.5x1.8	m	8,800	34.0%	16,800	66.0%	25,600	Included Head wall
(2)Pipe Culvert								
	Dia. 1.0	m	1,220	50.0%	1,220	50.0%	2,440	Incl. Head wall (F/C:L/C=1:1)
	Dia.1.0 x 2	m	2,420	50.0%	2,420	50.0%	4,840	Incl. Head wall (F/C:L/C=1:1)
	Dia. 1.5	m	1,880	50.0%	1,870	50.0%	3,750	Incl. Head wall (F/C:L/C=1:1)
	Dia.1.5 x 2	m	3,750	50.0%	3,750	50.0%	7,500	Incl. Head wall (F/C:L/C=1:1)
13.Drainage Works		l.s.		50.0%		50.0%		0.5%(1.0%) of SUBTOTAL(a)
14.Road Sign		l.s.		80.0%		20.0%		0.3% of SUBTOTAL(a)
15.Road Marking		l.s.		70.0%		30.0%		0.2% of SUBTOTAL(a)
16.Lighting								
(1)IC/JC Section		l.s.		75.0%		25.0%		3.5% of SUBTOTAL(a)
(2)Other Section		each	15,000	75.0%	5,000	25.0%	20,000	(F/C:L/C=6:4)
17.Safety Facility Works		l.s.		50.0%		50.0%		1.0% of SUBTOTAL(a)
18.Environmental Protection		l.s.		50.0%		50.0%		1.0% of SUBTOTAL(a)
19.Rest Area		each	33,750,000	50.0%	33,750,000	40.0%	67,500,000	(F/C:L/C=6:4)
20.Bus Stop		each	1,750,000	50.0%	1,750,000	40.0%	3,500,000	(F/C:L/C=6:4)
23.Maintnance & Operation		l.s.		60.0%		40.0%		2% of SUBTOTAL(b)
24.Land Acquisition		l.s.		0.0%		100.0%		
25. Engineering & Supervision		l.s.		40.0%		60.0%		4(6)% of TOTAL(d)

9.3 CONSTRUCTION QUANTITIES

9.3.1 Contract Packages Assumed

Contract packages were assumed that 12 packages for Lampang - Doi Saket Route and 15 packages for Bang Pong - Cha Am Route, in connection with construction planning. Basic policies of dividing into each package are as follows;

a) Roadway section and connection facilities section were divided at end of speed change lane,

b) For section of No.1 tunnel, the two tunnels (named A&B line) were separated to two contract packages (namely T1 and T2), to reduce construction duration,

c) No.3 tunnel is one independent package (namely T3) including two tunnels,

d) For six(6) lanes roadway of Bang Pong - Cha Am Route, maximum package length was limited to twenty(20) km.,

e) For four(4) lanes roadway of Lampang - Doi Saket Route, maximum package length was limited to twenty(30) km., and

f) Quantities of Doi Saket Inter Change was not calculated because the Inter Change is not constructed at this stage.

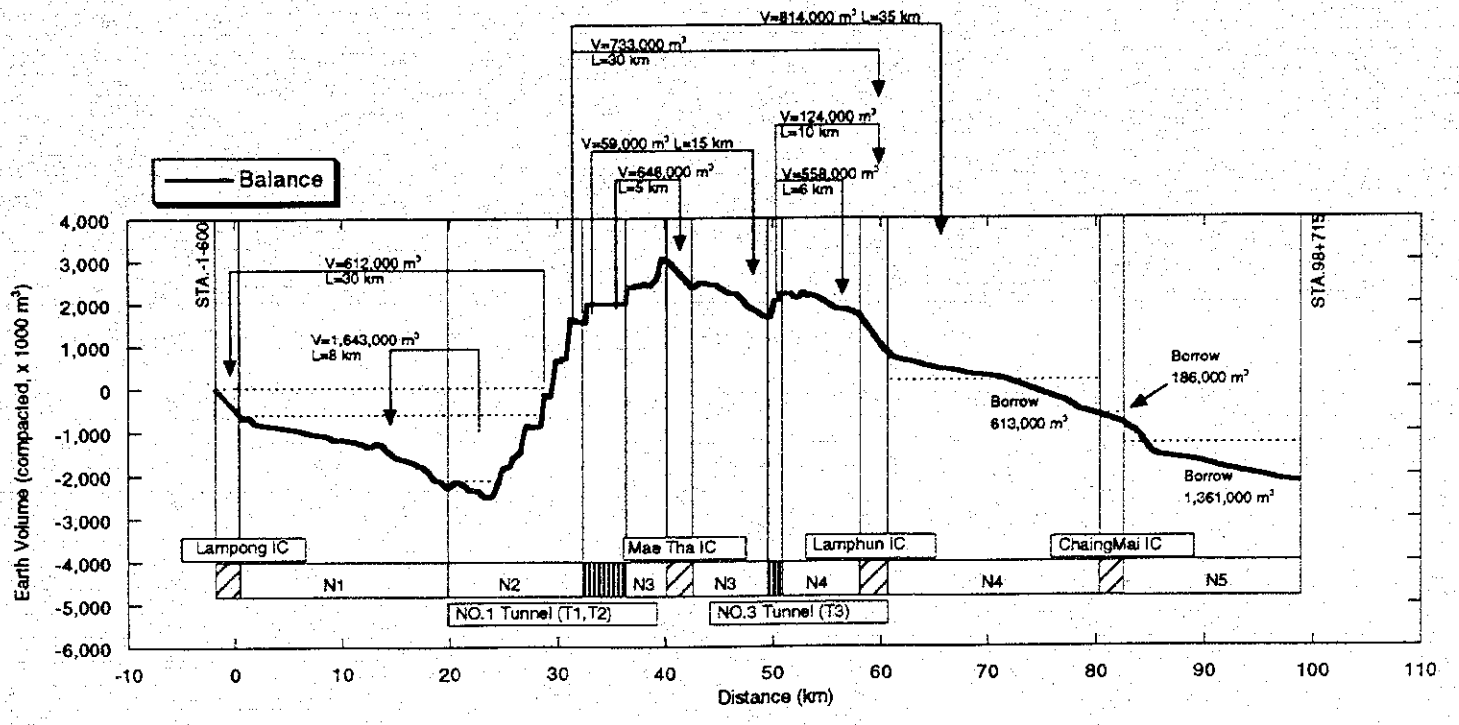
Each package name and their locations are readable such as Table 9.3-1.

9.3.2 Mass Hauling

Lampang - Doi Saket Route has mountainous terrain where to be excavated. These excavated materials are suitable for embankment according to NATURAL CONDITION SURVEY. Therefore, to utilize these volume for embankment, mass hauling was considered as shown in Figure 9.3-1 and Appendix 9.3-1. According to mass haul calculation, average hauling distance was assumed twenty(20) km. between excavation packages and embankment packages.

9.3.3 Estimated Construction Quantities

Construction quantities were calculated on the basis of preliminary design according to each contract package basis described above. Summary of major works quantities is shown in Table 9.3-1. Detailed quantities calculation is presented in Appendices 9.3-2, 9.3-3, and 9.3-4.



FEASIBILITY STUDY
ON
THE INTER-CITY TOLL MOTORWAY PROJECTS

FIGURE 9.3-1
MASS HAUL OF LAMPONG - DOISAKET ROUTE

TABLE 9.3-1 (a) SUMMARY OF MAJOR WORKS QUANTITIES (LAMPANG - DOI SAKET)

Work Items	Unit/ type	Lampang IC (0+000)	Contract Package for Roadway (CPR)				Mae Tha IC (41+400)	CPR		Lamphun IC (60+140)	ChiangMai IC (82+155)	CPR	TOTAL
			N1	N2	T1T2	N3		T3	N4			N5	
		DT	Flat	Mountainous	Tunnel	Mountainous	ST	Tunnel	Flat	DT	DT	Flat	
Start station		-1-600	0+300	20+000	32+400	36+500	40+300	49+600	50+770	58+000	80+200	82+500	
End station		0+300	20+000	32+400	36+500	49+600	42+700	50+770	80+200	60+600	82+500	98+714	
Section Length	km	1.90	19.70	12.40	4.10	10.70	2.40	1.17	26.83	2.60	2.30	16.214	100.3140
1.Preparation Works	sqm	404,000	847,000	613,000	28,000	445,000	322,000	53,000	1,189,000	294,000	406,000	706,000	5,307,000
3.Roadway Excavation	cum	0	204,000	5,845,000	194,000	1,253,000	195,000	549,000	290,000	0	0	4,000	8,534,000
4.Embankment	cum	612,000	1,802,000	1,073,000	19,000	1,098,000	800,000	23,000	2,211,000	857,000	186,000	1,364,000	10,045,000
5.Pavement	sqm	101,000	431,000	233,000	6,000	188,000	112,000	10,000	604,000	78,000	62,000	120,000	1,945,000
6.Plantation	sqm	265,000	377,000	205,000	7,000	171,000	72,000	11,000	535,000	142,000	220,000	105,000	2,110,000
7.Slope Protection Works	sqm	30,000	200,000	242,000	11,000	129,000	60,000	18,000	273,000	35,000	10,000	136,000	1,144,000
8.Bridge Works													
(1)Viaduct(L-D Route)	ea/m	0	3/1520	12/3095	0	12/3830	3/760	0	5/2110	1/1320	1/650	1/80	35/13,365
(4)Bridges(4 Lanes)	ea/m	0	9/225	3/190	0	0	0	0	12/466	0	2/55	3/155	29/1091
9.Tunnel Works	m	0	0	0	7,640	0	0	1,470	0	0	0	0	9,110
19.Rest Area	ea	0	1	1	0	0	1	0	2	0	0	1	6
20.Bus Stop	ea	1	1	1	0	1	0	0	1	1	1	1	8
24.Land Acquisition	sqm	466,000	1,189,000	829,000	38,000	667,000	358,000	65,000	1,622,000	294,000	486,000	973,000	6,987,000

TABLE 9.3-1 (b) SUMMARY OF MAJOR WORKS QUANTITIES (BANG PONG - CHA AM)

Work Items	Unit	Ban Pong JC (0+000)	CPR S1	Ban Pong IC (8+460)	Photharam IC (21+000)	CPR S2	Rachaburi IC (42+000)	CPR S3	Pak Tho IC (61+445)	CPR S4	CPR S5	Phetchaburi IC (91+000)	Tha Yang IC (104+512)	CPR S6	CPR S7	Cha Am IC (133+736)	TOTAL
		TB	Flat	DT	DT	Flat	ST	Flat	DT	Flat	Flat	ST	ST	Flat	Flat	ST	
Start sta		0+000	1+900	6+750	19+400	22+500	39+600	42+300	60+650	62+300	82+000	89+800	103+450	105+400	120+000	132+200	
End sta		1+900	19+400	9+400	22+500	39+600	42+300	60+650	62+300	82+000	103+450	91+800	105+400	120+000	132+200	134+300	
Section Length	km	1.90	14.85	2.65	3.10	17.10	2.70	18.35	1.65	19.70	19.45	2.00	1.95	14.60	12.20	2.10	134.3000
1.Preparation Works	sqm	376,000	760,000	338,000	416,000	895,000	166,000	966,000	293,000	1,022,000	1,014,000	350,000	344,000	786,000	610,000	428,000	8,764,000
2.Foundation Improvement Works	sqm	0	0	0	0	796,000	255,000	979,000	160,000	1,071,000	284,000	0	0	0	0	0	3,545,000
3.Roadway Excavation	cum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4.Embankment	cum	612,000	612,000	612,000	612,000	612,000	612,000	612,000	612,000	612,000	612,000	612,000	612,000	612,000	612,000	612,000	9,180,000
5.Pavement	sqm	67,000	427,000	53,000	52,000	526,000	89,000	571,000	64,000	590,000	577,000	115,000	91,000	455,000	358,000	111,000	4,148,000
6.Plantation	sqm	225,000	284,000	206,000	247,000	352,000	112,000	380,000	204,000	393,000	385,000	225,000	162,000	303,000	239,000	310,000	4,027,000
7.Slope Protection Works	sqm	16,000	172,000	16,000	13,000	169,000	33,000	189,000	17,000	215,000	220,000	23,000	53,000	168,000	119,000	21,000	1,444,000
8.Bridge Works																	
(2)Viaduct(B-C Route)	ea/m	1/1200	1/1200	1/2650	1/3100	4/87	1/1400	1/36	1/1050	4/850	2/1000	0	2/1200	1/12	1/800	0	21/14,585
(3)Bridges(6 Lanes)	ea/m	0	8/107	0	0	7/236	0	15/199	0	11/127	9/126	0	0	8/136	2/33	0	60/984
19.Rest Area	l.s.	0	1	0	0	1	0	1	0	1	2	0	0	0	1	0	7
20.Bus Stop	l.s.	1		1	1	0	1	0	1	1	0	1	1	1	1	1	11
24.Land Acquisition	sqm	503,000	1,040,000	465,000	537,000	1,197,000	467,000	1,285,000	386,000	1,379,000	1,362,000	338,000	243,000	1,022,000	854,000	375,000	11,453,000

9.4 PROJECT COST

9.4.1 Construction Cost

The construction cost was estimated by using the construction quantities of each package and unit cost of each work item. The construction cost was divided into foreign currency portion and local currency portion according to the unit cost currency portion.

Table 9.4-1 shows summary of the construction cost. Detailed construction costs are presented in Appendices 9.4-1, 9.4-2 and 9.4-3.

9.4.2 Maintenance and Operation Costs

This cost item was assumed for initial investment for system installation of maintenance and operation of the expressway. At the stage of completion of expressway networking in the future, there would be different organization for total system. However, at this stage, initial investment was estimated independently for both routes.

The system installation cost estimated using the data collected from Japan, Malaysia, and ETA (Expressway and Rapid Transit Authority of Thailand) intra-city expressway in Bangkok. This cost strongly depend on the service level of the expressway. Target service level was assumed as including installation of some maintenance facilities, operation and administration systems and purchase of some equipment.

Referencing the case of Japan's initial stage, 2 % of construction cost was applied for maintenance and operation cost.

9.4.3 Land Acquisition Cost

Based on land acquisition unit cost as of 1991, from Land Acquisition Division of DOH, land acquisition cost was calculated with considering recent rapid increasing.

9.4.4 Estimated Project Cost

Summary of estimated project cost including construction cost, maintenance and operation costs, land acquisition cost and engineering and supervision costs is presented in Table 9.4-1 and 9.4-2. Detailed project cost of each contract package basis is presented in Appendix 9.4-1.

9.4.5 Currency Portion and Work Cost Portion of Project Cost

Table 9.4-3 shows currency portion and work cost portion of the project cost.

TABLE 9.4-1 (a) SUMMARY PROJECT COST (LAMPANG - DOI SAKET)

(1000 Baht)

Work Items	Unit/ type	Lampang IC (0+000)	Contract Package for Roadwork(CPR) N1	N2	T1T2	N3	Mae Tha IC (41+400)	CPR T3	N4	Lamphun IC (60+140)	ChiangMai IC (82+155)	CPR N5	TOTAL	Remarks
		DT	Flat	Mountainous	Tunnel	Mountainous	ST	Tunnel	Flat	DT	DT	Flat	(baht)	
Start station		-1+600	0+300	20+000	32+400	36+500	40+300	49+600	50+770	58+000	80+200	82+500		
End station		0+300	20+000	32+400	36+500	49+600	42+700	50+770	80+200	60+600	82+500	98+714		
Section Length	km	1.90	19.70	12.40	4.10	10.70	2.40	1.17	26.83	2.60	2.30	16.214	100.3140	
1.Preparation Works	sqm	808	1,904	2,452	111	1,779	722	210	3,004	589	812	1,412	13,803	
3.Roadway Excavation	cum	60	26,742	695,059	23,611	166,412	19,560	65,409	47,780	60	60	411	1,045,164	Hauling 20 km
4.Embankment	cum	165,240	27,025	16,088	50,156	31,531	177,152	33,751	539,159	231,390	50,220	367,505	1,689,217	
5.Pavement	sqm	70,115	311,825	168,373	4,689	135,809	76,876	7,294	437,023	54,462	39,548	86,922	1,392,936	
6.Plantation	sqm	6,595	22,624	12,312	433	10,413	2,730	673	32,260	3,971	4,404	6,307	102,722	
7.Slope Protection Works	sqm	596	3,870	161,521	9,585	33,995	1,194	11,747	5,300	690	200	2,725	231,423	
8.Bridge Works	m	7,531	899,362	2,786,768	0	3,045,453	1,154,601	0	1,667,915	630,117	381,442	153,944	10,727,133	
9.Tunnel Works	l.s.	0	0	0	2,998,288	0	0	666,507	0	0	0	0	3,664,795	
10.Misellanous Works	l.s.	0	35,880	0	86,000	0	0	8,600	30,480	0	1,760	27,840	190,560	
SUBTOTAL(a)		250,945	1,329,232	3,842,573	3,172,873	3,425,392	1,432,835	794,191	2,762,921	921,279	478,446	647,066	19,057,753	
11.Retaining Wall Works	m	1,506	8,282	64,900	16,629	37,371	8,597	146	7,700	5,528	2,871	27,050	180,580	
12.Culvert Works	m	1,255	27,200	9,583	412	5,984	7,164	635	39,472	4,606	2,392	9,404	108,107	
13.Drainage Works	l.s.	1,255	6,646	38,426	873	34,254	7,164	638	13,815	4,606	2,392	3,235	113,304	0.5% of SUBTOTAL(a)*1
14.Road Sign	l.s.	753	3,988	11,528	524	10,276	4,299	383	8,289	2,764	1,435	1,941	46,180	0.3% of SUBTOTAL(a)
15.Road Marking	l.s.	502	2,658	7,685	349	6,851	2,866	255	5,526	1,843	957	1,294	30,786	0.2% of SUBTOTAL(a)
16.Lighting	l.s.	8,783	2,800	8,200	0	7,000	50,149	800	3,400	32,245	16,746	1,000	131,123	
17.Safety Facility Works	l.s.	2,509	13,292	38,426	1,746	34,254	14,328	1,277	27,629	9,213	4,784	6,471	153,929	1.0% of SUBTOTAL(a)
18.Environmental Protection	l.s.	2,509	13,292	38,426	1,746	34,254	14,328	1,277	27,629	9,213	4,784	6,471	153,929	1.0% of SUBTOTAL(a)
19.Rest Area	each	0	67,500	67,500	0	0	67,500	0	135,000	0	0	67,500	405,000	
20.Bus Stop	each	3,500	3,500	3,500	0	3,500	0	0	3,500	3,500	3,500	3,500	28,000	
SUBTOTAL (b)		273,517	1,478,390	4,130,747	3,195,152	3,599,136	1,609,230	799,602	3,034,881	994,797	518,307	774,932	20,408,691	
21.Miscellaneous	l.s.	19,146	103,467	289,152	223,661	251,940	112,646	55,972	212,442	69,636	36,281	54,245	1,428,608	7% of SUBTOTAL(b)
SUBTOTAL (c)		292,663	1,581,877	4,419,899	3,418,813	3,851,076	1,721,876	855,574	3,247,323	1,064,433	554,588	829,177	21,837,299	
22. Fysical Contingencies	l.s.	29,266	158,188	441,990	341,881	385,108	172,188	85,557	324,732	106,443	55,459	82,918	2,183,730	10% of SUBTOTAL(b)
DIRECT CONSTRUCTION COST(d)		321,929	1,740,065	4,861,889	3,760,694	4,236,184	1,894,064	941,131	3,572,055	1,170,876	610,047	912,095	24,021,029	
23.Maintnance & Operation	l.s.	6,439	34,801	97,238	75,214	84,724	37,881	18,823	71,441	23,418	12,201	18,242	480,422	2% of SUBTOTAL(b)
24.Land Acquisition	l.s.	74,516	106,997	49,724	1,886	40,011	34,819	3,272	194,628	72,937	312,375	729,654	1,620,819	
25. Engineering & Supervision	l.s.	19,316	104,404	291,713	225,642	254,171	113,644	56,468	214,323	70,253	36,603	54,726	1,441,263	6% of TOTAL(d)
PROJECT COST		422,200	1,986,267	5,300,564	4,063,436	4,615,090	2,080,408	1,019,694	4,052,447	1,337,484	971,226	1,714,717	27,563,533	

*1) Drinage Works Percentage of Packages N2 and N3 is 1.0% because of mountainious area including large cut and high bank.

TABLE 9.4-1 (b) SUMMARY PROJECT COST (BANG PONG - CHA AM)

(1000 Baht)

Work Items	Unit	Ban Pong JC (0+000)	CPR S1	Ban Pong IC (8+480)	Photharam IC (21+000)	CPR S2	Rachaburi IC (42+000)	CPR S3	Pak Tho IC (61+445)	CPR S4	CPR S5	Phetchaburi IC (91+000)	Tha Yang IC (104+512)	CPR S6	CPR S7	Cha Am IC (133+736)	TOTAL	Remarks
		TB	Flat	DT	DT	Flat	ST	Flat	DT	Flat	Flat	ST	ST	Flat	Flat	ST		
Start sta		0+000	1+900	6+750	19+400	22+500	39+600	42+300	60+650	62+300	82+000	89+800	103+450	105+400	120+000	132+200		
End sta		1+900	19+400	9+400	22+500	39+600	42+300	60+650	62+300	82+000	103+450	91+800	105+400	120+000	132+200	134+300		
Section Length	km	1.90	14.85	2.65	3.10	17.10	2.70	18.35	1.65	19.70	19.45	2.00	1.95	14.60	12.20	2.10	134.3000	
1.Preparation Works	sqm	752	1,519	676	832	1,790	332	1,932	586	2,044	2,029	701	689	1,571	1,219	857	17,529	
2.Foundation Improvement Works	sqm	0	0	0	0	375,356	120,960	410,492	83,160	504,262	132,456	0	0	0	0	0	1,626,688	
3.Roadway Excavation	cum	60	0	60	60	0	60	24	60	0	0	60	60	22	0	60	526	
4.Embankment	cum	49,410	496,260	65,610	73,710	414,651	53,190	463,629	69,120	808,549	574,130	101,250	155,520	421,958	309,598	90,720	3,947,305	
5.Pavement	sqm	51,639	372,914	40,401	37,884	461,964	72,513	496,807	51,588	515,548	504,561	89,455	72,547	397,944	312,996	91,887	3,572,648	
6.Plantation	sqm	4,757	17,064	4,329	4,944	21,139	3,525	22,825	4,896	23,591	23,088	6,823	3,906	18,209	14,323	8,637	181,856	
7.Slope Protection Works	sqm	324	3,442	328	266	3,375	658	3,774	330	4,305	4,408	466	1,060	3,367	2,371	428	28,900	
8.Bridge Works	m	806,999	801,371	1,619,243	1,882,291	260,571	939,990	251,935	671,805	632,414	665,303	53,618	696,991	191,663	453,038	27,281	9,954,483	
10.Miscellanous Works	m	9,000	15,720	0	5,520	16,440	0	33,600	0	37,660	30,240	0	0	28,500	0	2,255	178,935	
SUBTOTAL(a)		922,911	1,708,290	1,730,647	2,005,507	1,555,286	1,191,228	1,687,018	881,345	2,328,373	1,936,215	252,373	930,773	1,063,234	1,093,545	222,125	19,508,670	
11.Retaining Wall Works	m	5,537	10,250	10,384	12,033	9,332	7,147	10,122	5,288	13,970	11,617	1,514	5,585	6,379	6,561	1,333	117,052	
12.Culvert Works		4,615	20,516	8,653	10,028	29,744	5,956	27,444	4,407	28,364	29,325	1,262	4,654	23,489	18,043	1,111	217,611	
13.Drainage Works	l.s.	4,615	8,541	8,653	10,028	7,776	5,956	8,435	4,407	11,642	9,681	1,262	4,654	5,316	5,468	1,111	97,545	0.5% of SUBTOTAL(a)
14.Road Sign	Ls.	2,769	5,125	5,192	6,017	4,666	3,574	5,061	2,644	6,985	5,809	757	2,792	3,190	3,281	666	58,528	0.3% of SUBTOTAL(a)
15.Road Marking	l.s.	1,846	3,417	3,461	4,011	3,111	2,382	3,374	1,763	4,657	3,872	505	1,862	2,126	2,187	444	39,018	0.2% of SUBTOTAL(a)
16.Lighting	l.s.	32,302	5,600	60,573	70,193	1,600	41,693	1,200	30,847	4,400	3,000	8,833	32,577	1,000	3,000	7,774	304,592	
17.Safety Facility Works	Ls.	9,229	17,083	17,306	20,055	15,553	11,912	16,870	8,813	23,284	19,362	2,524	9,308	10,632	10,935	2,221	195,089	1.0% of SUBTOTAL(a)
18.Environmental Protection	l.s.	9,229	17,083	17,306	20,055	15,553	11,912	16,870	8,813	23,284	19,362	2,524	9,308	10,632	10,935	2,221	195,089	1.0% of SUBTOTAL(a)
19.Rest Area	l.s.	0	67,500	0	0	67,500	0	67,500	0	67,500	135,000	0	0	0	67,500	0	472,500	
20.Bus Stop	l.s.	3,500	0	3,500	3,500	0	3,500	0	3,500	3,500	0	3,500	3,500	3,500	3,500	3,500	38,500	
SUBTOTAL (b)		996,553	1,863,405	1,865,675	2,161,427	1,710,121	1,285,260	1,843,894	951,827	2,515,959	2,173,243	275,054	1,005,013	1,129,498	1,224,955	242,506	21,244,394	
21.Miscellaneous	l.s.	69,759	130,438	130,597	151,300	119,708	89,968	129,073	66,628	176,117	152,127	19,254	70,351	79,065	85,747	16,975	1,487,108	7% of SUBTOTAL(b)
SUBTOTAL (c)		1,066,312	1,993,843	1,996,272	2,312,727	1,829,829	1,375,228	1,972,967	1,018,455	2,692,076	2,325,370	294,308	1,075,364	1,208,563	1,310,702	259,481	22,731,502	
22. Fysical Contingencies	l.s.	106,631	199,384	199,627	231,273	182,983	137,523	197,297	101,846	269,208	232,537	29,431	107,536	120,856	131,070	25,948	2,273,150	10% of SUBTOTAL(b)
DIRECT CONSTRUCTION COST(d)		1,172,943	2,193,227	2,195,899	2,544,000	2,012,812	1,512,751	2,170,264	1,120,301	2,961,284	2,557,907	323,739	1,182,900	1,329,419	1,441,772	285,429	25,004,647	
23.Maintnance & Operation	l.s.	23,459	43,865	43,918	50,880	40,256	30,255	43,405	22,406	59,226	51,158	6,475	23,658	26,588	28,835	5,709	500,093	2% of SUBTOTAL(b)
24.Land Acquistion	l.s.	28,585	62,370	151,800	101,100	59,850	21,435	64,225	200,693	55,160	54,460	5,168	12,630	51,100	170,800	207,503	1,246,959	
25. Engineering & Supervision	l.s.	46,918	87,729	87,836	101,760	80,512	60,510	86,811	44,812	118,451	102,316	12,950	47,316	53,177	57,671	11,417	1,000,186	4% of TOTAL(d)
PROJECT COST		1,271,985	2,387,191	2,479,453	2,797,740	2,193,430	1,624,951	2,364,705	1,388,212	3,194,121	2,765,841	348,332	1,266,504	1,460,284	1,699,078	510,058	27,751,885	

TABLE 9.4-2 SUMMARY OF PROJECT COST (2)

No.	Contract Package	Length (m)	D.Const. Cost (1000 Baht)	Cost per KM. (1000 Baht/KM.)	Project Cost (1000 Baht)	Land Acq. (1000 Baht)	Object for Tax (1000 Baht)	Tax (1000 Baht)	Economic Cost(1) (1000 Baht)	Economic Cost(2) (1000 Baht)	Remarks
		A	B	C=B/A	D	E	F=D-E	G=F x 0.1	H=D-G	I=F-G	
1	Lampong IC	1,900	321,929	169,000	422,200	74,516	347,684	34,768	387,432	312,916	DT Type
2	Package N1	19,700	1,740,065	88,000	1,986,267	106,997	1,879,270	187,927	1,798,340	1,691,343	Flat Area
3	Package N2	12,400	4,861,889	392,000	5,300,564	49,724	5,250,840	525,084	4,775,480	4,725,756	Mountainous Area
4	Package T1	4,100	1,880,347	459,000	2,031,718	943	2,030,775	203,078	1,828,641	1,827,698	A-Line
5	Package T2	4,100	1,880,347	459,000	2,031,718	943	2,030,775	203,078	1,828,641	1,827,698	B-Line
6	Package N3	10,700	4,236,184	396,000	4,615,090	40,011	4,575,079	457,508	4,157,582	4,117,571	Mountainous Area
7	Maetha IC	2,400	1,894,064	789,000	2,080,408	34,819	2,045,589	204,559	1,875,849	1,841,030	ST Type
8	Package T3	2,340	941,131	402,000	1,019,694	3,272	1,016,422	101,642	918,052	914,780	A,B-Line
9	Package N4	26,830	3,572,055	133,000	4,052,447	194,628	3,857,819	385,782	3,666,665	3,472,037	Flat Area
10	Lamphun IC	2,600	1,170,876	450,000	1,337,484	72,937	1,264,547	126,455	1,211,029	1,138,092	DT Type
11	Changmai IC	2,300	610,047	265,000	971,226	312,375	658,851	65,885	905,341	592,966	DT Type
12	Package N5	16,214	912,095	56,000	1,714,717	729,654	985,063	98,506	1,616,211	886,557	Flat Area
	Total	105,584	24,021,029	228,000	27,563,533	1,620,819		2,594,271	24,969,262	23,348,443	

No.	Contract Package	Length (m)	D.Const. Cost (1000 Baht)	Cost per KM. (1000 Baht/KM.)	Project Cost (1000 Baht)	Land Acq. (1000 Baht)	Object for Tax (1000 Baht)	Tax (1000 Baht)	Economic Cost(1) (1000 Baht)	Economic Cost(2) (1000 Baht)	Remarks
		A	B	C=B/A	D	E	F=D-E	G=F x 0.1	H=D-G	I=F-G	
1	Banpong JC	1,900	1,172,943	617,000	1,271,965	28,665	1,243,320	124,332	1,147,653	1,118,988	Turbin Type
2	Package S1	14,850	2,193,227	148,000	2,387,191	62,370	2,324,821	232,482	2,154,709	2,092,339	Flat Area
3	Banpong IC	2,650	2,195,899	829,000	2,479,453	151,800	2,327,653	232,765	2,246,688	2,094,888	DT Type
4	Potharam IC	3,100	2,544,000	821,000	2,797,740	101,100	2,696,640	269,664	2,528,076	2,426,976	DT Type
5	Package S2	17,100	2,012,812	118,000	2,193,430	59,850	2,133,580	213,358	1,980,072	1,920,222	Flat Area
6	Ratchaburi IC	2,700	1,512,751	560,000	1,624,951	21,435	1,603,516	160,352	1,464,599	1,443,164	ST Type
7	Package S3	18,350	2,170,264	118,000	2,364,705	64,225	2,300,480	230,048	2,134,657	2,070,432	Flat Area
8	Pak Tho IC	1,650	1,120,301	679,000	1,388,212	200,693	1,187,519	118,752	1,269,460	1,068,767	DT Type
9	Package S4	19,700	2,961,284	150,000	3,194,121	55,160	3,138,961	313,896	2,880,225	2,825,065	Flat Area
10	Package S5	19,450	2,557,907	132,000	2,765,841	54,460	2,711,381	271,138	2,494,703	2,440,243	Flat Area
11	Phetchaburi IC	2,000	323,739	162,000	348,332	5,168	343,164	34,316	314,016	308,848	ST Type
12	Tha Yang IC	1,950	1,182,900	607,000	1,266,504	12,630	1,253,874	125,387	1,141,117	1,128,487	ST Type
13	Package S6	14,600	1,329,419	91,000	1,460,284	51,100	1,409,184	140,918	1,319,366	1,268,266	Flat Area
14	Package S7	12,200	1,441,772	118,000	1,699,078	170,800	1,528,278	152,828	1,546,250	1,375,450	Flat Area
15	Cha Am IC	2,100	285,429	136,000	510,058	207,503	302,555	30,256	479,803	272,300	ST Type
	Total	134,300	25,004,647	186,000	27,751,885	1,246,959		2,060,913	25,101,392	23,854,433	

Note: Economic cost(1) includes Land Acquisition Cost, Economic cost(2) does not include.

TABLE 9.4-3 (a) CURRENCY PORTION AND WORK PORTION OF PROJECT COST (LAMPANG - DOI SAKET)

Work Items	Unit/ type	TOTAL -1-600~98+714 100.314			Work Portion			Remarks
		F/C (Baht)	L/C (Baht)	TOTAL (Baht)				
1.Preparation Works	sqm	7,688,913	6,115,159	13,804,072	0.1%			
3.Roadway Excavation	cum	689,489,473	355,673,908	1,045,163,380	5.5%			
4.Embankment	cum	785,444,842	903,773,983	1,689,218,825	8.9%			
5.Pavement	sqm	639,832,808	753,103,787	1,392,936,595	7.3%			
6.Plantation	sqm	24,953,452	77,767,488	102,720,940	0.5%			
7.Slope Protection Works	sqm	157,443,799	73,980,601	231,424,400	1.2%			
8.Bridge Works	m	7,689,381,425	3,037,750,605	10,727,132,030	56.3%			
9.Tunnel Works	l.s.	2,638,652,160	1,026,142,507	3,664,794,667	19.2%			
10.Misellanous Works	m	114,336,000	76,224,000	190,560,000	1.0%			
SUBTOTAL(a)		12,747,222,671	6,310,532,038	19,057,754,709	100.0%	93.4%		
11.Retaining Wall Works		60,455,360	120,123,173	180,578,533		0.9%		0.6 %of SUBTOTAL(a)
12.Culvert Works		49,321,197	58,782,441	108,103,638		0.5%		0.5 %of SUBTOTAL(a)
13.Drainage Works	l.s.	56,652,315	56,652,315	113,304,629		0.6%		0.5 %of SUBTOTAL(a)
14.Road Sign	l.s.	36,943,102	9,235,776	46,178,878		0.2%		0.3 % of SUBTOTAL(a)
15.Road Marking	l.s.	21,550,143	9,235,776	30,785,919		0.2%		0.2 % of SUBTOTAL(a)
16.Lighting	l.s.	98,342,020	32,780,673	131,122,693		0.6%		
17.Safety Facility Works	l.s.	76,964,801	76,964,801	153,929,602		0.8%		1.0 % of SUBTOTAL(a)
18.Environmental Protection	l.s.	76,964,801	76,964,801	153,929,602		0.8%		1.0 % of SUBTOTAL(a)
19.Rest Area	each	243,000,000	162,000,000	405,000,000		2.0%		
20.Bus Stop	each	16,800,000	11,200,000	28,000,000		0.1%		
SUBTOTAL (b)		13,484,216,410	6,924,471,793	20,408,688,203		100.0%	74.0%	
21.Miscellaneous	l.s.	943,895,149	484,713,025	1,428,608,174			5.2%	7.0 % of SUBTOTAL(b)
SUBTOTAL (c)		14,428,111,559	7,409,184,818	21,837,296,377			79.2%	
22. Fysical Contingencies	l.s.	1,442,811,156	740,918,482	2,183,729,638			7.9%	10.0 % of SUBTOTAL(c)
DIRECT CONSTRUCTION COST(d)		15,870,922,715	8,150,103,300	24,021,026,015			87.1%	
23.Maintnance & Operation	l.s.	288,252,312	192,168,208	480,420,520			1.7%	2.0 % of TOTAL(d)
24.Land Acquisition	l.s.	0	1,620,819,400	1,620,819,400			5.9%	
25. Engineering & Supervision	l.s.	576,504,624	864,756,937	1,441,261,561			5.2%	6.0 % of TOTAL(d)
PROJECT COST		16,735,679,652	10,827,847,844	27,563,527,496			100.0%	
Currency Portion		60.72%	39.28%	100.00%				

TABLE 9.4-3 (b) CURRENCY PORTION AND WORK PORTION OF PROJECT COST (BANG PONG - CHA AM)

Work Items	Unit	TOTAL 0+000~134+300 134.300			Work Portion			Remarks
		F/C	L/C	TOTAL				
	km	(baht)	(baht)	(baht)				
1.Preparation Works	sqm	9,114,950	8,413,800	17,528,750	0.1%			
2.Foundation Improvement Works	sqm	555,102,108	1,071,585,492	1,626,687,600	8.3%			
3.Roadway Excavation	cum	347,160	178,840	526,000	0.0%			
4.Embankment	cum	1,776,288,245	2,171,017,526	3,947,305,770	20.2%			
5.Pavement	sqm	1,586,602,484	1,985,843,990	3,572,846,474	18.3%			
6.Plantation	sqm	44,034,062	137,822,338	181,856,400	0.9%			
7.Slope Protection Works	sqm	6,069,286	22,832,074	28,901,360	0.1%			
8.Bridge Works	m	5,314,704,572	4,639,776,958	9,954,481,530	51.0%			
10.Misellanous Works	m	107,361,000	71,574,000	178,935,000	0.9%			
SUBTOTAL(a)		9,399,823,867	10,109,045,018	19,508,868,884	100.0%	91.8%		
11.Retaining Wall Works		35,115,964	81,937,249	117,053,213		0.6%		0.6 %of SUBTOTAL(a)
12.Culvert Works		97,307,704	120,321,332	217,629,036		1.0%		0.5 %of SUBTOTAL(a)
13.Drainage Works	l.s.	48,772,173	48,772,173	97,544,346		0.5%		0.5 %of SUBTOTAL(a)
14.Road Sign	l.s.	46,821,286	11,705,321	58,526,607		0.3%		0.3 % of SUBTOTAL(a)
15.Road Marking	l.s.	27,312,417	11,705,321	39,017,738		0.2%		0.2 % of SUBTOTAL(a)
16.Lighting	l.s.	228,443,810	76,147,937	304,591,746		1.4%		
17.Safety Facility Works	l.s.	97,544,345	97,544,345	195,088,689		0.9%		1.0 % of SUBTOTAL(a)
18.Environmental Protection	l.s.	97,544,345	97,544,345	195,088,689		0.9%		1.0 % of SUBTOTAL(a)
19.Rest Area	l.s.	283,500,000	189,000,000	472,500,000		2.2%		
20.Bus Stop	l.s.	23,100,000	15,400,000	38,500,000		0.2%		
SUBTOTAL (b)		10,385,285,908	10,859,123,040	21,244,408,948		100.0%	75.2%	
21.Miscellaneous	l.s.	66,072,660	33,929,812	1,487,108,626			5.3%	7.0 % of SUBTOTAL(b)
SUBTOTAL (c)		10,451,358,568	10,893,052,952	22,731,517,574			80.5%	
22. Fysical Contingencies	l.s.	1,045,135,857	1,089,305,295	2,273,151,757			8.0%	10.0 % of SUBTOTAL(c)
DIRECT CONSTRUCTION COST(d)		11,496,494,425	11,982,358,247	25,004,669,331			88.5%	
23.Maintnance & Operation	l.s.	300,056,032	200,037,355	500,093,387			1.8%	2.0 % of TOTAL(d)
24.Land Acquisition	l.s.	0	1,246,959,000	1,246,959,000			4.4%	
25. Engineering & Supervision	l.s.	600,112,064	900,168,096	1,500,280,160			5.3%	6.0 % of TOTAL(d)
PROJECT COST		12,396,662,521	14,329,522,698	28,252,001,878			100.0%	
Currency Portion		43.88%	50.72%	100.00%				

9.5 ANNUAL MAINTENANCE COST

Annual maintenance cost consists of the following items;

a) Routine Maintenance Works,
b) Periodic Maintenance Works, and
c) Emergency Maintenance Works

At this stage, there was no data available from DOH. The cost estimated using the data collected from Japan, Malaysia, and ETA intra-city expressway in Bangkok.

Referencing a JICA study in Malaysia, 0.5% of construction cost was applied for annual maintenance and operation cost.

CHAPTER 10

PROJECT EVALUATION

CHAPTER10

PROJECT EVALUATION

This chapter provides project evaluation from engineering, economic and financial points of view. Engineering evaluation highlights civil engineering industry in Thailand which will contribute to boost local economy and comments on several construction work and structures. Economic and financial evaluation are made by using relevant data obtained in the studies of traffic forecast and cost estimation.

10.1 ENGINEERING EVALUATION

Civil engineering industry in Thailand has had enough capability so that high grade highways can be designed and constructed by local engineering firms including governmental bodies. It may be the era when standardizing the experiences in Thailand on the design and construction of the ordinary structures and facilities is required. Almost of civil engineering for motorways adopted in this study are followed or extended by the ordinary technique. There are some comments and recommendations on civil engineering for motorways, as below.

1. Pavement

Concrete pavement structure is proposed in this study, because of high availability and utilization of local material as it is widely used in national highway construction and widening projects recently.

The engineering requirements of concrete pavement are, i) construction accuracy especially on surface which affects to comfortable driving and to reduction of tire wear and ii) effective maintenance and repair. A certain execution control which may have to be standardized ensures accuracy of pavement surface. As for ii), standardized maintenance and repair manual must be established.

2. Cut Work in Mountainous Section

In mountainous area of Lampang - Doi Saket Route, there are some sections which require the cut work in huge scale. Successful cut work in terms of safe construction and environment is assured by a certain execution control which follows the effective construction planning including selection of machine, hauling cut material, methods of environmental mitigation, etc.

3. Slope Protection

Various slope protection structures are introduced in cut and embankment sections along both routes, in consideration of prevention measures on natural disaster and environmental aspects including aesthetic values.

In detail engineering stage, suitable slope protection structures especially to cut sections of Lampang - Doi Saket Route should carefully selected based on detail

geological information, which will refer to the results of the Feasibility Study on Road Disaster Prevention Plan being studied by JICA and DOH.

4. Soil Improvement Work

This study proposes some soil improvement work along soft ground areas of Ban Pong - Cha Am Route, i.e. i) cement stabilization and filling control for low embankment sections and ii) bearing unit for bridge approach sections with high embankment.

Cement stabilization method is new technology in Thailand while filling control and bearing unit is widely used in the same sections as of highways. The followings are engineering requirements in the detail design and construction stages:

1) The soil profile of the relevant sections should be examined with care by detail investigation and the spots to be stabilized should be identified as to reduce the construction cost.
2) The optimum mixture ratio of soil and cement should be found by laboratory and field tests before starting the construction.
3) The appropriate execution control should be done.

5. Tunnel

Tunnel structure is affected considerably by topographic and geological condition and construction method. On the other hand, it may be difficult and uneconomical to get completely enough data on the ground condition for using in design. Therefore, design of tunnel always requires high technical judgments based on the experiences gained in all engineering process from planning to maintenance. The observation and measurement data on ground movement, timbering condition and seepage water condition during construction will correct the design including construction method and will require some countermeasures of unforeseen situation.

Road tunnel requires special facilities such ventilation, lighting, disaster prevention measures, etc. as they assure safe and comfortableness of users.

Since Thailand has no experiences of road tunnel project, technical assistance of well experienced engineers may have to be required during detail engineering design and construction stages.

6. Steel Truss Structure

Steel truss structure is designed in order to avoid high embankment mainly in the environmental aspects and to solve the difficulty in constructing other structures such as PC-box girder with high pier.

There are few experiences, in Thailand, of designing, constructing and maintaining steel truss structure with high pier sitting on the rock foundation. Therefore, technical assistance also for design and construction of this structure may have to be needed.

10.2 ECONOMIC EVALUATION

10.2.1 Methodology

1. Framework of the Analysis

The main purposes of an economic evaluation are to assess the degree of contribution of the projects to the national economy and to investigate whether the implementation of the projects are justified or not from an economic point of view. In this context, all input resources (project costs) and output (benefits) are,in principle, estimated based on the economic prices which reflect the real resource values.

Although the two motorway routes i.e. Lampang - Doi Saket Route (L/D Route) and Ban Pong - Cha Am Route (B/C Route) compose parts of the same motorway network and are not the mutually exclusive projects, the economic evaluations of the two routes are conducted separately each other. The economic benefits to be estimated in this approach are, therefore, incremental benefits by each route to the whole motorway network at each benchmark years.

2. Economic Benefits of Motorways

There exist many types of impacts on a society by the new motorways. Those are classified conveniently into "Direct Benefits" and "Indirect Benefits" or "Users Benefits", "Non-users Benefits". From the aspects of degree of perception and quantification, other classifications such as "Tangible Benefits" and "Intangible Benefits" are used.

The direct benefits are defined as the benefits enjoyed by road users who use the motorway network directly and the following two kinds of benefits are estimated quantitatively in this economic evaluation:

- Vehicle Operating Cost Savings (VOC Savings)
- Travel Time Savings of passengers

It is necessary to estimate the same kinds of benefits as above which are attributable to the vehicles remaining on existing highways. Although they are not the direct users of the motorways and they do nothing other than driving on the same highways, they will also enjoy the benefits because of diversions of other vehicles to the new motorways. Those are not called as the direct benefits theoretically but included in this category for convenience and distinguished from the indirect benefits (more broadly speaking, they are direct users of roads network system including motorways).

Indirect Benefits,on the other hand, are kinds of induced effects generated through the directs benefits and realized as regional development effects. More detailed explanations will be given qualitatively in other sections of this Chapter.

3. "With" and "Without" Comparison Method

The economic direct benefits of each motorway route are calculated as savings in Vehicle Operating Costs (VOC) and savings in Travel Time Cost based upon a "With Project" and "Without Project" comparison method. The network conditions of each situation are presented in Table10.2-1:

TABLE 10.2-1 DEFINITIONS OF "WITH" AND "WITHOUT" CASES

(For evaluation of L/D Route)

Situation	L/D Route	B/C Route	Other Motorway sections
Without Project Case	Without	With	With sections proposed in the Implementation Schedule of the Motorway Network
With Project Case	With	With	same as above

(For evaluation of B/C Route)

Situation	L/D Route	B/C Route	Other Motorway sections
Without Project Case	With	Without	With sections proposed in the Implementation Schedule of the Motorway Network
With Project Case	With	With	Same as above

The same network conditions are, therefore, applied commonly in both "With Project Cases" for the evaluations of L/D and B/C routes.

4. Benefits of Induced Traffic

As analyzed in Traffic Forecasting stage, there are two types of traffic demands which were defined as "Normal Traffic" and "Induced Traffic". Benefits of normal traffic can be estimated based on the "With" and "Without" comparison method. However, benefits of Induced Traffic are not estimated by the same way and hence half of the unit benefit of normal traffic is applied to induced traffic for benefit calculations.

10.2.2 Economic Project Costs

1. Economic Costs

The economic costs by each project route estimated at market prices (financial costs) are as presented and explained in the previous Chapter. For the purpose of the economic evaluation, transfer items such as taxes and duties are deducted from the financial costs and re-summarized in Table10.2-2 and Table10.2-3 with its annual disbursement schedules: It is assumed that the taxes and duties are at 10% of the total costs (excluding land acquisition costs).

TABLE 10.2-2 ECONOMIC COSTS
(Lampang - Doi Saket Route)

(Million Baht)

	Item \ Year	(Total '95-'01) (1994 Prices)	1995	1996	1997	1998	1999	2000	2001
F/C	-Direct Cost	14,428.11	0.00	0.00	0.00	2,019.83	5,394.18	4,675.26	2,338.84
	-Physical Contingency	1,442.81	0.00	0.00	0.00	201.98	539.42	467.53	233.88
	Sub-Total	15,870.92	0.00	0.00	0.00	2,221.81	5,933.60	5,142.79	2,572.72
	-Engineering	576.52	120.21	177.86	57.65	33.12	62.56	62.56	62.56
	-Administration	288.25	0.00	0.00	0.00	0.00	57.65	115.30	115.30
	Sub-Total	864.77	120.21	177.86	57.65	33.12	120.21	177.86	177.86
	Total	16,735.69	120.21	177.86	57.65	2,254.93	6,053.81	5,320.65	2,750.58
L/C	-Direct Cost	7,409.19	0.00	0.00	0.00	893.10	2,895.55	2,411.16	1,209.38
	-Physical Contingency	740.92	0.00	0.00	0.00	89.31	289.56	241.12	120.94
	Sub-Total	8,150.11	0.00	0.00	0.00	982.41	3,185.11	2,652.28	1,330.32
	-Engineering	864.75	180.31	266.79	86.48	49.68	93.83	93.83	93.83
	-Administration	192.17	0.00	0.00	0.00	0.00	38.43	76.87	76.87
	-Land Acquisition	1,620.82	0.00	0.00	1,134.57	486.25	0.00	0.00	0.00
	Sub-Total	2,677.74	180.31	266.79	1,221.05	535.93	132.26	170.70	170.70
	Total	10,827.85	180.31	266.79	1,221.05	1,518.34	3,317.37	2,822.98	1,501.02
GRAND TOTAL (Financial Costs)		27,563.54	300.52	444.65	1,278.70	3,773.27	9,371.17	8,143.62	4,251.60
Taxes & Duties		2,594.27	30.05	44.47	14.41	328.70	937.12	814.36	425.16
ECONOMIC COSTS (Incl. Land Acquisition costs)		24,969.27	270.47	400.19	1,264.29	3,444.57	8,434.06	7,329.26	3,826.44
(Excl. Land Acquisition costs)		23,348.45	270.47	400.19	129.72	2,958.32	8,434.06	7,329.26	3,826.44

TABLE 10.2-3 ECONOMIC COSTS
(Ban Pong - Cha Am Route)

(Million Baht)

	Item \ Year	(Total '95-'00) (1994 Prices)	1995	1996	1997	1998	1999	2000
F/C	-Direct Cost	11,112.25	0.00	0.00	0.00	4,355.36	4,052.53	2,704.36
	-Physical Contingency	1,111.23	0.00	0.00	0.00	435.54	405.25	270.44
	Sub-Total	12,223.48	0.00	0.00	0.00	4,790.90	4,457.78	2,974.80
	-Engineering	400.08	88.02	128.02	40.01	48.01	48.01	48.01
	-Administration	300.05	0.00	0.00	0.00	60.01	120.02	120.02
	Sub-Total	700.13	88.02	128.02	40.01	108.02	168.03	168.03
	Total	12,923.61	88.02	128.02	40.01	4,898.92	4,625.81	3,142.83
L/C	-Direct Cost	11,619.27	0.00	0.00	0.00	5,109.74	3,987.79	2,521.74
	-Physical Contingency	1,161.93	0.00	0.00	0.00	510.97	398.78	252.17
	Sub-Total	12,781.20	0.00	0.00	0.00	5,620.71	4,386.57	2,773.91
	-Engineering	600.10	132.02	192.04	60.01	72.01	72.01	72.01
	-Administration	200.03	0.00	0.00	0.00	40.01	80.01	80.01
	-Land Acquisition	1,246.96	0.00	0.00	872.87	374.09	0.00	0.00
	Sub-Total	2,047.09	132.02	192.04	932.88	486.11	152.02	152.02
	Total	14,828.29	132.02	192.04	932.88	6,106.82	4,538.59	2,925.93
GRAND TOTAL (Financial Costs)		27,751.89	220.04	320.06	972.89	11,005.74	9,164.40	6,068.76
Taxes & Duties		2,650.49	22.00	32.01	10.00	1,063.17	916.44	606.88
ECONOMIC COSTS (Incl. Land Acquisition costs)		25,101.40	198.04	288.05	962.89	9,942.58	8,247.96	5,461.88
(Excl. Land Acquisition costs)		23,854.44	198.04	288.05	90.02	9,568.49	8,247.96	5,461.88

2. Annual Economic Operation and Maintenance Costs (O & M Costs)

The annual economic operation and maintenance costs after opening year are estimated at 0.5% of total economic costs (excluding land acquisition costs).O & M costs by each project route are summarized as follows:

L/D Route : 116.7 (Million Baht/year)
B/C Route : 119.3 (Million Baht/year)

10.2.3 Calculation of Direct Benefits

1. Vehicle Operating Costs (VOC)

In order to calculate the savings to road-users resulting from the new construction of motorways in the quality of roads and changes in travel distances and speeds, it is necessary to develop unit travel costs for road-users and the vehicles they employ.

Collection of reliable data for vehicle operating costs from the beginning under clearly identified and quantifiable conditions is a very difficult and time-consuming operation. It is normal practice, therefore, to draw on existing research as a basis for developing such costs. The Department of Highways (DOH) has developed a generalized methodology for the calculation of vehicle operating costs and has been applying to highway projects. The same method was applied to the master plan study on Motorway Network in 1991 ("Toll Highway Development Study in the Kingdom of Thailand" : JICA, 1991). In this economic analysis, VOC data developed by DOH ("Vehicle Operating Cost in Thailand 1993) was also updated and used for benefit calculation of the project routes.

VOCs consist of the following components:

- Fuel cost
- Oil cost
- Tire cost
- Maintenance cost
- Capital cost
- Crew cost (for commercial vehicles)
- Overhead cost (for commercial vehicles)

Detailed price data and applied technical parameters are presented in Appendix 10.2-1. Summarized VOCs are shown in Table10.2-4.

2. Travel Time Values of Passengers

The valuation of time for vehicle occupants forms an another major part of road user costs. The time values of drivers and assistants for commercial vehicles have been included in VOCs as crew costs and, therefore, only the time values for passengers are calculated here through updating recent studies. Table10.2-5 and

TABLE 10.2-4 ECONOMIC VEHICLE OPERATING COSTS (1994 PRICES)

(Baht/km)

Speed (km/h)	Road Condition RC1	RC2	RC3	RC4	RC5	RC6	RC7	Road Condition RC1	RC2	RC3	RC4	RC5	RC6	RC7
	MOTORCYCLE							PICKUP:PASSENGER						
20	1.0275	1.0761	1.1247	1.1734	1.2463	1.2568	1.4237	5.0759	5.2628	5.4497	5.6366	5.9189	6.1446	7.1607
30	0.9700	1.0168	1.0635	1.1103	1.1804	1.1895	1.3481	4.6316	4.8093	4.9870	5.1647	5.4312	5.6473	6.6125
40	0.9220	0.9673	1.0126	1.0579	1.1259	1.1333	1.2840	4.3218	4.4932	4.6646	4.8361	5.0932	5.2989	6.2246
50	0.8846	0.9285	0.9724	1.0163	1.0821	1.0902	1.2380	4.0825	4.2481	4.4137	4.5793	4.8277	5.0291	5.9288
60	0.8579	0.9019	0.9458	0.9898				3.8811	4.0421	4.2031	4.3641			
70	0.8394	0.8842	0.9290	0.9738				3.7231	3.8843	4.0454	4.2065			
80	0.8287							3.5981	3.7574	3.9167	4.0759			
90	0.8261							3.4947						
100	0.8467							3.5393						
110								3.5952						
120								3.8671						
Speed	RC1	RC2	RC3	RC4	RC5	RC6	RC7	RC1	RC2	RC3	RC4	RC5	RC6	RC7
	PASSENGER CAR							LIGHT TRUCK						
20	4.6895	5.0011	5.3126	5.6242	6.0918	6.3360	7.7596	3.3311	3.5291	3.7270	3.9250	4.2219	4.4679	5.5536
30	4.2780	4.5742	4.8704	5.1665	5.6108	5.8495	7.2156	3.0278	3.2164	3.4049	3.5935	3.8763	4.1078	5.1364
40	3.9939	4.2787	4.5636	4.8485	5.2758	5.5023	6.8100	2.8368	3.0200	3.2013	3.3826	3.6545	3.8766	4.8647
50	3.7747	4.0492	4.3237	4.5982	5.0099	5.2315	6.4982	2.7028	2.8782	3.0536	3.2290	3.4922	3.7080	4.6659
60	3.5917	3.8630	4.1343	4.4056				2.5924	2.7629	2.9335	3.1041			
70	3.4425	3.7092	3.9758	4.2424				2.5146	2.6847	2.8549	3.0250			
80	3.3298	3.5907	3.8516	4.1125				2.4602	2.6282	2.7961	2.9641			
90	3.2441							2.4205						
100	3.2467							2.5212						
110	3.2932							2.6290						
120	3.5253							2.9475						
Speed	RC1	RC2	RC3	RC4	RC5	RC6	RC7	RC1	RC2	RC3	RC4	RC5	RC6	RC7
	LIGHT BUS							MEDIUM TRUCK						
20	5.0759	5.2628	5.4497	5.6366	5.9189	6.1446	7.1607	8.7191	9.0583	9.3935	9.7307	10.2365	10.4274	11.8209
30	4.6316	4.8093	4.9870	5.1647	5.4312	5.6473	6.6125	8.1273	8.4482	8.7691	9.0900	9.5713	9.7644	11.1131
40	4.3218	4.4932	4.6646	4.8361	5.0932	5.2989	6.2246	7.7030	8.0155	8.3279	8.6404	9.1090	9.3043	10.6320
50	4.0825	4.2481	4.4137	4.5793	4.8277	5.0291	5.9288	7.4432	7.7555	8.0678	8.3801	8.8485	9.0425	10.3674
60	3.8811	4.0421	4.2031	4.3641				7.2422	7.5588	7.8755	8.1922			
70	3.7231	3.8843	4.0454	4.2065				7.1049	7.4258	7.7467	8.0676			
80	3.5981	3.7574	3.9167	4.0759				7.0744	7.4054	7.7364	8.0674			
90	3.4947							7.0397						
100	3.5393							7.0424						
110	3.5952							7.2368						
120	3.8671							7.6841						
Speed	RC1	RC2	RC3	RC4	RC5	RC6	RC7	RC1	RC2	RC3	RC4	RC5	RC6	RC7
	HEAVY BUS							HEAVY TRUCK						
20	10.0598	10.5313	11.0028	11.4744	12.1816	12.5100	14.5814	11.2013	11.7688	12.3363	12.9038	13.7551	14.1234	16.5624
30	9.4409	9.8955	10.3501	10.8047	11.4865	11.8143	13.8337	10.4379	10.9849	11.5319	12.0789	12.8994	13.2586	15.6181
40	8.9214	9.3624	9.8033	10.2442	10.9057	11.2354	13.2178	9.8052	10.3297	10.8543	11.3789	12.1658	12.5329	14.8411
50	8.6472	9.0866	9.5260	9.9654	10.6245	10.9475	12.9117	9.4581	9.9822	10.5062	11.0303	11.8164	12.1609	14.4220
60	8.5249	8.9733	9.4216	9.8700				9.2888	9.8244	10.3600	10.8957			
70	8.5013	8.9611	9.4209	9.8807				9.2367	9.7912	10.3456	10.9001			
80	8.5188	8.9911	9.4634	9.9357				9.2365	9.8057	10.3749	10.9440			
90	8.5850							9.2957						
100	8.6723							9.3808						
110	9.0757							9.7458						
120	9.7601							10.5334						

Note: Road Condition:
RC1: Paved Road (Good)
RC2: Paved Road (Good/Fair)
RC3: Paved Road (Fair)
RC4: Paved Road (Fair/Poor)
Laterite Road (Good)
RC5: Paved Road, Poor
RC6: Laterite Road (Fair)
RC7: Laterite Road (Poor)

Table10.2-6 indicate the time values per passenger and per vehicle by region in 1994 prices. These tables were obtained applying a 5% of increase rate of average wage rate to the 1993 data. Unlike the highway projects, the averages of the two regions were calculated for this evaluation because the motorways will handle the inter-city and inter-regional traffic demands especially in future years.
In addition, the future time values (at constant 1994 price) were estimated based on the future increase in income level of passengers (by referring to the increase of per capita GNP at constant price) as shown in Table10.2-7.

TABLE10.2-5 TIME VALUES OF PASSENGERS FOR BUSINESS TRIPS

(1994 prices)

Region	Vehicle Type	Average Monthly Wages (Baht)	Working Hours (Hrs/Month)	Value of Time (Baht/hr.)
CENTRAL	P/C	7880	216	36.5
	L/B	3520	216	16.3
	H/B	3520	216	16.3
	P/P	3520	216	16.3
NORTH	P/C	7560	216	35.0
	L/B	3360	216	15.6
	H/B	3360	216	15.6
	P/P	3360	216	15.6
AVERAGE OF TWO REGIONS	P/C	7720	216	35.7
	L/B	3440	216	15.9
	H/B	3440	216	15.9
	P/P	3440	216	15.9

TABLE 10.2-6 TIME VALUES OF PASSENGERS BY VEHICLE TYPE

(1994 prices)

Region	Vehicle Type	Average Vehicle Occupancy (Persons)	Business Trip Rate (%)	Time Values for Business Trip(Bht/h)	Time Values for other Trip (Bht/h)	Time Values(Baht/hour)		
						Business Trip	Other Trip	Total (Baht/hr. /vehicle)
		[A]*	[B]**	[C]	[D]	[E]	[F]	[G]
CENTRAL	P/C	2.3	48.4	36.5	9.1	30.5	10.8	41.3
	L/B	3.7	37.7	16.3	4.1	17.0	9.4	26.4
	H/B	30.0	35.9	16.3	4.1	131.6	78.3	210.0
	P/P	1.8	51.9	16.3	4.1	11.4	3.5	14.9
NORTH	P/C	2.2	46.6	35.0	8.8	26.9	10.3	37.2
	L/B	5.9	39.7	15.6	3.9	27.3	13.8	41.2
	H/B	49.5	40.7	15.6	3.9	235.0	114.2	349.2
	P/P	1.7	50.1	15.6	3.9	9.9	3.3	13.2
AVERAGE OF TWO REGIONS	P/C	2.2	39.0	35.7	8.9	23.0	12.0	35.0
	L/B	4.5	38.7	15.9	4.0	20.8	11.0	31.8
	H/B	33.2	38.3	15.9	4.0	151.9	81.6	233.4
	P/P	1.8	52.0	15.9	4.0	11.2	3.4	14.6

Note: [A]*: P/C and P/P: from O-D Survey by the JICA Study Team in 1993
L/B and H/B: from DOH except for the averages of the two regions

[B]**: The same as [A]

TABLE 10.2-7 TIME VALUES BY VEHICLE TYPE

(Baht/hr.)

Vehicle Type	1994	2000	2010	2020
P/C	35.0	45.7	82.8	145.4
L/B	31.8	41.5	75.3	132.1
H/B	233.4	304.9	552.7	970.0
P/P	14.6	19.1	34.6	60.8

3. Estimation of Direct Benefits by the Study Route (Base Case)

The road user costs were calculated applying the unit VOCs and time values to the results of traffic assignment in both "with" and "without" cases. The results of traffic assignment were compiled in the form of vehicle-hours and vehicle-kms by vehicle type, by speed and by road condition. As the speed-volume relationships were taken into account in the assignment, time savings and savings in VOCs due to reduction in congestion were considered as well.

Regarding to the Northern Route (Lampang - Doi Saket Route), some parts of the sections in Lampang - Hang Chat - Mae Tha - Lamphun will pass through mountainous areas. Additional costs due to gradients and curves were, therefore, estimated for the existing highways and project motorways in the L/D Route . On the other hand, the Southern Route (Ban Pon - Cha Am Route) passes through almost flat areas and no sharp turns on the existing highways and planned motorways. Therefore, no additional costs to the basic VOCs were considered for B/C Route.

The results of the calculation of VOC savings and time savings are shown in Table10.2-8 and Table10.2-9 with the benefits of induced traffic.

TABLE 10.2-8 BENEFIT CALCULATION (L/D ROUTE)

(Lampang - Doi Saket Route)

Year	Benefits of Normal Traffic						Benefits of Induced Traffic (Million Baht)	Total Benefits (Million Baht)
	With or Without	VOC (1000Baht/day)	Time Cost (1000Baht/day)	Benefit (Million Baht/year) VOC Saving	Time Saving	Sub-Total		
2000	W/O	886,465	104,766					
	With	886,186	104,672	101.8	34.3	136.1	0.4	136.5
2010	W/O	2,070,310	478,987					
	With	2,059,448	476,461	3,964.6	922.0	4,886.6	25.2	4,911.8
2020	W/O	4,207,614	1,808,476					
	With	4,193,673	1,786,531	5,088.5	8,009.9	13,098.4	327.6	13,426.0

TABLE 10.2-9 BENEFIT CALCULATION (B/C ROUTE)

(Ban Pong - Cha Am Route)

Year	Benefits of Normal Traffic						Benefits of Induced Traffic (Million Baht)	Total Benefits (Million Baht)
	With or Without	VOC (1000Baht/day)	Time Cost (1000Baht/day)	Benefit (Million Baht/year) VOC Saving	Time Saving	Sub-Total		
2000	W/O	888,378	106,817					
	With	886,318	104,665	751.9	785.5	1,537.4	28.8	1,566.2
2010	W/O	2,083,302	491,784					
	With	2,060,255	479,057	8,412.2	4,645.4	13,057.5	601.2	13,658.7
2020	W/O	4,233,168	1,820,803					
	With	4,193,904	1,792,531	14,331.4	10,319.3	24,650.6	982.8	25,633.4

10.2.4 Indirect Benefits

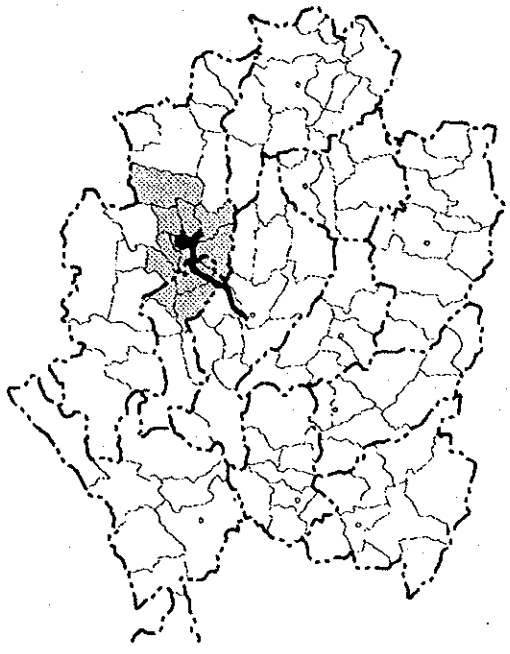
It is necessary and important to construct motorway for growth of economy and for future development in Thailand. Besides above-mentioned direct benefits, following effects are indirectly brought not only in area along mortorway but also other parts of the whole country.

- Promotion of regional development
- Promotion of manufacturing Industry
- Promotion of tourism
- Promotion of agriculture
- Promotion of commerce
- Improvement of living conditions
- Rise of value on resources and changes of method for utilization
- Rationalization of transportation plan
- Influence of project investment

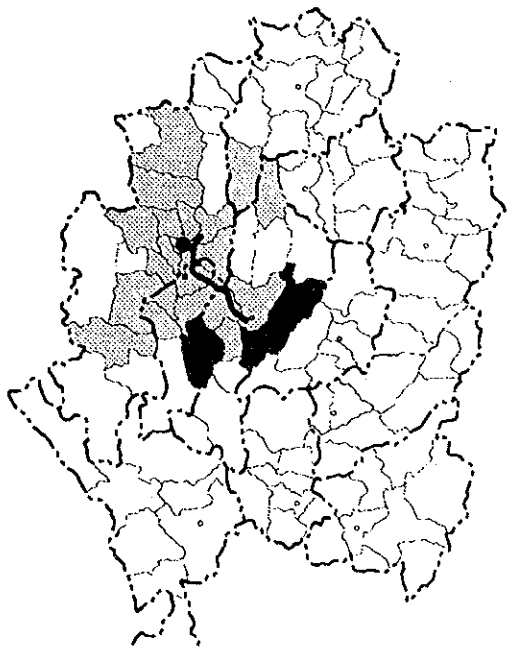
1. Promotion of Regional Development

Regional development play an important role in achieving suitable economic growth, dispersion of income and economic advance to rural areas and improvement of quality of life which are purpose of the Seventh Plan. It brings traffic congestion and other economic loss that economy extremely concentrates on Bangkok; therefore construction of urban growth center is carrying out to let a rural area disperse socio-economic activities. Chiang Mai was appointed the primary urban growth center, Ratchaburi was the secondary urban growth center and Phetchaburi was the tertiary urban growth center. Improved traffic conditions disperse in a rural area the industry that concentrated on a large city, and the regional development will promote.

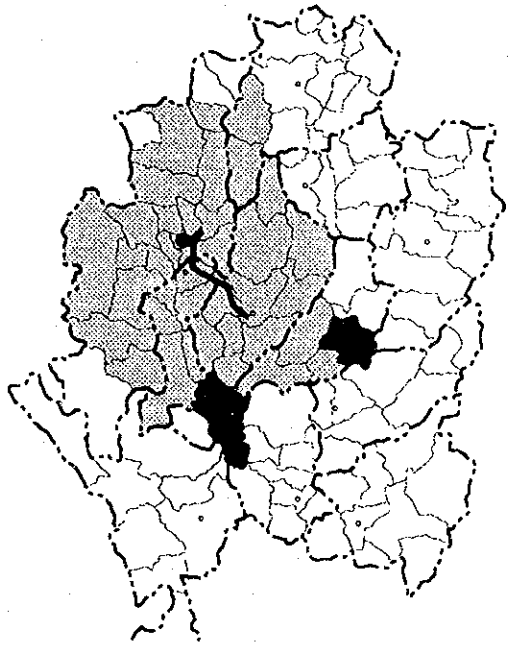
Figure 10.2-1 shows the coverd areas that can arrive at each Amphoe from Chiang Mai Changwat Center by traveling time in case of with and without project. Coverd population within two hours travel increases 156 thousand comparing with the population in case of without project. In the same way, coverd population increases 274 thousand for three hours trvel and 910 thousand for four hours travel sa shown in Table 10.2-10. Influenced areas within four hours travel extend to Chanwat Chiang Rai, Phayao, Phrae, Uttaradit, Sukhothai and Tak in the Northern Region.



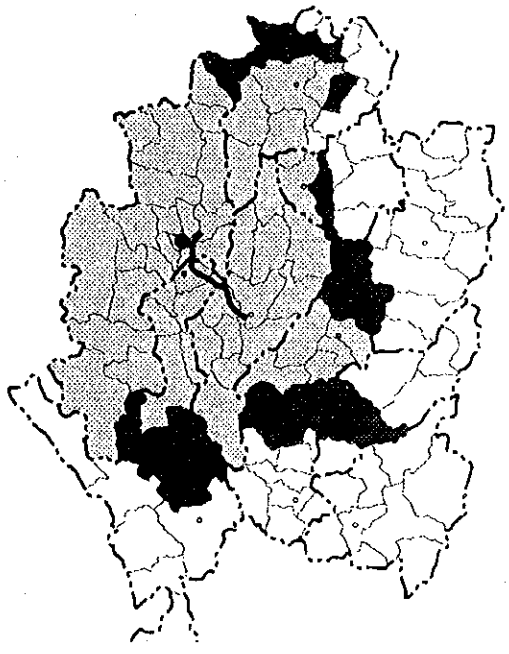
- Within one hour -



- Within two hours -



- Within three hours -



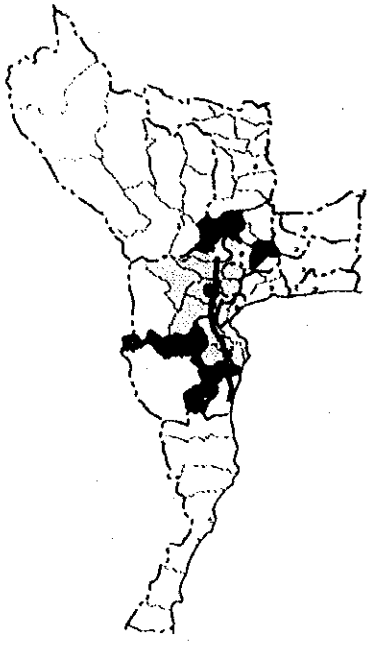
- Within four hours -

LEGEND

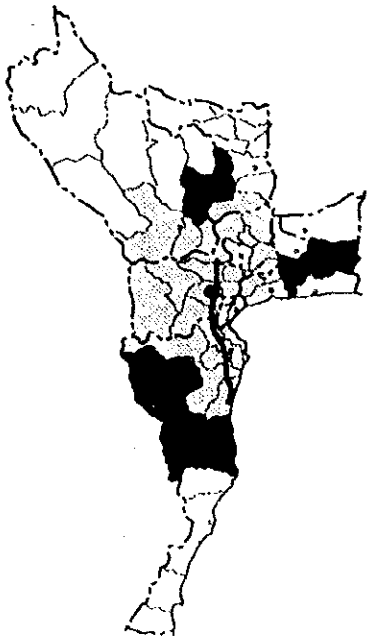
Covered Amphoe in "Without Project" case from Chiang Mai Changwat Center

Added Amphoe in "With Project" case from Chiang Mai Changwat Center

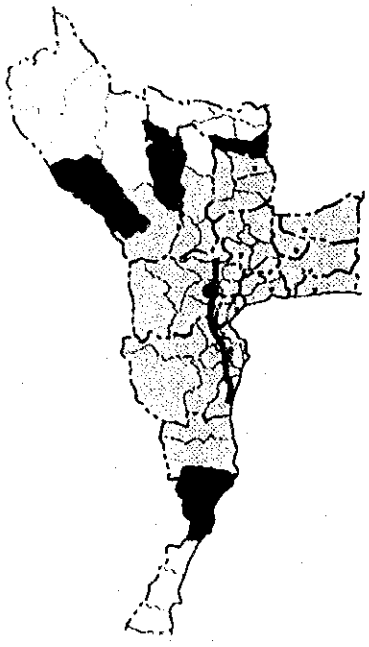
FEASIBILITY STUDY ON THE INTER-CITY TOLL MOTORWAY PROJECTS	FIGURE 10.2-1 COVERED AMPHOE BY TRAVELING TIME ON LAMPANG - DOI SAKET ROUTE



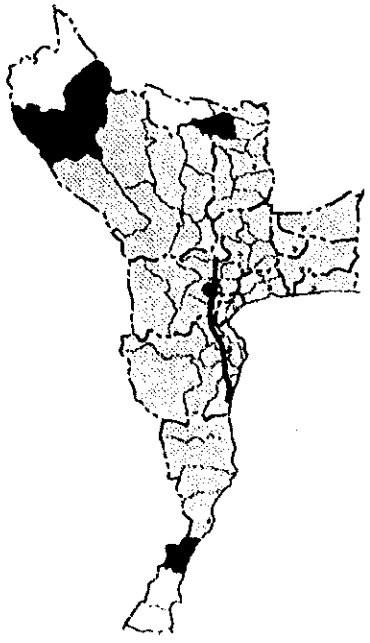
- Within one hour -



- Within two hours -



- Within three hours -



- Within four hours -

LEGEND

Covered Amphoe in "Without Project" case from Ratchaburi Changwat Center

Added Amphoe in "With Project" case from Ratchaburi Changwat Center

FEASIBILITY STUDY
ON
THE INTER-CITY TOLL MOTORWAY PROJECTS

FIGURE 10.2-2
COVERED AMPHOE BY TRAVELING TIME
ON BAN PONG - CHA AM ROUTE

TABLE 10.2-10 COVERED POPULATION BY TRAVELING TIME ON LAMPANG - DOI SAKET ROUTE

(Unit:thousand persons)

Travel Time	Without Project	With Project	Increase
Within one hour	1,125.6	1,125.6	0
Within two hours	1,890.6	2,046.8	156.2
Within three hours	2,686.7	2,960.6	273.9
Within four hours	3,776.0	4,686.2	910.2

On the other hand, Figure 10.2-2 shows covered area on Ban Pong - Cha Am Route. Covered population increases 416 thousand for one hour, 358 thousand for two hours, 279 thousand for three hours, 137 thousand for four hours, respectively as shown in Table 10.2-11.

TABLE 10.2-11 COVERED POPULATION BY TRAVELING TIME ON BAN PONG - CHA AM ROUTE

(Unit: thousand persons)

Travel Time	Without Project	With Project	Increase
Within one hour	1,337.5	1,753.4	415.5
Within two hours	2,909.1	3,267.4	358.3
Within three hours	3,546.1	3,825.1	279.0
Within four hours	4,029.8	4,116.3	136.5

Influenced area extend to Changwat Kanchanaburi, Prachuap Khiri Khan, Samut Songkram and Suphan Buri in the Western Regin. Besides, Bangkok and Vicinity such as Chanwat Nakhon Pathom, Samut Sakhon, Samut Prakan, Pathum Thani, Nonthaburi and Bangkok Metropolis also will be in influence area.

In this way, If mortorway is built, influence area from Chiang Mai and Ratchaburi is greatly magnified. In other words, importance of Chiang Mai and Ratchaburi rises, and regional development in both urban growth centers will be promoted.

2. Promotion of Manufacturing Industry

The transport condition is a very important factor in plant location. Manufacturing plants and those facilities concerned will be built in the neighborhood of Interchange if the transport condition is improved by motorway construction. One of the most important impacts by motorway construction is promotion of manufacturing industry. Besides raw materials and products can transport more fast and on time.

Figure 10.2-3 shows flow of industrial development effects. To disperse manufacturing industry from urban area to rural area prevent excess-agglomeration of urban activities in a limited number of cities and promote the regional development, and liven socio-economic conditions in a local area. The existing factories in area along motorway become possible to incresa productions by facility investment. Those have effect rising employment opportunity of worker, too.

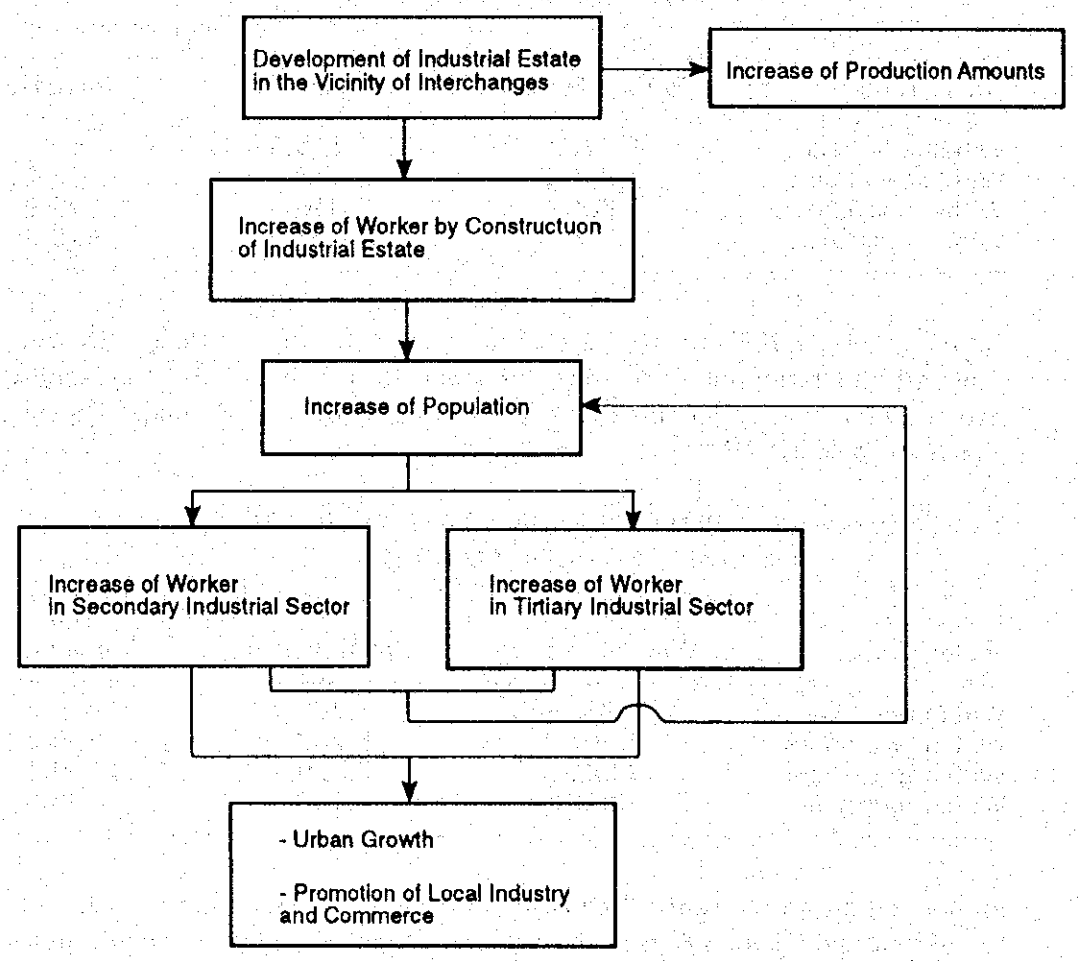


FIGURE 10.2-3 FLOW OF INDUSTRIAL DEVELOPMENT EFFECTS

3. Promotion of Tourism

It is convenient to use the car when people moves, and it can go to a destination without transfer. Therefore the car is important for sightseeing and the leisure industry. When high traveling speed and comfortable driving become provide by construction of motorways, there are increase of tourist and extension of tourism activities. The tourism development in a tourism area is promoted with increase of tourist.

Because the road length of Lampang - Doi Saket route is approximately 100 km and the sightseeing spots such as Chiang Rai and Sukhothai are apart from motorway, increase of tourist can not expect by construction of motorway. If motorway will construct to Chiang Rai and Sukhothai, increase of tourist can expect because day return trip becomes possible.

On Ban Pong - Cha Am route, it will take approximately 2 hours from Bangkok to sightseeing spots such as Hua Hin and Cha Am, increase of tourist can expect.

The motorway lets potential of region improve, but even if motorways are built, it can not make the effects large and can not let that last. Only instead of infrastructure improvement, construction of various facilities becomes necessary.

4. Promotion of Agriculture

Effects given to agriculture in area along routes by construction of motorway are expansion of market and improvement of agricultural structure by shortening of time distance to urban growth center. The area that supplied agricultural products spreads out further by reduction of traveling costs and shortening of traveling time.

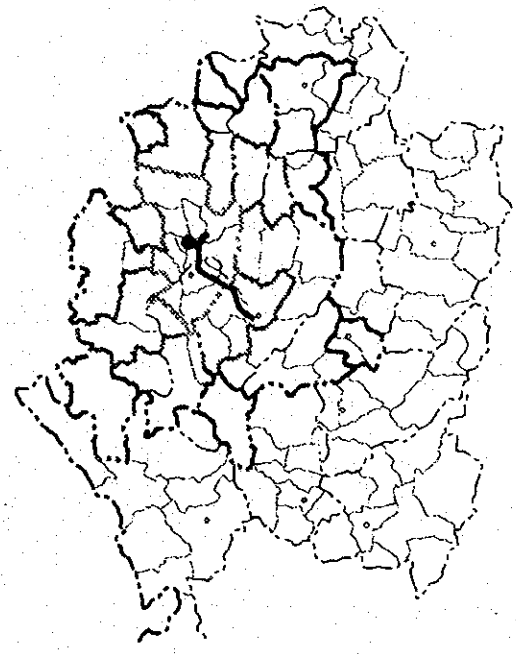
Figure 10.2-4 shows changes of the coverd area from Chiang Mai, Lamphun and Lampang Changwat Centers to Amphoes by hour on Lampang - Doi Saket Route. Each Changwats show the widening area.

On Ban Pong - Cha Am Route also shows the widening market area from Ratchaburi and Petchaburi Changwat Centers by construction of motorwayas shown in Figure 10.2-5.

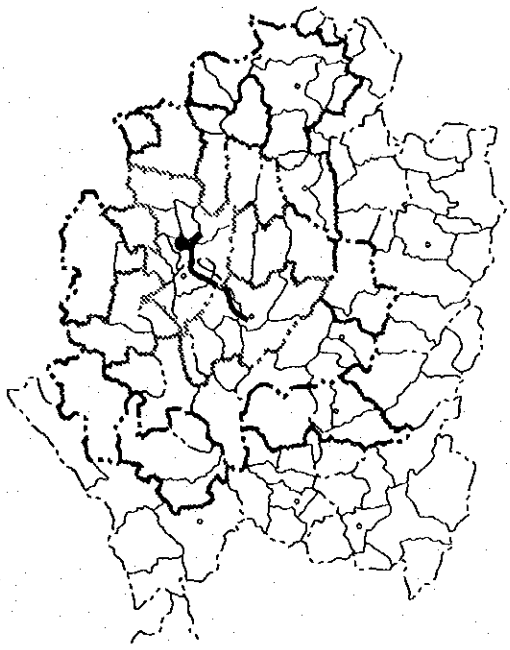
Freshness is a vital factor for fresh agricultural and fishery products. With motorway construction which will cut down the time required for delivering the products to the big markets, many areas will see a shift in such products. The structure change will be brought from lower priced products to higher ones, and the amount of production and production item will be increased.

5. Promotion of Commerce

Market area is magnified by motorway construction as shown in Figure 10.2-4 and 10.2-5. Buisiness activities in each Changwat Center will be activated. When access to a large city is improved, anybody can easily go to shopping to a large city. As a result, it seems that a local retail will make effort by themself. Competition among them can produce, and the commerce whole becomes active and attractive.

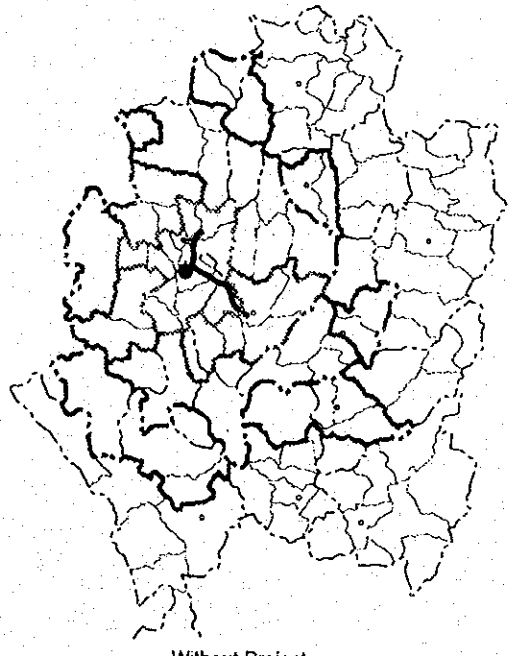


- Without Project -

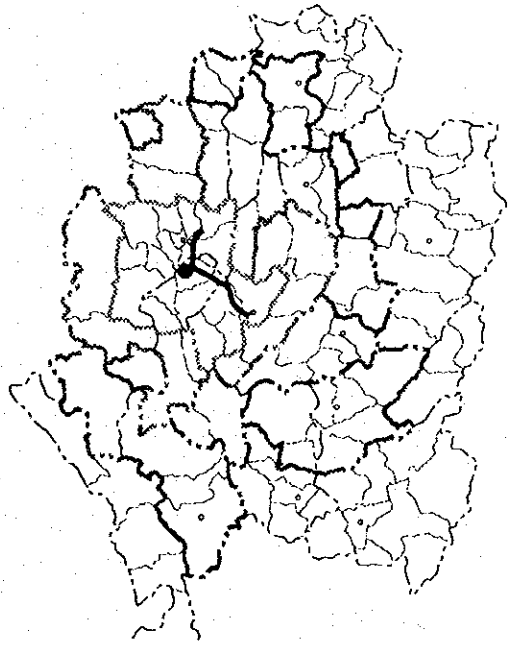


- With Project -

(1) From Chiang Mai Changwat Center



- Without Project -



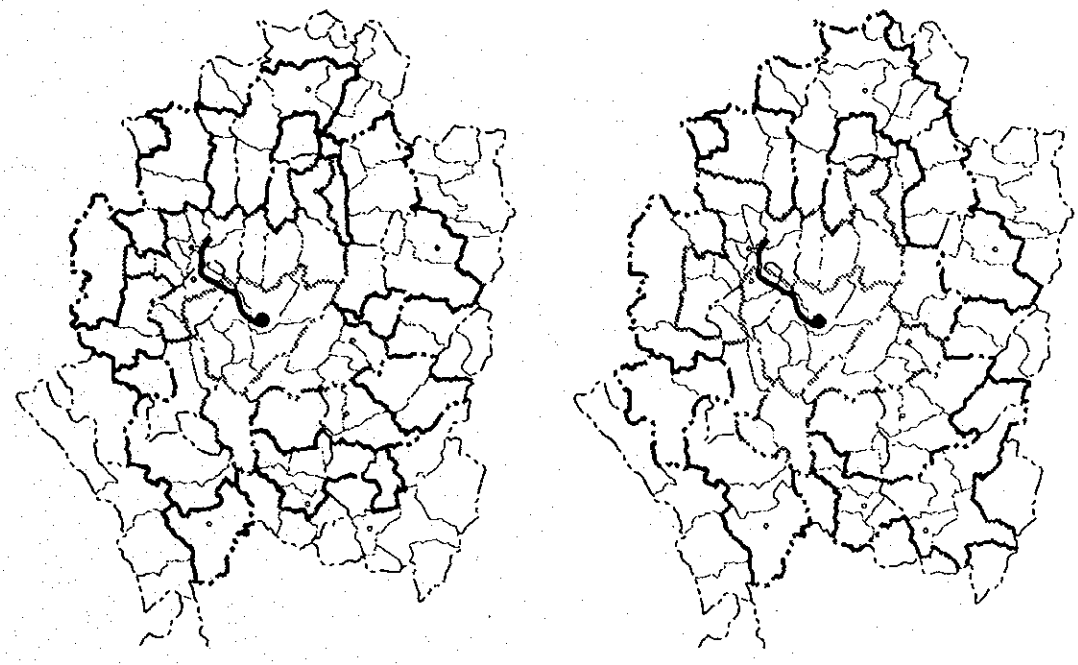
- With Project -

(2) From Lamphun Changwat Center

LEGEND

- One Hour Trip
- Two Hours Trip
- Three Hours Trip
- Four Hours Trip

FEASIBILITY STUDY ON THE INTER-CITY TOLL MOTORWAY PROJECTS	FIGURE 10.2-4 (1/2) CHANGES OF COVERED AMPHOE BY TRAVELING TIME ON LAMPANG - DOI SAKET ROUTE



- Without Project -

- With Project -

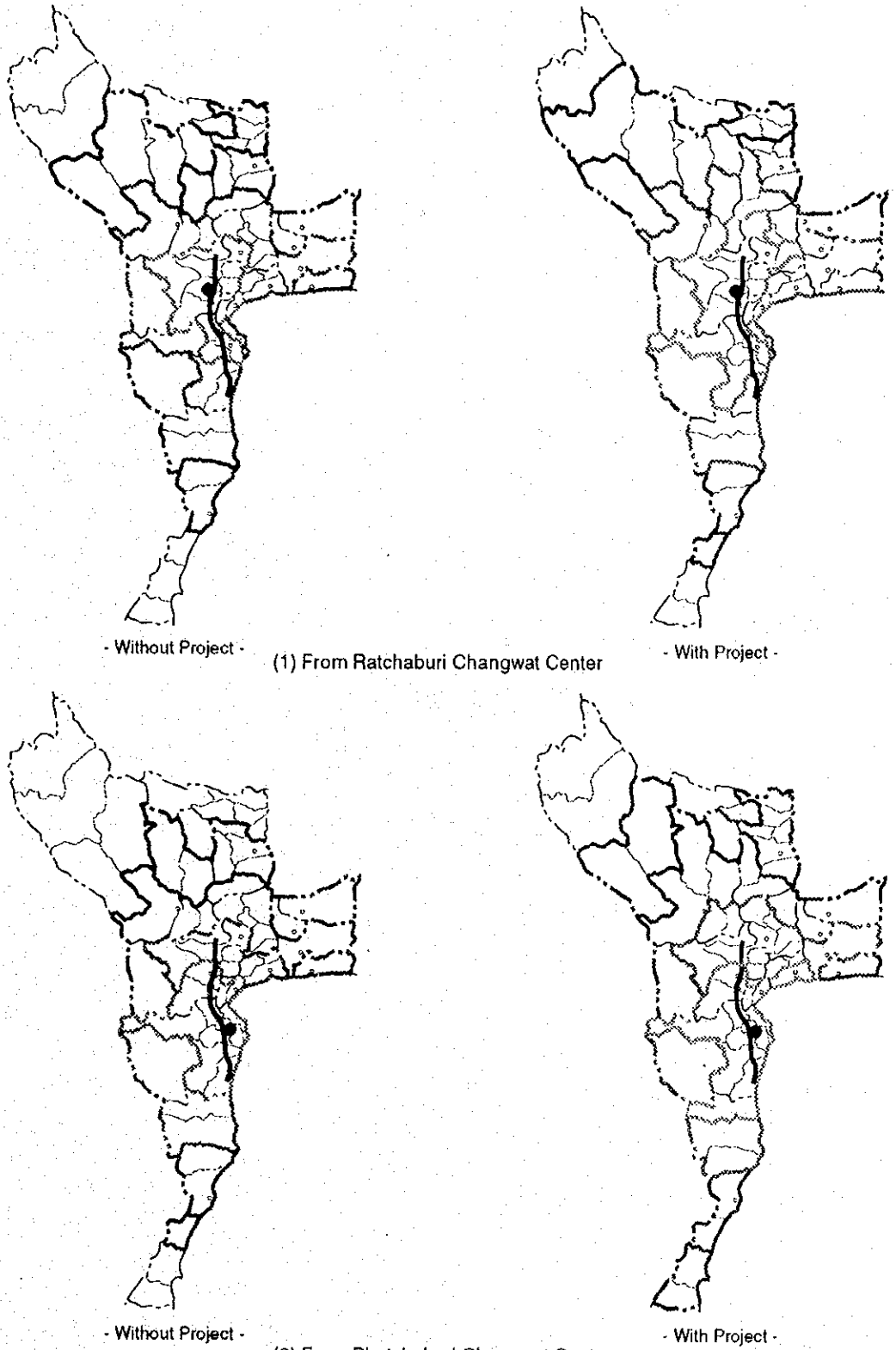
(3) From Lampang Changwat Center

LEGEND

- One Hour Trip
- Two Hours Trip
- Three Hours Trip
- Four Hours Trip

FEASIBILITY STUDY
ON
THE INTER-CITY TOLL MOTORWAY PROJECTS

FIGURE 10.2-4 (2/2)
CHANGES OF COVERED AMPHOE BY TRAVELING TIME ON LAMPANG - DOI SAKET ROUTE



FEASIBILITY STUDY
ON
THE INTER-CITY TOLL MOTORWAY PROJECTS

FIGURE 10.2-5
CHANGES OF COVERED AMPHOE BY TRAVELING TIME ON BAN PONG - CHA AM ROUTE

6. Improvement of Living Conditions

The improvement in transportation conditions through construction of motorway will help people in a rural area in utilizing and gaining access to such social facilities as government offices, schools, hospitals, etc. located far from their residence. Furthermore, they will be able to enjoy shopping, theatrical performances, sports games, etc., and will also gain access to libraries, cultural centers and museums in Chanwat center. Accordingly, life style of people will be wider without changing their residences.

High medical care that means special hospital for such as cancer, brain damage and heart diseases can not provided for all rural areas not only because of cost of facilities but also due to the availability of medical experts. People in many Amphoes along motorway will be examined medical care of high level through construction of motorway.

7. Rise of Value on Resources and Changes of Method for Utilization

Effect appearing by construction of motorways most conspicuously is a rise of land price of interchange outskirts. A change for land use is brought from farmland to an industrial area or a residential area.

The resources which were not utilized till now become utilize by reduction for the transportation costs and shortening of traveling time, and value of the resources rises.

8. Rationalization of Transportation Plan

With direct economic benefits that are time savings and voc savings by construction of motorways, it will be planned to produce reasonably. The saving of traveling cost brings reduction of transportation cost, and bring down market price. On the other hand, the transportation company will plan to allocate rationally on the basis of on-time traveling of motorway. As a result, stock investment can be reduced. A capital interest affecting stock investment will be reduced.

9. Influence of Project Investment

When construction of motorway begins constructoin materials are purchased, and a wage is paid to the woker who engage in motorway construction. This material demand lets production of raw materials increase. As a result, business profit of each company and income of employer will increase. The most of these income lets outgo increase of consumption, and production by company will increase again. In this way, the economy will be pushed up by repeating a process of demand, production, consumption and demand.